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Section 201: Independent Assessment of the Health Care Delivery Systems and Management Processes of the Department of Veterans Affairs

Assessment H (Health Information Technology)

September 1, 2015

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Preface

Congress enacted and President Obama signed into law the Veterans Access, Choice, and Accountability Act of 2014 (Public Law 113-146) ("Veterans Choice Act"), as amended by the Department of Veterans Affairs (VA) Expiring Authorities Act of 2014 (Public Law 113-175), to improve access to timely, high-quality health care for Veterans. Under "Title II – Health Care Administrative Matters," Section 201 calls for an Independent Assessment of 12 areas of VA's health care delivery systems and management processes.

VA engaged the Institute of Medicine of the National Academies to prepare an assessment of access standards and engaged the Centers for Medicare & Medicaid Services (CMS) Alliance to Modernize Healthcare (CAMH)[1] to serve as the program integrator and as primary developer of the remaining 11 Veterans Choice Act independent assessments. CAMH subcontracted with Grant Thornton, McKinsey & Company, and the RAND Corporation to conduct 10 independent assessments as specified in Section 201, with MITRE conducting the 11th assessment. Drawing on the results of the 12 assessments, CAMH also produced the Integrated Report in this volume, which contains key findings and recommendations. CAMH is furnishing the complete set of reports to the Secretary of Veterans Affairs, the Committee on Veterans' Affairs of the Senate, the Committee on Veterans' Affairs of the House of Representatives, and the Commission on Care.

The research addressed in this report was conducted by The MITRE Corporation.

[1] The CMS Alliance to Modernize Healthcare (CAMH), sponsored by the Centers for Medicare & Medicaid Services (CMS), is a federally funded research and development center (FFRDC) operated by The MITRE Corporation, a not-for-profit company chartered to work in the public interest. For additional information, see the CMS Alliance to Modernize Healthcare (CAMH) website (http://www.mitre.org/centers/cms-alliances-to-modernize-healthcare/who-we-are/the-camh-difference).

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Executive Summary

Assessment H (Health Information Technology) responded to language in Title II, Section 201, of the Veterans Choice Act of 2014 that mandated an independent assessment of "the information technology strategies of the Department with respect to furnishing and managing health care, including an identification of any weaknesses and opportunities with respect to the technology used by the Department, especially those strategies with respect to clinical documentation of episodes of hospital care, medical services, and other health care, including any clinical images and associated textual reports, furnished by the Department in Department or non-Department facilities."[2]

To gain comprehensive insight into Department of Veterans Affairs (VA) health information technology (IT) and the strategies that guide its implementation, the Assessment H team conducted 185 interviews in the course of site visits to Veterans Integrated Service Networks (VISNs), VA Medical Centers (VAMCs), and community-based outpatient clinics (CBOCs), as well as VA's Office of Information and Technology (OI&T). The team also reviewed plans, reports, audits, and protocols procured from OI&T and the Veterans Health Administration (VHA), as well as external reports and journal articles relevant to health IT and complex system development. Further, the team compared its observations and findings against lessons learned and best practices identified by executives, administrators, clinicians, and IT professionals at high-performing private health systems. Because IT touches nearly every aspect of operations at VHA, the data gathered by Assessment H generally support the qualitative evidence related to IT collected by the other assessments.

Findings

Several decades ago, VA led the development of electronic health record (EHR) technology with its Veterans Health Information Systems and Technology Architecture (VistA) system and Computerized Patient Record System (CPRS). Most VHA clinicians have a high opinion of the clinical applications and databases enabled by VistA and CPRS, as well as VA's newer technologies such as telehealth and mobile applications (apps). Numerous Assessment H interviewees attributed the success of the early VistA and CPRS development efforts to the close working relationship between VistA/CPRS developers and clinicians. This collaboration seems to have degraded with the centralization of IT in 2006, resulting in uncoordinated execution of health IT strategy and limited development of new and improved capabilities for VistA/CPRS. During the past decade, VistA and CPRS development has been confined to point solutions and minor enhancements.

Clinical users have become increasingly frustrated by the lack of any clear advances during the past decade. Numerous VHA clinicians have experience with commercial EHR systems and want the same level of features, modern clinical capabilities, integration, and mobility they see emerging in the commercial marketplace.

[2] United States. Congress. Veterans Access, Choice, Accountability, and Transparency Act, 38 U.S.C. § 1701 (2014) (Pub. L. No.113–146, 128 Stat. 1754).

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VHA and OI&T do not collaborate effectively with respect to the planning and execution of IT strategies for managing and furnishing health care. Although the goals of OI&T and VHA do not conflict at the strategic planning level, the organizations often do not agree on priorities for executing the strategic plans.

During the past decade, VA's ability to deliver new capabilities for its VistA system to meet changing Veteran health care needs has stalled. As a result, VA/VHA health care systems are in danger of becoming obsolete. The VistA/CPRS systems are based on a tightly integrated, monolithic architecture and design with numerous and diverse functional components and associated interdependencies. These characteristics impose significant barriers to modernizing these systems. In addition, the high cost of infrastructure operation and maintenance (85 percent of the total IT budget) reduces funding available for new development efforts.

Maintenance and data sharing are further complicated because most VAMCs have customized their local versions of VistA, leading to approximately 130 different instances of VistA across the country.

Overly demanding processes for system development, as defined by OI&T's Project Management Accountability System (PMAS), impede cost-effective delivery of new health IT capabilities and limit VA's ability to measure the value of IT investments. The PMAS process is schedule driven and risk averse, leading many project managers to limit the amount of functionality in each release, thereby increasing the total time for any capability to be released.

The lack of standard clinical documentation has made it harder to develop effective clinical decision-support systems and hinders EHR information exchange among VAMCs, between VA and non-VA facilities (including those of the Department of Defense [DoD]), and between VA and the individual Veteran. The lack of data standards presents challenges to using comparable data for analysis and disparities among the 130 tailored local instances of VistA, complicating information sharing, data aggregation, and analytics. The outdated technology underlying VistA weakens VHA's ability to leverage powerful new technologies for extracting information from free-form text, processing genomic data and images, and extracting and analyzing data from personal health monitoring devices.

While VA has successfully developed and deployed telehealth capabilities and mobile apps, it does not effectively assist end users of these technologies, and it does not match the pace of the commercial marketplace. VA's support for telehealth users (patients and clinicians) is weak, understaffed, and poorly integrated with IT systems. In addition, barriers associated with providing VISN-to-VISN telehealth make optimizing the caseload across VISNs more difficult, creating unnecessarily long waits for care in certain regions. VA has the opportunity to apply mobile technology at a low price point, but the previously mentioned issues with the PMAS process prevent VA from realizing the strategic value of mobile technologies as an enabler of both Veteran access and Veteran satisfaction.

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Recommendations

VA/VHA must resolve IT challenges comprehensively, targeting solutions to the entire system rather than seeking to solve isolated problems. To their credit, many leaders within OI&T and VHA, as well as administrators, health information management and IT professionals, and users at the facility level, recognize the need to address these issues. This report describes a future vision for VA/VHA as a high-performing health care system and a continuously learning health system that implements enterprise IT service management best practices.

At the strategic level, VA and VHA need to transform IT strategy, planning, and execution in a systematic manner with dedicated executive-level leadership. Specifically:

The VA chief information officer (CIO) should select a CIO for VHA to manage and advocate for VHA's IT needs and assist in transforming the VA IT strategy to a model based on enterprise IT service model standards and best practices. The VHA CIO acts primarily as an advocate and facilitator between OI&T and VHA to ensure both organizations are successful in meeting health IT needs. The VHA CIO will not move IT operations to VHA nor decentralize the organization. This involves taking the following actions, explained in more detail in this report:

- The VHA CIO should facilitate the requirements collection and prioritization within VHA with final approval provided by the VHA Under Secretary for Health and establish IT service level agreements that are mutually acceptable between OI&T and VHA and optimize the services for effectiveness.
- Refine the planning and budgeting process to ensure that business needs are effectively identified, prioritized, funded, and used to drive health IT investments.
- Develop a governance policy to ensure the strategic plans are executed well and in a timely manner.
- Establish product (capability)-focused teams to ensure delivery of needed capabilities to users.
- Refine VA's development process from a document-and-schedule focus to a delivery focus.

The VHA CIO, in partnership with the VA CIO, should oversee a comprehensive cost-versus-benefit analysis among commercial off-the-shelf (COTS) EHRs, Open Source EHRs, and continued in-house custom development of the VistA EHR currently in use. The analysis should take into account all the complexities of the VistA/CPRS architecture and infrastructure and known issues with performance, scalability, extensibility, interoperability, and security. It should also address full life-cycle costs, including development time (based on recent delivery trends), availability of development resources, maintenance and licensing costs, and infrastructure costs. The VHA CIO should participate in the VHA requirements collection to fully understand strategy and needs. Prioritization and final approval will be provided by the VHA Under Secretary for Health (USH).

The VA and VHA CIOs should conduct site visits and review the successful IT practices implemented at high-performing health care systems (including VISN 4), to inform their

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strategies for effective approaches and potential contributions that IT can provide to improve the treatment of Veterans today.

The VA CIO and VHA CIO should report to Congress at the end of fiscal year 2016:

- Evidence provided by both VHA USH and VA CIO that the VHA CIO serves as an effective advocate for the IT needs for health care delivery. This should include, but not be limited to, a description of the requirements for an effective health care management system that annually provides advancement to VHA mission and goals.
- Actions taken and evidence that OI&T acts as a service provider and delivers IT capabilities and IT services that improve health care delivery to Veterans. Evidence should include results of clinician and Veteran surveys confirming the quality of and satisfaction with the newly delivered capabilities and services.
- Results of the cost-versus-benefit analysis between the COTS, Open Source, and VistA EHRs.

VA should implement a broad process, inclusive of clinicians, to pursue requirements that support clinical documentation best practices and improved functionality and usability while considering the positive aspects of existing systems. Although providers can continue to leverage the free text capability available in the current EHR, it must be augmented with discrete, structured data capture using industry standard definitions to increase the interoperability with other systems inside and outside of VHA. This is especially critical due to the increased use of non-VA care.

VHA should accelerate efforts to establish semantic definitions for data elements through the use of standard nomenclatures, terminologies, and code sets. By doing so, VA can ensure consistency and integration across multiple systems, leverage follow-on IT products, and facilitate analytics for clinical decision making.

VA/VHA should assess the effectiveness of analytical products in driving health and business outcomes. They should identify and recommend improvements needed in the information systems that serve as the sources of the data to improve the reporting capabilities. VA/VHA should track actions taken as a result of the analytical products and quantify how effective those actions were in improving health and business outcomes.

To provide greater access through telehealth technology and reduce the number of Veterans who abandon these services, VA should offer technical support to Veterans, should make testing a connection between Veterans and providers easier for all parties, and should better integrate telehealth technologies across VA medical facilities and VISNs. Assisting Veterans with using this technology should improve the Veteran experience and reduce health care costs. VA should also address the challenges that complicate telehealth appointments between VISNs.

VA should explicitly identify mobile applications as a strategic enabler to increase Veteran access and satisfaction and help VHA transition to a data-driven health system. Mobile technology could effectively leverage patient-generated data to augment the data captured in the EHR to feed the learning health system.

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1 Introduction

Published reports of long wait times for medical appointments, accusations of Veterans dying while waiting for care, and evidence of "secret" waiting lists prompted Congress to pass the Veterans Access, Choice, and Accountability Act of 2014 (hereafter the "Veterans Choice Act"). Section 201, Title II – Health Care Administrative Matters, of the Veterans Choice Act, called for an independent assessment covering 12 aspects of the health care and other services that the Department of Veterans Affairs (VA) delivers to the nation's Veterans. This report documents the results of Assessment H (Health Information Technology [IT]). As directed by Section 201, Assessment H focused on:

> The information technology strategies of the Department with respect to furnishing and managing health care, including an identification of any weaknesses and opportunities with respect to the technology used by the Department, especially those strategies with respect to clinical documentation of episodes of hospital care, medical services, and other health care, including any clinical images and associated textual reports, furnished by the Department in Department or non-Department facilities.[3]

1.1 Scope

Assessment H examines VA health IT on two levels, where the first level plays a critical role in the success of the second level:

1. **IT Strategies:** The methods, processes, objectives, and metrics used to plan, implement, operate, manage, and measure health IT capabilities and technologies for Veterans.
2. **Health IT Capabilities and Technology:** Computerized systems, applications, databases, and other IT for delivering and managing Veteran health care.

VA's overarching strategic plans and roadmaps include descriptions of IT investments and expected outcomes, emphasizing Veteran health and satisfaction. These VA strategic plans should provide direction for VA and Veterans Health Administration (VHA) health IT strategies. These plans should identify health IT investment priorities and associated outcomes that form the basis for planning, implementation processes, and value measurement of resulting health IT clinical applications and new technologies. Assessment H focuses on these health IT strategies and resulting health IT capabilities and outcomes. Assessment H also identifies links to other Veterans Choice Act assessments that examine management applications related to health IT. The Assessment H study covers the electronic health record (EHR), scheduling, clinical documentation, and informatics and analytics. In addition, it examines the new technologies of telehealth and mobile applications (apps). The assessment does not include general aspects of the infrastructure, such as architecture, networks, performance, and reliability. Figure 1-1 summarizes Assessment H's scope.

[3] United States. Congress. Veterans Access, Choice, Accountability, and Transparency Act, 38 U.S.C. § 1701 (2014) (Pub. L. No.113–146, 128 Stat. 1754).

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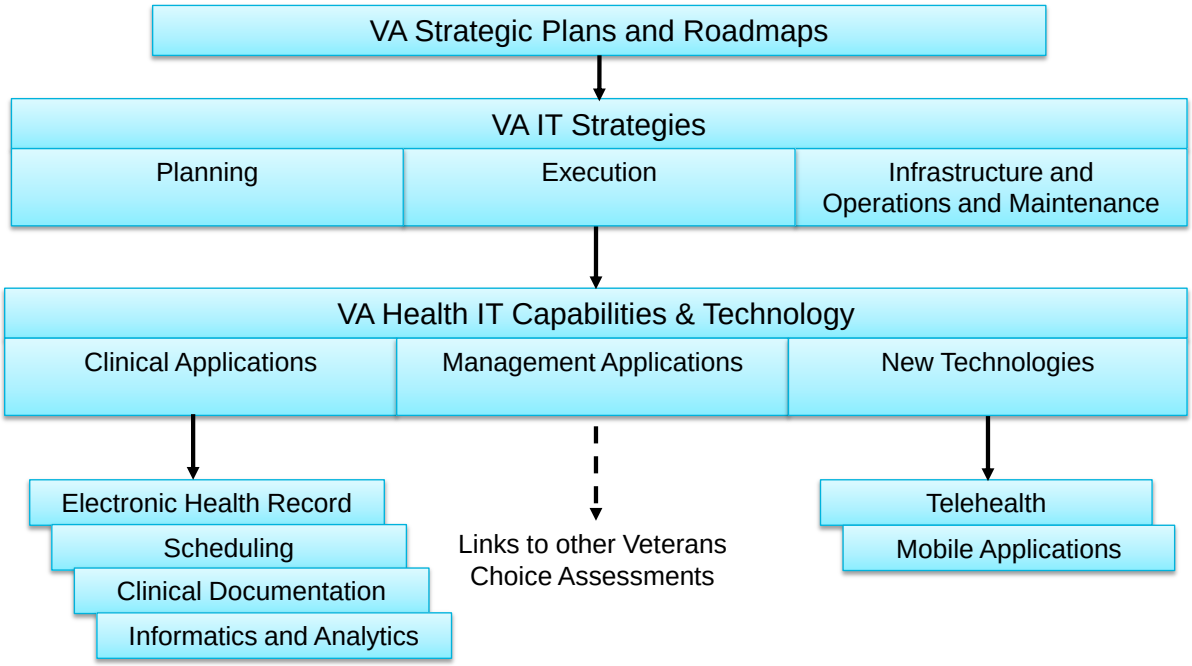
Figure 1-1. Assessment H Scope



1.2 Document Organization

Following this introductory section, Section 2 explains the methodology applied to conduct the Assessment H study on VA health IT. Section 3 summarizes VA's strategic plans and roadmaps, focusing on direction in those plans for improving outcomes in Veteran health through improvements to VA IT strategies and implementing advanced health IT capabilities and technology. Section 4 addresses VA's strategies for delivering health IT capabilities and technology. Sections 5–8 describe VA's major clinical applications, including the EHR, scheduling, clinical documentation, and informatics and analytics. Sections 9 and 10 describe new VA health IT technologies: telehealth and mobile applications. Sections 4–10 also present findings and recommendations relevant to the topics examined.

Section 11 outlines a future vision for transforming VA into a high-performing health care system (based on a current VHA exemplar), a learning health system, and an organization that applies industry best practices for enterprise IT service management across the life cycle of all its IT systems.

Appendix A contains white papers developed as part of Assessment H to capture detailed descriptions of VA's IT strategies and underlying software infrastructure for health IT. This information supplements the findings in Sections 4–8. These white papers address:

- VA Project Management Accountability System (PMAS)
- VA/VHA IT infrastructure and operations and maintenance (O&M)
- EHR/Veterans Health Information Systems and Technology Architecture (VistA).

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Appendix B contains additional white papers developed as part of Assessment H to support analysis of current and future VA/VHA IT strategies and health IT capabilities and technology. These white papers cover:

- Industry outreach
- Common failure and success factors for large-scale EHR systems
- Return on investment (ROI) in health IT.

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2 Methodology

To evaluate VA's IT strategies and health IT capabilities and technologies, the Assessment H team collected qualitative data through 185 interviews—117 during site visits to six Veterans Integrated Service Networks (VISNs), 11 VA Medical Centers (VAMCs), and two community-based outpatient clinics (CBOCs)—and the other 68 during visits to Office of Information and Technology (OI&T) and VHA leaders. The team reviewed more than 200 artifacts (strategic and operational plans, reports, audits, and protocols) procured from OI&T and VHA and more than 100 external reports and peer-reviewed journal articles to derive comparative information on topics such as IT expenditures for private sector health systems, IT implementation success and failure factors, and related issues.

The Assessment H team compared its observations and findings against lessons learned and best practices gathered from chief information officers (CIOs) known for their innovation and industry leadership (15 interviews), as well as executives, administrators, clinicians, and IT professionals at high-performing health systems (The Permanente Medical Group, Cleveland Clinic, and Geisinger Health System). In addition, as noted, the team linked its findings to those of other assessments in the present series.

2.1 VA/VHA Health IT Evaluation Process

The Assessment H team used the data collected from site visits, interviews, and document reviews to identify and document findings based on insights, observations, and evaluation of detailed technical data. The team then derived recommendations to address the findings related to VA/VHA IT strategies and health IT capabilities and technology.

2.2 Interviews

2.2.1 VA/VHA Staff

The Assessment H team developed specific lines of inquiry during semi-structured interviews with staff at VA/VHA sites. The interviews gathered a wide spectrum of stakeholder perspectives on topics from planning to outcomes. Interviewees played a representative variety of roles at centers and sites and included:

- Leaders of OI&T and VHA who develop the IT visions and strategies (planners)
- IT professionals who design, develop, and implement information systems, technology, and architecture (builders)
- Clinicians who use health IT (users).

The team conducted its interviews over the telephone or in person at the VA Central Office (VACO) and during site visits to VISNs, VAMCs, and CBOCs. Appendix C lists sites visited by the Assessment H study team.

Assessment H considered the generic roles of planners, builders, users, and others. To ensure that the team could gather honest and candid information from the interviewees, team members assured interviewees that no comments would be directly attributed to them.

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However, for evidentiary purposes, the team had to tie comments made by the interviewees to certain roles so that the weight of their comments could be taken in the context of those roles. Among the different types of interviewees, the team chose the roles of planners, builders, and users. Table 2-1 illustrates the role categories aligned to critical health IT functions and the rationale for their inclusion in Assessment H interviews.

Table 2-1. Role Categories Mapped to Assessment H Interviews

Critical IT Aspect	Stakeholder Category	Description
Planning *Business Focus*	**Planners**	Involved in strategic planning; business requirements analysis; prioritization and allocation of resources (funding and/or staffing). Examples include the VA CIO; VHA directors and management; OI&T directors and management.
Execution *Technology Focus*	**Builders**	Involved in IT/software requirements analysis; development project planning and execution; software development, integration, testing, and deployment. Examples include PMAS project managers, software development project leads, software developers, and so on. Involved in development and operations (DevOps) activities and the sustainment of IT assets, including software applications, in the deployment environments (e.g., data centers, Clinical Operational Environments, and so on.).
Using the System *Patient Focus*	**Users**	Staff at VAMCs and sites, including directors, Chief of Medical Operations, clinicians, schedulers, and so on.

2.2.2 Chief Information Officers

The team interviewed CIOs from both health care and non-health care institutions who were selected because they had developed and implemented innovative IT solutions. They provided valuable insights, lessons learned, and best practice IT strategies. Their input, summarized in a white paper on industry outreach in Appendix B, helped the team to compare VA's IT effectiveness with that of the private sector.

2.3 Document Reviews

2.3.1 VA/VHA Artifacts

The Assessment H team reviewed VA-level strategic plans, health IT strategic plans, health IT business requirement documents, and internal assessment reports related to IT strategies and health IT capabilities and technologies.

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2.3.2 External Documents

The Assessment H team reviewed the following types of external documents for specific purposes.

- **Assessments and Audits** from sources such as the VA Office of the Inspector General (OIG), Government Accountability Office (GAO), and the Office of Management and Budget (OMB) contained numerous previous findings that could be compared to the Assessment H team's findings and recommendations to determine VA/VHA progress toward remedying identified problems over the years.
- **IT Spending Profiles and Health Care Quality/Performance Metrics** yielded basic insights into costs, benefits, and software development results for comparison to VA/VHA information.
- **Software Quality and Development Efficiency Metrics** presented measurements that could be used to establish OI&T's and VHA's ability to develop, test, integrate, deploy, and sustain quality software and obtain the desired outcomes efficiently and cost effectively.
- **Published Case Studies of IT and Health IT Projects**, representing a large collection of peer-reviewed and grey literature, identified critical success and common failure factors based on analysis of numerous health IT and non-health care IT projects.

2.4 Findings and Recommendations

The *GAO High Risk* series (GAO, 2015a) calls attention to more than 100 recommendations for VA health care that have yet to be resolved in five areas, including IT. This strongly suggests that developing more pairs of findings and recommendations would not prove particularly effective, especially since many of the Assessment H findings are consistent with existing recommendations from oversight organizations such as GAO or VA's OIG. Thus, rather than match recommendations to specific findings, many Assessment H recommendations are combined to provide a more holistic approach to resolving findings in this report.

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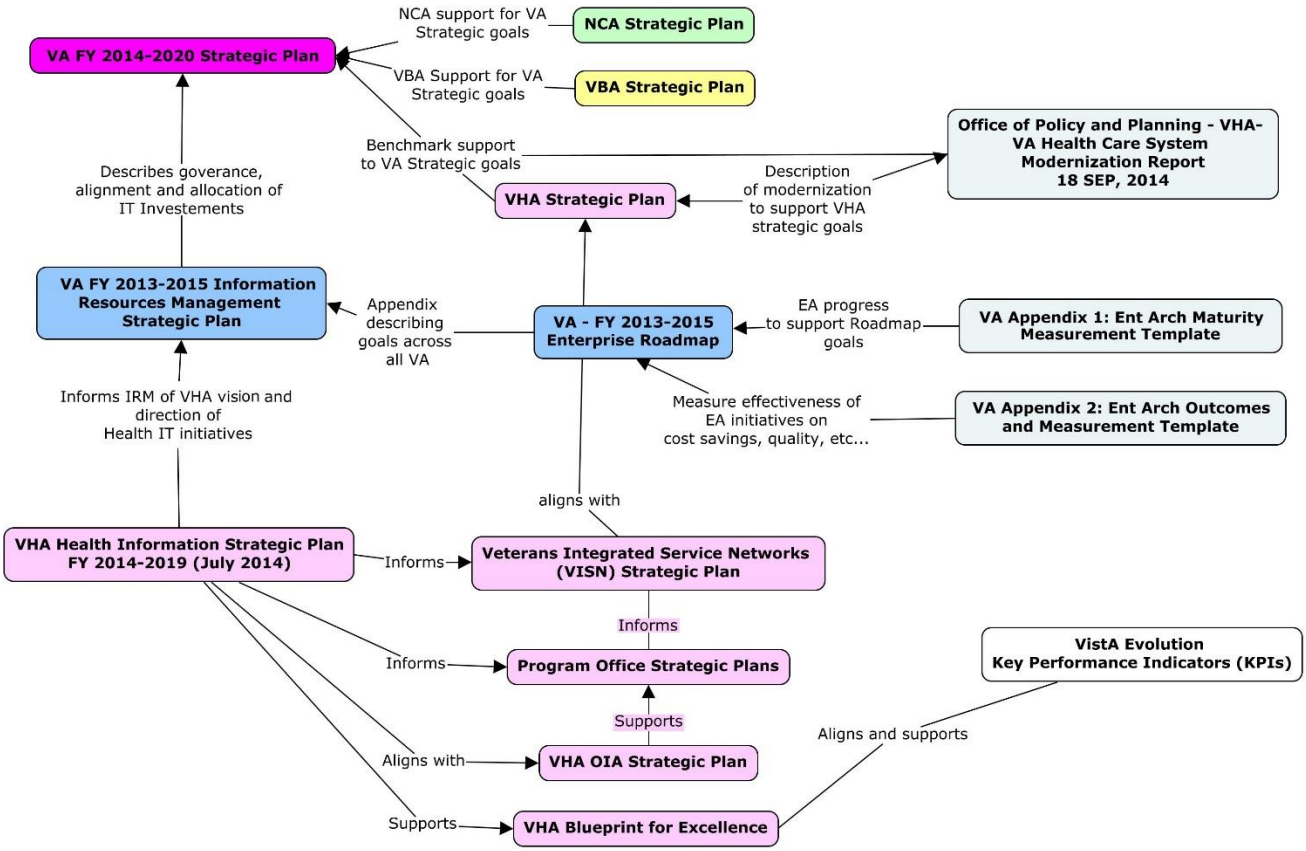
3 VA Strategic Plans and Roadmaps

3.1 IT Investments for Veteran Health Outcomes

VA's strategic planning documents and roadmaps are generally acceptable products. These documents and roadmaps articulate desired business and Veteran health outcomes based on IT investments in terms of: (1) improved Veteran access to care; (2) better care for Veterans; (3) better Veteran health; (4) improved Veteran health care experience; (5) increased Veteran satisfaction; and (6) increased cost effectiveness of VA and VHA health IT. Of these outcomes, VA considers Veteran health and satisfaction as important measures of effectiveness and success of health-related IT strategies and resulting health IT capabilities and technologies produced by these strategies.

Figure 3-1 illustrates relationships among the most significant VA strategic planning documents and roadmaps.

Figure 3-1. Relationships Among VA Strategic Planning Documents



Source: MITRE summary of interview data and documentation relationships outlined in the VHA Health Information Strategic Plan; Information Resources Plan; VA, 2014c; and VA, 2015c.

VA's strategic planning documents are comprehensive in terms of the IT topics they address and generally reflect similar goals, objectives, and outcomes. However, they do not consistently inform, align, and support each other. For example, in many cases, multiple levels in the VA

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organization develop independent strategic plans with limited alignment with one another, resulting in competing or conflicting priorities for the same funding. Although these documents represent an ambitious approach to strategic planning for a large, complex enterprise, they also create a need to coordinate and orchestrate 70 goals and 156 objectives as well as an additional five goals and 14 objectives reflected in the *Federal Health IT Strategic Plan (2015–2019)* (VHA, 2014a). Successfully executing all these plans would prove challenging for any organization.

3.2 VA Centralization of IT Organization

In 2006, the current OI&T became a centralized component of VA and was assigned responsibility for delivering, operating, and managing IT capabilities across the department. The division of health IT responsibilities and concerns between VHA and OI&T has created a situation where each has its own values and priorities, and these may diverge. For example, improving the quality, safety, and efficiency of health care delivery and management is the top priority for VHA but not necessarily for OI&T, which is also responsible for delivering IT capabilities to other major VA organizations.

3.3 Execution of Strategic Plans

OI&T and VHA struggle to identify, prioritize, and translate clinical goals and strategic initiatives reflected in VA's overarching planning documents into buildable, testable health IT requirements that result in measurable health care outcomes for the Veteran. Although the goals of OI&T and VHA do not conflict at the strategic planning level, the organizations often do not agree on priorities for executing the strategic plans.

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4 IT Strategies

VA introduced the Project Management Accountability System (PMAS) in 2009 to improve its strategies and processes for delivering IT capabilities. VA Directive 6071, issued February 20, 2013, mandated the use of PMAS in all IT projects (VA, 2013d). PMAS requires that projects be completed in increments not exceeding six months and be validated and accepted by the customer. This time-bound requirement aligns with OMB guidance designed to reduce investment risk, deliver capabilities more quickly, and facilitate the adoption of emerging technologies (OMB, 2012). This guidance states, "All projects (regardless of whether they use modular development principles) must produce usable functionality at intervals of no more than six months." Section A.1 of this Assessment H report provides a more detailed review of PMAS.

4.1 Findings

The PMAS Guide 5.0 (VA OI&T 2014e) documents the current IT life-cycle management process, governance mechanisms, participant roles and responsibilities, and reporting requirements. PMAS is supplemented by ProPath, a repository that contains the detailed artifacts, processes, and procedures to execute PMAS (VA, 2015h). ProPath also includes more than 400 documents and templates to assist project teams, 60 of which are deemed essential to support PMAS milestone reviews. A web-based PMAS dashboard presents an authoritative view of all PMAS data, giving senior leaders visibility into the current status of projects. VA submits PMAS dashboard data to the Federal IT Dashboard via the OMB 300B process.

Finding 4.1.1: VHA and OI&T are not effectively collaborating with respect to the planning and execution of IT strategies for managing and furnishing health care.

Effective planning starts with clear business objectives, which case studies have consistently identified as a critical success factor for IT projects (see Section B.2.4). Conversely, lack of clear business objectives is a top failure factor (Standish Group, 2011). Ineffective collaboration between VHA and OI&T has limited VA's ability to establish and communicate clear business objectives to ensure IT investments align with its health care objectives. During Assessment H interviews, 28 of the 62 planners and builders (or 45 percent) in OI&T and VHA (e.g., CIO, director-level, deputy-level, chief-level, lead, senior adviser, program manager, project manager) provided unprompted comments about the problems with collaboration and communication.

Effective IT planning requires clear goals and objectives to guide the schedules and resource allocation needed to successfully execute the plans. The large number of goals, objectives, and measures listed below obscure the highest priorities:

- At least 70 goals and 156 objectives in VA/VHA/OI&T strategic planning documents
- An additional five goals and 14 objectives in the Federal Health IT Strategic Plan (VHA, 2014a)
- Currently 382 measures in its 10-N National Measures Report (see Assessment L [Leadership]).

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When asked about these planning documents, key OI&T leads referred to the documents as "dated" and "useless," noting that "the value of our documents is very questionable." Regarding collaboration, key OI&T leads indicated they were not aware of VHA's *Blueprint for Excellence* at all or had heard about it only on the day it was published.

VHA stakeholders offer a different perspective regarding requirements. VHA provides business requirement documents, but Assessment H could find no evidence of communication between the VHA and OI&T teams to confirm that the technical requirements reflect or are updated to reflect the business requirements through agile development. The Assessment H team found no evidence of a joint health care architecture or a joint IT investment management process to improve their communication and collaboration. This also relates to VA OIG findings (OIG, 2015c) on cyber security, which identified ineffective communication with field offices as a reason for the inconsistent adherence to cyber security policies.

Many Assessment H interviews revealed perceptions that a risk-averse culture and a lack of trust between OI&T and VHA undermine effective collaboration. Of the 185 individuals interviewed, 88 (or 48 percent) volunteered statements that indicated some degree of discord between OI&T and VHA. These perceptions apply equally to both VHA and OI&T leaders. Neither organization appeared solely responsible for the lack of clear communication and collaboration, but poor collaboration clearly curtails the ability to plan and develop new IT capabilities to assist clinicians and Veterans.

Finding 4.1.2: VA's project management and execution processes are document centric, emphasize schedule over results, and fail to deliver capabilities called for in VHA health care strategies.

During Assessment H interviews, 15 of 46 planners (33 percent) and 17 of 26 builders (65 percent) indicated that, although PMAS improves accountability and transparency, it has become overly complex and burdensome and reduces project success rates. Both planners and builders indicated that process-focused meetings and documentation consume a significant percentage of each six-month increment, along with several months required for contracting. Interviews with OI&T leaders indicated they recognize these issues and have a working group assessing ways to simplify the process.

The complexity of PMAS, conveyed in Figure 4-1, creates excessive overhead for small projects, lowering the effectiveness of rapid prototyping and other means of increasing technical innovation. "Project Management" and "System Development" are two of the primary process areas described in PMAS. The Project Management process consists of 71 separate activities and the System Development process involves 91 activities to produce deliverables or artifacts required to design, develop, test, and implement a solution. Assessment H interviewees indicated that PMAS overemphasizes schedule while accommodating little evaluation of the quantity or quality of functionality delivered. As a result, many project managers include less functionality in each increment to ensure that they meet their schedules.

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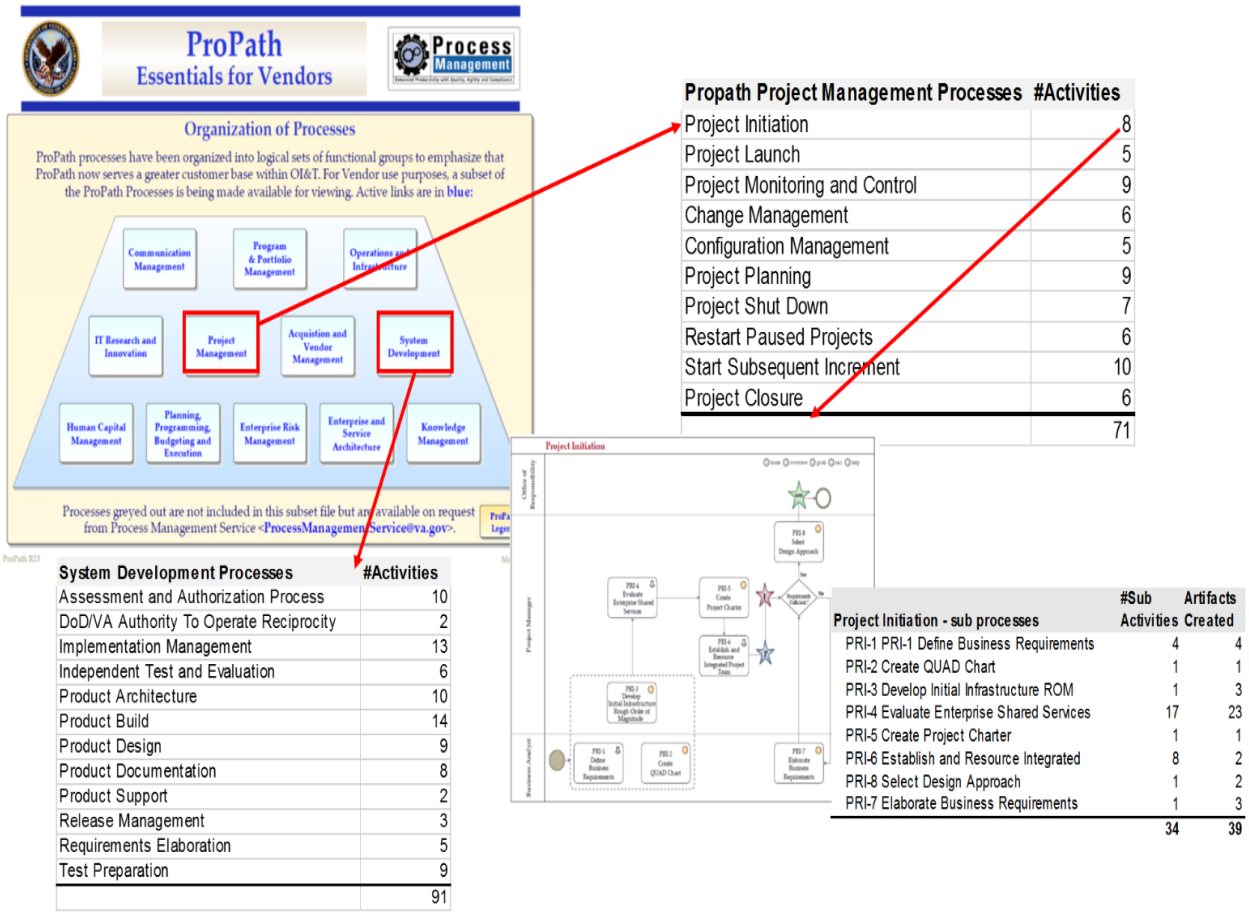
Figure 4-1. PMAS and ProPath Complexity



Propath Project Management Processes	#Activities
Project Initiation	8
Project Launch	5
Project Monitoring and Control	9
Change Management	6
Configuration Management	5
Project Planning	9
Project Shut Down	7
Restart Paused Projects	6
Start Subsequent Increment	10
Project Closure	6
	71

System Development Processes	#Activities
Assessment and Authorization Process	10
DoD/VA Authority To Operate Reciprocity	2
Implementation Management	13
Independent Test and Evaluation	6
Product Architecture	10
Product Build	14
Product Design	9
Product Documentation	8
Product Support	2
Release Management	3
Requirements Elaboration	5
Test Preparation	9
	91

Project Initiation - sub processes	#Sub Activities	Artifacts Created
PRI-1 PRI-1 Define Business Requirements	4	4
PRI-2 Create QUAD Chart	1	1
PRI-3 Develop Initial Infrastructure ROM	1	3
PRI-4 Evaluate Enterprise Shared Services	17	23
PRI-5 Create Project Charter	1	1
PRI-6 Establish and Resource Integrated	8	2
PRI-8 Select Design Approach	1	2
PRI-7 Elaborate Business Requirements	1	3
	34	39

Source: Graphics from VA, 2015h.

Agile development approaches typically generate frequent modifications to project artifacts such as the Requirements Specification Document and the System Design Document, leading to redundant reviews for the same project. PMAS guidance indicates that tailoring might allow smaller projects to reduce the documentation required. Unfortunately, Assessment H interviews uncovered cultural reluctance to tailoring. Each modification involves extensive reviews and burdensome documentation requirements.

PMAS limits projects to a 24-month duration. Even if business requirements remain unfilled, managers must close the project and initiate a new project to deliver the remaining functionality. Although projects can request two-month extensions, longer term projects potentially require multiple cycles of initiations and closeout. Thus, while this approach reduces the risk of long project overruns, complex projects may require repetitive startup and closure documentation and activities. The PMAS process for achieving Initial Operational Capability (IOC) and release (depicted in Figure 4-2) identifies more than 61 separate activities and provides another example of the high overhead incurred by PMAS.

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Figure 4-2. PMAS Mandatory Activities

Pre-IOC	IOC	Release
Development Activities: • EDE Training, EDE ETS, EO Perf, & Vista Installs (1 week); Smoke Tests (1 week) • ETS Testing & Defect Development/Test (4 weeks) • EO Performance & 508 Testing (1 month) • Security Testing – WASA, SwA V&V w/Fortify & Nessus scans and remediation (1 month) • EO Performance, 508, & Security Testing (4 weeks) • Proxy/Dev Accounts Created & Tested (2 weeks) • EO Pre-Prod install and smoke test (2 weeks) • IOC Test VistA Install (1 week) • Pre-Prod Testing (3 weeks) • ESE Training Development & dry runs (8 weeks)	**Development Activities:** • EO Prod Install & IOC Prod VistA Install (2 weeks) • Training (2 weeks) • Production Testing (3 weeks) • Collect Concurrences and IOC Capability Evaluation Data (1 week)	**Development Activities:** • Site coordination/Training roll-out (1 – 5 months) • Prepare and Distribute Release (1 – 5 months) • Monitor Installation Activities (1 – 5 months) • Execute Backout/Roll Back/Rework Procedures (1 – 5 months)
PMAS & ProPath Activities: • Complete/updates to RSD, SDD, OAP (8 weeks) • SEDR Review Process (8– 12 weeks) • ID Test Sites; Complete MOUs (2 – 3 weeks) • Testing Intake Assessment; Independent Testing • Perform CARA Analysis (2 – 4 weeks) • IV&V, ORR, Final UFT (8 weeks) • Complete National Release & ORR Checklists (2 – 3 weeks) • Conduct ORR PMAS Readiness Review (1 day) • Prepare IOC Entry/Exit Summary (1 week) • Master Test Plan (1 week) • Coordinate and Verify ATO (4 – 8 weeks) • SQA Checklist (1 week) • Define ESE Training Plan (2 – 3 weeks) • Coordinate ATO Activities (2 months) • Update System Security Plan (SSP) (1 Month) • Update Privacy Impact Assessment (PIA) (3 weeks)	**PMAS & ProPath Activities:** • Confirm ATO (2 – 3 weeks) • IOC Entry/Exit Summary (1 week) • Request VHA Release Management Approval for IOC Entry (2 weeks) • Meeting with Health Systems Rep. (1 day) • IOC Kick-off meeting with test sites (1 week) • Perform Testing (2 weeks min.) • Update Issues, Anomalies, Exceptions and Risks (1 week) • Documentation for IOC Exit Approval (1 week) • Finalize Transition Plan (2 – 3 weeks) • Create/Finalize Deployment Plan (3 weeks) • Finalize OAP (2 – 3 weeks) • Submit Final National Release Checklist (1 day) • NSD Updates (1 week)	**PMAS & ProPath Activities:** • Release Site Readiness (1 – 2 weeks) • Health Product Support Approval (2 weeks) • VHA Release Team Mgmt. Approval (2 weeks) • ESE Release Office Approval (2 weeks) • Final Customer Acceptance Form (1 week) • Lessons Learned Report (1 week) • Milestone 2 Review (1 day) • Initiate Change Request (1 day) • Verify Final Configuration (1 – 2 weeks) • Distribute Release (1 – 5 months) • Close Change Request (1 day) • Notification of Successful Release (1 day) • Milestone 3 Review* (1 day)

Source: VA OI&A, PMAS IOC Mandatory Activities (briefing presented during Assessment H interview)

VA naturally considers the delivery of useful capability as the primary metric for agile software development. However, during Assessment H interviews, 36 planners, builders, and users provided unsolicited insights suggesting that an over-emphasis on schedule diminishes the incentive to deliver working software demonstrably suitable for its intended purpose.

- Planners with the most insight into funding allocations for business requirements described PMAS as a broken process due to its over-emphasis on time-bound deliveries, which forces projects to drop functionality, creating a backlog of unmet requirements. They noted similar problems with testing that depended on the missing functionality; as a result, the tests would fail, but no funding or time would remain to fix the problems that were uncovered.
- One planner stated, “Over 80% of projects are meeting their milestones but are delivering 10% of what we wanted. The increments have so little in them. We’re not delivering anything of major significance.” This perception was corroborated by interviews with users who claimed that VA has made no significant updates to the legacy health IT

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systems and that only 20 percent of Computerized Patient Record System (CPRS) feature requests have been implemented in the past three years. Finding 5.1.1 contains additional details.

- Other planners claimed that business owners are sometimes pressured into "signing off" on deliveries; otherwise, they will lose funding. The Assessment H team observed that many health care business owners resided at VACO, served as a business owner for multiple projects, and had other leadership responsibilities. In other words, they had little time to devote to each task and were far removed from the clinical environments they were intended to represent. In contrast, visits to high-performing health care systems revealed that these organizations typically establish dedicated teams focused on specific IT initiatives with complete participation from the business owners who drove prioritization of requirements.

A January 2015 follow-up audit of PMAS by the VA OIG had similar findings and reported that, for VA's portfolio of IT development projects totaling $495 million, VA and OI&T leaders "lacked reasonable assurance that development projects were delivering promised functionality" on time and within budget (VA OIG, Office of Audits & Evaluations, 2015).

Finding 4.1.3: The current OI&T IT service management (ITSM) philosophy is that of an internal project-focused organization rather than that of an IT service provider focused on the enterprise, customer needs, and service delivery to both VHA personnel and Veterans.

Today's best-practice concepts for enterprise ITSM are based on a discipline for managing IT services centered on the customer's perspective regarding IT's contribution to the business. Section 11.2 of this report further describes enterprise ITSM standards and best practices.

Infrastructure and O&M

Many of VA's current technical challenges stem from the decentralized approach to IT that VA adopted during the 1990s. At the time, the decentralized approach was credited with VA's dramatic turnaround in health care services (Walters, 2009). In addition, the characteristics of self-organizing teams; small-scale, close user engagement; and continuous delivery of useful software were precursors of what would later be termed "agile software development" and produced an effective breeding ground for innovation and rapid advancements in health IT. However, this also created the foundation for maintenance difficulties because, according to Walters, "new applications were popping up sporadically and haphazardly." The lack of standardization and effective IT governance ultimately created significant technical complexity in the form of a "sprawling, aging, and unwieldy system of computer and communications technologies spread across the department's more than 1,000 medical centers, clinics, nursing homes, and Veterans' centers" (Walters, 2009).

VA recognized the need to overcome these technical problems, but high-cost, software-intensive consolidation initiatives failed (GAO, 2008) and contributed to Congress directing VA to adopt a centralized approach to IT in 2005 (U.S. House of Representatives, 2005a). However, Assessment H findings suggest that VA has not achieved sufficient improvements with respect to these enterprise integration and modernization efforts despite the centralization of IT

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authority, a sustained VA IT emphasis on consolidating and integrating IT solutions (VA, 2007), and billions of dollars in IT funding.

Finding 4.1.4: Earlier decentralized software-development approaches and continued evolution of VA's custom-built health IT systems have created infrastructure complexity that poses significant challenges for VA's ability to effectively execute IT strategies.

An unintended consequence of VA's decentralized IT development in the 1990s was the creation of a custom health IT system consisting of many versions of numerous different software modules with many different dependencies between these modules. Although this decentralized approach quickly satisfied local requirements for IT to help in managing and furnishing health care, it established inconsistencies that undermined enterprise-wide data sharing and innovative applications.

A gold-standard VistA activity has consolidated nearly 60 percent of these software modules (VA, 2015g) and is currently being deployed across the enterprise to reduce the numerous variations that emerged during the previous era. Even so, Assessment H found that VA's IT and software infrastructure remains an extremely intricate, heterogeneous mix of software frameworks and technologies.

The scheduling system currently used by VA offers one example of the problems caused by these complexities. This scheduling system is approximately 30 years old and has more than 1,000 integration points (VA, 2014d)—locations in software where one software module depends on the functionality implemented in another software module. The system relies on 31 different software modules, and 71 software modules depend on the scheduling module (VA OI&T, 2014c). The number of dependencies exceeds 100 because different versions of these modules exist and must be addressed. The gold-standard VistA activity intends to reduce the number of different versions of each module, but the roughly 100 integration points will remain. As GAO recently noted (GAO, 2015a), the tangible impact of this programming complexity is that:

> VA undertook an initiative to replace its scheduling system in 2000 but terminated the project after spending $127 million over 9 years due to weaknesses in project management and a lack of effective oversight. The department has since renewed its efforts to replace its appointment scheduling system, including launching a contest for commercial software developers to propose solutions but VA has not yet purchased or implemented a new system.

Dependencies among the many VA software modules have an impact on the cost of change associated with enterprise-scale software, which is considered one of the highest software-related cost factors and is closely correlated with the dependencies among the software modules. These dependencies also raise the cost of integration, which directly affects the ability to integrate commercial off-the-shelf products into VA's health IT systems. All these complexity factors explain why replacing the VA scheduling system remains a costly and highly technical challenge (Booch, 2015; Knoernschild, 2012). Section 6 of this Assessment H report provides more information on IT aspects of VA's scheduling capability.

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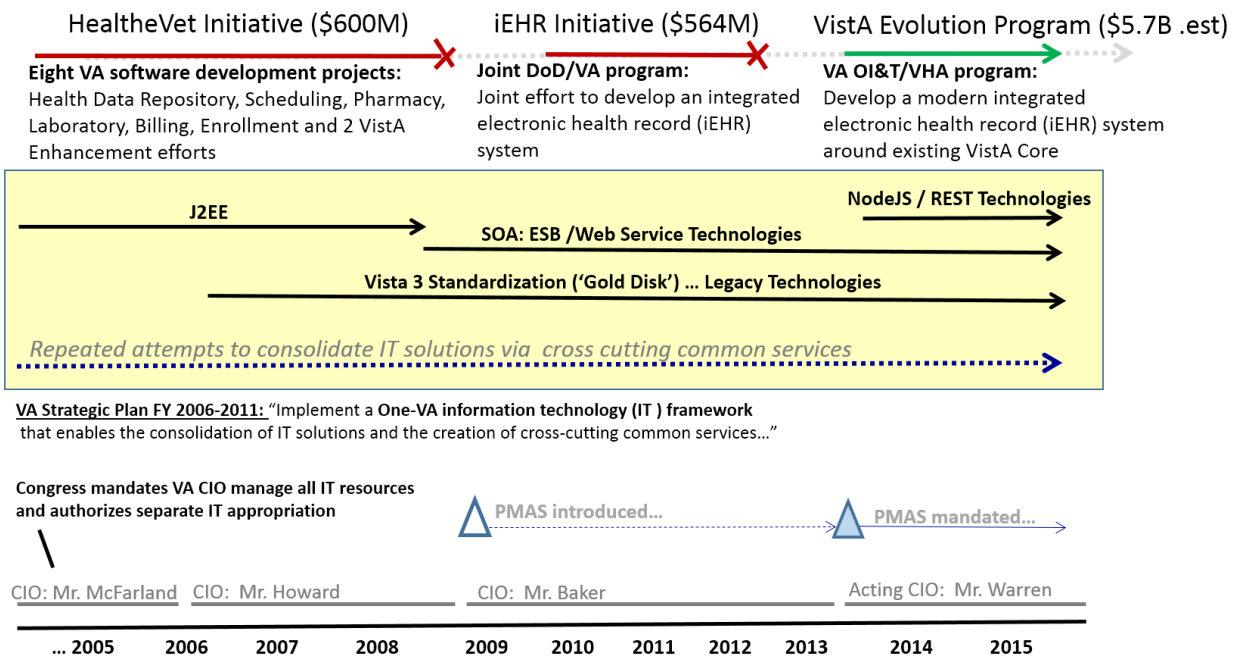
The enterprise perspective on VA IT adopted by Assessment H is critical to understanding the scale, scope, and complexity of the technical challenges OI&T has faced in accomplishing its decade-long strategic IT objective to create "One-VA" (VA, 2005). In theory, One-VA will transition VA "from disparate stovepiped processes and systems to a unified environment of integrated, interoperable business processes and technical services" (VA OI&T, 2014a). The approach requires special expertise and appropriate IT processes for successful large-scale, centralized IT management; large-scale software infrastructure; and large-scale software development. However, these capabilities are not well aligned with the expertise and processes required for the decentralized IT and local software customizations that created the successful health IT solutions in the 1990s.

Figure 4-3 shows a graph of VA's ongoing struggle to transition from a distributed approach to an enterprise approach. During the period shown, each new CIO attempted consolidation using new infrastructure technologies. Unfortunately, none of the consolidation attempts was completed, resulting in even greater software complexity and more challenges for the next CIO.

Figure 4-3. Timeline for VA IT Modernization Using a Mix of Technologies



Source: MITRE rendition of data from planning documents and reports.

The simplified version of the VA software health architecture in Figure 4-4 illustrates the lack of standardization created by the mix of technologies introduced over the past decade. The software stack on the left of the diagram represents the results from VA's move toward a service-oriented architecture (SOA) and web services. The software stack in the middle represents the legacy software (without the hundreds of modules and their many different versions). The software stack on the right shows the recent move toward a modern

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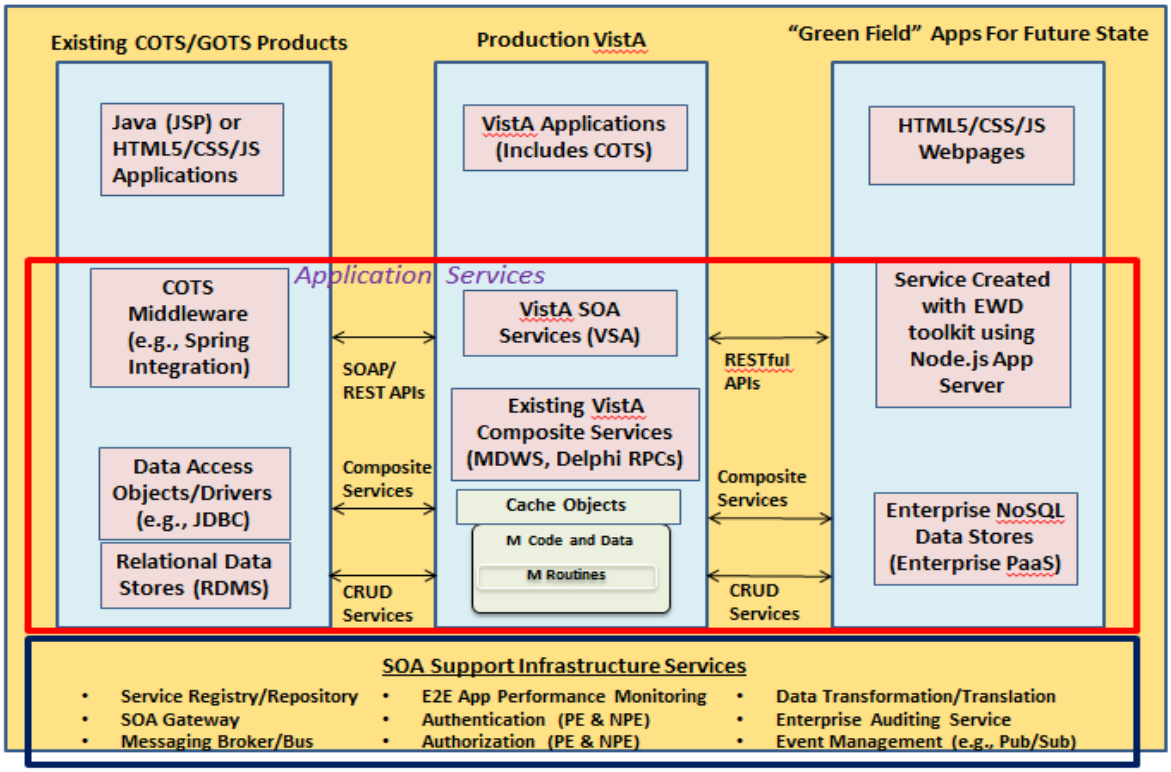
infrastructure technology called "Node.js," which has emerged as one of the most popular technologies in today's open source software community.

Figure 4-4. VA's Heterogeneous Software Architecture



Source: OI&T ASD, VistA 4 Product Architecture Review Triad Meeting Winter 2015 (briefing), January 27, 2015.

This mix of software stacks reflects a "non-standardized infrastructure," which has been identified in industry case studies as a common failure factor for IT projects (Standish Group, 2011). As noted in Figure 4-3, VA's efforts to transition from small scale to large scale have increased software complexity due to implementing multiple software application and infrastructure technologies over a 10-year time span. Instead of consolidating the software infrastructure, VA has expanded it, creating more challenges that impede VA's ability to upgrade and extend the existing software systems. Figure 4-4 illustrates this mix of software applications and infrastructure (e.g., Java J2EE Technology, SOA: Enterprise Service Bus (ESB)/web service technologies and Node.js/REST Technologies) that VA must now simultaneously maintain as a non-standardized infrastructure. Consequences of such a non-standardized software infrastructure include increased time and cost to implement changes due to complexity and duplication of efforts, higher costs to maintain teams with multiple skill sets, and greater challenges to establish effective cyber security across multiple technologies.

Increasing O&M Costs

VA's enterprise IT infrastructure includes the combination of hardware, software, networks, and facilities required to develop, test, monitor, secure, support, control, and operate VA's IT

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services. VA's annual IT spending published on the Federal IT Dashboard can be organized into four categories (SemanticInfo, 2015):

- **New/Upgrades Spending for Mission Area**: Program costs for new investments, changes, or modifications to existing systems reported as IT investments directly supporting an agency-designated mission area.
- **New/Upgrades Spending for Infrastructure**: Program costs for new investments, changes, or modifications to existing systems identified as IT investments supporting infrastructure, strategic management of IT operations, or a grants management system.
- **Maintenance Spending for Mission Area**: Spending covering maintenance and operation (O&M) costs at current performance level for systems reported as Mission Area Spending.
- **Maintenance Spending for Infrastructure**: Spending reported as IT investments supporting infrastructure, strategic management of IT operations, or a grants management system.

A detailed assessment of VA's enterprise IT infrastructure and itemized annual IT O&M spending was beyond the scope of Assessment H. Because OI&T provides infrastructure and mission area capabilities for the Veterans Benefits Administration (VBA), the National Cemetery Administration (NCA), and VHA, the proportion of IT spending for health care capabilities and infrastructure cannot be discerned from available data. However, analysis of VA IT spending trends found that maintenance costs have grown almost continually since 2002, as shown in Figure 4–5. More troubling, spending on upgrades or new capabilities for the VA mission now represents only 15 percent of the total IT budget. During Assessment H interviews, several stakeholders, including those directly involved with IT investment planning and funding allocations, echoed concerns that O&M funding is "eating up our development, modernization, and enhancement funding." As a result, the growing cost of operating and maintaining the complex infrastructure reduces the availability of funding for new IT capabilities needed to manage and meet health care needs.

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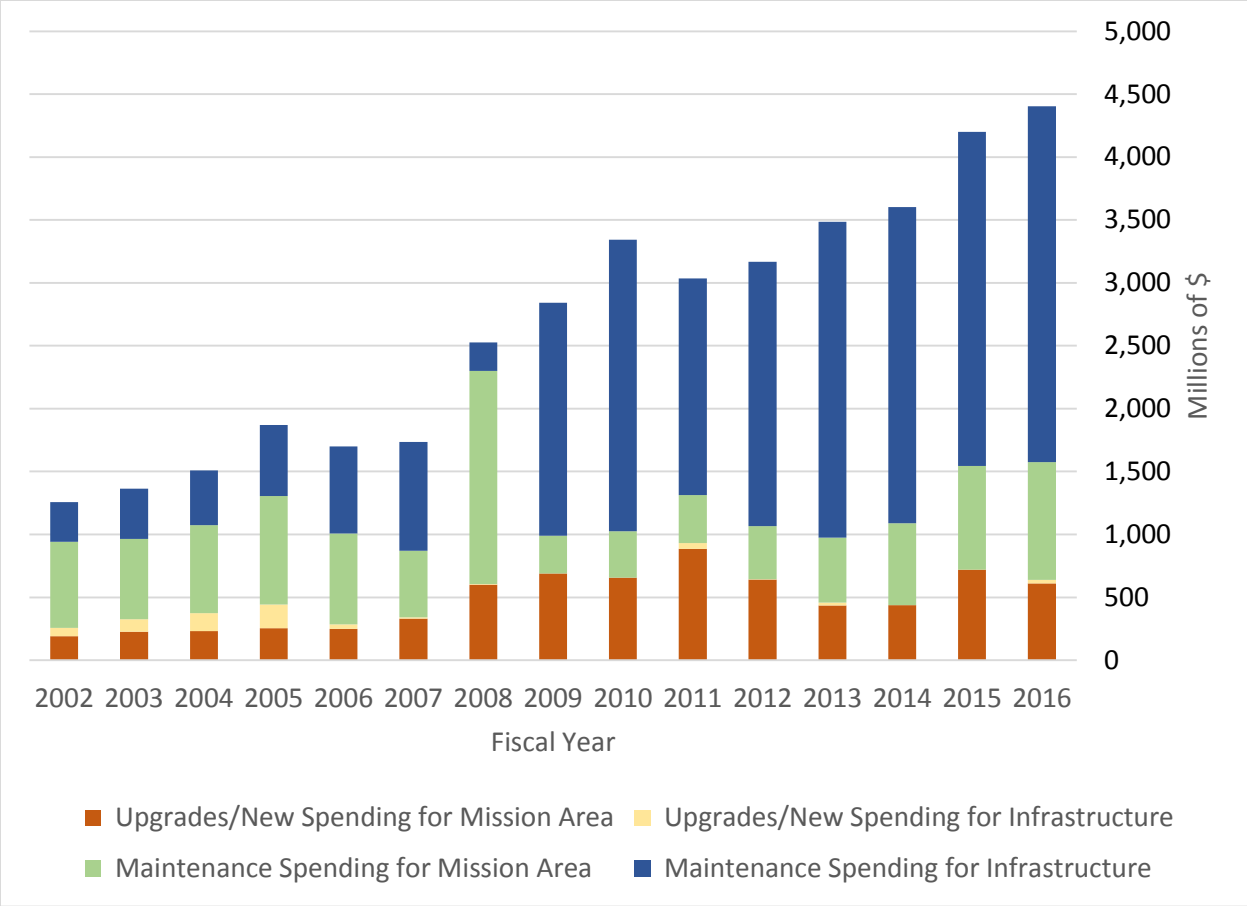
Figure 4-5. VA IT Spending on Upgrades vs. Maintenance



Source: MITRE graph derived from data collected from the Federal IT Dashboard 2015, https://itdashboard.gov/

Increases in the cost of VA IT infrastructure have continued despite several IT initiatives to reduce them, such as:

- **Physical consolidation of enterprise IT infrastructure assets:** Since 1998, VA has attempted to consolidate its distributed physical servers (and software applications) into four regional data centers (GAO, 1998) with completion originally planned by 2010 (OMB, 2008). VA described this cost cutting in a 2008 OMB Exhibit:

  > *To address [costly existing model], VHA is moving to a Regional Data Processing Center (RDPC) model of centralization of VHA health information data processing by co-locating and/or integrating services to a smaller number of data centers (from 128 to four, nationwide).*]

  As of 2014, this consolidation remains far from complete (VA Enterprise Centers, 2014). Phase 1 of the National Data Center Program (NDCP) consolidation effort completed 18 VistA migrations, and Phase 2 is slated to migrate an additional 52 instances "subject to funding availability." According to the fiscal year (FY) 2016 Enterprise Operations Business Plan, "Enterprise Operations (EO) supports development of the VA National Data Processing Strategy, which over time will consolidate more than 80 data centers within the Franchise Fund." EO is responsible for infrastructure investments, including

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modernization and consolidation, at a cost exceeding $300 million per year per the FY15 Pre Volume II Medical Programs and Information Technology Programs Congressional Submission—the highest line item in the FY15 O&M budget. VA was unable to clearly demonstrate the cost-cutting aspects or ROI gained from these efforts to date.

- **Ruthless Reduction Task Force**: VA established this task force specifically to eliminate hardware and software redundancies within the VA enterprise (Miller, 2011). The group's focus included consolidation of IT contracts where possible, IT virtualization, elimination of desk-side printers, and purchase of more multi-functional devices (e.g., printers with fax capability). Although OI&T leaders indicate some costs were reduced, the overall growth of maintenance costs continued.

Despite increased spending on IT infrastructure, Assessment H interviewees expressed dissatisfaction with OI&T's ability to meet local IT infrastructure needs as illustrated by the following examples.

- VA has disparate telephone technologies at various levels (local/site, regional, VISN, administration). At one VAMC, a leader indicated, "We have three incompatible phone systems in the VAMC that OI&T won't replace, so we cannot transfer calls from Veterans to a department using one of the other phone systems."
- Sites have insufficient resources to meet local requirements, such as increased bandwidth for telehealth deployments, scanners, and telephone upgrades.
- Sites lack sufficient local IT staff to assist users with infrastructure needs.

4.2 Recommendations

Key findings regarding IT strategies in Assessment H echo previous reports over the past decade and also reflect top failure factors identified in a large body of published case-study analyses of large-scale IT projects. Assessment H findings reveal complexities and limitations in key aspects of IT planning and execution that affect business (patient-facing clinical systems) and IT (system-engineering processes). These recurring findings indicate high-risk exposure in the form of chronic, fundamental problems that discrete recommendations cannot adequately address.

In light of these recurring findings, the resulting high-risk exposure, and the obvious limited value of repeating individual recommendations previously made, Assessment H recommends an integrated transformation involving executive-level leadership to address numerous findings associated with VA/VHA IT strategies. These recommendations are summarized as follows:

1. Select a CIO for VHA to manage and advocate for VHA's IT needs.
2. Transform the VA IT strategy to a model based on enterprise ITSM standards and best practices that includes the following actions:
    - Establish mutually agreed-upon service level agreements and optimize them for effectiveness.
    - Refine the planning and budgeting process to ensure business needs are effectively identified, prioritized, funded, and used to drive IT investments.

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- Develop a governance policy to ensure the strategic plans are executed well and in a timely manner.
- Establish product (capability)-focused teams to ensure delivery of needed capabilities to users.
- Shift the focus of VA's agile development process from documentation and schedule to service delivery.

Recommendation 4.2.1: The VA chief information officer should select a CIO for VHA to manage and advocate for VHA's IT needs and assist in transforming the VA IT strategy to a model based on enterprise IT service model standards and best practices.

Subject to the oversight and direction of the VA CIO, the VHA CIO acts primarily as an advocate and facilitator between OI&T and VHA to ensure both organizations are successful in meeting health IT needs. The VHA CIO will not move IT operations to VHA nor decentralize the organization. The VA CIO will define the specific roles and responsibilities of the VHA CIO. In the interest of consistency, VA should consider appointing equivalent CIOs for VBA and NCA.[4]

VHA needs a dedicated executive who can understand the changing health care needs that the complex VHA organization must meet, establish the IT priorities needed to address the ever-evolving health care challenges, and advocate for IT investments at the department level with the VA CIO. In addition, the VHA CIO should monitor delivery of the OI&T organization on behalf of VHA to ensure projects and services are completed or updated in a timely manner and deliver the needed capabilities. This recommendation is consistent with the requirements of the Federal Information Technology Acquisition Reform Act (FITARA) and the Clinger-Cohen Act[5] as implemented by recent OMB guidance[6] that expects departmental CIOs will appoint "bureau CIOs" or, in the case of VA, administration CIOs.[7]

Recommendation 4.2.2: VA should transform its IT strategy for delivering and managing health IT capabilities and technologies to a model based on enterprise ITSM standards and best practices.

[4] The recommendation is derived from the text of H.R. 4061, Department of Veterans Affairs Information Technology Management Improvement Act of 2005, introduced to the House on October 27, 2005, and passed by that body on November 2, 2005, by a vote of 408 to 0 but never passed by the Senate. Govtrack.us, Text of the Department of Veterans Affairs Information Technology Management Improvement Act of 2005, available at https://www.govtrack.us/congress/bills/109/hr4061/text/rh and https://www.govtrack.us/congress/votes/109-2005/h560. See also: H.R Report 109-256 (2005), at 2, available at: https://www.congress.gov/congressional-report/109th-congress/house-report/256/1

[5] Codified in relevant part respectively at 40 U.S.C. §11319 and 41 U.S.C. §3506.

[6] OMB M-15-14 (June 10, 2015) and related FAQs and Federal CIO comment, available at: https://management.cio.gov/#attachment-a-common-baseline-for-it-management-and-cio-assignment-plan

[7] "Official with the title or role of Chief Information Officer within a principal subordinate organizational unit of the agency, as defined in Section 20 of OMB Circular A-11, or any component organization of the agency (contrast with "agency CIO") OMB M-15-4, Attachment B at 18; OMB Circular A-11 provides: "Bureau means the principal subordinate organizational units of an agency." OMB Circular A-11 (2015) at Page 4 of Section 20, available at: https://www.whitehouse.gov/sites/default/files/omb/assets/a11_current_year/s20.pdf

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Acting upon this recommendation should improve VA's ability to effectively and cost-efficiently plan and execute IT strategies for delivering and managing clinical applications, management applications, and new technologies. Key objectives should include developing modular IT system architectures, open and well-defined interfaces, and standardized infrastructure.

A key aspect of the recommended transformation is to establish clearer roles, responsibilities, and accountability between VHA and OI&T. This should improve the working relationship and provide transparency in process and decision making. Ultimately, such changes should help to create a culture that ensures joint, collaborative efforts focused on service to the Veteran—clearly the driving goal of all the VA staff interviewed during the Assessment H study.

The selection of a VHA CIO should ensure that VA acquires and allocates health IT resources in a manner commensurate with VHA program requirements. This would entail establishing clear responsibilities and ensuring that everyone understands them. Staff in VHA and OI&T need to know that other parts of the organization can and will deliver on their commitments. Further, with respect to the definition and execution of IT strategies, each organization's expectations must be unambiguous and widely disseminated.

VA must unambiguously define OI&T accountability for service agreements. Specifically in the case of VHA, service agreements should be driven by health care needs identified by VHA. OI&T should implement a comprehensive portfolio-management business model that allocates investments and delivers services based on business priorities as established by the VHA staff under the leadership of the new VHA CIO. Key features of this model include accountability to health care business owners, metrics, and controls. Industry outreach interviews described IT departments' clear accountability to the business owners for outcomes. Most of these organizations also have standard metrics by which they gauge performance of IT products and the IT delivery process.

OI&T should establish service-level measurement programs jointly with VHA to include:

- **Business outcomes** (tangible, delivered IT capabilities with an assigned business value shown to have an impact on health IT)
- **System performance** (for example, user response times, processing times, capacity, bandwidth, availability, scalability, and security)
- **Service management** (for example, service desk support, incident management, problem resolution)
- **User satisfaction**.

Joint agreements between OI&T and VHA should define the metrics as well as openly shared measurements, trends, and plans to address shortfalls. The agreements should resemble industry standards. Failure to meet the intent of service agreement should have consequences, such as contracting with a different provider who can meet the service agreement measures.

Recently OMB published a memorandum (Donovan, 2015) that emphasizes the importance of understanding business needs and implementing metrics to measure and improve outcomes and customer satisfaction. The above recommendation to align the VA IT function "with the needs of VHA organizations" reflects this guidance aimed at assisting "agencies in establishing

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management practices that align IT resources with agency missions, goals, programmatic priorities, and statutory requirements."

OMB published this guidance in the form of a memorandum to implement FITARA, which significantly enhances the authorities of the CIO to assure that the CIO plays a central role in the program planning, budget, acquisition processes, and the Clinger-Cohen Act, whose terms (when read together with FITARA) require the CIO to use the enhanced authorities to support "agency missions, goals, programmatic priorities and statutory requirements" and that the Secretary "[is] responsible for . . . carrying out the agency's information resources management activities to improve agency productivity, efficiency, and effectiveness."

The OMB guidance mandates that the CIO report directly to the Secretary "to carry out the responsibilities of the agency under this subchapter" and to "establish and maintain a process to regularly engage with program managers to evaluate IT resources supporting each agency's strategic objective" and share responsibility with program managers "to ensure that legacy and ongoing IT investments are appropriately delivering customer value and meeting the business objectives of programs."

In summary, the OMB memorandum on FITARA (Donovan, 2015) indicates:

> World-Class Customer Service Agencies shall discuss how their portfolio management practices emphasize the customer-centric themes of the U.S. Digital Services Playbook,[8] OMB's capital planning and investment control guidance,[9] and the Smarter IT Cross-Agency Priority (CAP) Goal.[10] Agencies should describe where in their policies the following are implemented: the Playbook's 'Understand what people need,' the capital planning guidance requirement for major investments to measure customer satisfaction performance metrics, and the Smarter IT CAP Goal's focus on improving outcomes and customer satisfaction with Federal services.

A detailed substantive discussion of the recently issued OMB guidance is outside the scope of this Assessment H study and would in any case be incomplete in that the guidance will be extensively supplemented in the future. However, an initial review of its provisions makes clear that the Secretary of the VA has authority and tools to develop an "inclusive governance process" that will be sufficiently flexible to adapt to VA's and VHA's unique mission requirements and to ensure that the CIO and OI&T are accountable for aligning IT resources with VHA mission and program requirements.

The following specific actions supplement the Assessment H recommendation for transforming VA/VHA IT strategies based on enterprise ITSM standards and best practices.

Optimize IT service agreements. The VHA CIO should facilitate the requirements collection and prioritization within VHA, with final approval provided by the VHA Under Secretary for

[8] U.S. Digital Services Playbook, available at: https://playbook.cio.gov/

[9] IT Budget Capital Planning Guidance available at: https://www.whitehouse.gov/omb/e-gov/strategiesandguides.

[10] Smarter IT Delivery Cross-Agency Priority Goal, available at: http://www.performance.gov/node/3403?view=public#overview.

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Health; establish IT service level agreements (SLAs) that are mutually acceptable between OI&T and VHA; and optimize the services for effectiveness. OI&T should ensure that service agreements support the clinical environment and decrease overhead, bureaucracy, and the number of processes involved. For example, with respect to telehealth, as VHA increases virtual access for the delivery of care, a National Telehealth Services Agreement would eliminate the need for separate agreements between VHA, IT Development, and IT O&M.

Refine the planning and budgeting process. VA should revise the planning and budgeting process to ensure business needs are effectively identified, prioritized, funded, and used to drive IT investments—while simultaneously avoiding the proliferation of the "local site" optimizations that created some of the underlying problems identified in Assessment H key findings. VA should ensure identification and prioritization of health care objectives with more accurate cost and outcome analysis (e.g., better use of the existing planning and budgeting process). Industry outreach interviews indicated that all successful organizations tightly align IT investment to the organization's strategic plans and needs.

Develop a governance policy to ensure the strategic plans are executed well and in a timely manner. The VHA CIO should facilitate VHA measurement of services to ensure compliance with the agreements. Fifty-one percent of the VHA CIO performance will be based on how well SLAs with VHA are being met by OI&T. SLAs would cover support for requirements development, project cost estimation, health IT systems project design and delivery, and the quality and performance of the health IT systems. Performance would also be measured by how well the CIO understands the current and future health IT needs of VHA to improve care delivery for the Veterans.

Establish product (capability)-focused teams. Product or capability teams would execute their tasks under the authority of a business owner fully accountable for the product's entire life cycle, from identifying priority requirements through planning, delivering, and verifying measurable health care outcomes in patient-facing clinical environments. The teams must actively and sufficiently represent all relevant stakeholders associated with the product and include embedded, collocated IT staff (e.g., software developers) in critically necessary but subordinate roles. The tight coupling of planners, builders, and users would facilitate more effective identification and translation of prioritized objectives outcomes—essentially, more effective collaboration between "business" and "IT."

Each product-focused team should be allocated to, responsible for, and exclusively dedicated to the planning, execution, and full life-cycle delivery of integrated, end-to-end, top-to-bottom, working products with verified outcomes. These teams should focus on "vertical" business needs with tight coupling to the enterprise technical leads for consistent, effective integration with the cross-cutting IT needs.

The teams must actively and sufficiently represent all relevant stakeholders associated with the product and include tightly integrated IT staff (e.g., software developers).

VA OI&T has discussed emerging ideas for incorporating product-focused teams and has introduced a similar concept. However, OI&T's approach must define the critical responsibilities of the business owner and effectively communicate the importance and details of a product-

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focused approach. Finally, the approach must incorporate cross-cutting architecture and integration activities to ensure that the IT infrastructure evolves consistently and acceptably.

Refine VA's development process. VA can improve the PMAS process by incorporating best-practice agile principles for delivering prioritized, measurable outcomes into the operational environments (in the case of VHA, the patient-facing clinical environment) in the context of VA's enterprise IT development. The suggested refinements would specifically work in conjunction with the product-focused teams that address vertical business requirements and the enterprise technical teams that address cross-cutting concerns associated with an integrated, unified IT framework.

Assessment H's recommended transformation of IT strategy retains aspects of VA's existing agile approach but incorporates key principles from best-practice strategies for scaling these processes to accommodate their effective use in large-scale enterprise modernization efforts. These refinements essentially eliminate the current fragmented approach when combined with the vertical product-focused business teams and horizontal IT-focused technical teams (holistic approach). They should also incorporate the flexibility required to accommodate small-scale innovative development activities that should not require the overhead imposed by PMAS—a common source of complaints by VA stakeholders during Assessment H interviews. OI&T should turn to small-scale, rapid development and verification of innovative health IT concepts that could subsequently be incorporated into the enterprise-level product-driven process.

While industry uses some prescriptive enterprise agile models (for example, Scaled Agile Framework [SAFe], Disciplined Agile Delivery, and Large Scale Scrum), Assessment H does not recommend that VA shift to one of these scaled agile development processes. Instead, OI&T should modify the existing PMAS process to reduce the risks and learning curve associated with shifting to a completely new methodology. Assessment H recommends the following refinements to PMAS:

- **Adopt an enterprise agile model that implements portfolio and program team structures** to coordinate efforts of multiple teams that simultaneously develop products with mutual dependencies. The enterprise agile model would clearly define the structure of the program teams and describe how to allocate business goals to the teams for execution. VA OI&T and each of its business partners (VHA, VBA, NCA) should work together to identify the right portfolio/program/project structure.
- **Create agile teams that effectively collaborate with the enterprise software architect** (and team) to ensure OI&T receives the feedback required for evolution of the enterprise architecture.
- **Establish a sufficiently defined and implemented enterprise-level technical infrastructure** to support agile delivery, which includes use of more effective development and operations practices.
- **Evolve PMAS to support enterprise agile development**:
    - Accommodate more complex portfolio/program/project structures so that the business owner and other stakeholders can see a complete picture of the entire implementation plan for a business endeavor.

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  - Identify meaningful agile project performance metrics and adapt PMAS to support the definition, capture, and analysis of those metrics.
  - Allow tailoring of PMAS documents and schedule and encourage tailoring for small or unusually large projects.
  - Accelerate PMAS enhancements already identified by OI&T that are consistent with these goals.
  - Evolve contracting practices that facilitate enterprise agile development.

The Assessment H team recognizes the difficulty of instituting cultural changes and implementing agile technical practices in a large organization. Attempts to create such fundamental shifts through self-teaching and self-monitoring would likely fail. Assessment H therefore recommends that VA:

- Seek external training and consulting to establish the desired agile culture, practices, and the technical infrastructure needed to support an enterprise agile endeavor.
- Retain appropriate consultant(s) to conduct periodic reviews of progress and recommend how to improve the adoption of agile processes.
- Test the new practices in small scale pilot projects prior to deployment across the entire organization. An enterprise agile consultant could assist with project selection and organizational rollout strategy.
- Establish an agile-focused Program Management Office (PMO).

An effective enterprise agile approach will place more emphasis on deliverables and cost and less emphasis on schedule. It will also provide greater flexibility for particularly large or particularly small projects because current approaches tend to focus on the average size project.

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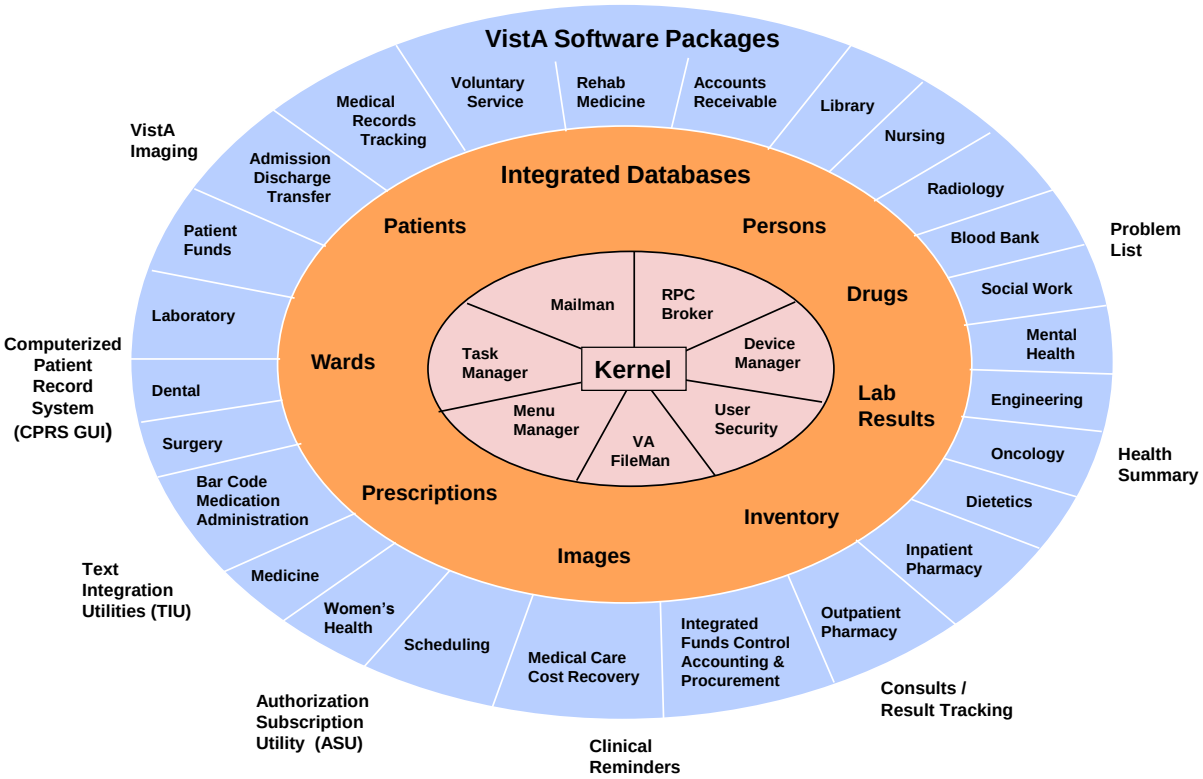
5 Electronic Health Record

Veterans Health Information Systems and Technology Architecture (VistA) encompasses EHR data, several associated applications, and other databases that furnish and manage health care at VHA. As shown in Figure 5-1, VistA has a highly sophisticated architecture with a kernel that provides low-level services; shared databases that contain patient, facility, and other information; a large suite of applications that serve clinical and management needs; and the Computerized Patient Record System (CPRS) component that presents a modern user interface.

Figure 5-1. VistA Technical Architecture



Source: MITRE rendition of VistA specifications

Discussions of health care systems can lead to confusion because the term "EHR" can be used to specify the contents of one person's health record, the database of all health records within an organization, or the combination of data and applications described by a system such as VistA. This Assessment H report uses EHR to describe a complete system, such as VistA, including health data, health IT applications, related management applications, and several databases that support applications.

5.1 Findings

Several decades ago, VistA and CPRS led the development of EHR technology. Many commercial off-the-shelf (COTS) EHRs are based on the concepts and even the code introduced by VistA.

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Almost all VHA clinicians interviewed by the Assessment H team preferred VA's CPRS over other EHR user interfaces because of its flexibility and functionality, which resemble those of a paper patient chart.

Several interviewees attributed the success of the early VistA and CPRS development efforts to the close working relationship between VistA/CPRS developers and clinicians. This collaboration seems to have degraded with the centralization of IT, which has resulted in disconnects and limited new capabilities developed for VistA/CPRS. Also, during the past decade, VistA and CPRS development has been confined to fixes and minor enhancements.

Finding 5.1.1: During the past decade, VA applied the majority of its development resources to HealtheVet (not the same as My HealtheVet) and the integrated EHR (iEHR) projects, both of which failed. This delayed further development and improvement of VistA and CPRS so that they are no longer leading-edge products and are in danger of becoming obsolete.

Clinical users remain fairly pleased with VistA and CPRS but have become increasingly frustrated by the lack of any obvious advances over the past decade. Numerous VA clinicians have experience with commercial EHRs and want the same level of features, modern clinical capabilities, integration, and mobility they see emerging in the commercial marketplace. A majority of Assessment H interviews across nine VAMCs and five VISNs indicated that users are unaware of and uninvolved in any major VA EHR modernization and development efforts.

As shown in Table 5-1, information from VHA's Office of Strategic Investment revealed that in the last three years, VA has addressed only 44 out of 225 CPRS requests ranked as high priority, which amounts to only 20 percent of the high-priority requests for the main clinical system seen by end users.[11] In addition, both interviews and literature studies indicated that system usability suffered due to the lack of a continuous development and improvement process. As described in Section 4 of this report, users noted that the PMAS process requires such significant overhead that it reduces the resources actually contributing to development. Users also characterized the PMAS process as schedule focused and risk averse and believed that this leads many program managers to limit the amount of functionality in each release, thereby increasing the total time to complete any *useful* capability.

[11] VHA, Office of Strategic Investment (10P2e) 10 June 2015.

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Table 5-1. CPRS Request Satisfaction for Past Three Years (2013–2015)

5	Requests to be satisfied in CPRS v30b
8	Requests to be satisfied in CPRS v31
30	Requests to be satisfied in CPRS v32
1	Requests closed (Code Space Expansion)
44	Total requests addressed in the last three years by CPRS planned releases
225	Number of CPRS requests ranked high priority by Clinical Capability Management Board plus number of new requests that have not been reviewed to date
$\frac{44}{225} * 100\% = 20\%$	Percentage of CPRS requests in the last three years have been addressed or are being addressed

The results in Table 5-1 do not reflect the level of effort required to satisfy each request. OI&T does not track this information as part of the PMAS reporting process, so there is no existing way for users to assess the degree of difficulty or impact of delivered CPRS services. Additionally, "product effectiveness" assessments are only conducted when requested by the project manager and are not a required step of the current PMAS process. Thus, data are not readily available to show the extent to which requests are satisfied from a user's perspective. In interviews, some users expressed frustration about the lack of feedback on the usability or impact of new CPRS capabilities.

Users noted that, over time, CPRS has developed usability issues, including excessive alerts, poor alerts, too much unfiltered data, and a lack of assistance for the clinical workflow. Some clinical users reported that these usability problems created potential safety risks; for example, the large number of alerts prompted users to turn off alerts altogether, and clinicians encountered problems when trying to copy and paste information between records. Interviewees emphasized the importance of involving subject matter experts in such areas as clinical decision support, human factors, and clinical documentation improvement to ensure a balance between prescriptive practices and system usability.

Finding 5.1.2: The complex and obsolete technologies underlying VistA and CPRS make it difficult to maintain resources and adopt mainstream software coding and security tools to aid in development.

Much of the VistA and CPRS software code is written in the MUMPS (Massachusetts General Hospital Utility Multi-Programming System) programming language. Because MUMPS is not broadly offered in college curricula and is not widely used by other organizations, the software ecosystem of books, tools, services, training classes, and experienced programmers is limited compared to that of more mainstream languages (e.g., Java, C, C++, Python). Similarly, only a few productivity and quality improvement tools are available for MUMPS; for example, there is

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a lack of automated tools for testing, behavior-driven development, code coverage, and performance tuning.

Finding 5.1.3: VistA skills are essential for developing future capabilities, and these skills require several years to develop. VA currently has no formal program to predict the attrition and need for developers and to train their replacements.

VA needs to migrate the current VistA and CPRS EHR to a more capable health IT and EHR system based on a flexible, modular design and modern system and software technologies to achieve its strategic health objectives and to meet the 2014 National Defense Authorization Act (NDAA, 2013), Section 713, mandate to deliver a modernized VistA system by December 31, 2016.

Finding 5.1.4: The complexity of VA's underlying software infrastructure (e.g., multiple access layers, multiple software technologies, and numerous diverse functional components) and the existence of approximately 130 VistA instances across VAMCs compound the difficulty of developing an EHR on time with the reliability and performance required by its clinical users.

These many points of complexity significantly reduce maintainability, extensibility, and scalability of VistA/CPRS. Effectively managing federated health records across 130 instances of VistA (Fihn et al., 2014) requires complex integration schemes to achieve performance goals and reduce network latency. This complexity increases the cost to develop, manage, and troubleshoot applications.

Finding 5.1.5: The differences among approximately 130 instances of the VistA/CPRS system are not well documented, complicating efforts to upgrade and maintain the system and to conduct end-to-end testing outside of the operational environment.

The CPRS fat client architecture and associated stateful design constrain performance of the current VistA/CPRS, which may not scale to support thousands of users (or tens of thousands of users via telehealth and mobile applications).

Recent VistA performance statistics indicate that the current VistA system availability has ranged from 99.4 to 99.9 percent. Assessment H interviews indicated that a majority of the outages were due to network issues that resulted in days of manual data entry, possibly introducing data errors and impacting patient safety.

Assessment H interviewees stated that VA has no environment in which all system components can be tested end-to-end before going into production. An initial field test of the enterprise Health Management Platform (eHMP) at Hampton Roads, Virginia, brought the production CPRS system down for several hours, and identifying a root cause of the event took several weeks.

VA established the VistA Evolution program in 2014 to oversee modernization of VA's EHR system—the third EHR modernization program in the past 10 years. VistA Evolution is a joint program of OI&T and VHA and is intended to provide interoperability with the DoD EHR systems and with the systems of other health care partners to promote better outcomes in quality, safety, efficiency, and satisfaction in health care for Veterans, service members, and their dependents.

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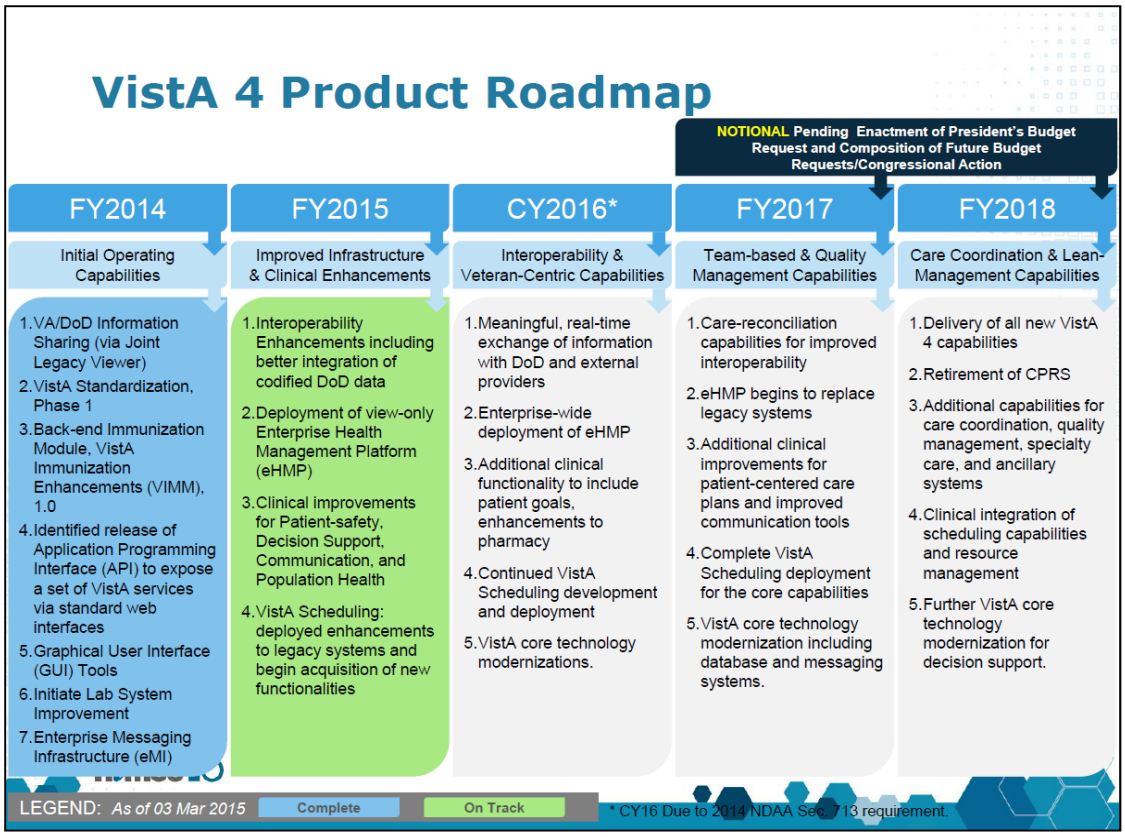
The VistA Evolution program includes plans to upgrade the technical infrastructure for health data interoperability while reducing overall system complexity, converting to standards-based services, formats, protocols, and data models, and enabling expanded and improved data exchange with partner providers. VA must maintain the current VistA/CPRS operating environment while the VistA Evolution program simultaneously modernizes key components of those legacy systems and integrates them with newly developed software applications across the enterprise.

The VistA Evolution replacement component for CPRS is a web-based platform that, as currently designed, may encounter even greater problems in meeting performance and scalability of VA's EHR system due to the stateful design of the overall VistA system, which is not compatible with modern web-based technologies. This issue is discussed in more detail in Section A.3. Assessment H interviews and project documentation reviews indicated that few VA staff understand the optimization that will be required to handle the user loads and workloads for a web-based system with data aggregation from multiple systems versus a single system today.

As explained in Figure 5-2, VistA Evolution will develop and deploy capabilities in four major feature increments over five to six years, completing in fiscal year 2018.

Figure 5-2. VistA Evolution Roadmap

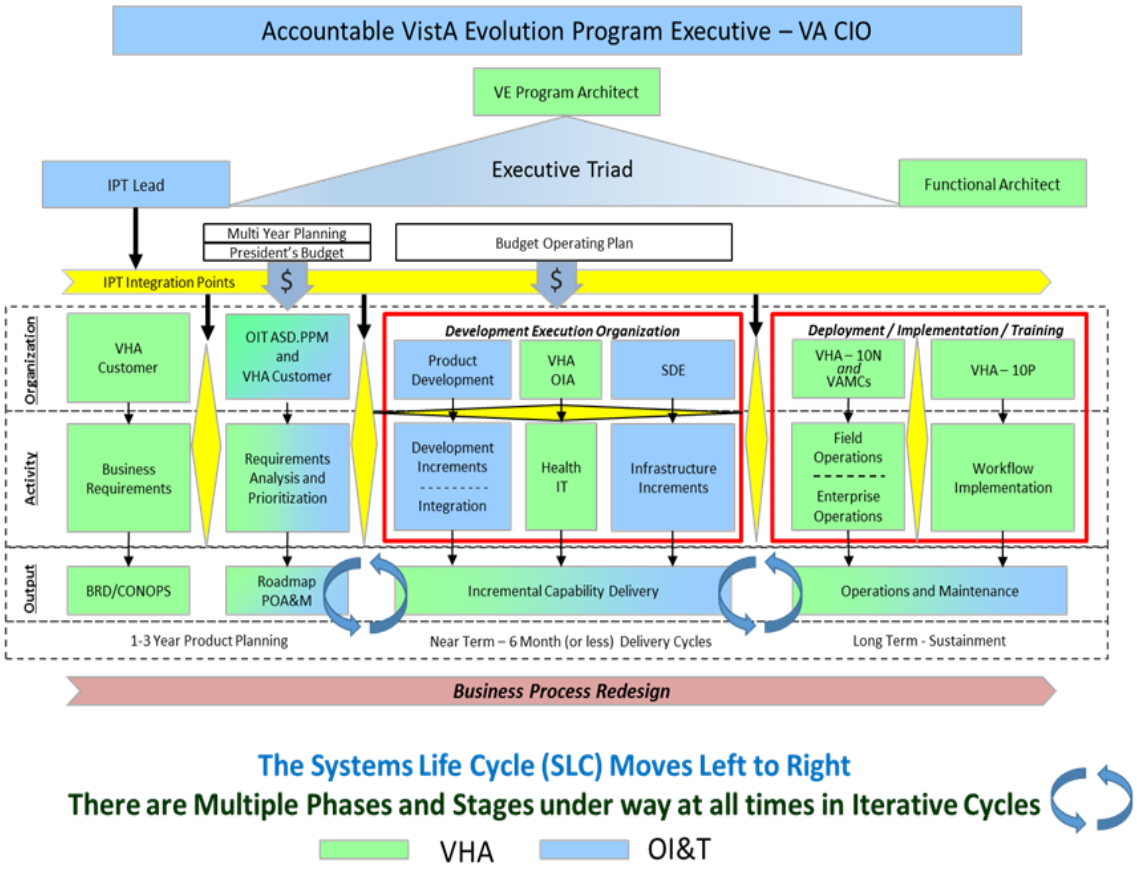


Source: Drew & Nebeker, 2015

Finding 5.1.6: The VistA Evolution program is not adequately organized or staffed to successfully manage the development and integration of such a large complex software program, which increases the risk of schedule delays or failed delivery of clinical IT capabilities.

VistA Evolution is managed by a matrixed organization, with the VA CIO acting as the single point of accountability. As depicted in Figure 5-3, the VistA Evolution Program Executive Triad reports to the VA CIO and oversees activities related to budget, scope, schedule, objectives, strategy, and internal prioritization of program activities related to acquisition, implementation, and sustainment of the EHR and ancillary health IT systems.

Figure 5-3. VistA Evolution Program Triad



Source: Cullen & Constantian, 2015

VistA Evolution is attempting to use the Triad and a capability team development approach to continually design, develop, and deploy functional product lines that integrate and test all layers of a solution. Examples of product lines may include clinical core systems (eHMP and Clinical VistA), clinical ancillary systems (e.g., laboratory, pharmacy, radiology, and scheduling), population analysis and management systems, shared services (e.g., enterprise Messaging Infrastructure), and health IT infrastructure.

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Assessment H interviews with VistA Evolution project development and program management staff indicated that the initial creation of the VistA evolution program was not sequenced properly. Business requirements were given priority over technical dependencies, and capabilities were built before the underlying infrastructure was completed. VistA Evolution is beginning to correct these mistakes now that the VistA Evolution Triad is providing clear direction. The Triad is engaging senior leadership at the department level to increase program support. However, even with an OI&T member as part of the Triad, several senior OI&T leadership officials indicated during Assessment H interviews that they do not feel adequately engaged and empowered in the current VistA Evolution Triad structure, reducing team and program efficiency.

Neither the 2014 VistA Evolution Program Plan (OIT 06) nor the 2015 Program Charter (OIT 07) designates a single program manager or integration lead responsible for oversight and integration across all VistA Evolution projects. These omissions increase the risk of incompatibilities, duplicated effort, and rework and are magnified because the VistA Evolution architecture is not fully approved. As a result, individual teams may make incompatible design decisions or may delay making decisions until the architecture is completed.

Neither OIT 06 nor OIT 07 includes specific documentation or reporting requirements, so information maintained on the internal VA VistA Evolution SharePoint site was outdated and missing critical program documentation. The Assessment H team could find no evidence that VistA Evolution performs frequent analysis of project schedules, and this reduces the program's ability to assess delivery across the program. An April 2015 VistA Risk Register (OIT 08) report indicated that "VistA Evolution lacks foundational documentation to clearly articulate program expectations and scope to the execution teams." For example:

- "The Program Work Breakdown Structure has been weakly supported and poorly communicated and still lacks reasonable leadership input for scope definitions."
- "The VistA Evolution Integrated Master Plan has not been completed and injects a significant level of risk exposure to the VistA Evolution Program."
- "A VistA Evolution Program Integrated Master Schedule (IMS) that is resource loaded, with dependencies and milestones and is tied to the budget has not been developed."

The assessment team reviewed a May 2015 IMS (OIT 10), developed with Microsoft Project, that was not resource loaded, did not provide all cross-project dependencies, and lacked sufficient detail to generate a critical program path. VistA Evolution risk documentation indicates that "the quality of some information received related to contracts and the lack of key decisions impede the ability to provide a true programmatic path." Timelines are difficult to meet given the large magnitude amount of work and large number of dependencies across the enterprise.

5.2 Recommendations

VA was a thought leader in health IT development for many years but, during the past decade, delayed development of VistA and CPRS has brought these key system components to a point where they are practically obsolete. Failures of major programs during the past decade have

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demonstrated that these systems cannot be modernized and have resulted in a complex set of EHR components built on outdated software. The VistA Evolution program represents another attempt to upgrade these systems, but VA has proven unable to develop and execute a health IT strategy to evolve with rapidly changing technologies. Further, as explained in Appendix A.3, the VistA Evolution program exhibits several failure factors seen in industry and encountered on prior VA initiatives of equivalent size and complexity. Industry articles reviewed by the Assessment H team and interviews of VA staff indicated that several technical issues, in particular the architectural complexity of the platform, constituted major contributing factors to failures of previous attempts to modernize the VistA/CPRS system.

The complexity of VA's underlying EHR software infrastructure—a large heterogeneous mix of software frameworks and technologies—makes the infrastructure difficult to efficiently develop, modernize, and manage. These risks will be magnified by the lack of a single VistA Evolution integration lead responsible for managing cross-project dependencies and failure to develop the tools (i.e., IMS, Integrated Master Plan, common project technical/program repositories) needed to effectively manage the 30–40 dependent projects across the program.

Recommendation 5.2.1: The VHA CIO, in partnership with the VA CIO, should oversee a comprehensive cost-versus-benefit analysis among COTS EHRs, Open Source EHRs, and continued in-house custom development of the VistA EHR currently in use.

The analysis should take into account all the complexities of the VistA/CPRS architecture and infrastructure and known issues with performance, scalability, extensibility, interoperability, and security. The analysis should also address full life-cycle costs, including development time (based on recent historical trends), availability of development resources, maintenance and licensing costs, and infrastructure costs. The analysis should consider the need to share data among the clinical and business activities within VA and to exchange data across the VA system, with third-party providers, with DoD, and with payers. The VHA CIO should participate in the VHA requirements collection to fully understand strategy and needs. Prioritization and final approval will be provided by the VHA USH.

This Analysis of Alternatives (AoA) should be led by an organization capable of assessing the total cost and return on investment of acquiring and implementing an integrated COTS EHR suite and best-of-breed solution, compared to continued in-house custom development. This requires an organization with:

- The clinical expertise needed to assess requirements supporting VA's clinical structure, treatment modalities, practice workflow, and business management.
- Expertise with operating large health care systems to assess the approaches to automate and integrate both clinical and business functions across the system.
- Experience with large-scale COTS EHR implementations to assess the technical and operational impact of adapting the VHA practice workflows and the COTS default settings to meet VHA needs.
- Technical expertise with systems development, large-scale system integration, health IT interoperability (i.e., health information exchange), clinical data standards, data conversion, and data migration.

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- Federal acquisition and security expertise to assess the impact and cost of meeting unique government requirements.

Additional factors that the AoA should address include:

- The importance that VA accords to maintaining core competencies in EHR development and health IT leadership, even if this proves more expensive than procuring and integrating COTS technology.
- The extent to which continued in-house system/software development provides VA with greater freedom to develop a learning system focused on clinician and patient needs and driven less by commercial business and billing requirements. The AoA should also weigh the option of having VA share its vision with a vendor who can build these requirements into an existing product for VA's use.
- The impact of losing VA-unique capabilities associated with VistA.
- The extent to which a COTS EHR would provide immediate automation of VHA business processes that are currently mostly manual.
- The possible advantages of building on DoD's EHR Request for Proposal for an integrated best-of-breed solution. This proposal aligns with many of VA's requirements, including longitudinal patient data, medical device integration, ancillary services, scheduling and (VA-DoD and VA-Private Provider) interoperability (DoD, 2014).
- The rapid maturation and improving interoperability of COTS EHRs. Assessment H industry outreach interviewed 14 provider organizations and found that 11 of them already use COTS EHR solutions. Of the remaining three, one was actively moving to a COTS solution and one plans to do so in the next few years. Procuring a COTS EHR could provide continuous alignment with industry standards (i.e., ICD [International Classification of Diseases]-10, Meaningful Use [MU]) and would allow VA to focus IT development on innovation and VA-unique capabilities.
- The value of implementing industry best practices (i.e., care plans, workflow, and team management) by adopting a solution driven by the large private sector provider ecosystem.
- The ability of a joint VA and DoD COTS EHR purchase to provide significant leverage for influencing data ownership, vendor development, and modernization priorities.
- The long-term (20-year) impacts of licensing and maintenance on reducing VA's O&M costs, which currently prevent developing modernized and new capabilities and technologies.
- The ability of VA's networks, system infrastructure, and centralization strategy to support a COTS procurement.

The VA and VHA CIOs should conduct site visits and review the successful IT practices implemented at high-performing health care systems (including VISN 4), to inform their strategies for effective approaches and potential contributions that IT can provide to improve the treatment of Veterans today.

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The VA CIO and VHA CIO should report to Congress at the end of fiscal year 2016:

- Evidence provided by both VHA USH and VA CIO that the VHA CIO serves as an effective advocate for the IT needs for health care delivery. This should include, but not be limited to, a description of the requirements for an effective health care management system that annually provides advancement to VHA mission and goals.
- Actions taken and evidence that OI&T acts as a service provider and delivers IT capabilities and IT services that improve health care delivery to Veterans. Evidence should include results of clinician and Veteran surveys confirming the quality of and satisfaction with the newly delivered capabilities and services.
- Results of the cost-versus-benefit analysis between the COTS, Open Source, and VistA EHRs.

Recommendation 5.2.2: VHA should select a program executive to oversee and coordinate the more than 40 independent projects and initiatives related to EHR modernization, regardless of whether VHA continues in-house development or pursues a COTS solution.

Any program of the size and complexity of the EHR modernization requires program executive and lead integration roles and governance processes to manage integration across the many interdependent projects and initiatives. VA must create a program structure that scales to address the challenges of developing and integrating a large software system.

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6 Scheduling

VHA relies on a VistA scheduling package to provide Veterans with access to health care. Attempts to modernize and improve access have a history of delayed and inadequate product delivery, highlighted in reports by the GAO (2012), the VA OIG (VA OIG, 2014), and the Northern Virginia Technology Council (NVTC, 2014). Currently, tools for access to health care and operational support, such as reporting and resource allocation, do not fully support goals related to business processes, access, and satisfaction of both internal and external customers. The VistA system does not *prevent* scheduling of outpatient appointments, but its technologies exacerbate existing issues with access to appointments (as described in detail in Assessment E [Workflow – Scheduling]).

VistA Scheduling was initially developed in the 1980s and was not designed to handle the complexities and volumes required by over 100 million appointments in fiscal year 2014 (OI&T Product Development, 2014). Current operations involve workarounds and rework, producing inefficiencies and unsatisfactory results.

From a strategic standpoint, VHA has a commitment to improve scheduling and access for Veterans and recognizes that the current system may be incapable of providing the robust infrastructure necessary for the envisioned future state. For example, VistA is not aligned with the *Blueprint for Excellence* statement:

> Scheduling capabilities will need to include assessing provider productivity as related to virtual care, as well as management of virtual care encounters (resource management). Limitations of the current system include inadequate capture of provider supply and demand, as well as lack of ability to schedule resources across the system (VA, 2014c).

Currently, VistA Scheduling also performs poorly in terms of integrating mobile, web, and telehealth scheduling.

6.1 Findings

Several recent reports have highlighted challenges with VA's development and deployment of scheduling improvements. Not originally designed as a scheduling system, over time VistA has evolved into a system that does not optimally support processes or allow for efficient scheduling of appointments. Over the past decades, VA/VHA has made several attempts to modernize its scheduling system as described in the following paragraphs.

Scheduling Replacement Project

VA's Scheduling Replacement Project initiative, underway during 2002–2009, failed after VA had invested $127 million. The GAO report on this project (GAO, 2010) cited several key factors:

- The project suffered from managerial issues (no acquisition plan, ad hoc acquisition activities, and lack of competition).
- System requirements were incomplete and not sufficiently detailed.
- Earned value management data did not serve as a reliable indicator of project performance.

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- Even though VA had a plan and process for managing project risks, it did not identify key risks or take steps to mitigate them.
- Although VA recognized major issues with the project through several external reviews, the lack of effective institutional oversight allowed the project to continue unchecked and, ultimately, to fail.

This project included efforts to develop requirements for the scheduling product and program, which led to the Medical Appointment Scheduling System (MASS) Request for Proposal (RFP) package under source selection as of June 2015.

The NVTC report on scheduling for medical examinations in 2014 (NVTC, 2014) noted that "VA's exam-scheduling processes are insufficiently enabled by state of-the-art technologies or (consistently applied) standard operating procedures." The report cited outdated software, inadequate performance measurement, and poor system usability as IT functions that VHA should address. NVTC also suggested that VHA improve call centers and telephone systems and adopt a system-wide approach to redesign. According to NVTC's summary of a follow-up with VA stakeholders, current or future initiatives address many of the issues noted in the report, although VA also considered some recommendations not feasible.

HealtheVet Scheduling Program

Following the failure of the Scheduling Replacement Project, VA completed an AoA in 2009 to evaluate five potential options (developed by an OI&T study team) (VA OI&T and Office of Enterprise Development AoA Study Team, 2009). In 2011, under the HealtheVet Scheduling Program, VA initiated efforts to replace the VistA Scheduling capability through a Request for Information and other measures to upgrade its legacy scheduling system.

After evaluating the HealtheVet Scheduling Program with respect to performance, cost, and schedule, VA decided to pursue a COTS solution, ultimately leading to the current and ongoing technical evaluation for MASS. An interim report by the VA OIG in May 2014 (VA OIG, 2014a) cited wait-time concerns related to deficiencies in electronic wait list management, as well as process and procedural practice issues, and made recommendations about monitoring and wait list management.

VistA Scheduling Enhancements

VHA launched the development and implementation of a VistA Scheduling Enhancements (VSE) project (due fall 2015), which will lead to some improvements. As noted above, VHA has a major technical evaluation in progress for a COTS solution for MASS that will replace many current interfaces, improve administrative functions, and automate and improve business rules, but seemingly will still rely heavily on interfacing with VistA. According to requirements for the new COTS scheduling solution, when implemented, the new product is expected to move VHA from primarily a face-to-face appointment model to a coherent, resource-based system with broad opportunities for improved services across VA stakeholders (OI&T, Product Development, 2014).

The MASS Business Requirements Document (BRD) designates the Access and Clinic Administration Program (ACAP) as the business owner for scheduling initiatives. ACAP is "a

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single entity responsible for defining, standardizing and coordinating system-wide administrative clinic operations and management" (VA, 2015g). ACAP will cover outpatient access standards and workload capacity alignment, with the highest priorities being primary care, mental health, and call-center operations to include triage, queuing, and standard operating procedures. Specialty care clinic access will include establishing tracking and monitoring standards. ACAP, in collaboration with OI&T, will also serve as VA's business owner and manager for medical appointment scheduling.

Additionally, ACAP is expected to bridge the gaps and disconnects between policy and operations necessary to comprehensively define and coordinate the transformation of clinic operations. This will require standardization through consistently implemented policies, reliable and actionable performance measures, and reporting structures that facilitate accountability. The resulting fundamental business processes will ensure standardization of clinic practices across VA health care systems and will focus proactively and strategically on systemic improvements to Veterans' access to care. Assessment E (Workflow – Scheduling) contains extensive details about ACAP and its process efforts.

MASS

VHA is acquiring MASS as a COTS solution to replace VistA Scheduling over the next few years. According to section 3.1.1 of the Performance Work Statement (PWS) (OI&T Product Development, 2014),

> The objective of the MASS program is to acquire a COTS medical scheduling application, integrate it with VA enterprise, build out all required portions of VA infrastructure, and implement the MASS solution within VHA's clinical and administrative operations. Implementation includes all activities needed to deploy and install the infrastructure, configure the COTS application, and train staff who will use and maintain MASS.

Assessment H limitation: The ongoing acquisition process prevented the Assessment H team from conducting a full-scope review of the current plan to acquire MASS.

Legal constraints surrounding the technical evaluation for MASS prevented the Assessment H team from interviewing key members of the MASS team who are sequestered during the procurement. These MASS team members were involved over the life of the RFP development (initiated May 2014), and some have had a far longer involvement in VHA Scheduling and other related VHA/OI&T programs and projects. As of late June 2015, the technical evaluation continued. Therefore, the Assessment H team could not:

- Gain a deep understanding of how key VHA, VA, and OI&T integrated product team (IPT) members worked together and of successes and challenges during the requirements development process.
- Evaluate early design plans and ascertain how and/or how well the new vendor will be able to begin development and integration.
- Discover the opinions of key IPT members as to the completeness of the RFP, key factors in a successful rollout, any changes critical to success, and the readiness of both VHA and OI&T for such a large-scale rollout if/when an award is granted.

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This group could have provided significant insight, given that members have decades of experience in program, project, and IT implementations, and understand the strengths, challenges, and opportunities of MASS.

VistA Evolution Program

Under the VistA Evolution program, VSE will also support MASS procurement and will ensure that any COTS products adhere to the VistA 4 roadmap (see Section 5 and Appendix A.3 of this report for more information on the VistA Evolution program). Notional roadmaps and interviews indicate that VSE and MASS will produce some improvements for schedulers, in particular an improved graphical user interface, as early as fall 2015.

Telephony

Telephony plays an integral role in scheduling, as many Veterans make VHA appointments on the telephone via schedulers and various call center systems. This section briefly examines aspects of VHA telephony IT, but an evaluation of VA's telephone systems does not fall within the scope of Assessment H. Additionally, while these dependencies exist, fixing VA's telephone issues lies outside the scope of MASS.

Outdated technology hinders VHA telephony from achieving enterprise-wide success because interim solutions are managed locally, which restricts some national-level initiatives and prevents VHA from realizing economies of scale. As detailed in a December GAO report titled "Reliability of Reported Outpatient Medical Appointment Wait Times and Scheduling Oversight Need Improvement" (GAO, 2012b), outdated technology, limited human capital, high call volumes, and lack of call centers had a negative impact on the Veteran experience. This GAO report recommended oversight and process changes in order to improve conditions and responsiveness, including VISN-level oversight and routine monitoring. Assessment E has detailed the current state of call centers, focusing on opportunities and weaknesses across VHA. Improvements to the phone systems must be prioritized appropriately against other expensive, pressing needs in CPRS, scheduling, cyber, and other areas.

Recent efforts to improve telephony have shown some successes through policy standardization, and some call-center pilot activities have had positive results. However, the Managing Veterans Access via the Telephone (MVAT) plan outlines an extended timeline and will require enterprise-level effort and funding. Existing artifacts produced by VA describe limitations to the current system in detail and indicate that the solutions noted will not be easily funded or implemented (VA, 2014d).

VA can and should address issues related to business and operations (discussed in Assessment E) with solutions that support IT modernization related to VHA phone systems.

Relevant Health Care Objectives and Business/Clinical Strategies

Future scheduling systems should reflect the overarching vision of VA to "improve the quality of care for Veterans with complex medical conditions through an evolving approach to personalized, proactive, and patient-centered care" (VA, 2014c). The current VistA scheduling system is difficult to use and does not provide adequate insight into business operations. Table 6-1 summarizes the strengths and weaknesses of VHA scheduling IT systems.

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Table 6-1. Summary of VHA Scheduling IT System Strengths and Weaknesses

Strengths	1. ACAP is making process and policy changes that will complement ongoing and future IT improvements. The ACAP team has deep insight into the issues around scheduling and will provide strong insight as the MASS activity is initiated. 2. Recent efforts have improved access to appointments for Veterans, and VSE will ameliorate some critical issues with scheduling when employed in the operating environment by fall 2015. 3. The Scheduling Program Council (SPC) is addressing the larger concept of access via scheduling modalities across VHA, and is bringing together leadership with the authority and vision to drive change.
Weaknesses	1. Inconsistent/poor relationships between VHA and OI&T over the years have slowed initiatives and improvements in scheduling. This systemic organizational issue has manifested itself within scheduling. 2. The current VistA scheduling system exacerbates inadequate processes and procedures that currently impede access to care. 3. System-wide scheduling initiatives so far lack fully supported governance to guide prioritization, funding, resource allocation, etc.

Efforts to improve access to health services through the development of various scheduling products and enhancements have included some collaboration between OI&T and VHA. Misalignment of funding streams and accountability have led to delays in schedules, failed development and deployments, and failure to incorporate appropriate business requirements and features into the operating environment. Unless VHA and OI&T realign governance, funding, and accountability, any product development or implementation will risk delaying improvements in access and lead to inefficiencies and higher costs.

Finding 6.1.1: The RFP package for the COTS MASS scheduling product has been developed over several years and was built on decades of experience, lessons learned, evaluations, and analyses. However, without enterprise-level improvements in management processes and governance, there is a risk that the MASS project will not succeed.

Components of IT design, planning, and implementation that are not yet fully planned and funded, and whose scope is not understood, pose particular concern. Specific shortfalls include standardization of clinic profiles, education and training, policy changes, resourcing and budget allocation, organizational challenges, the effect of the COTS product on VistA, and full lifecycle cost assessments. VistA Evolution program evaluations included high-level ROI assessments for scheduling initiatives (VA, 2014); however, the Assessment H team could not discover a detailed, current analysis.

Finding 6.1.2: The deployment of the MASS COTS package will require significant adaptation of existing VHA scheduling processes and an unknown amount of custom software

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development to achieve effective integration with other VA systems, including the multiple instances of VistA across VAMCs.

Section 4 describes factors that will likely affect a project as large as MASS, including the following:

- **Culture and Leadership.** Many Assessment H interviews across VA noted lack of effective collaboration between OI&T and VHA with respect to IT strategies. Like any large program, MASS must overcome process and cultural hurdles, but ACAP is adapting policies and procedures to satisfy requirements for the next phases of the program (see Assessment E). Top-down accountability and collaboration of both business and technical leadership will prove key to delivering business and technical requirements to the operational environment throughout the life of this project.
- **Planning.** Difficulties in translating clinical goals into IT requirements may complicate the implementation of MASS. While some reports indicated a good working relationship between OI&T and VHA during the RFP package development, history and the inability to gather firm evidence to the contrary (due to sequestration) would indicate that risks related to design and planning remain.
- **Resourcing.** According to interviews across VA, allocation of resources remains inconsistent and insufficient despite efforts to improve the process, and interviewees reported incomplete lifecycle planning pertaining to project funding. Considering the complexity and scope of MASS, the potential for scope and feature modification along the way, and the reported issues related to delivery of business requirements, consistent and adequate resourcing could pose concerns throughout the life of the project.
- **Implementation.** Currently VHA and OI&T take a fragmented approach to large-scale health IT development. MASS documents provide a great deal of information for potential vendors about integration points and related requirements, but VA so far has not succeeded in solving large-scale system problems, and governance issues noted could impact many facets of implementation. VHA and OI&T could ease implementation issues through ongoing efforts to coordinate business, technical, functional, and non-functional requirements across programs and offices.
- **Infrastructure.** Any implementation with the scale of MASS will require highly detailed plans and oversight at many levels and throughout the development and delivery process. The project will involve many technical challenges, including numerous dependencies and the need for many data exchanges. In an effort to improve and simplify some scheduling features across the system, ACAP has begun work on standardization that will support national-level business rules, data capture, and other aspects of MASS, as detailed in Assessment E.

Finding 6.1.3: VA does not yet have a robust, detailed strategy and roadmap for scheduling initiatives across VA that integrates Veteran access to scheduling via phone, telehealth, and mobile apps.

VHA envisions a “Single View of the Veteran” (described in the MASS Business Blueprint; VHA 2014b) that demands consistent, accurate, secure data capture and exchange for the Veteran

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experience, including support for scheduling modalities. The MASS Business Blueprint and the MASS PWS (VA OI&T Product Development, 2014) note that the new MASS vendor must support web and mobile requests by Veterans, and as such the documents list such requests as unique, high-priority business needs. They also cite the need to support telehealth as a medium. While the Connected Health FY15-16 Operating Plan V19 delves deeply into mobile apps and serves as a roadmap for that program, it makes little mention of MASS or the larger scheduling initiative.

However, interviews conducted during the Assessment H study indicated that VA has recently made progress in its scheduling efforts. VA has tasked the Scheduling Program Steering Committee (SPSC) that supports the SPC with oversight of the individual ad hoc teams that will aid the SPC. The SPSC represents the major stakeholder groups that will integrate with MASS and scheduling initiatives, and it will likely include stakeholders from Connected Health, VSE, MASS, the HealtheVet (HeV) portal, and others. While the new SPC has had some difficulty gaining traction as a formal entity, limited reports indicate that the stakeholders have made inroads in recent weeks and months during the technical evaluation of MASS, and that leadership levels have achieved some concurrences around budgets and priorities.

Finding 6.1.4: VA must refresh the technology of its telephony system to support scheduling process changes. Some pilot projects that have developed call centers have succeeded, but resources (funding, human capital) and the lack of consistent guidance and prioritization have limited progress across the system.

The VHA phone system performs poorly in data collection, warm transfers, and other customer-facing features, as described in a white paper developed by the VHA Offices of Primary Care Service (10P4F), Primary Care Operations (10NC3) and Access and Clinic Administration Program (10NA12) in December 2014 (VHA, 2014d). Assessment H found the same challenges in leadership, funding, expertise, and prioritization described in this paper. The MVAT Project that supports the Telephone Access and Contact Management (TACM) Office is addressing some of these issues, but the timeline presented extends over 15 years with core concepts identified on a 7–10 year roadmap (VA, 2014d). VHA could shorten that timeline by dedicating additional resources, potentially increasing Veteran access and satisfaction.

6.2 Recommendations

The VA/VHA scheduling program reflects many of the same strengths and risk factors seen across other VHA programs. Recent and ongoing programmatic achievements such as VSE, on track to rollout enhancements by fall of 2015, and the MASS effort to date, highlight the enormous effort that VHA has devoted to improving a dynamic environment with unique drivers and metrics, a convoluted legacy infrastructure, embedded cultures, and the need to counter negative press. Still, risks inherent to the infrastructure, governance, and resource planning, along with lack of human capital, hamper the program's ability to plan, build, implement, and maintain systems and technology.

Modernization of scheduling and telephone systems should provide access for both new and established Veterans seeking care within VHA. Improvements to the existing scheduling program, as well as the planned phase-in of MASS, should lead to efficiencies, cost savings,

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expanded access, and higher satisfaction from internal and external customers. These improvements should foster innovations in health modalities such as telehealth, virtual care, and mobile engagements. Development of key metrics and consistency in data capture and sharing should help VHA transition into a more data-driven organization and allow VHA to better forecast supply, demand, and other operational drivers.

Continued investments in phone systems over time, with strong considerations for a shorter timeline than is seen in current plans, should support VHA's goals of improved access and customer satisfaction. However, VHA makes these investments in scheduling and telephone systems at the cost of other investments; thus, an enterprise-level understanding of the costs and benefits across all VA projects will prove key to success. Without significant cultural and organizational changes, there is risk to any path forward for these initiatives. The SPC is making strides toward establishing accountability and governance at the appropriate levels, but will require time, effort, and resources to reach its potential.

A holistic approach to improving access through scheduling initiatives and modernization should provide VA/VHA with improved access and outcomes at a better cost over time. However, the lack of effective collaboration and high-level planning, difficulty in data translation, poor resource allocation, and an overly complex infrastructure hamper design, development, and execution. Table 6-2 shows a summary of VHA scheduling opportunities.

Table 6-2. Summary of VHA Scheduling Opportunities

1. VHA can provide cradle-to-grave support for scheduling initiatives once prioritizations are determined. MASS is currently under technical evaluation, creating opportunities to exploit new governance structures (SPC) and build the path forward through experience and action.
2. Through the SPC there is an opportunity to make impactful decisions that align business and clinical needs under a fully considered budget. This Council has the line authority and leadership-level vision to make the hard decisions that will be required to balance needs in scheduling against needs of EHRs, phone systems, innovations, cyber, and other high impact areas. Full support of this team at all levels of governance will ensure that the voice of the front line is recognized and considered within the existing fiscal constraints.
3. Improvements in scheduling should dramatically increase access and satisfaction, as well as data quality, productivity, and operational reporting capabilities.
4. Enhanced transparency will help to rebuild trust with the community of Veterans.
5. Developing/aligning scheduling capabilities across modalities (outpatient, telehealth, mobile apps, etc.) should provide the 21st century access that Veterans desire.
6. Broadening and improving scheduling capabilities will provide more opportunities for Veterans to become active partners in their own care.
7. VSE and MASS will improve operations and free up human capital, potentially leading to shorter wait times for traditional outpatient appointments, an increased capacity for telehealth and other provider/Veteran engagement modalities, and cost savings.
8. Heavier investments in telephone systems could improve access and shorten the timeframe for improving access and services, albeit at the expense of other projects.

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Recommendation 6.2.1: VA should develop a more detailed strategy and roadmap encompassing outpatient scheduling, mobile apps, telehealth, and modernized phone systems to ensure success of the COTS MASS product acquired.

Without full support of an enterprise-level strategy and budget allocations, these ongoing and future efforts will produce only moderate gains in access to health services, Veteran satisfaction, and operational efficiencies. As previously detailed in this report, strengthening or modifying IT business and technical processes will aid delivery of capabilities into the operating environment. To do so, VA should take the following actions:

- Support the SPC (and SPSC) fully as soon as possible as this group has the appropriate level of vision and insight, as well as the authority and diversity, to initiate and drive change where and how it is needed. VA should address any outstanding concerns or leadership issues, and modify and formalize any charter and governance documents to ensure engagement.
- Refine the strategic funding and resource processes to align technical and clinical goals. VA should realign access and scheduling initiatives (MASS, mobile, telehealth, etc.) so that stakeholders understand all aspects and will support prioritization at an appropriate level.
- Once the contract for MASS is awarded, develop a roadmap to include all aspects of VHA scheduling (telehealth, mobile, phone systems, etc.) and use the roadmap to guide integration of scheduling across VHA clinics and management applications and new technologies as appropriate. VHA must integrate cross-program efforts, and this will demand a more robust strategy and roadmap that address all of the modalities involved. The SPC should make decisions soon after award about prioritizations related to MASS and scheduling across VHA. Through this, VA could gain better short-term and long-term insight into fiscal planning and requirements.
- Through the SPC or related efforts, align all OI&T and VHA activities related to access to execute a health IT strategy that will contribute to improving Veteran health. Better alignment of program business needs with technical requirements, specifically for MASS, mobile, web, and telehealth, could reveal economies of scale, provide insight into future collaborative efforts, support better prioritization, and spur innovation. This would help to associate IT outcomes more tightly with clinical outcomes to improve Veteran health and satisfaction.
- Perform regular assessments of scheduling-related core services of COTS versus continued in-house development to ensure that VHA delivers the best products at the best value to the operating environment. VHA should initiate this process as soon as possible after the launch of MASS, with evaluations at each step of design to determine and prioritize products best suited for funding. VHA should evaluate cost versus benefits of leveraging existing systems over new ones with consideration for all aspects of lifecycle costs and impacts. This may demand that the SPC conduct additional studies after the contract for MASS is awarded.
- Incorporate full lifecycle costs into integration and interoperability plans early on, providing insight into resource allocations and future funding requirements. This, too, may call for additional SPC studies after MASS contract award.

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- Ensure that the portfolio of metrics developed for MASS provides an assessment of impacts on Veterans with each incremental deployment, as well as insight into costs, so that robust cost assessments can be used for decision making. With regular assessments of products and options, VHA could develop a well-balanced portfolio of COTS and in-house products that best meets the needs of Veterans and drives improvements in clinical outcomes.

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7 Clinical Documentation

Clinical documentation includes clinical images and associated textual reports that cover clinicians' descriptions of episodes of hospital care, medical services, and other health care. This section examines clinical documentation practices within VHA, including the means by which clinical documents are created (the documentation process) and the documents produced by the system.

7.1 Findings

VHA was once a leader in clinical documentation, adopting best practices ahead of the majority of health care institutions in the United States. Unfortunately, in 2015, the clinical documentation produced by the VHA health system is, at best, average in terms of quality and support for data standards. VHA has lagged in the movement towards greater standardization of clinical documentation practices, particularly with respect to the incorporation of standard structured and coded terminologies. This lack of standardization has impeded communication inside the VHA system, made it harder to develop effective clinical decision support systems, and caused downstream challenges and shortcomings in health information exchange and analytics.

Capturing relatively little information in machine-readable form hampers VHA's ability to examine its clinical, operational, and financial performance and to exchange data among VA facilities and with third parties. Moreover, the failure to adequately utilize coded terminologies and standards in the capture of data during the clinical documentation process, as well as additional limitations in information exchange, reduce VHA's ability to measure outcomes of care and learn from them – impeding the creation of a continuously learning health system.

Observations regarding clinical documentation cover:

1. **Point of Care (POC) Documentation Systems.** The assessment of clinical documentation must consider: (1) the *practice* of documenting health information, whether on paper or through an information system; and (2) when electronic systems are used, the manner in which those systems support clinical documentation best practices. While Section 5 examines VA's EHR capabilities, this section centers on the ways in which clinicians use the current EHR to document care as well as on the quality of the clinical documentation produced by POC systems.
2. **Data Quality Management and Clinical Documentation Improvement (DQM/CDI) Programs.** The quality of clinical documentation depends on both the quality of the data and adherence to data standards that impose consistent syntax and semantics (i.e., harmonization of data definitions, as well as incorporation of standard nomenclatures, terminologies, classifications, and code sets). Monitoring data quality, documentation for coding, and adherence to data standards help identify any clinical documentation issues, as well as the appropriate interventions (e.g., face-to-face training programs vs. handouts) to address them.

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3. **Secondary Data Use.** VHA uses data from POC systems for analytics, reporting, and health information exchange. Each of these activities requires that data be cleansed and transformed for the particular purpose. These data cleansing and transformation processes yield valuable insights into the manner in which POC systems can collect data, balancing the data needs for health care delivery, transitions of care, and analytics.[12]
4. **Feedback Loop.** Feeding back the insights and lessons learned from DQM/CDI programs and secondary data use initiatives in the form of system requirements (e.g., data validation routines, standards-based copy-and-paste functionality, proper use of codes) can result in enhancements to IT systems such as VistA and CPRS, or in specifications for future IT products such as those planned for the VistA Evolution program. These insights can also suggest updates to clinical documentation best practices that will support clinical decision support in future systems.

The above components, as shown in Figure 7-1, demand a comprehensive, integrated, and collaborative approach among product development, health information management, and analytics staff, as well as the clinicians who use POC systems. Moreover, the implementation of these components in an integrated manner conforms to the principles of a learning health system.

[12] The description of analytics and secondary data use is provided as background on the analytics issues related to clinical documentation; it is not intended to describe the wider area of informatics and analytics. Section 8 contains a more detailed description of informatics findings and recommendations.

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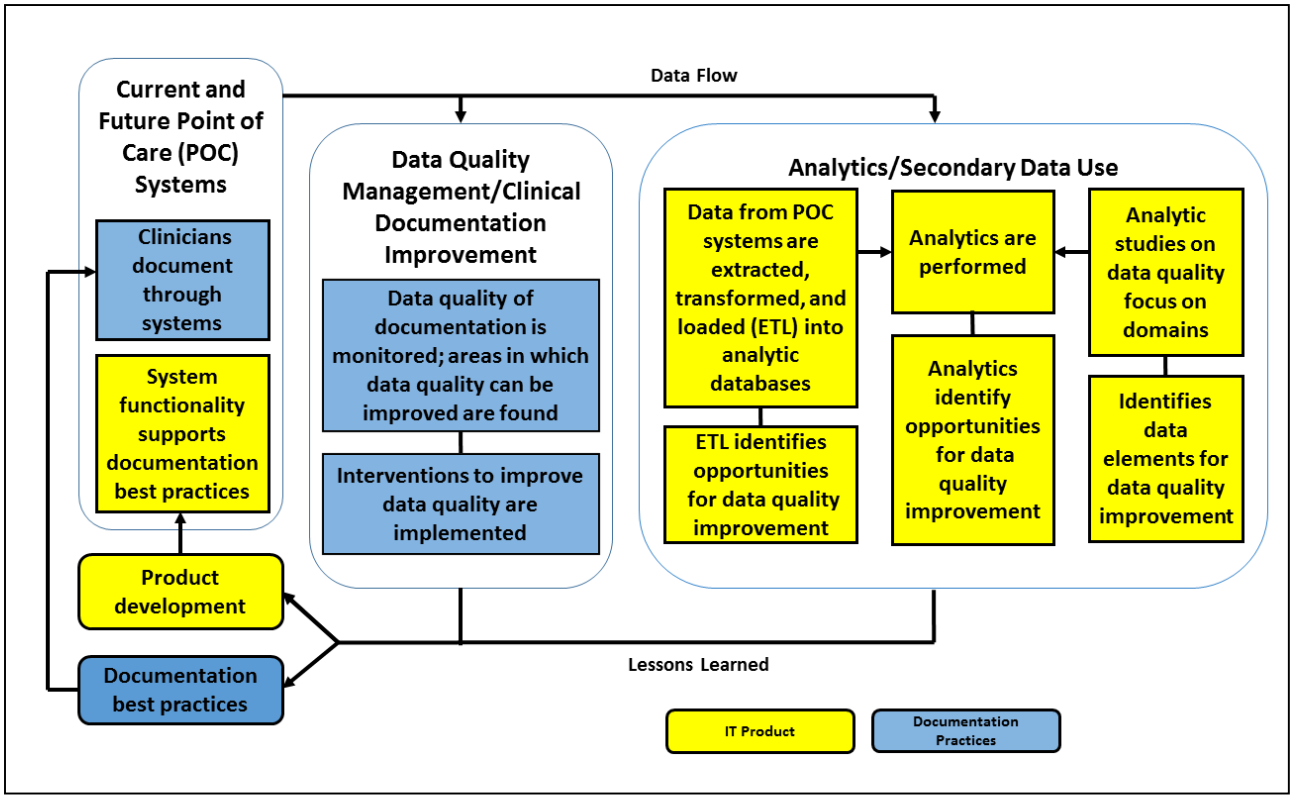
Figure 7-1. Assessment of Clinical Documentation



Source: MITRE rendition of VHA process.

Relevant Healthcare Objectives and Business/Clinical Strategies

The VA *Blueprint for Excellence* (VA, 2014c) advances four themes and 10 strategies that together frame a set of activities aimed at improving VHA health care, building a service culture, transitioning from "sick care" to "health care," and developing more agile, efficient business systems. Theme One of the *Blueprint* centers on improving the performance of VHA with respect to the current delivery system. The *Blueprint* states that:

> VHA is fortunate to have a longstanding electronic health record, offering the possibility of generating "big data" related to care and health. Advanced analytics should be used predictively to identify and intervene on risks, improving the outcomes for individuals, cohorts, and the overall population of Veterans enrolled for care within VA.

VHA captures the majority of data coming out of EHRs during the documentation of care in the form of clinical documents and reports. Thus, effective analytics have a critical dependence on the quality of clinical documentation (see Section 8).

Under Theme One, Strategy Three states: "Leverage information technologies, analytics, and models of health care delivery to optimize individual and population health outcomes." This strategy describes two transformational actions that rest squarely on best practices in the creation of clinical documentation: "Enhance the interoperability of Health Information with DoD and the Private sector" and "Enhance Clinical Decision Support using Analytical Systems and Predictive Analytics (VA, 2014c).

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Finding 7.1.1: VHA lacks a comprehensive and collaborative approach for producing clinical documentation. Clinical documentation tools do not collect key data in a consistent or standardized manner and often lack the functionality to support current documentation best practices.

To assess the general quality of clinical documentation generated by VHA facilities, the Assessment H study team used the American Health Information Management Association (AHIMA) guidelines (AHIMA 2007), which assess clinical documentation according to parameters that include:

- Accuracy—Ensure data are the correct values, valid, and attached to the correct patient record.
- Accessibility—Data items should be easily obtainable and legal to access with strong protections and controls built into the process.
- Comprehensiveness—All required data items should be included. Ensure that the entire scope of the data is collected and document intentional limitations.
- Consistency—Value of the data should be reliable and the same across applications.
- Currency—Data should be up to date.
- Definition—Clear definitions should be provided so that current and future data users will know what the data mean. Each data element should have clear meaning and acceptable values.
- Granularity—Attributes and values of data should be defined at the correct level of detail.
- Precision—Data values should be just large enough to support the application or process.
- Relevancy—Data are meaningful to the performance of the process or application for which it is collected.
- Timeliness—Timeliness is determined by how and when the data are being used and the context.

The Assessment H study team identified documents containing similar guidance distributed by VHA. These documents conveyed clear expectations for clinical documentation generated at VHA facilities (VA_AssessH_COR_156, 2014); however, interviews indicated that Health Information Management (HIM) departments and staff at the VISN and hospital levels interpret these standards in different ways. Clinical documentation provided and related activities most often pursued at many hospital level HIM departments appeared to focus on the proper coding of diagnoses and testing for attributing costs, with less attention to the general quality of documentation from a clinical perspective as detailed in the AHIMA and VHA documents. By contrast, VA's Office of Information and Analytics (OI&A) emphasizes the structure and coding of clinical documentation to support clinical decision support and analytics. Most activity advocating standardization of key clinical data has come from OI&A. Thus, both AHIMA and VHA have established initiatives aimed at improving different aspects of clinical documentation. VHA would benefit from better planning, coordination, and collaboration between these and other groups that contribute to the quality of clinical documentation produced by VHA systems.

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Finding 7.1.2: The quality of VHA clinical documentation produced by current systems does not support accurate and optimal analytics or clinical decisions. Unclear definitions of data elements and extensive free text entries within clinical documents impede the creation of effective analytic data resources.

As noted in Section 5, Assessment H interviews revealed that most clinicians are moderately satisfied with the flexibility and functionality of the CPRS user interface—their primary system for creating clinical documentation. VistA and CPRS capture some data in discrete fields and retain the data in coded form. However, clinicians enjoy the flexibility of entering a significant portion of the data as unstructured "free text," reporting that this allows them to convey a richer patient story and context that helps them better understand their patients.[13] This flexibility (1) introduces variability in clinical documentation; (2) demands greater effort to extract quantifiable data as well as monitor, cleanse, and transform the data downstream (VA OI&A, 2014b and 2014c); and (3) results in analytics or reports that contain different results although they were ostensibly drawn from the same data, undermining trust in the information.

Finding 7.1.3: Current VHA clinical documentation practices do not adequately support accurate measurement of quality, safety, or performance metrics.

Capturing information in a semantically clear, machine-readable form has an important impact on measurement of operational performance, quality, safety, costs, and support for general analytics. VHA's ability to provide these functions depends on making a greater portion of the data generated in the course of documenting care accessible in this form throughout VHA in order to assess these measures at a single site, within a VISN, or across the entire VHA system. Currently, the widespread use of unstructured, uncoded text in clinical documentation and the failure to support emerging clinical documentation exchange standards force VHA to exchange data in a manner that the data recipients cannot interpret without manual intervention (VA OI&A, 2014b and 2014c).

To enable large-scale measurement of performance, quality, and safety, and to build effective analytics, IT systems must capture data in a way that supports these functions. This usually means adhering to a standard for each data type, capturing information via the use of coded terminologies, and structuring forms to contain as much coded data as possible. However, requirements to capture too much data in coded structured form can slow down the physician and degrade the physician-patient interaction. It also can add time to the documentation process for busy physicians. Clinicians can easily enter certain data, such as problems and medications, in structured form, but other data types, such as medical history, are less suited to structured entry.

Ultimately, VHA must find a balance that captures useful information efficiently without compromising physician or patient experience (Rosenbloom et al., 2011). To improve speed, vendors and their physician users have developed various shortcuts for documenting care, such

[13] Section 5 contains a more detailed assessment of CPRS. The description of clinician use and satisfaction with VistA and CPRS in the present section is provided only as background on implications for clinical documentation.

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as cutting-and-pasting of prior notes, "copy forward" functions, and macros that create large blocks of text quickly. While these techniques may accelerate the process, they result in large amounts of unnecessary text (so-called "note bloat") and sometimes introduce errors, while at the same time making it difficult for other clinicians to read and understand the patient's true situation. The Medical Informatics Committee of the American College of Physicians has developed guidelines to deal with this phenomenon (Kuhn, Basch, Barr, & Yacket, 2012).

Today's best systems balance all competing needs to produce high-quality clinical documentation (Schiff & Bates, 2010; Silow-Carroll, Edwards, & Rodin, 2012). VistA and CPRS capture some data types in coded form—most notably problems, laboratory data, medications, and allergies—but could capture more information in structured coded form without unduly burdening clinicians. Assessment F (Workflow – Clinical) found, "In spite of national efforts to address these issues [appropriate use of copy-paste functionality] through mandated monthly EHR quality reviews, VHA clinical staff and medical coders reported that challenges persist: 80 percent of sites reported limited template utilization or use of suboptimal templates and 55 percent reported inappropriate use of copy-paste."

Finally, many specialists at non-VA hospitals and practices increasingly use natural language processing to extract important data from free text records. This technology can sometimes extract coded concepts from text, freeing physicians from the need to laboriously enter this information themselves. Increasing use of this new technology should improve physician productivity and VA should explore its use.

Finding 7.1.4: The standards and terminology used in clinical documentation, as implemented by VistA and CPRS, do not suffice to enable interoperability across multiple systems within VA, as well as between VA and non-VA facilities, including payers, private sector providers, DoD, and individual Veterans.

VHA must exchange health-related data between VHA facilities and increasingly with non-VA health care facilities at which Veterans receive treatment. VHA facilities have difficulty exchanging data with each other and find it nearly impossible in most cases to send information electronically to outside health care facilities. This results in part from the lack of clear standards for the exchange of clinical documents between facilities.

Commercial vendors are rapidly adopting certain standards, such as the HL7 Consolidated Clinical Document Architecture (CCDA) and the Fast Health Internet Resources (FHIR) standard, which will soon allow far greater exchange of data. By embracing these standards and creating the necessary application programming interfaces (APIs) to support interchange using these standards, VHA would greatly enhance the communication and quality of care received by Veterans treated at multiple sites. Finally, beyond improving the quality of clinical documentation and the quality of care, greater exchange of data will also increase VHA's ability to measure health care results and use this information to improve future care.

Finding 7.1.5: Clinical imaging and document archival systems are functionally adequate; however, accessing raw images and reports from within clinical workflow processes can be awkward and often requires users to navigate multiple systems.

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CPRS users wishing to access medical images and reports must often navigate to native VistA imaging systems and/or document archival systems—particularly when attempting to review third-party reports that are currently mailed and scanned for incorporation into VistA with little accompanying metadata. Researchers also have difficulty searching for the images they need and extracting data from images and associated text reports because CPRS lacks sufficient metadata on many of the images to make extraction practical. VHA is aware of these shortcomings and has planned for improvements both in current systems and as part of the VistA Evolution program.

Interviewees characterized support for other clinical imaging systems as adequate but providing little opportunity for substantive improvements or innovation. VHA currently has a project underway to create a centralized optical character recognition (OCR) capability that will securely scan and extract metadata, including encounter-level information that will give clinicians much faster access to data. Finally, the improvements noted above will create an opportunity for previously impossible image mining and analytics.

7.2 Recommendations

VHA should reduce the amount of unstructured data in clinical documentation by analyzing instances in which IT systems could collect currently unstructured data as discrete structured data and by changing the data field definitions over time. At the same time, VHA must consider the need to balance maintaining ease of documentation for clinicians and providing more computable data for downstream analytics needs.

Recommendation 7.2.1: VHA should implement a broad process, involving clinicians, to pursue requirements that support clinical documentation best practices and improved functionality and usability while taking into consideration the positive aspects of existing systems.

Where analyses conclude that unstructured text (free text) remains the best means for capturing detailed clinical data, VHA should accelerate informatics efforts to study and deploy emerging technologies (e.g., natural language processing) that can parse unstructured data and reliably extract computable structured data. Implementing a comprehensive integrated clinical documentation quality program and fully engaging stakeholders in IT product development will help VA/VHA balance ease of documentation with the collection of computable data and increase the potential for more robust software functionality in the VistA Evolution project.

Recommendation 7.2.2: VHA should accelerate efforts to establish semantic definitions for data elements through the use of standard nomenclatures, terminologies, and code sets to improve exchange of data and interoperability among VA facilities and with payers and non-VA providers.

VHA should incorporate current data standards into initial releases of VistA Evolution, rather than wait for later releases. By doing so, VA/VHA can ensure consistency and integration across multiple systems, leverage development and implementation of follow-on IT products, and facilitate clinical decision making, analytics, quality, safety, performance measurement, and health information exchange.

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Specifically, VHA should invest in the technologies needed to exchange HL7 clinical documents containing more computable structured data. This may require developing business drivers that motivate non-VA facilities to implement HL7 CCDA, FHIR, and other applicable standards on their side of the exchange process. Exchanging more standardized computable data will promote interoperability in the health care industry and could position VA/VHA as an industry leader in this area. Engaging in industry-level data standards and information modeling initiatives (e.g., HL7, Clinical Information Modeling Initiative) should benefit similar VA/VHA efforts, promote adoption of data standards across the health care industry, and place VA/VHA in a leadership role.

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8 Informatics and Analytics

VA formed OI&A in February 2011 to "Support patient-centered care by facilitating the deployment of innovative, secure health data systems and collecting, analyzing and disseminating the highest quality health information for Veterans, caregivers, clinicians and administrative staff for decision-making" (VA, 2014a). In December 2012 the majority of the Office of Health Information (OHI) was realigned with OI&A to leverage both health data and health IT.

Relevant Healthcare Objectives and Business/Clinical Strategies

OI&A provides capabilities and services that are critical to the themes, strategies and transformational initiatives described in the *Blueprint for Excellence* (VA, 2014c). Theme One of this *Blueprint* centers on improving the current delivery system. Under this theme, Strategy Three states: "Leverage information technologies, analytics, and models of health care delivery to optimize individual and population health outcomes." One of the transformational initiatives associated with this strategy, "Enhance Clinical Decision Support using Analytical Systems and Predictive Analytics" (VA, 2014c), depends heavily on OI&A. The third theme focuses on advancing health care innovation for Veterans and the country. OI&A contributions are also critical to the success of several transformational initiatives associated with Strategy Seven ("Lead the nation in research and treatment of military service-related conditions"): "Rapidly Translate Research Findings and Evidence-Based Treatments into Clinical Practice," "Conduct Veteran-Focused Comparative Effectiveness Research," and "Enhance VA Research with Health Informatics."

IT Systems Used for Informatics and Analytics

OI&A provides reporting and analytics capabilities through the:

- CDW (Corporate Data Warehouse): Data, infrastructure, and tools housed at the Austin Corporate Data Center Operations (CDCO), covering national clinical, financial, and administrative data from across the enterprise
- RDW (Regional Data Warehouse): Data, infrastructure, and tools housed in OI&T Regions 1–4 , covering VISN clinical, financial, and administrative data collected through the CDW process
- VINCI (Veterans Informatics and Computing Infrastructure): Data, infrastructure, and tools used to support the Health Services Research community as well as the advanced analytics needs of the enterprise

The VistA systems (described in Section 5.1) and the clinical documentation records (described in Section 7.1) feed the CDW, RDW and VINCI.[14] CDW consolidates the highest priority domains of key clinical and operational data and permits near-real-time analysis and reporting. VHA produces a number of dashboards, graphs, maps, and reports from CDW data. These products are aimed at assessing treatment safety and effectiveness, improving patient care, monitoring

[14] http://www.hsrd.research.va.gov/for_researchers/vinci/cdw.cfm

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costs and efficiencies, and preparing for national emergencies. The consolidation of reporting systems and activities through the OI&A allows VHA to generate authoritative analysis with more consistent results.

Although the CDW was created primarily to support health care delivery, researchers also use its contents. VINCI provides secure workspaces for informatics researchers to use this data in experiments with advanced tools such as the Hadoop framework for processing large data sets across clusters of servers, machine learning software, Bayesian statistical analysis tools, human factors analysis, and natural language processing tools. In the research arena, analytics are moving from a traditional encounter-based view of patient care to a more longitudinal population-based view of groups that researchers could use to predict the outcome of care and assess health interventions in a risk-based way.

The numbers below, drawn from CDW training materials, provide a glimpse of the volumes of data stored:

- Unique Veterans: 20 million
- Outpatient encounters: 1.6 billion
- Inpatient admissions: 9 million
- Clinical orders: 3.2 billion
- Lab tests: 5.6 billion
- Pharmacy fills: 1.5 billion
- Radiology procedures: 162 million
- Vital signs: 2.3 billion
- Text notes: 2.0 billion.

8.1 Findings

OI&A seems positioned to lead VHA's transformation into a learning health system that can achieve better Veteran health, better care, and lower costs. However, the slow pace of VA's IT development, the constraints imposed by old systems that pre-date modern technologies and health data standards, and limits on resources constrain OI&A's ability to succeed.

Informatics and analytics capabilities in VHA leverage VistA, which became operational in 1985, and the associated CPRS user interface. Since 2004 VHA has used VistA/CPRS to document clinical activities, retrieve results, and enter orders for medications, procedures, and consultation. Local sites developed early analytical tools and used them to extract structured data, create facility-level reports, and identify practices that improve the quality of patient care. Although VHA has obtained some analytical value through these methods, technical limitations of VistA/CPRS continue to hamper true progress in advancing informatics and analytics (see Sections 5, 7, and A.3).

OI&A has formed some effective partnerships and shows evidence of producing analytic products for use across VHA (Findings 8.1.1 through 8.1.3). However, VHA's aging information systems limit its ability to keep pace with rapid advances in the field of health informatics and

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analytics. Section 5 of this report describes the challenges and root causes of the issues with VHA's information systems, and the high cost of maintaining them. Findings 8.1.4 through 8.1.6 center on the impacts that these systems limitations have on the ability of VHA to perform accurate and useful informatics and analytics functions.

Finding 8.1.1: Research partnerships have proven effective in expanding and demonstrating the value of VA/VHA informatics and analytics capabilities.

OI&A occasionally partners with other components of VHA and with external health organizations to conduct analytic research on key health challenges of the Veteran population. An example is a recently published collaborative effort between the National Institute of Health, the VHA office of mental health operations, the VHA office of public health, VHA mental health services, OI&A, and VISN 2. The research team performed statistical analysis on clinical data from the VHA National Patient Care Database, a collection of integrated patient care data from all VistA systems. The study analyzed hundreds of variables, including clinical, demographic, military service history, behavior, mental health, and drug use factors. The model used succeeded in accurately predicting subgroups with suicide rates up to 80 times higher than VA patients as a whole, and found that current practices do not flag all patients in the high risks groups (McCarthy et al., 2015).

In FY14, VINCI supported over 600 Health Services Research & Development (HSR&D) projects. Projects included studies on self-directed violence and suicide, homelessness, post-traumatic stress disorder, military sexual trauma, end of life care, hepatitis C, acute kidney injury, and traumatic brain injury, just to name a few.[15] VHA has also established a set of policies and procedures that enable sharing of data in secure workspaces with research institutions, while complying with privacy and security regulations. One example mentioned during Assessment H interviews was a collaboration with IBM on application of the Watson predictive analytic capabilities to the health care domain, initially exploring the utility of Watson for post-traumatic stress disorder.

Finding 8.1.2: Strategic Analytics for Improvement and Learning Value Model (SAIL) reports supply valuable information across VA/VHA.

Operational Analytics and Reporting (OAR) within OI&A produces a quarterly report called SAIL, which offers high-level views of health care quality and efficiency at VHA. SAIL has grown and improved since 2012 with the addition of new measures and new facilities. As of June 2014, the SAIL reports included data from 128 VAMCs that provide acute inpatient medical and/or surgical care to Veterans and 19 facilities that do not offer acute inpatient medical and/or surgical care (VA, 2014c; VA, 2014d). SAIL reports are adapted from the Truven Health Analytics' Top Health Systems Reports,[16] and include all eight inpatient Truven measures as well as additional measures related to health care quality, employee satisfaction, quality of life, and efficiency. As of 2014, the reports included measures across the following domains:

[15] Research highlights for several of these projects can be found at http://www.hsrd.research.va.gov/publications/forum/oct14/default.cfm.

[16] http://truvenhealth.com/

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- Acute care mortality
- Avoidable adverse events
- CMS Risk Standardized Mortality Rate (RSMR) and Risk Standardized Readmission Rate (RSRR)
- Length of stay
- Performance
- Customer satisfaction
- Ambulatory Care Sensitive Condition (ACSC) hospitalizations
- Clinical wait times and call center responsiveness
- Clinical efficiency
- Administrative efficiency

Quarterly reports graphically depict both scores at each participating facility and aggregate scores, and show the degree of improvement from one quarter to the next. The reports highlight successful strategies of top performers and help facilities identify areas for improvement.

An investigation of the actual use of SAIL reports in each of the facilities was beyond the scope of the Assessment H study. However, other Section 201 assessments have found evidence that SAIL reports drive behavior changes in some facilities and that OAR should further improve the reports.

- Facilities view a high score on the SAIL report as a source of pride, suggesting that leaders pay attention to their reports and seek ways to improve their scores (Assessments F [Workflow – Clinical] and L [Leadership]).
- Some facilities have discovered inaccuracies in underlying EHRs from which SAIL metrics are derived and have taken steps to improve the accuracy of clinical documentation at the point of entry through better training and education (Assessment F).
- The sheer number of operational performance measures overwhelms some leaders, making it difficult to focus on the most important items. While SAIL has not replaced the existing hundreds of performance measures, the reports now align more consistently to the VHA mission and are seen as a foundation upon which improved target setting could be built. (Assessment L).

Finding 8.1.3: Analytical reports and products provide useful insight and support decision making by VA/VHA organizations.

The Business Intelligence Service Line (BISL) FY14 Annual Report (VA, 2014f) describes some of the standard analytical reports and products built from corporate and regional data warehouses. Those products align to Veteran health and VHA business outcomes as follows:

- Improved Veteran access:
  - Supervisory appointment tools improve efficiency and accuracy of appointment creation.

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- Improved Veteran quality of care:
  - Electronic Clinical Quality Measures allow near-real-time reporting of clinical performance measures on all Veterans.
  - A follow-up dashboard on seriously mentally ill patients identifies Veterans who are living with serious mental Illness and who have not received outpatient or inpatient care at a VA facility for at least one year. The dashboard helps care providers proactively engage with patients who are at elevated risk of suicide or death.
- Improved Veteran safety:
  - The Opioid Monitoring dashboard helps care providers monitor use of opioid medications and ensure safe and effective use of the drugs.
  - The Time in Therapeutic Range Monitoring dashboard improves management of outpatient anticoagulation medication to reduce rates of adverse events such as stroke, blood clotting and major hemorrhaging.
- Improved financial management:
  - The Non-VA Care Consult Program Management Report links non-VA care consults and fee basis claims authorizations and appointments for use in reconciliation of budget and cost processes.
- Reduced VA cost:
  - Pharmacy Benefits Management monitors and analyzes pharmaceutical cost management programs to assess effectiveness.
  - Prosthetics and Sensory Aids Management dashboards monitor and analyze the use of national contracts to ensure Veterans receive clinically appropriate devices at the best value consistently across the health care system.
- Improved operational efficiency:
  - The VISN Morning Report provides daily updates of a variety of key patient care metrics.
- Emergency preparedness and response:
  - The Ebola Situational Awareness report tracks suspected and confirmed Ebola cases across the United States.

Assessment H did not conduct a comprehensive survey of users to determine which reports and dashboards, if any, they consider most valuable and the actual impact of these tools. However, other assessments uncovered evidence of perceived value of some reports and dashboards, as well as improvements needed. For example:

- The Pharmacy Benefits Management reports are used to manage the pharmaceutical supply chain (Assessment J [Supplies]).
- Opioid Monitoring tools have proven effective in reducing the utilization of high-risk medications such as opioids and benzodiazepines (Assessment J).

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- Senior leaders make increasing use of visual reports during daily performance meetings, which increases transparency and helps leaders and employees to focus on key metrics (Assessment L).
- Current decision support capabilities do not suffice to support oversight and management of Non-VA Care claims processing and payment. For example, VA cannot determine the reasons for denial or suspense of claims. This deficiency prevents VA from analyzing enterprise-wide denials (Assessment I [Business Processes]).

Finding 8.1.4: Problems with VistA/CPRS interoperability among VHA facilities and with external health care providers present challenges for data aggregation and analytics.

The interoperability problems identified in Section 5 will likely increase as Veterans increasingly seek care outside VHA from health care providers who produce either paper records or electronic records incompatible with VHA systems. Furthermore, over time variants of the VistA/CPRS system evolved across VAMCs, resulting in approximately 130 different instantiations of the system (Fihn et al., 2014). This poses significant challenges in integrating new technologies and data sources into VistA/CPRS and complicates VHA's ability to leverage powerful new technologies such as image processing analysis, language processing techniques for extracting information from free-form text, algorithms for processing genomic data, and analytic tools for extracting and analyzing data from personal health monitoring devices.

Finding 8.1.5: Aggregation of data across the entire VA system is problematic when each system conforms to different local data standards. This constrains the ability of VHA to conduct research, identify trends, identify best practices, and assess the effectiveness of treatments across the entire VA population.

A recent clinical code gap analysis commissioned by OI&A performed a thorough assessment of VHA's ability to electronically extract the required, standard data elements from the CDW for nine eligible provider (EP) meaningful use (MU) clinical quality measures (CQMs) and 16 eligible hospital (EH) CQMs. Key findings included (VA OI&A, 2014b and 2014c):

- Data capture can vary significantly across VISNs. This complicates data aggregation for metrics analysis and reduces data quality.
- VHA does not routinely use a Problem List or Medication List for each patient. As a result, clinicians cannot discern when a diagnosis becomes inactive. It is also difficult to determine which medications are currently active.

Most OI&A leaders interviewed cited the inconsistent use of industry data standards as a key challenge. The following comment provides an example of impact:

> …a greater issue is the lack of standardization of code sets. One aspect of data standardization is in lab tests – any given site may name it any number of ways, e.g., Hemoglobin tests. That site may know what it means. When you roll it up nationally – there is a lot of variability. Reference ranges can be different. Different sites use different lab instances.

Others described the growing challenges of integrating records from third parties:

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> Imaging is a huge issue. There are lots of different images. Image information from 3rd party consult reports is not well integrated into VistA. Currently, 98% of reports are currently mailed in and scanned into a pdf in VistA with very little (if any) metadata [searchable, computable data about the image]. Users need to dig through the system which is a disaster.

Assessment I identified other consequences of the lack of standards. VA uses a mostly manual process for receiving claims and the supporting medical records for non-VA Care, because VHA cannot process electronic records that conform to private sector standards. This also can introduce errors in analytical products, which may fail to incorporate inputs from non-VA care providers. CDW represents a particular opportunity to focus effort on data quality and common data standards and to demonstrate immediate benefits to health outcomes from better enterprise-wide data management.

Finding 8.1.6: VA faces challenges in building and maintaining a workforce with skills in health informatics and analytics at the capacity needed for an evidence-based, data-driven learning organization.

Health informatics and analytics require advanced skills and experience across a number of domains, including clinical quality measures and decision support, health care operations, computer science (machine learning, data mining, data standards, natural language processing), and mathematics (statistics, algorithm development, analytical modeling). VHA has concerns about its ability to attract and retain sufficient numbers of staff with the right capabilities.

VA OI&A participates in a very competitive marketplace for talent. Health informatics and analytics depend on a discipline labeled as data science, which relies heavily upon elements of statistics, machine learning, optimization, signal processing, text retrieval, and natural language processing to analyze data and interpret results. Partly as a result of the explosion of data generated from smart devices, web applications, mobile devices, and social media, demand for data scientists is growing across a number of business sectors, including marketing, security, fraud detection, finance, insurance, health care and manufacturing. For example:

> According to Dr. Tara Sinclair, Indeed.com's chief economist, the number of job postings for data scientist grew 57% for the first quarter this year compared to the year-ago quarter. And searches for data scientist grew 73.5% for the same period (Darrow, 2015).
>
> Salaries rose 8 percent on average in the last year, with bonuses adding $56,000, according to a salary and employment survey released on Tuesday by Burtch Works, a recruiter of professionals with quantitative skills (Lohr, 2015).
>
> A McKinsey study predicts that by 2018, the United States alone faces a shortage of 140,000 to 190,000 people with analytical expertise and a 1.5 million shortage of managers with the skills to understand and make decisions based on analysis of big data (Strong, 2015).
>
> It's clear that talent equipped for these roles is in high demand and low supply across a number of industries as more agencies turn to data to inform creative and media strategies (Bruell, 2014).

VHA expressed concerns in written documentation and interviews about maintaining a sufficient number of well-qualified staff.

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> As of December 16, 2012, as part of VHA realignment which brought OHI into OI&A, OI&A had 680.73 Full-Time Equivalent Employees (FTEE). The authorized FTEE ceiling was 646.43. The Resource Management Committee (RMC) approved 22.0 FTEE above the limit for 36 months beginning January 1, 2012 (VHA, 2014e).

OI&A personnel also noted frustrations with OI&A staffing levels, for example:

> We were created as an organization – but have been sorely under-resourced. We have been undersized. VA has done most investment in data collection and storage. We've got lots and lots of data—we tend to not use it very well. We touch 2% of the data we have. We don't do this as well as we should or could—because we are largely resource-constrained.

Assessment H interviewees also cited concern over getting the right types of skills.

> We have a serious lack of talent in the organization – in the clinical and technical. Very few people left who understand our processes.

> Getting the right skillsets is hard, e.g., in quality measurement. A mindset used to be—ordered measures, compliance mentality. Need to think about decision support, some analytic skillsets are required. We see a need for Bayesian analysis skills. It's a challenge in a government environment to hire the right folks.

The consumers of health informatics products and services at VA span VHA and VA OI&T and include nurses, pharmacists, physicians, dentists, and researchers who perform health informatics functions as at least part of their job responsibilities. In 2013, OI&A estimated the size of this population at some 6,000 individuals, based on the numbers of individuals culled from known informatics-related email distribution lists (VHA, 2014e).

The Health Informatics Initiative, established in 2011 within OI&A, is building the capacity to deliver informatics solutions for health care delivery. The Initiative conducted two workforce assessments, one in 2011 and one in 2013. The assessments included surveys to determine professional qualifications, health informatics roles, competence, and career and community development activities. OI&A uses the results of those assessments to decide on its workforce investments. As a result of these assessments, OI&A has implemented a number of training and awareness programs, increased engagements with professional organizations, and established career paths. The assessments also help VHA to anticipate workforce changes well in advance, so that interventions can be made early. For example, the 2013 assessment identified a risk of significant loss of talent due to retirements:

> Approximately one-third (32%) staff expect to discontinue their role in health informatics at VA within the next five years and over half (59%) expect to leave their roles in the next 10 years. This is not surprising given the number of people who have had a role for over 10 or 20 years; it suggests that many respondents are coming up on retirement (VHA, 2014e).

8.2 Recommendations

OI&A is in a position to lead VHA in the transition to become a learning health system. With appropriate resources, leadership, and direction, the use of informatics and analytics has the potential to achieve the outcomes of better health, better care, and lower costs. Indeed, VHA

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already produces and uses analytical products to improve Veteran health care and business operations. All leading private health care systems use data to drive improvements. In addition, VHA is well positioned to lead a comprehensive new initiative on "precision medicine" in response to the Presidential Initiative in Precision Medicine (IPM), 30 Jan 2015.[17] This section offers recommendations to build on and improve the current suite of VA/VHA analytical products, and overcome resource challenges. However, these recommendations will not be effective unless VHA also makes significant improvements to the information systems upon which it depends. Other sections note the steps necessary to improve VHA's health IT systems. These system improvements will be critical to the success of informatics and analytics at VHA.

Recommendation 8.2.1: OI&A should assess the quality and validity of analytical products and results across VHA and their effectiveness in driving health and business outcomes.

OI&A should engage with leadership and staff across VHA on a frequent basis and identify ways to make the products more useful. Evidence from other assessments indicates the value of continued outreach, education, and awareness campaigns. OI&A may have to make further incremental improvements in the types of metrics collected. Pruning less useful products will prove important for mitigating the sense of data overload that some leaders experience.

OI&A should also identify specific improvements needed in the information systems that serve as the sources of the data used for VHA analytics to generate more complete and accurate results. VHA should also track actions taken as a result of the analytical products and quantify how effective those actions are in improving health and business outcomes.

OI&A should expand its research to cover trends in the larger health informatics community, tapping into resources such as the Healthcare Information and Management Systems Society (HIMSS), which performs compensation surveys. Comparisons to leading health care providers should guide staffing targets and compensation within VHA.

Recommendation 8.2.2: OI&A should assess workforce needs in informatics and analytics on an ongoing basis to estimate future needs and acquire skilled expertise in a timelier manner.

Workforce assessments should consider a variety of factors that may influence employment decisions, such as compensation, work environment, demographics, technology resources, and research opportunities. As a government employer, VHA may have only limited ability to influence some factors, such as compensation. However, VHA should identify factors within its control to attract and maintain an effective health informatics and analytics workforce. For example, in many high technology fields the presence (or lack) of leading-edge information systems and tools within the environment influences decisions about where to accept employment. OI&A could consider offering scholarship programs in exchange for government services, similar to the U.S. Office of Personnel Management (OPM) Scholarship for Service (SFS) CyberCorps program[18] as a way to increase the pipeline of graduates to fill OI&A analytic positions.

[17] https://www.whitehouse.gov/the-press-office/2015/01/30/fact-sheet-president-obama-s-precision-medicine-initiative

[18] https://www.sfs.opm.gov/

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Recommendation 8.2.3: OI&A should increase collaborative partnerships for analytics research with research institutions and other health care providers to better understand the value of integrated health data analytics.

OI&A should continue to develop collaborative relationships with research institutions offering advanced degree informatics programs and sponsor joint research. Assessment H research reviewed two examples of successful research partnerships: one with the National Institutes of Health and one with IBM. OI&A should increase the use of these types of partnerships as a way to improve research outcomes despite the constraints on internal staffing.

Expanded collaborative partnerships with health care providers could also help improve the exchange of electronic health records. Interviews identified one such pilot initiative with Walgreens. OI&A should increase the number and scope of these partnerships to enable integrated health data analytics across all providers of health services to Veterans, including VHA, the private sector, and DoD.

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9 Telehealth

VA defines telehealth as:

> The wider application of care and case management principles to the delivery of health care services using health informatics, disease management and telehealth technologies to facilitate access to care and improve the health of designated individuals and populations with the intent of providing the right care at the right place and right time" (VA, 2014a).

In FY 2014, VA used telehealth to serve more than 690,000 Veterans, amounting to approximately 12 percent of the overall Veteran population. Of those, 55 percent were Veterans in rural areas (VA Office of Public and Intergovernmental Affairs, 2014). The total number represents an increase from 608,000 Veterans in FY13, approximately 11 percent of the overall Veteran population (Hall, 2014). As described in Assessment B (Health Care Capabilities), not only are more patients taking advantage of telehealth, but they also remain satisfied with the telehealth services.[19] Assessment H examines telehealth from the perspective of VA/VHA's ability to implement new technologies that could help achieve strategic VA health care outcomes.

VA provides three main types of telehealth services: Clinical Video Telehealth (CVT), Home Telehealth, and Store-and-Forward Telehealth. Table 9-1 (also included in Assessment B), describes these three categories and explains how each supports various health care objectives.

Table 9-1. Telehealth Definitions

Modality	Description	Health Care Objective
Clinical video telehealth	Use of real-time interactive video conferencing, sometimes with supportive peripheral technologies, to assess, treat and provide care to a patient remotely. Typically, clinical video telehealth links patient(s) at a clinic to provider(s) at another location; however, it can also connect a remote provider and a patient at home.	▪ Provide access to specialists practicing in regional medical centers ▪ Reduce travel burden for Veterans in remote or underserved areas
Store-and-forward telehealth	Use of technologies to acquire and store clinical information (e.g., high-resolution images, sound, and video) that is then made available to a provider at another location for clinical	▪ Provide access to specialists practicing in regional medical centers ▪ Reduce travel burden for Veterans in remote or underserved areas

[19] Assessment B describes VA's telehealth capabilities and utilization rates in greater detail.

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Modality	Description	Health Care Objective
	evaluation. It is frequently used in radiology, dermatology, and diabetic retinopathy.	
Home telehealth	Applies care and case management principles to coordinate care using health informatics, disease management, and technologies such as in-home and mobile monitoring, messaging, and/or video technologies.	▪ Facilitate continuous (non-episodic care) to improve clinical outcomes ▪ Provide acute and chronic care management, and promote health and disease prevention

Source: The RAND Corporation, Assessment B.

9.1 Findings

VA was an early adopter of telehealth and has been a leader in this space for years, but many Assessment H interviewees expressed concern that VA could not stay at the forefront of telehealth. VA help desks do not offer technical support directly to Veterans who have difficulty using the telehealth service. Assessment H interviewees reported that:

> Telehealth appointments are typically scheduled one or, at most, two per hour and they can often take longer than in-person appointments because of the time it takes to get the equipment setup. The Permanente Medical Group (TPMG) reports they can see an average of six patients per hour via telehealth, compared with an average of 1.6 per hour for in-person visits (Tahir, 2015).

Table 9-2 summarizes telehealth strengths and weaknesses examined in the subsequent findings.

Table 9-2. Telehealth Strengths and Weaknesses

Strengths	1. VA was an early adopter of telehealth. 2. The National Telehealth Governance Board (NTGB), co-chaired by VHA and OI&T, is a useful forum for providing oversight of telehealth services. 3. Users view VHA's National Telehealth Technology Help Desk as responsive and helpful.

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Weaknesses	1. VHA believes OI&T is slow to provide support to the VISNs, which has a negative impact on Veteran access to care. 2. Veterans are not offered technical support for telehealth resulting in many Veterans abandoning telehealth. 3. There are many challenges and correspondingly little incentive to provide care between the VISNs through telehealth.

In a 2014 internal survey conducted by VHA Telehealth Services, the VISNs reported "inadequate OI&T and Biomedical Engineering infrastructure and support" as a major barrier to the sustainment and expansion of telehealth (VHA Telehealth Services, 2014). Assessment H interviews with VAMC staff echoed this view.

Finding 9.1.1: Although providers report an unacceptable time to resolution for configuration requests, roles and responsibilities are uncertain, and National Service Desk ticket data do not track to the service level agreement (SLA) metrics, creating uncertainty whether service levels are being met.

The NTGB provides a useful forum to help align VHA clinical needs with OI&T infrastructure support, thereby increasing the likelihood that more Veterans can access care through telehealth in the future. However, users interviewed cited confusion about the roles and responsibilities of OI&T and Biomedical Engineering. This contributes to delays in problem resolution because both organizations must often assist with the same piece of equipment, since OI&T manages the general IT assets, such as the network, and Biomedical Engineering manages the medical devices, such as a telemedicine cart. One interviewee said, "It usually ends in a stalemate." Another site representative said that OI&T thought Biomedical Engineering was responsible for configuring the cart, but Biomedical Engineering said the responsibility belonged to OI&T.

As the National Service Desk consolidates (from over 100 help desks to one), disparities remain in help desk ticket data. Assessment H received ticket data from VA (VA SDE, 2015), but these data did not directly track to any of the metrics in the three telehealth-related SLAs (VA, 2013a, 2013c, and 2013d). Table 9-3 summarizes the service level targets defined in these three SLAs that specifically or logically should be measurable by National Service Desk ticket data.

Table 9-3. Service Desk Telehealth-related Service Level Targets

Metric	Service Level Target
CVT Endpoint Normal configuration request submitted by NTTHD once precondition checklist met	Completed within 20 business days after equipment arrives
CVT Endpoint Urgent configuration request submitted by NTTHD once precondition checklist met	Completed within 10 business days after equipment arrives

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Metric	Service Level Target
SFT Acquisition Workstation Configuration: New User Requests	95% within 3 days
SFT Telereader Configuration: New User Requests	95% within 3 days
SFT Acquisition Site Configuration: New User Requests	95% within 3 days
HTH Virtual Private Network restore time	4 hours
HTH Average Speed of Answer	<60 Secs
HTH [call] Abandonment Rate	<5%
HTH First Contact Resolution Tier One	>70%

Finding 9.1.2: Lack of technical support to Veterans discourages Veterans from participating in home telehealth, thereby missing opportunities to reduce health care costs. Veterans cannot call a VA help desk to receive technical support.

VA screens Veterans to see if they have the videoconferencing technology and know how to use it for home telehealth and CVT. A Telehealth Coordination Technician (TCT) tests the technology with the Veteran in advance of an appointment with a health care provider. An Assessment H interviewee stated that the TCT schedules an actual appointment and notifies the provider separately that the interaction only represents a test and can be ignored. The TCT can provide guidance if the Veteran has difficulty with the technology, but the value depends on the technical abilities and willingness of the TCT to offer help. VISNs cited challenges in recruiting and retaining TCTs (VHA Telehealth Services, 2014). If this trend continues, VHA will have fewer TCTs and they will have even less time to spend helping Veterans use the technology.

If Veterans cannot install and use the videoconferencing technology, they are “screened out” of the telehealth appointment. This not only degrades the Veteran experience but also increases health care costs because home telehealth is a proven low-cost alternative to more traditional modes of care (VA OIG, Office of Audits & Evaluations, 2015a).

Finding 9.1.3: The barriers associated with providing VISN-to-VISN telehealth make it harder to optimize the caseload across VISNs, resulting in unnecessarily long waits for care in certain regions.

As discussed in Assessment B, only 1 percent of telehealth appointments happened across VISNs in FY14. This results in missed opportunities to balance the caseload nationally and results in long waits for care in certain areas and no waits in others. VA must make it easier for a patient in one VISN to receive care from a provider in a different VISN. The challenges that complicate telehealth appointments between VISNs include requirements around telehealth services agreements and rules governing provider privileges and credentials. Currently, every

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pair of medical centers that plan to connect via telehealth must create a telehealth services agreement. Also, providers must be privileged and credentialed wherever the patient is located. In addition, once the appointment has taken place the provider cannot update patient records held by another VISN.

VA is moving in the right direction. For example, VA has a plan for a new Telehealth Scheduling System (TSS) that will pull all telehealth resources and telehealth service agreements together. However, several Assessment H interviewees expressed concern that TSS would not meet all their needs. For example, they feared that it would not allow them to determine if both a room and a technician would be available for an appointment. VA has an opportunity to assess the current and planned processes and systems to ensure they remove as many of the barriers to VISN-to-VISN telehealth as possible.

9.2 Recommendations

To take advantage of the full potential of telehealth to improve access to care, VA must make it easier for providers to treat their patients through telehealth. VA can expand telehealth to become more responsive to clinical needs. Table 9-4 summarizes the telehealth opportunities described in the subsequent recommendations.

Table 9-4. Telehealth Opportunities

Opportunities	1. VA can clarify telehealth-related roles and responsibilities. 2. VA can strengthen the NTGB by identifying a lead from Biomedical Engineering to co-chair the NTGB with the Office of Telehealth Services and OI&T. 3. VA can improve SLAs to ensure they meet the clinical need yet remain achievable and measurable. 4. VA can offer telehealth technical support directly to Veterans. 5. VA can improve policies, processes, and systems to make it more attractive to provide VISN-to-VISN care through telehealth. 6. VA and private industry can both benefit from exchanging telehealth best practices.

Recommendation 9.2.1: To improve the execution of telehealth, VA should clarify roles and responsibilities between OI&T and Biomedical Engineering and reexamine service agreements. VA should identify a lead from Biomedical Engineering to co-chair the NTGB with the Office of Telehealth Services and OI&T.

VA must ensure that all stakeholders agree on service-level targets. Because VAMC staff believe IT support is too slow, representatives of VAMCs, the Office of Telehealth Services, OI&T, and Biomedical Engineering should examine the SLA targets to ensure they meet the clinical need. Once the stakeholders have set the service agreement targets, they must communicate them to the facilities so that each site can adjust its expectations. OI&T and Biomedical Engineering

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must also communicate directly with any requestor of support to acknowledge the request and provide an approximate time to resolution. VA must then ensure measurement and reporting of service agreement compliance.

The NTGB would become an even more effective forum and could contribute to greater Veteran access to care if it added a Biomedical Engineering representative as a co-chair. First, this would ensure Biomedical Engineering participation in discussions of telehealth clinical needs and support to be provided by OI&T and Biomedical Engineering. Second, it would assist in clarifying and communicating roles and responsibilities of OI&T and Biomedical Engineering.

Recommendation 9.2.2: To provide greater access through telehealth technology and reduce the number of Veterans who abandon these services, VA should offer technical support to Veterans who have trouble using telehealth technology and make it easier for all parties to test a connection.

For VA to become truly Veteran-centric, it cannot screen out Veterans from telehealth simply because they cannot figure out how to use videoconferencing technology on their own. Assisting with use of this technology should improve the Veteran experience with VHA and reduce health care costs. This means that VHA should provide an easy mechanism for testing a telehealth connection with the Veteran without involving a provider. If a mechanism already exists for easily creating a test appointment without notifying the provider, VHA should ensure all TCTs are trained on how to use it.

Recommendation 9.2.3: To provide more care across VISN boundaries through telehealth, VA should revise policies, processes, and systems to migrate toward virtual access as the norm for the delivery of care.

VA should consider establishing a National Telehealth Services Agreement that would eliminate the need for agreements between each pair of sites, and grant providers national-level privileges and credentials rather than requiring privileges and credentials for each location. If national credentialing and privileging are not possible, VA should at least explore centralized administration of credentials and privileges as opposed to storing them locally in each VAMC.

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10 Mobile Applications

> The future of VA health care is a Veteran-centric system of care that treats the whole person regardless of their physical location. Technology innovations and consumer-demand are enabling this transformation. VA Connected Health virtual and mobile technologies are key elements of a healthcare environment that is supportive and responsive and that enhances relationships between Veterans and their providers. Connected health technologies offer powerful opportunities to extend access to health information, knowledge and support at the place and time when it is needed, and improve the interactions between patients, caregivers, and health care teams regardless of their physical location. The use of connected health technologies such as patient web portals, mobile applications (apps), video telehealth, sensors, wearable devices, and home monitoring systems have had significant impacts on VA health care processes and outcomes with encouraging results thus far. Strategically, VA seeks to expand the use of connected health technologies to support the transformation towards patient-centric and consumer-driven health care delivery for the benefit of Veterans, beneficiaries, and health care providers. (VA OI&A, 2014a)

OI&A's Connected Health (OI&A/CH) organization, formed in 2012, has responsibility for web and mobile solutions, My HealtheVet, kiosks, and innovation. Several Assessment H interviewees cited the Connected Health management team as possessing the strength of personality to move the mobile application concept forward, noting that this team has given caregivers, providers, and Veterans initial mobile capabilities that improve access to VA-approved health care capabilities.

From a strategic planning perspective, Connected Health has mapped VA and VHA Strategic Plans (VA OI&T, 2013; VA 2014c) into its organizational operating plan. Specific actions and initiatives in the operating plan are derived from Connected Health's goals and assigned to Connected Health senior staff. Connected Health has identified key performance measures for its mobile technology offerings; each measure has a targeted quality threshold with specific staff assigned.

As a baseline, VHA operates a mobile application store from which Veterans and providers can download applications. According to a table in Assessment B, as of May 2015 over 300,000 downloads of publicly released mobile applications had taken place. Approximately half of the more than 20 released mobile applications are in a controlled roll out with no publicly available data. The Assessment H team also discovered that VA has approximately 30 additional applications in the release pipeline.

VA's mobile applications target only Apple or Android devices. Also, only mobile applications developed by VA personnel or contractors and qualified and certified by VA are available through the VA AppStore. However, several of these applications are also available through the Apple iTunes and Google Play stores.

The current VA Mobile Framework (VAMF) (VA OI&T ASD, 2014) shown in Figure 10-1 performs infrastructure services for all mobile applications. VAMF also provides an environment to meet OI&T's process for releasing mobile applications, which includes enterprise-level certification (testing, certification, and release).

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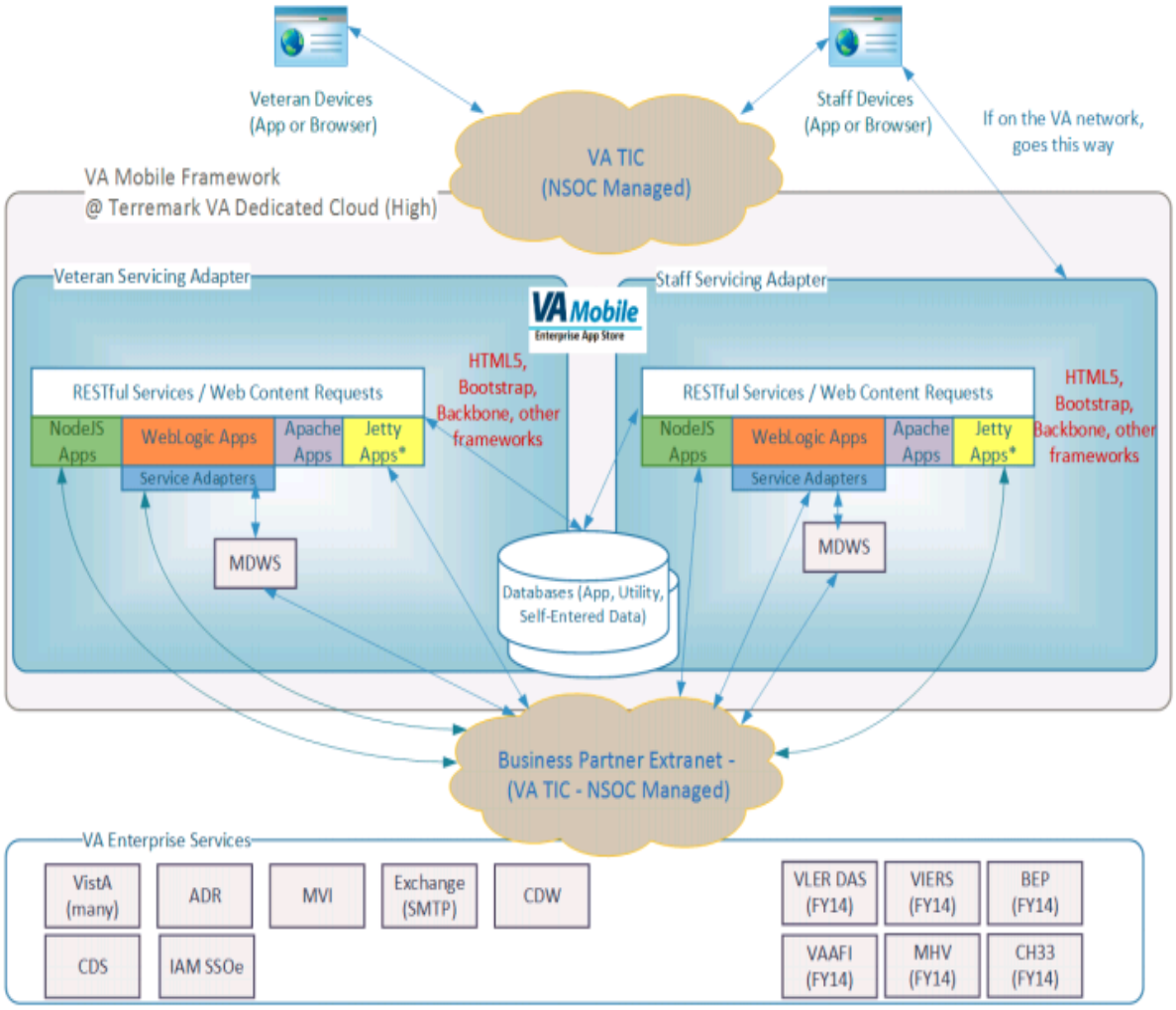
Figure 10-1. VA Mobile Framework "As-Is" Logical Architecture



Source: VA OI&T ASD, 2014.

The Medical Domain Web Services (MDWS) provide the interface to VistA and other data stores and services. VAMF also maintains a local database to support self-entered and patient-generated data. The VA Mobile Application Environment (MAE) is a production and testing environment that consists of four separate environments to provide tools and services for testing and compliance of internal VA mobile applications. The environments are:

- Development
- Test (Federal Information Security Management Act [FISMA] Low)
- Integration
- Production (FISMA High).

MAE also includes project management tools such (e.g., JIRA), the mobile solutions development wiki, and a documentation repository.

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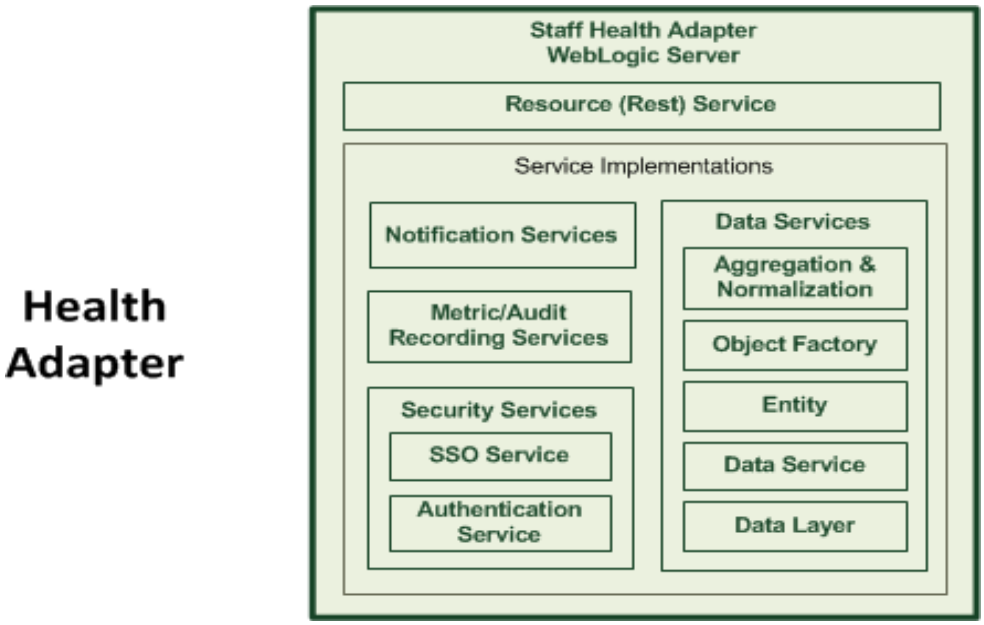
The high-level application design for each mobile application is provided through the HealthAdapter model depicted in Figure 10-2. "The HealthAdapter has been designed to decouple the service endpoints, business logic, and data sources from each other … decoupling data sources makes it easier to utilize the HealthAdapter for different needs" (VA, 2014l). Separate HealthAdapters are provided for Veteran-facing applications and staff applications.

Figure 10-2. Mobile Application Health Adapter



Source: VA, 2014l.

VA provides a "to-be" architecture (VA OI&T ASD, 2014) for enterprise mobile solutions (Figure 10–3) and evolving mobile capabilities and infrastructure to all VA Lines of Business (LOBs). The to-be architecture shows a uniform VA enterprise with a seamless network and data access experience across all Veteran- and clinician-facing applications regardless of user platform, role, or location, and a reliable user experience that conforms to and enforces standards (HL7, FHIR, etc.).

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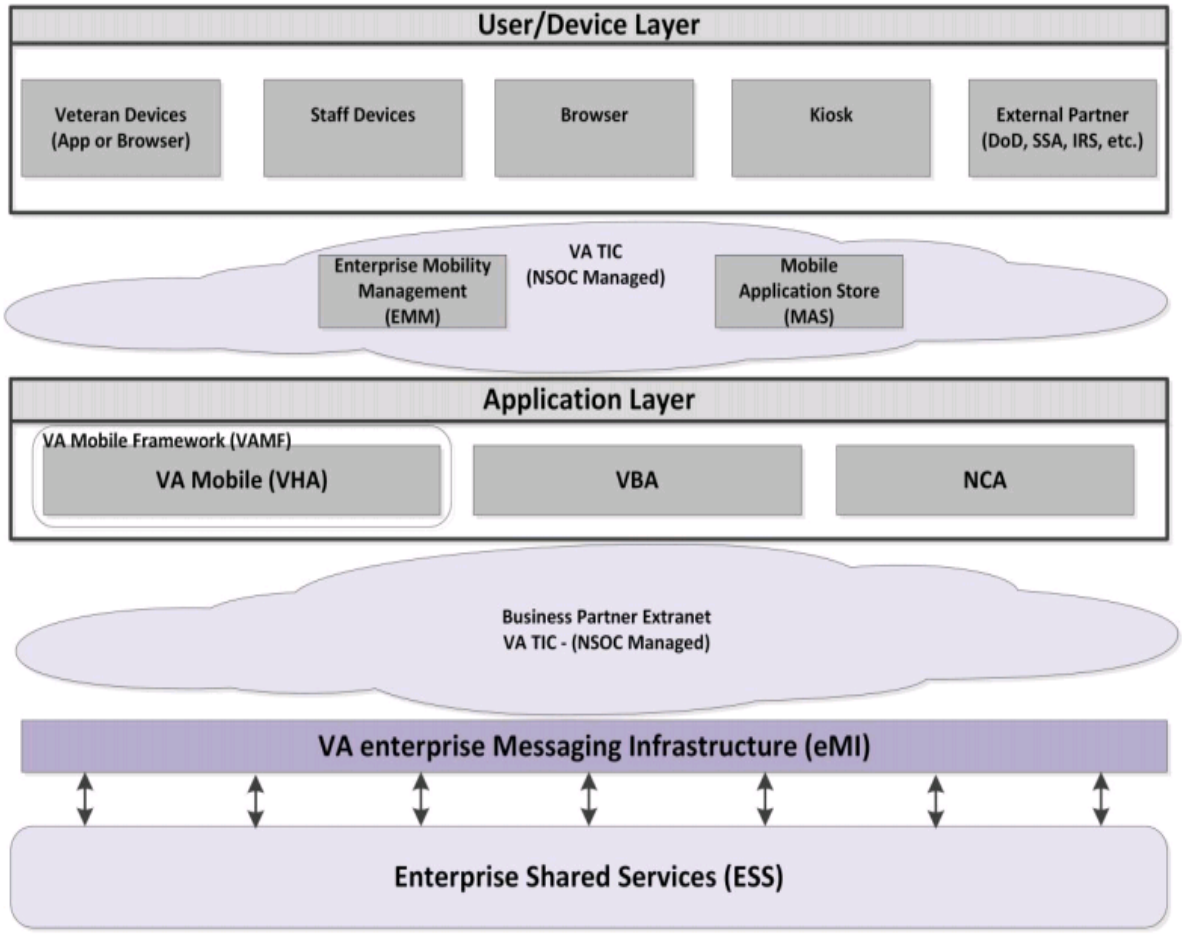
Figure 10-3. VA Mobile Framework "To-Be" Logical Architecture



Source: VA OI&T ASD, 2014.

The to-be architecture also allows high-level interactions between multiple users/devices on varying platforms accessing Enterprise Shared Services (ESS) through both internal and external applications. This is achieved through the respective LOB mobile environments contained within VAMF. VA is also developing further detailed guidance through capability-specific design patterns and through the implementation of the VA Mobile Application Reference Architecture (MARA).

Additionally, OI&T's Architecture, Strategy, and Design (ASD) team has identified a way forward that includes, but is not limited to, more robust mobile device management (MDM) for staff, mobile security, application management, deployment, certification, and governance.

10.1 Findings

Finding 10.1.1: VA mobile capabilities are extending health care delivery beyond physical facilities to Veterans. VA is releasing mobile applications that capture patient satisfaction but not patient-generated health data.

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The Connected Health office has delivered more than 20 mobile applications to a user base that includes Veterans, caregivers, and other health care providers. The limited number of applications reflects VA's very recent adoption of mobile approaches and the rollout of state-of-the-practice mobile infrastructure and applications within VA. Connected Health and its partners within OI&T continue to deliver and execute pilot programs while increasing infrastructure capability. The partnership model at the working level between Connected Health and OI&T Product Development Mobile Infrastructure teams is based on mutual respect and strong leadership with commitment to success of mobile capability for VHA.

The initial Veteran-facing applications are simplistic relative to their interactions with clinicians and in general provide the ability to view patient (Veteran) data and (Veteran) self-management applications. Additionally, VA has embarked on developing a video visit capability to extend telehealth through the of use mobile sensing capabilities. Video Visits is the first mobile application that will use multiple sensors[20] (camera and microphone) to gather and exchange patient information.

VA is releasing mobile applications that capture patient feedback/satisfaction.[21] However, VA does not currently capture patient-generated health data. In the private sector, patient-provided data help create a data-driven health system and enable a shift from "sick care" to "health care."

Finding 10.1.2: Connected Health is underfunded and understaffed for achieving the aggressive initiatives and development activities identified in its operating plan. VHA should evaluate opportunities to enhance access and satisfaction through relatively small investments in mobile solutions.

According to its own operating plan (VA OI&A, 2014a), Connected Health is underfunded and understaffed with "$26.6 million of unfunded contracts… [and] experiencing a significant shortfall in personnel resources, particularly experienced program managers…" (VA OI&A, 2014a). In the same plan Connected Health sets forth an aggressive set of initiatives and development activities for the next two fiscal years. OI&T currently has difficulty filling open job requisitions, which reduces the efficiency of the organization. Thus, it cannot fill key positions, specifically engineering positions at the mobile infrastructure and technology senior leadership (Executive Director) levels. This inhibits the execution of mobile programs.

In general, mobile applications are small, self-contained capabilities, so development requires less investment to deliver focused, incremental capability, and can have higher proportional impact. For example, Business Solutions cites four specific areas where mobile apps have had a positive impact:

- **Addressing chronic disease**: An Accenture study of early trial data revealed a 15 to 20 percent reduction in hospital days and 30 percent fewer emergency room (ER) visits (Accenture, 2015).

[20] Typical mobile devices include several sensors, including microphones, cameras, ambient light, proximity sensor, gyroscope, and compass as well as Bluetooth, Wi-Fi, and GPS radios (from Apple iPhone 4 Specifications [https://www.apple.com/fr/support/]).

[21] https://mobile.va.gov/appstore

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- **Avoiding non-urgent use of the ER**: iTriage, an app that offers a symptom checker, location of the nearest urgent care or retail clinics and ERs, and a comparative cost of those providers, boasts a potential savings of $300 to $3000 per visit (Aetna, 2015).
- **Reducing preventable readmissions**: The Mayo Clinic conducted a controlled study involving mobile monitoring applications for cardiac rehabilitation patients and found a 40 percent decrease in readmission for patients who did use the app, resulting in a significant reduction in costs and penalties (Mayo, 2014).
- **Improving prescription adherence**: An app with reminders could easily send push messages to the provider and patient to help improve prescription adherence rates (Lynch, 2013).

While mobile technology could have strategic importance to VA in increasing Veteran access and Veteran satisfaction, the *Blueprint for Excellence* (VA, 2014c) does not explicitly identify mobile application development as a priority.

Finding 10.1.3: While VA can develop and deploy mobile applications successfully, it cannot do so at the pace of the commercial sector.

The major contributors to delays in developing and deploying mobile applications appear to be PMAS's documentation, process, quality assurance, and certification requirements. As described in Section A.1 of this report, PMAS documentation and processes add overhead to any development project—including small-scale mobile app development projects. The required quality assurance processes for compliance and governance are based on governance policies and procedures for large IT systems. Mobile application projects must follow the same or similar PMAS steps/workflow as new capabilities for VHA/VBA/NCA. Thus, each mobile application release encompasses more than 50 discrete artifacts required for deployment to the user communities (VA, 2013b).

The Connected Health team seeks to follow commercial mobile delivery practices to speed delivery of mobile products that increase access and satisfaction for Veterans and clinicians/providers. Trends in mobile application development rely on user (i.e., Veteran) feedback and rapid application modification and deployment. Current practices in commercial industry indicate multiple releases per day is the norm for organizations adopting continuous delivery approaches. (Valasquez, 2014). For iOS applications, there is an additional one-to-two week delay for approval from Apple to include it in its AppStore (Apple, 2015b).

OI&T Product Development and Connected Health typically require fewer than six staff months and anecdotally as little as three months to develop a mobile application. However, quality assurance and certification requirements delay deployment over 90 days (VA OI&A, 2014a). This totals over nine months of development and certification time before an app can be deployed to the Google Play Store or to Apple for approval to put in its AppStore.

10.2 Recommendations

Recommendation 10.2.1: VA should explicitly identify mobile applications as a strategic enabler to increase Veteran access, satisfaction, and patient-generated data to help VHA transition to a data-driven health system.

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Current technology trends include using and taking advantage of mobile devices as personal sensors and activity monitors to collect data to feed into health, fitness, and medical applications. These applications have become more powerful with innovative use of social media to gather community input and data to modify and expand options within a particular application. For example, an input option in diet applications can assess aspects of the food to be consumed.

As VA rolls out mobile applications, it has an opportunity to absorb data generated by Veterans to help clinicians proactively manage health outcomes. Mobile applications can contribute to increased personalized attention, better health outcomes, and greater Veteran satisfaction at a low price point. As in most areas of health IT, budget and staffing present challenges. VA should build out the mobile infrastructure and streamline the mobile release (qualification and certification) processes, tailoring them to enable faster approval while not increasing liability to VA.

Recommendation 10.2.2: VA should streamline PMAS methods for mobile applications and adopt an "automate quickly" mindset for mobile application qualification, vetting, and certification within OI&T to reduce application delivery timelines.

VA should investigate the application of commercial products for static code analysis and other methods to automate quality measurement, and explore the emerging commercial market for automated application vetting products and services. In doing so, VA should follow the principles in the Guide to Vetting of Security of Mobile Applications (NIST, 2015). VA should also investigate and adopt continuous integration and continuous delivery practices for mobile development *where appropriate*, recognizing the need to ensure patient safety and accuracy of the applications developed.

Recommendation 10.1.3: VA should open the development of VA mobile applications to third parties to increase delivery of health care to Veterans through innovative community-developed mobile solutions.

VA should explore the possibility of allowing external entities (third parties) to develop mobile applications that can be released via the VA AppStore. If the governing agreements properly address privacy and security concerns (NIST, 2015), this may enable increased delivery of health care to Veterans through innovative community-developed mobile solutions. VA must carefully review and test all applications to ensure a consistent level of quality (including privacy, security, patient safety, accuracy, etc.) prior to publication in the VA AppStore.

VA should publish standards, quality expectations, and interfaces to the ESS, MDWS, etc. to enable third-party development and integration. VA should consider publishing these data through the Open Source Electronic Health Record Alliance (OSEHRA).

VA should also investigate and adopt commercial practices where appropriate for mobile app store efficiencies, including investigating alternative licensing and pricing models[22] with third-party providers. Further, VA should evaluate COTS health, fitness, and medical mobile

[22] Alternative licensing and pricing model considerations is a continuing topic at the Federal Mobile Computing Summit series as well as the Federal CIO Council (Federal Mobile Computing Summit, 2014).

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applications for use by Veterans and providers for ROI of build versus buy. VA could consider using existing third-party rating systems, such as iMedicalApps, to determine the potential value of third-party health and medical mobile applications.

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11 Future Vision for VA and VHA

To significantly improve VA IT strategies and health IT, Assessment H recommends that VA emulate successful high-performing health care system (HPHS) organizations, implement enterprise IT service management as the organizational process for developing and managing delivery of VA health IT to achieve stakeholders' prioritized outcomes, and become a learning health system (LHS). As a part of this VHA should undertake an initiative on "precision medicine" to regain a cutting edge position in health informatics.[23] VA and VHA already have elements of these factors in place and can build upon them to create the future vision described in this section.

11.1 High-Performing Health Care System

Concept

In visits to centers with HPHSs, the Assessment H team observed a number of common attributes:

- **Incentive to improve.** Many of the HPHS organizations at one time faced serious financial difficulties, requiring them to transform their delivery model. The presence of a "burning platform" created the necessary willingness to make transformational changes.
- **Physician leaders.** Physicians played leadership roles in all key organizations, even the IT organizations. Because physicians are highly educated, they tend to learn the requisite skills rapidly, and because they understand the health care system and patient needs, they can prioritize activities and investments that will provide maximum benefit to patients. Later in the transformation, HPHS organizations identified physicians with leadership potential and placed them in a training pipeline to ensure availability of an adequate supply of trained, qualified leaders in the future.
- **Patient-centric.** The organizations established health care quality and patient satisfaction as their primary objectives. Decisions about investments and changes to processes were based on potential improvements in these two areas.
- **Same-day access.** Although the goals initially appeared impossible, HPHS organizations changed their models of supply and demand, shifted their priorities, improved their clinical workflows, and ultimately achieved their goals of same-day access.
- **Fully integrated IT system.** The organizations constantly updated their IT systems with the latest data. The systems shared data across all applications to minimize manual data entry. As a result, physicians entered diagnoses and treatments in the system, enabling rapid billing of insurance companies.
- **Data transparency.** The organizations made data broadly available to all providers and clinicians so they could observe quality and satisfaction by provider, clinic, and facility. The data also provided the basis for examining new health care approaches and collecting

[23] https://www.whitehouse.gov/the-press-office/2015/01/30/fact-sheet-president-obama-s-precision-medicine-initiative

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evidence about which innovations improved quality and satisfaction. Ultimately, the integrated IT system provided the basis for an LHS system. The quality and patient satisfaction data for all providers was visible throughout the system. Physician leaders coached underperforming physicians rather than punishing poor performance. Highly performing physicians and teams shared their approaches so that everyone in the system improved. Because many physicians are high achievers, the mere ranking of their scores led to efforts to improve their results.

VHA Exemplar

A skeptic might dismiss the approaches of the HPHS organizations as feasible in the private sector but not realistic for VHA with its burden of federal regulations. However, at least one VISN has demonstrated the ability to overcome or work around the onerous regulations to achieve some of the best health care outcomes of any VISN in VHA.

Assessment H conducted an analysis to identify those VAMCs that have consistently demonstrated high performance at VHA. The team considered several sources of information and ranked the VAMCs across all of these factors. Key sources used for this analysis include:

- Veteran Affairs Site Tracking (VAST) FY15 – Complexity, rural/urban, VAMC classification
- American Hospital Association facility data, 2014 – Adjusted admissions, volume of patients, number of beds
- SAIL FY15, Q1 data (SAIL Value Data, 2015)
- Survey of Healthcare Experiences of Patients (SHEP) FY12, FY13, FY 14
- The Joint Commission top performers 2011, 2012, 2013 (The Joint Commission, 2015)
- Robert W. Carey Performance Excellence Award 2010, 2011, 2012, 2013 (Carey, 2015)
- Health Grove SMART Scores (HealthGrove, 2015)
- VHA leadership vacancy report as of 3/9/2015

The resulting analysis put several of the VAMCs at VISN 4 in the top tier:

- Five of the ten VAMCs with the most SAIL scores in the top 10 percent are located in VISN 4.
- The Erie VAMC has received several national awards, including the VA Secretary Robert W. Carey Performance Excellence Award in 1998 and 2000, in addition to receiving national recognition as one of the nation's top Homeless Care Programs and as a Top Performer in the Joint Commission's Key Quality Measures program in 2011 and 2012.
- VISN 4 leads the nation in non-recurring maintenance (NRM) investment and has the lowest facility deficiency rate of all VISNs (where the deficiency rate is defined as the total deficiency costs divided by the total replacement costs).

To understand the secret to their success, the Assessment H study team visited the VISN 4 leaders, the Pittsburgh VAMC, and the Erie VAMC. Findings indicated that VISN 4 and its VAMCs apply many of the approaches found in the private sector HPHS organizations.

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- **Incentive to improve**. A large number of the smaller VAMCs faced declining Veteran populations. As a result, they realized it would be difficult to maintain key clinical skills at many of the hospitals because each VAMC would treat too few complex cases. Therefore, they transformed the delivery model in western Pennsylvania to a hub-and-spoke approach: the smaller VAMCs would provide standard services, but Veterans with the most complicated needs would be transferred to the Pittsburgh VAMC, which maintained an experienced cadre of physicians.
- **Leaders.** The leaders across VISN 4 and the nearby VAMCs have long tenure in VISN 4 and have built a strong rapport and trust. This improves collaboration and coordination compared to VISNs that have a higher rate of leadership turnover.
- **Patient-centric.** VISN 4 organizations established health care quality and patient satisfaction as their primary objectives. Most VA personnel are already committed to these objectives, but the VISN 4 facilities take steps to systematically measure and improve quality and satisfaction. For example, the Erie VAMC asks patients to fill out a small questionnaire on an index card to understand the patient's satisfaction with their visit. The Erie leaders hold periodic town hall meetings with the Veteran Service Organizations to answer questions and request suggestions on how to improve. The Erie VAMC also engages frequently with the local television, radio, and newspaper organizations to publicize health-related events and share information. This leads to strong rapport with and support from the Veterans in their area.
- **Same-day access.** VISN 4 recognized that Veterans would accept the hub-and-spoke approach only if the Pittsburgh VAMC could treat all high-acuity cases when they arrived. As a result, VISN 4 established an access objective of "Never Say No." The first step was to overhaul the rooms, pre-admission processes, and observation processes to make them sufficiently flexible to manage a broader range of conditions. Second, VISN 4 established agreements with local hospitals (in particular, the University of Pittsburgh Medical Center) to take lower acuity cases when needed to ensure available bed space for incoming patients. Finally, VISN 4 developed real-time reports based on the timely data managed at the VISN level to track discharges and admissions to ensure they had adequate beds available. The larger load of high-acuity cases has enabled the Pittsburgh VAMC to maintain a quaternary care certification.
- **Fully integrated IT system.** VISN 4 implemented an operational data store that contains centralized copies of all data (100 percent sampling) and is constantly refreshed with the latest data. The system shares data across applications to minimize manual data entry. Because the data are always current, changes in quality or in patient satisfaction are immediately visible. Likewise, if a facility deploys an innovative process to improve quality or satisfaction, the results are immediately apparent and available for sharing throughout the system. New applications and reports can be developed to monitor and control innovative processes.
- **Data transparency.** Using the VISN 4 operational data store, providers can see how they compare to their peers. While the system does not show the names of the peers, providers can observe whether they perform near the top or bottom among providers in

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the VISN with respect to quality and satisfaction. This provides a powerful incentive for providers to improve. The leadership places emphasis on coaching the low performers on how to improve (as opposed to implementing punitive measures). However, the data also provide a means to hold physicians accountable if they make no effort to improve. In addition, the data serve as the basis for examining new health care approaches and collecting evidence about which innovations improved quality and satisfaction. Finally, the accurate, timely data serve as the basis for improving communications, responsiveness, and issue resolution on contracts with outside providers. In essence, the integrated IT system creates the foundation for an LHS.

- **Continuous process improvement.** Using the VISN 4 operational data store, staff can develop new applications and reports to monitor and control innovative processes. The leadership encourages a culture of innovation and the IT systems provide evidence of improvements. At the Erie VAMC, a robust lean improvement approach led to extraordinary improvements in hiring and food service built on strong employee engagement. At the Pittsburgh VAMC, evidence-based system redesign lay at the heart of achieving the "Never Say No" objective. A periodic forum called "Expoceptional" gives employees the opportunity to suggest improvement initiatives based on their familiarity with the front-line processes.

In summary, VISN 4 achieves excellent outcomes in quality and patient satisfaction for the Veterans it serves in many categories of service. An effective, experienced leadership team, enabled by effective IT services that allow leaders to monitor and control their processes in real time, drives much of this outstanding performance.

11.2 Enterprise IT Service Management

Concept

ITSM refers to a discipline for managing IT services centered on the customer's perspective regarding IT's contribution to the business. ITSM provides an enterprise framework to structure IT-related activities and the interactions of IT personnel with business customers and users. The current OI&T ITSM philosophy is that of an internal, project-focused organization rather than that of a service provider model focused on the enterprise, customer needs, and service delivery to both VHA personnel and Veterans.

The standard Information Technology Infrastructure Library (ITIL, 2011), Control Objectives for Information and Related Technology (COBIT), and International Standards Organization (ISO) 20000 contain ITSM best practice frameworks. These standards present an enterprise-level view and can help improve an organization's IT service delivery and support capabilities. All three offer a comprehensive set of best practices and practical guidance that could help OI&T oversee and manage all key aspects of its work, including governance, enterprise strategy and goals, tactical planning, and operations.

OI&T has defined processes for project management in PMAS which require an agile software development methodology. However, PMAS imposes numerous requirements for process steps and upfront documentation that undermine agile development. To improve design,

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development, and deployment of IT services, systems, and products, OI&T could tailor its implementation of the ITSM framework to augment existing practices with industry best practices and achieve the best balance of enterprise IT management for VA.

Industry Standard

ITIL provides a full service lifecycle perspective on managing IT services at an enterprise level. ITIL lifecycle phases include Strategy, Design, Transition, Operations, and Continual Improvement. Each phase includes processes, activities, metrics, and technology considerations, as well as integration points to the other lifecycle phases.

ITIL is the de facto industry standard for implementing ITSM best practices and can serve as a reference knowledge base of robust, mature, time-tested IT management practices that OI&T could harmonize with its current practices. Both federal agencies and private sector companies have implemented ITIL successfully.

Benefits for VA

An ITSM framework based on ITIL helps organizations manage and improve key areas such as IT governance, organization, processes, and technologies. OT&T could leverage ITIL to refine its definitions of services, standardize IT processes, define roles and responsibilities, establish a centralized IT governance and optimized IT support structure, and implement measures that focus on metrics relevant to Veterans and end users. By applying ITIL best practices, OI&T should realize the following benefits:

- Better alignment between OI&T services and VHA and Veteran priorities and needs
- IT acquisition and investment decisions that result in tangible and quantifiable business value
- Reduction in IT costs via improved planning and controls
- Secure and reliable operation of IT services, reducing failures and unexpected disruptions and meeting service levels
- Standardized, consistent IT processes implemented across OI&T groups with clearly defined roles and responsibilities
- Continuous service improvement through ongoing focus on improving quality, effectiveness, and efficiency of IT processes and services
- Improved communication and information sharing between OI&T and VHA business units
- Improved customer satisfaction for Veterans and end users.

Figure 11-1 provides a notional view of an ITSM framework using ITIL.

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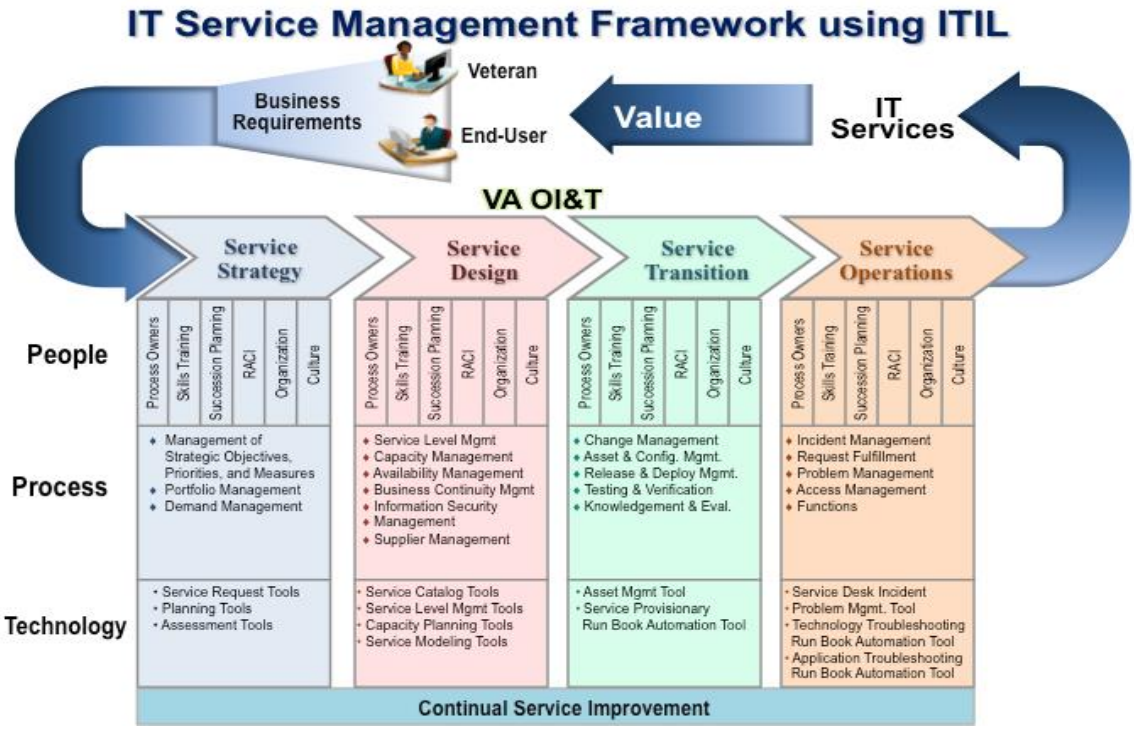
Figure 11-1. IT Service Management Framework



Source: MITRE rendition of ITSM as applied to OI&T

By adopting proven and tested ITSM best practices, OI&T could become a business-aligned, customer-focused, high quality provider of services and capabilities to VA, and position itself to become a trusted and capable mission-enabling partner.

11.3 Learning Health System

Concept

Since 2006, the Institute of Medicine (IOM) has promoted the learning health system (LHS) concept (Olsen et al., 2007). An LHS is

> . . . one in which science, informatics, incentives, and culture are aligned for continuous improvement and innovation, with best practices seamlessly embedded in the care process, patients and families active participants in all elements, and new knowledge captured as an integral by-product of the care experience (Roundtable, 2012).

Continuous learning enables organizations to:

- More quickly produce evidence of the effectiveness of treatment interventions and wellness programs, so that they can be adopted as early as possible to reduce deaths, improve patient health, and reduce cost
- Manage the increasing complexities in health care (i.e., increasing diagnostic, treatment, and care management options; technological advances in medicine; fragmented financing; and complicated clinical workflows (Smith et al., 2013)

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- Manage unsustainable increases in health care costs (Smith et al., 2013)

Table 11-1 describes the characteristics of an LHS.

Table 11-1. Characteristics of a Continuously Learning Health System

Science and Informatics Real-time access to knowledge—Continuously and reliably captures, curates, and delivers the best available evidence to guide, support, tailor, and improve clinical decision making and care safety and quality. Digital capture of the care experience—Captures the care experience on digital platforms for real-time generation and application of knowledge for care improvement.
Patient-Clinician Partnerships Engaged, empowered patients—Anchored in patient needs and perspectives; promotes the inclusion of patients, families, and other caregivers as vital members of the continuously learning care team.
Incentives Incentives aligned for value—Incentives are aligned to encourage continuous improvement, identify and reduce waste, and reward high-value care. Full transparency—Systematically monitors safety, quality, processes, prices, costs, and outcomes of care; makes information available for care improvement, informed choices, and decision making by clinicians, patients, and their families.
Continuous Learning Culture Leadership-instilled culture of learning—Stewarded by leadership committed to a culture of teamwork, collaboration, and adaptability in support of continuous learning as a core aim. Supportive system competencies—Constantly refines complex care operations and processes through ongoing team training and skill building, systems analysis and information development, and creation of feedback loops for continuous learning and system improvement.

Source: Grossman, Powers, & McGinnis, 2011.

A continuously learning health system requires a digital infrastructure (Grossman, Powers & McGinnis, 2011) that:

- Supports diagnosis (e.g., molecular diagnostics), treatment (e.g., individualized medicine), and research (e.g., genetics, genomics) that have high computational needs
- Integrates *intelligent* functionality into and across EHRs, personal health records (PHRs), telehealth and mobile health applications, and electronic monitoring devices, to better:
  - Engage patients and guide them toward healthier lifestyles
  - Coordinate care
  - Anticipate resource needs of health care facilities as well as care needs of patients

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  - Predict outcomes of individual patients
- Provides large-scale, federated databases containing clinical, behavioral health, administrative, socio-environmental, and patient-generated health data that can be accessed by:
  - Clinicians from different facilities to get a comprehensive and longitudinal view of the patient
  - Clinical and health services researchers who can analyze the data to measure outcomes, program performance, post-market drug monitoring, and social determinants of health
- Enables seamless interoperability between electronic systems and health information exchange among providers, patients, payers, and researchers.

Transforming VHA into an LHS

The LHS can serve as an excellent transformation model for VHA as it strives to return to its previous status as a world-class health care delivery system. The Assessment H team found evidence that VHA aspires to be an LHS and has adopted LHS concepts. The VHA *Blueprint for Excellence* states that "[R]obust clinical and health services research supports VHA's efforts to be a learning health system" (VA, 2014c). Moreover, Strategic Initiative #5 (page 23) describes how VHA wishes to "foster an environment of continuous learning" and use it to improve organizational effectiveness, foster psychologically safe risk-taking, and increase personal accountability.

VHA deserves praise for adopting these important LHS concepts at the strategic planning level, but transforming into an LHS requires a fuller commitment to planning and, more important, to executing its concepts and tenets. *VHA would have less difficulty transforming into an LHS than other health systems once it makes such a commitment.* VHA already has many of the digital infrastructure building blocks of an LHS (Kupersmith, 2007); a fuller commitment would allow VHA to improve and then assemble these building blocks into a tightly integrated transformational model. Executing that model would then enable VHA to transform into an LHS over the next few years.

IOM reports dating back to 2007 (Olsen et al., 2007; Grossman, Powers& McGinnis, 2011; Smith et al., 2013) have highlighted excellent examples of how VHA had begun building LHS capabilities, including rapid learning (Etheredge, 2007a; 2007b). In addition, the reports cite VHA as one of the health systems in the United States with the best potential for becoming an LHS. Etheredge (2007a; 2007b) further suggests that VHA could become one of the public sector leaders in transforming into an LHS.

Transforming VHA into a Learning Health System

Clearly, VHA has the building blocks for an LHS. From a strategic planning perspective, the *Blueprint for Excellence* (VA, 2014c) states the aforementioned aspiration to become an LHS, as well as a strategic initiative (#5) that specifically calls for the application of LHS principles to achieve organizational effectiveness. However, the *Blueprint* contains other themes and

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strategic initiatives that, while not called out as such, reflect LHS concepts and tenets. For example, it notes the need for evidence-based results as VHA:[24]

- *Transitions* from a "sick care" *to a "health care" model* (theme)
- Delivers *high-quality, Veteran-centered care* that compares favorably to the best of private sector in *measured outcomes, value, efficiency, and patient experience* (strategy #2)
- *Leverages information technologies, analytics,* and models of health care delivery to *optimize individual and population health outcomes* (strategy #3)
- Advances *personalized, proactive, and patient-driven health care*, and *engages Veterans,* inspiring them to their highest possible level of health and well-being (strategy #6)
- Leads the nation in *research* and treatment of military service-related conditions (strategy #7)

From a planning perspective these strategic initiatives set an excellent course for VHA to transform into an LHS. Fully committing to the LHS would require VHA to frame the above initiatives more extensively within the LHS vision and concept.

Leveraging VHA's Digital Infrastructure

VHA also has the essential components of a digital infrastructure for an LHS (Kupersmith, 2007). In addition, Assessment H's analysis of VHA's informatics and analytic capabilities, as well as VA's IT infrastructure and health IT applications, found the following more notable digital infrastructure capabilities:[25]

- A portfolio of IT applications—including VistA/CPRS, HealtheVet, and their telehealth and mobile applications—currently captures demographic, clinical, behavioral health, and administrative data, with VistA Evolution/eHMP positioned to do so in the future (digitally capturing the care experience, Table 11-1).
- VHA plans to use smartphone apps and monitoring devices (e.g., Fitbit) to capture patient-generated and other health data (Table 11-1).
- The Clinical and Regional Data Warehouses currently serve as large-scale databases, providing clinicians and researchers near-real-time access to knowledge (Table 11-1).
- VHA plans to conduct genomic research and perform individualized medicine (supporting research and clinical processes with high computational needs).
- VA's OI&A plans to build in intelligent functionality within VistA Evolution (new knowledge captured as a natural by-product of providing care).

Challenges in the Transformation to an LHS

While VHA may possess the essential components of an LHS, it must still develop or enhance other components. With regard to the characteristics of a continuously learning health system

[24] Italicized words tie back to the definition of an LHS stated above.

[25] Parenthetical statements tie back to Table 11-1 and LHS tenets stated above.

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found in Table 11-1, VHA appears to have a good start on Science and Informatics, but given the current culture, resources, IT infrastructure complexity, and implementation issues described in Assessment H findings, a number of characteristics listed in Table 11-1 remain as challenges for VHA. For example, OI&T and VHA must work together to align incentives to support continuous improvement and reduce waste. Moreover, while OI&A truly aspires to monitor safety, quality, processes, and outcomes, it lacks sufficient resources and staff to create all the metrics needed to do so and generate the reports to monitor these areas. This lack of resources and staff also prevents OI&A from channeling process and quality improvements back to the clinicians in the field.

In addition, leadership committed to a culture of teamwork and collaboration must exercise stewardship of the continuous learning culture. Given the lack of effective collaboration between OI&T and VHA, these two entities must first rebuild their own levels of trust and collaboration before they can instill a culture of learning within the staff.

Summary

VHA aspires to become an LHS and already has many of the essential components to become one. In fact, LHS experts have stated that VHA is one of the few health systems in the United States with the best potential to become an LHS. However, transforming into an LHS requires a fuller commitment. VHA plans must more forcefully convey a concrete vision of VHA as an LHS and the actions VHA must perform to achieve that vision. Even more important is how VHA executes those actions. VHA must overcome the cultural, resource, staffing, infrastructure, and implementation issues identified in the Assessment H findings. By transforming into an LHS, VHA can regain recognized status as a world class health care delivery system.

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Appendix A Assessment H Background Data

A.1 Project Management Accountability System (PMAS)

A.1.1 Background

Prior to a congressionally directed internal review by the VA Office of Inspector General (OIG), VA's on-time IT project delivery success rate was in the mid-30 percent range. Many projects were delivering late, not delivering, or delivering inaccurate functionality resulting in millions of dollars being wasted or mismanaged with little or no accountability.

In response to the Congressional direction, the VA Office of Inspector General conducted an internal review of more than 280 IT development projects (VA OIG, 2009). OIG discovered that a major cause was the lack of timely, thorough IT development project reviews and poor management of project or program life cycle costs and schedules. OI&T implemented the Project Management Accountability System (PMAS) across all projects to address these issues and improve VA's IT on-time project delivery success rate.

Applicability

PMAS applies to all IT projects except those that are managing the sustainment of existing systems and that are not defined as product delivery projects. Infrastructure projects that provide new capability fall under the management discipline of PMAS. VA IT projects, whether funded by the IT Appropriation or any other appropriation, and that are resourced at a value greater than $250K (which includes both contract and full time equivalent) total lifecycle cost, must use PMAS.

Structure

PMAS focuses on delivering IT projects and recognizes that these programs fit into a larger VA planning, programming, budgeting and execution structure in which large collections of related work are represented in VA's multiyear plans. "A work stream represents the budget request, which identifies the specific goals within the Program or Initiative that VA will be achieving for the two-year budget cycle. Each project executes by increments, which are manageable subsets of project work delivered every six months or less." Each increment can then have releases, which are even smaller subsets of usable functionality put into production within each increment.

PMAS execution starts after the Initiative/Program and Work Stream levels and begins at the Project level, which is also when the PMAS project officially commences. Every PMAS project must have an Integrated Project Team (IPT) and associated leadership structure.

PMAS outlines a process for managing single projects in short six-month increments and relies on IPTs to manage integration across dependent initiatives. This approach does not scale for large, complex enterprise initiatives. For example, VistA Evolution is a large program comprising over 40 individual projects. PMAS is used to manage each project, but integration and management of dependencies across these projects is the sole responsibility of the IPT teams,

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which provide little feedback and discussion. There is no overarching process outside of PMAS to establish program structure needed to manage multiple, complex initiatives as a program.

PMAS describes "project" processes, documentation, and roles and does not provide "program" specific governance or oversight. However:

- An IPT may be responsible for more than one project if it is established at the program level.
- A program level IPT could be chaired or co-chaired by the IT Program Manager (PM), while the IT Project Manager is the chair or co-chair for a project level IPT. The primary customer or Business Sponsor must serve as a member of the IPT and is frequently the co-chair with the IT PM.
- Program-level artifacts applicable to all programs and projects may be developed at the Data Access Service/Deputy CIO level.
- Projects are welcome to use program level artifacts, if applicable. Program-level artifacts promote consistency, save planning time, and improve quality through reuse. If a program-level artifact is being used for a project artifact requirement, the information must be clearly stated at the Milestone Review.

A.1.2 Principles and Objectives

PMAS's primary objective is to establish a disciplined repeatable approach to identify the processes, products and responsibilities of the IT project team, IPT, vendors, and all stakeholders responsible for achieving on-time project delivery. PMAS is based on eight major principles:

1. Incremental development - PMAS requires delivery of new capability or capabilities in increments of six months or less to reduce delivery risk.
2. Integrated teamwork across VA - All PMAS projects must have a fully functioning project or program level Integrated Project/Program Team (IPT) comprising all applicable stakeholders from OI&T, the Office of General Counsel (OGC), and the Office of Acquisition and Logistics (OAL), in addition to the Business Sponsor (VHA).
3. Accountability – PMAS teams continuously report and hold mandatory 60-day project assessments in addition to normal milestone reviews to assess schedule, cost and scope.
4. Resource management – Project increments will not start or maintain execution without the allocation of resources required to execute the project. Projects are provided resources by increment based on established OI&T project priorities.
5. Transparency – PMAS requires that each project publish cost, schedule, quality, scope, and resource status throughout the project's lifecycle. Projects are continuously monitored and flagged (Green, Yellow, and Red) to provide status and warn of increased risk and issues that require management intervention. This information is collected and published in the VA internal PMAS Dashboard for reporting both internal and external to VA—most notably to the Federal IT Dashboard and to Congress.
6. Senior leadership engagement – Leadership participates in major milestone reviews in addition to the continuous dashboard and reporting mechanism mentioned above.

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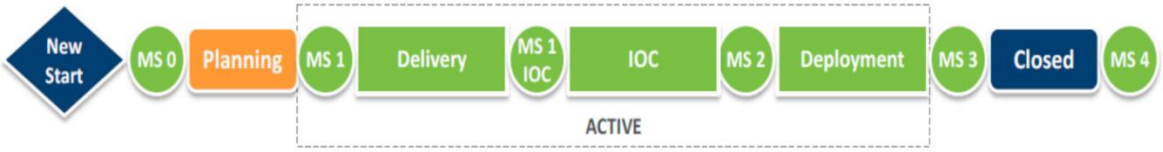
7. Direct participation by the customer - Sponsors participate as member of the IPT, as reviewers for critical milestone decisions (e.g., New Start State, Closed State), participate in user testing and make the final decision to accept the delivery of capabilities.
8. An emphasis on agile program and development practices.

A.1.3 Management Process

The PMAS Guide 5.0 (VA OI&T, 2014e) documents the current process life cycle, governance mechanisms, participant roles and responsibilities and reporting requirements. PMAS is supplemented by ProPath,[26] a repository that contains the detailed artifacts, processes, and procedures to execute PMAS. An electronic web-based PMAS Dashboard is the authoritative source for all PMAS data. It captures not only project-level data, but also increment data. The PMAS Dashboard is also used to submit data to the Federal IT Dashboard via the OMB 300B process and provides senior leaders visibility into the current status of the projects.

PMAS defines four standard states: New Start, Planning, Active, Closed and two conditional states: Provisioning and Paused in which a program can reside. PMAS projects may be in only one of six states at a time. Advancement through the states is made by successful completion of the requirements for each state and through approval at the required Milestone Review.



Source: VA OI&T, 2014c.

New Start State, Planning State, and Closed State focus at the project level, while the active State focus is on increments and product delivery.

New Start – During the New Start State, the initial project scope and intent are defined by the Business Sponsor (who works with either the IT Program Manager [ITPROG] or PM within the Office of Responsibility [OOR]). Artifacts that are required prior to entry into the Planning State are listed in ProPath. Projects in the New Start State must be evaluated every 90 calendar days by the OOR.

Planning State – Projects that are performing initial planning activities including: Artifacts that must be completed during the Planning State, prior to entry into the Active State, are listed in ProPath.

Active State – A project cannot remain in the Active state for more than 24 months. The Active State has three PMAS applicable increment types: Delivery, Initial Operational Capability (IOC) and Deployment. The core business objective of these processes is to develop and deliver functionality within their increments. These are known as “Delivery” increments.

[26] https://www.voa.va.gov/DocumentView.aspx?DocumentID=223

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- Delivery: A cycle of less than six months within the project schedule in which a project develops and deploys customer accepted functionality into production within the committed increment timeline. A Delivery increment may end at IOC Entry or Deployment.
- IOC: A cycle within the project schedule for large or complex projects whose increments need to be placed into limited production environments of varying size and complexity. This is done to test the new functionality and determine if the features and functionality perform as expected and do not adversely affect the existing functionality of the product/system.
- Deployment: A cycle within the project schedule dedicated to deploying usable functionality to a system, data center, site, and/or product. Because of the nature of the functionality being deployed, the project may need to roll out its functionality in a deliberate area-by-area or site-by-site manner.
- Closed State - A project enters or is placed in the Closed State when the project objectives have been met, business priorities have changed or the project performance was poor and not meeting objectives.

An increment deliverable is defined as a new or enhanced IT capability used by one or more customers in production. This is true for software/system increment deliverables and for infrastructure upgrades, enhancements, or expansions. For some high-risk projects, delivery of a prototype or pilot may be an acceptable increment deliverable and would be approved as such during the Milestone 1 Review for that increment. For some complex systems for which field deployment is resource intensive, the increment deliverable may be defined as the first production deployment, also known as the alpha site.

Figure A-1 shows the PMAS project management lifecycle.

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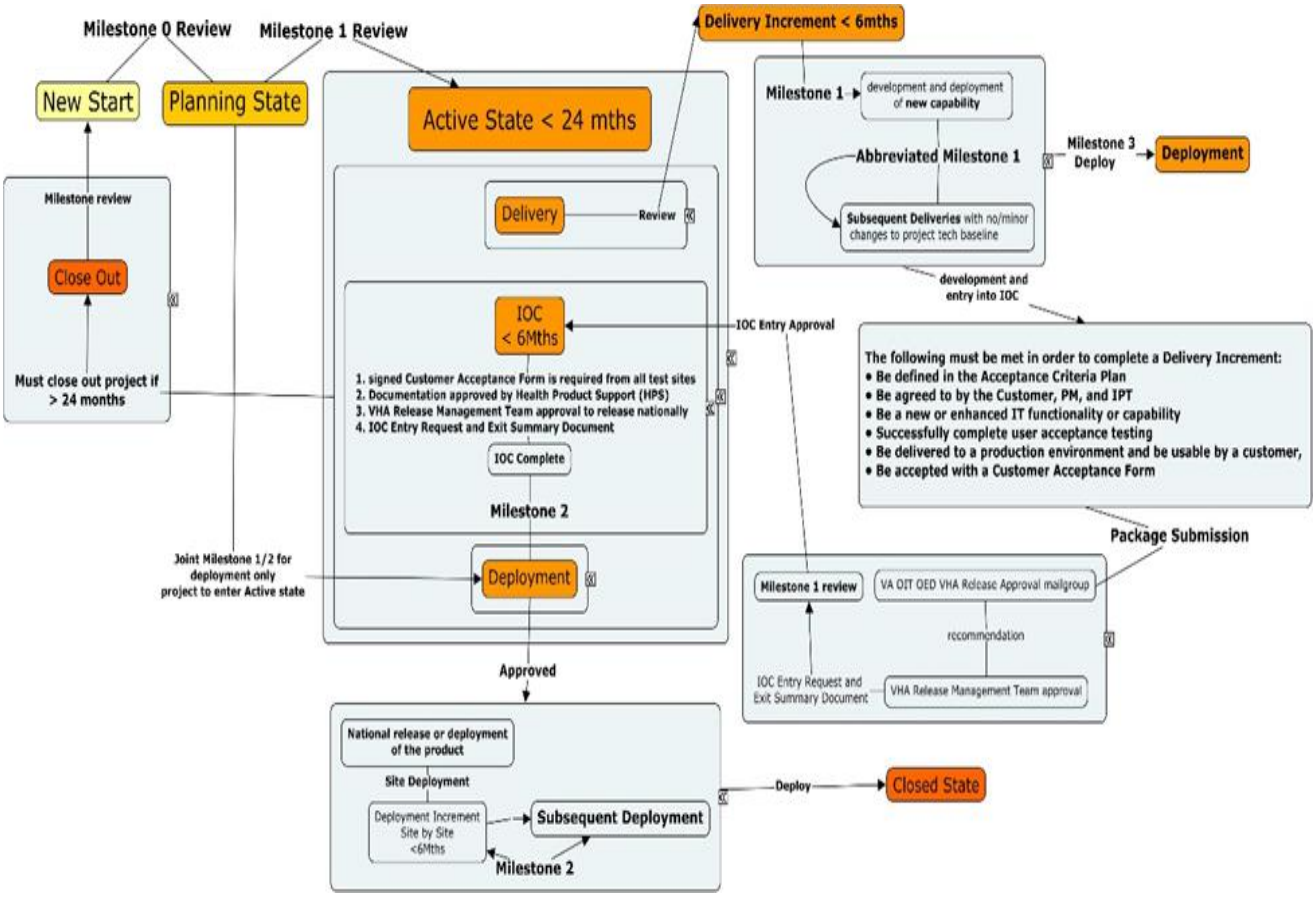
Figure A-1. PMAS Project Management Life Cycle



Source: MITRE summarization of PMAS and ProPath Guides process diagrams.

A.1.4 ProPath

The ProPath process supplements PMAS by providing a repository that contains artifacts, processes, and procedures. ProPath is the companion to PMAS and maps directly to the requirements outlined within the guide. It supports PMAS execution by providing the detailed processes and instructions, descriptions, roles and responsibilities required by PMAS policy and practice. It also provides a front-end Process Asset Library containing information regarding standard processes and over 400 artifacts and templates to assist project teams. Sixty of the over 400 documents and templates are deemed essential as part of the SDLC process to support PMAS milestone reviews.

Process Effectiveness

A 2009 GAO audit (US GAO, 2009) was conducted at the request of the CIO to evaluate the effectiveness of PMAS. The report indicated that OI&T created and instituted the PMAS concept without a roadmap, adequate leadership, and staff to effectively implement and manage the new methodology. Specifically, key management controls to ensure PMAS data reliability, verify project compliance, and track project costs had not been well established. Also detailed

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guidance on how such controls should be used within the framework to manage and oversee IT projects had not been fully established.

In fiscal year 2011 OI&T reported that the on time delivery rate jumped to 89 percent, continued at 80 percent in fiscal year 2012 and was 82 percent in 2013. OI&T also reported that PMAS has delivered 97.3 percent of all IT commitments to its customers since its inception. However, a second follow up audit on OI&T implementation of the prior audits' recommendations (GAO, 2015b) pointed to continuing issues with process execution and impact.

The 2015 audit reported "OI&T has taken steps to improve PMAS. Although steps were taken to improve PMAS, more than five years after its launch, it still has not fully infused PMAS with the discipline and accountability necessary for effective oversight of IT development projects." OIG specifically identified that OI&T had not provide adequate oversight to ensure OIG's prior recommendations were sufficiently addressed and process controls were operating as intended; also, PMAS Guide enhancements were not implemented. OIG identified that "IT development projects are potentially being managed at an unnecessarily high risk."

PMAS does not have the proper balance between cost, schedule, and performance incentives. Incentives are weighted too heavily towards meeting the schedule. Several Assessment H interviewees reported that requirements are "deferred" to stay on schedule—"Over 80% of projects are meeting their milestones but are delivering 10% of what we wanted." Several interviewees felt that the resulting deliverables, while coming every six months, were often too short of value/capability to be useful for the cost of the deliverable increment and there was risk that the project would be completed without the minimum capabilities to be successful.

User satisfaction assessment is not mandated by the PMAS process making it difficult to understand the impact of product releases.

PMAS Efficiency

PMAS is overly complex and requires an immense amount of paperwork to complete, creating significant overhead for smaller projects – "PMAS has too much process overhead with 78 steps." In its existing form, PMAS cannot easily be tailored depending on the project's size, risk, and complexity. Most projects are smaller, putting a great burden on the projects' resources to abide by the PMAS process, to the point that in several reported cases - such as projects to quickly address defects or immediate needs, the effort to support PMAS requirements far surpassed the effort to delivering value for the project.

A recent VA OIG audit (OIG, 2013) of OI&T's PMAS implementation acknowledges that the implementation has come along since its inception, while additional work remains. Key gaps identified included lack of oversight tools, continued VA staff vacancies, and inadequate planning and compliance reviews.

PMAS has addressed several issues well. It stopped projects from living on for years and not producing anything. It accomplishes this by validating that projects have a plan, conduct regular reviews, and report progress providing greater transparency. Projects are regularly assessed when they fail to make delivery and must explain why and must produce a get-well plan. The

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plan is reviewed and a decision is made as to whether to approve an extension or shutdown the project. However, Assessment H interviewees identified 15 of 46 Planners (33 percent) and 17 of 26 Builders (65 percent) who conveyed that, while PMAS improves accountability and transparency, it has become overly complex and burdensome and is impacting project efficiency. PMAS has also made many project managers risk averse and "very, very conservative." Several lead project managers acknowledged that many project managers schedule conservatively so the six months increments contain less functionality. The process needs some way to measure the quantity and quality of things being delivered.

The true complexity of the management processes are captured in ProPath. The ProPath Project Management process consists of 71 separate activities focusing on the project life cycle to produce deliverables or artifacts to initiate, plan, and manage IT projects. ProPath System Development processes contain over 91 activities focused on the System Development Life Cycle producing deliverables or artifacts to design, develop, test, and implement the solution. Figure A-2 demonstrates PMAS and ProPath complexity. The top-level Project Management "Project Initiation" phase consists of eight major planning activities supported by 34 process tasks, generating or reviewing over 39 project documents or artifacts.

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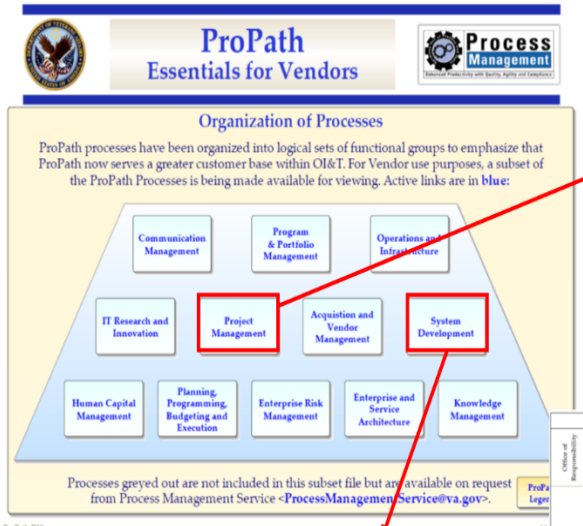
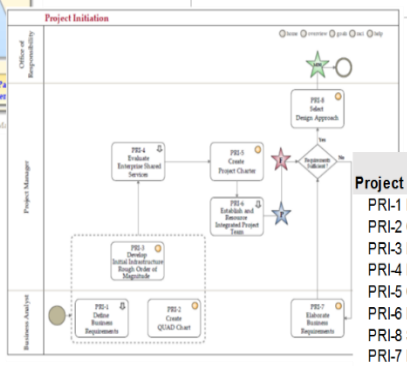
Figure A-2. PMAS and ProPath Complexity



Propath Project Management Processes	#Activities
Project Initiation	8
Project Launch	5
Project Monitoring and Control	9
Change Management	6
Configuration Management	5
Project Planning	9
Project Shut Down	7
Restart Paused Projects	6
Start Subsequent Increment	10
Project Closure	6
	71



System Development Processes	#Activities
Assessment and Authorization Process	10
DoD/VA Authority To Operate Reciprocity	2
Implementation Management	13
Independent Test and Evaluation	6
Product Architecture	10
Product Build	14
Product Design	9
Product Documentation	8
Product Support	2
Release Management	3
Requirements Elaboration	5
Test Preparation	9
	91

Project Initiation - sub processes	#Sub Activities	Artifacts Created
PRI-1 PRI-1 Define Business Requirements	4	4
PRI-2 Create QUAD Chart	1	1
PRI-3 Develop Initial Infrastructure ROM	1	3
PRI-4 Evaluate Enterprise Shared Services	17	23
PRI-5 Create Project Charter	1	1
PRI-6 Establish and Resource Integrated	8	2
PRI-8 Select Design Approach	1	2
PRI-7 Elaborate Business Requirements	1	3
	34	39

Source: MITRE summarization of ProPath Guide Project Management and System Development Workflow diagrams.

PMAS is designed with some flexibility. If the specifics of the project do not require the use of all these documents and justification is given at the Milestone 1 Review, the Milestone 1 Review Board grants waivers for artifacts or ancillary processes. Projects in the Planning State must be evaluated every 60 calendar days by the OOR to determine if the project will remain in Planning, move to the Provisioning or Active State, be re-evaluated, or closed. For projects that will be technically complex, early engagement with the Architecture Engineering Review Board (AERB) is highly recommended but not required.

However, agile processes with frequent modifications do not fit well within the current PMAS process. Each modification requires extensive reviews and burdensome documentation requirements. The agile process causes frequent modifications to project artifacts causing redundant reviews. The CIO process incurs over 61 separate activities and is another example of the high overhead incurred by PMAS as demonstrated in Figure A-3.

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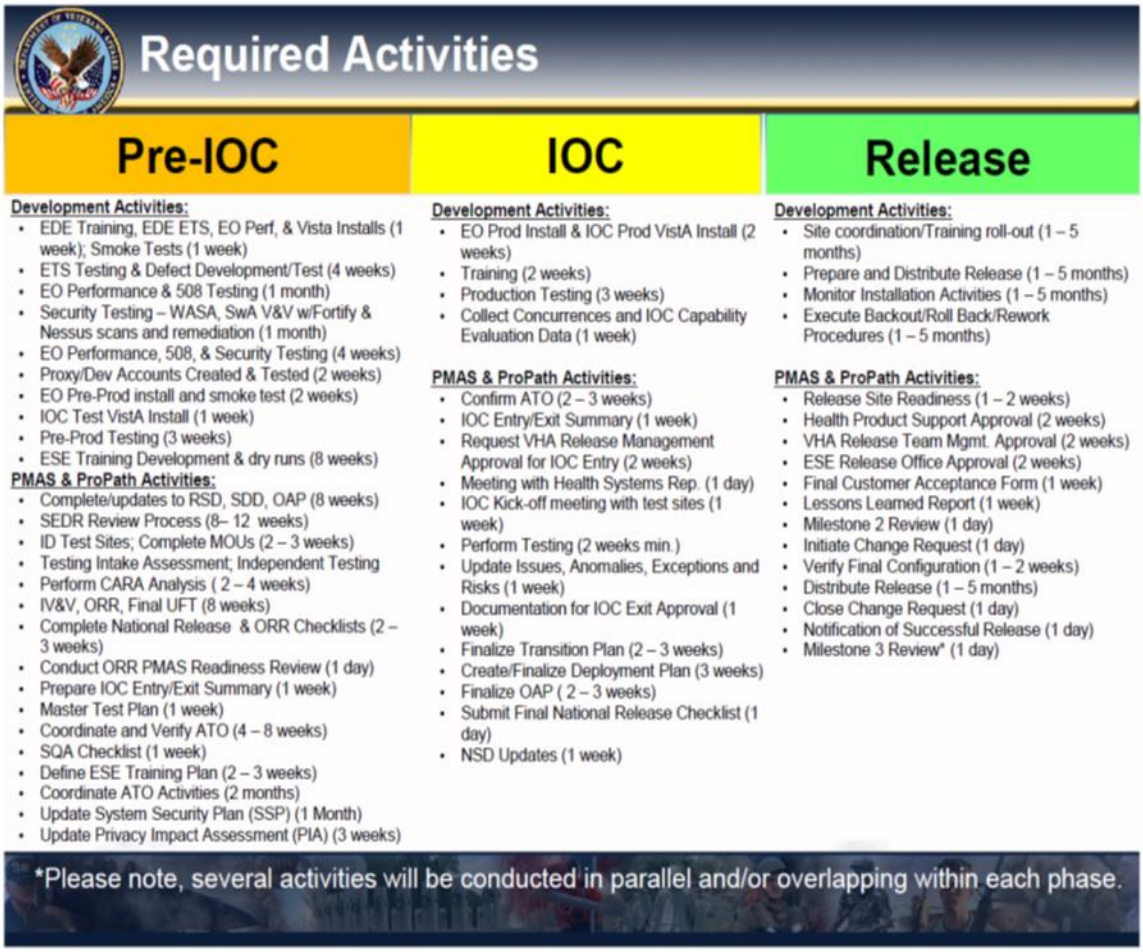
Figure A-3. PMAS Mandatory Activities



Source: VA OI&T, 2014c.

A.1.5 How PMAS Supports Agile Development

PMAS strongly encourages adoption of agile practices during project development as one of the eight basic principles documented in the PMAS Guide. However, the PMAS guide and ProPath process contain little in the way of agile execution. Each project must assess and declare the development methodology it uses.

PMAS and ProPath documentation stipulate that not all projects require exactly the same artifacts. Agile project managers can select activities that best fit their requirements, as long as they adhere to mandated policies, such as PMAS, Information Security, or National Release policies. These policies mandate creation and completion of certain artifacts which reflect clearly established milestones necessary for both project funding and/or acquisition and to mitigate risks associated with deploying systems nationwide.

VA's OI&T established an Agile Lean Community of Practice (ALCP) to provide guidance to Program and Project Managers using Agile and Lean methodologies. The COP is supported by

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the Agile/Lean Implementation Work Group (ALIWG) which comprises senior agile practitioners and holds to the principle that the Program and Project Mangers determine the appropriate methodologies to use for their assigned projects. The ALIWG leadership follows policies and procedures for oversight and review as outlined in the latest version of the PMAS Guide and ProPath processes and recommends changes as appropriate.

ALCP also provides an Agile Suitability and Maturity Guide and tools. The context for the document and tools is to help determine if a project should be managed using agile methods and how to measure that agility specific to VA.

- Agile Suitability Assessment tool provides a framework for assessing whether a project is suited for agile. Additionally, it supports decisions related to:
  - Identifying and mitigating risks specific to delivering a project using agile methodologies.
  - Pinpointing necessary changes to team and stakeholders' skill sets to support the use of agile.
- Agile Maturity Assessment tool provides a framework for assessing whether a project can be considered agile or not based on certain minimum characteristics of agile projects.
- Agile Project Characteristics Suitability and Maturity Guide provides guidance to help determine if a project should be managed using agile methods and how to measure that agility specific to VA.

The ProPath team has an active member on the ALIWG and is responsible for incorporating into ProPath the agile management guidelines, templates, and toolsets once determined and established by the ALIWG. Additional agile template and tools were added to PMAS and ProPath to adopt a more common agile approach and ensure projects are using the same measures to assess projects performance.

As shown in Figure A-4, these documents are meant to provide common agile management and measurements capabilities in the following areas of the PMAS process.

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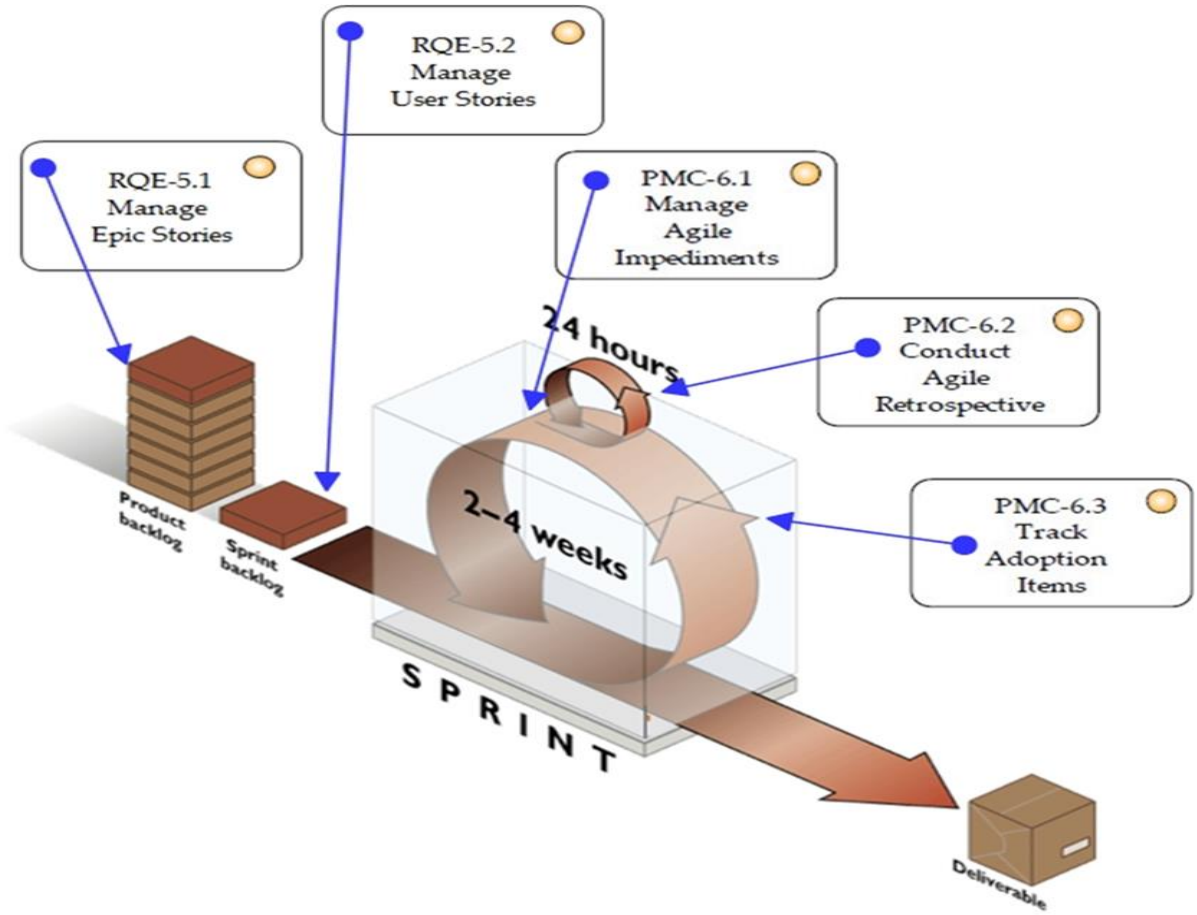
Figure A-4. PMAS Agile Management and Measurement Process



Source: VA, Agile Methodology and VA, 2015h.

The audience for these tools and the guideline are the project managers, development leads, and project oversight boards that make the decision on development methodology, often in consultation with their teams and the PMO. However, during Assessment H interviews, none of the 46 planners (i.e., architects, program managers/leads) or 20 builders (i.e., project leads, development staff, software engineers) mentioned the community of practice, the tools, or the ALIWG when specifically asked.

Is PMAS Agile?

The Agile Manifesto set down some simple objectives. ProPath strives to be SDLC agnostic and does not adhere to or endorse any specific development methodology (e.g., Waterfall, Rational Unified Process, or Agile). Agile project managers are expected to use their expert judgment and discretion to select those activities that best fit the project's needs and create project plans to meet the need of the selected development methodology. While sequencing of activities (and creation of artifacts) can be at the project team's discretion, ProPath provides a recommended sequencing of activities based on a logical progression of artifact development in

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support of a project which does not support agile development. This process is serial in nature and overly focused on process and creating artifacts as opposed creating working software.

PMAS guidance emphasizes the need for good "customer collaboration," but over 60 percent of Assessment H interviewees indicated that customer interactions at the clinical working level (i.e., VAMC, VISN, Innovation Centers, Research Centers) are limited, sporadic, and usually unidirectional.

PMAS seems to address "working software" in the guidance, but the Assessment H study discovered that schedule drives delivery more (at the expense of working software) which is evident by the focus on schedule and financial process metrics used to track project status and the lack of customer satisfaction and content delivered.

The Agile Suitability Assessment tool, Agile Maturity Assessment tool, and Agile Project Characteristics Suitability and Maturity Guide provide common method to measure differing implementations and adoption of agile processes across projects.

Agile processes with frequent modifications do not fit with the current PMAS process. Each modification requires extensive reviews and burdensome documentation requirements. For example, because of the dependency on the Requirement Specification Document (RSD), a System Design Document (SDD) cannot be completed prior to the development of a RSD.

Doing Agile, but Not Being Agile

PMAS and the OMB guidelines for incremental development are basically trying to exploit aspects of 'agile' development, which emerged as a best practice over the past decade and has consistently been identified as a success factor for IT projects. However, *the highest priority for agile development is* "*to satisfy the customer through early and continuous delivery of valuable software.*" In contrast, the highest priority for PMAS is meeting a complex schedule of milestones.

PMAS and supplemental agile related documentation align with the recommended set of principles in the Government Accountability Office (GAO) report on "Effective Practices and Federal Challenges in Applying Agile Methods." They center on the Agile Manifesto themes of small, frequent capability releases, a dynamic requirements process that allows for the continuous prioritization of requirements, active involvement from the user community throughout the development process, and commitment to delivering working software based on a time-boxed schedule. However, they fail to define and standardize agile-based practices to ensure a Department-wide consistent and common understanding of what constitutes an agile-based DoD program or project (Lapham, Williams, Hammons, Burton, & Schenker, 2010). This leads to misunderstanding and misrepresentation of agile principles. After defining the principles, VA needs to provide detailed guidance to the acquisition community that describes how to execute the agile acquisition processes within acquisition guidelines and regulations.

Adopting only a handful of agile practices without a broader agile strategy fails to achieve desired results. For example, one DoD early adopter initially attempted to implement agile practices by breaking large requirements into several four-week sprint cycles. However, the program lacked high-level agreement on what to develop in each cycle, and did not have a

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robust requirements identification and planning process in place. Furthermore, the program lacked an organized user community and active user-participation throughout the development process—a fundamental agile tenet. As a result, the agile processes quickly degenerated and the program only delivered 10 percent of its objective capability after two years of failed agile development attempts. The program finally retreated to a waterfall-based process. It simply could not execute the agile strategy without the proper environment, foundation, and processes in place.[27]

The primary metric for true *agile* development is not based on rigid timelines – *the primary metric is whether or not working software actually exists and is demonstrably suitable for its intended purpose*; which should be determined empirically at the end of every increment. The insights above, combined with other findings, lead us to conclude that PMAS has simply incorporated the temporal aspect of agile development, but is not actually 'being agile' in the sense of incorporating best practice approach.

A.1.6 Summary

PMAS follows a waterfall project management approach which is a sequential process broken into stages. This typically includes eight stages; conception, requirements, analysis, architecture, development, testing, implementation, and maintenance. The steps in these processes are intentionally sequential, so that the team transitions from each step in directed order, with meticulous record keeping/documentation and shared awareness in capabilities so that the client knows what to expect. Software architecture is almost entirely focused on its one phase of a waterfall product management process. PMAS should be retooled to account for the documentation and process to support continuous planning, multiple sprints including design, development, integration, and test cycles that culminate in demonstration of capabilities to users and other stakeholders.

Agile is not an "all or nothing" approach for "all VA projects." However, once the decision to use an agile project management approach to manage a project is made, agile should affect every phase of a software project. Any constraints on agile project management processes which co-mingle waterfall processes will be a significant risk to realizing the benefits of using agile.

Properly implemented agile processes should result in capabilities developed and potentially shipped into the hands of users at the end of every sprint. Industry norms see these sprints range from four weeks, to as little as two weeks. Mixing successful agile processes with parts of the PMAS prescriptive IT development processes represent a risk to successfully using agile. The PMAS process will need to be enhanced to support and encourage more rapid software release processes for all projects so that agile development teams can easily deliver a "shippable product" as frequently as every two weeks. Operationally, successfully implemented agile project management will depend on strict adherence to well-known and well-understood practices for the engineering team. This should include software development coding conventions, software code complexity analysis, continuous integration servers that run unit

[27] (Defense Information Systems Agency, 2015)

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test code upon every iterative check-in, strict adherence to reviewing delivered capabilities at the end of sprint burn-down meetings (as frequently as every two weeks), and transparent management of and technical debt that the team knowingly assumes.

The PMAS process is currently an impediment to more rapidly introducing new capability and collecting feedback from VA's users. This longer latency introduced in the PMAS processes represents an impediment in successfully implementing agile if VA is to see more software projects incrementally update their working software systems.

For instance, the Enterprise Health Management Platform (eHMP) is a VistA Evolution project that is taking significant steps to ensure the adoption of processes that align well with a stricter agile project management activity.

A cursory review of eHMP documents and team interviews indicated that the project uses many best practice development and management methodologies. eHMP is fully embracing agile development strategies, involving two-week sprints with demos to stakeholders at the end of each sprint for a tight feedback loop. Potentially Shippable Increment (PSI) planning sessions are conducted periodically at the end of several sprints to revisit and plan for new features, develop and update user stories, look for interdependencies with other projects, and prioritize development for the next PSI.

PMAS processes need to be more flexible with respect to the ability to rapidly change technologies used by software projects in the PMAS process. For instance, the PMAS process needs to reduce the impediments and latency associated with introducing new and emerging versions of software languages and frameworks.

It should be an aim of the PMAS process to identify and introduce a new version of a language or software framework in as little as two weeks. This would align with a more rapid software development process that VA software teams should also be striving to meet (bi-weekly software builds and associated releases). This additional flexibility would allow VA software teams to more rapidly incorporate capabilities into projects that will benefit Veterans.

VA must successfully align the incentives for contractors to use agile well within the bounds of government regulation. Contracts will need to be enhanced to align incentives for shared benefit to VA and VA's contractors when capabilities are delivered ahead of schedule, and under-cost. Alternatively, VA contracts may need to be more flexible if capabilities need to be extended either beyond the original Period of Performance or via increased mission scope based on positive user feedback.

Agile must be scaled to support complex enterprise initiatives and programs. To support increased program-level visibility of both interdependencies and overall program risk, VA should adopt any one of the scalable enterprise models including processes like "scrum of scrums." These agile processes allow teams to continue to maintain high velocity designing and developing the most relevant capabilities for their users. To address the need for heightened awareness and visibility into the activities of individual projects, "ambassadors" from the various teams conduct their own daily "read out" scrums to share all new and emerging decisions that the teams are incrementally making. This has the same benefit to managing risk as scrum does on the individual basis.

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A.2 IT Infrastructure and O&M

A.2.1 Introduction

VA's IT infrastructure for its enterprise software architecture is large and overly complex with a heterogeneous mix of software frameworks and technologies, making it difficult to efficiently modernize health IT functionality and products that impact health care delivery. Impacts include:

- Sustainment costs are increasing and are unsustainable, taking resources away from new capability development.
- VA has not established the data standards required for intra-VA interoperability.
- The size and complexity of VA's enterprise IT infrastructure continues to impact their ability to effectively secure sensitive data within their information systems. Increased dependence on telehealth, mobile applications, and information exchange with external providers will increase their challenges with achieving an acceptable cyber security posture.

A.2.1.1 Historical Perspective

The Assessment H team found that VA's ability to *execute* IT strategies revealed significant challenges created by the compounding, accidental complexity resulting from the initial development approach and ongoing evolution of their custom-built software-intensive health IT system[28]. Related findings associated with this complexity include increasing O&M costs, intra-VA interoperability challenges, and the long-standing inability to effectively secure the sensitive data in VA's information systems.

Much of VA's current technical challenge stems from their *decentralized* approach to IT during the 1990s, which was credited with their dramatic turnaround in health care services during that time. It is important to note that *decentralization and autonomy were* the *most often cited reasons for that remarkable turnaround in VA health care during the 1990s* (Walters, 2009) -- and it was the local-scope, small-scale, decentralized approach to software development that produced an effective breeding ground for innovation and rapid advancements in health IT. However, this also created unsustainable IT cost via the *accidental software complexity* created as "*new applications were popping up sporadically, and haphazardly.*" The lack of standardization and effective IT governance ultimately created significant technical complexity in the form of a "*sprawling, aging, and unwieldy system of computer and communications technologies spread across the department's more than 1,000 medical centers, clinics, nursing homes and Veterans' centers"* (Walters, 2009).

VA's initial failed attempts to overcome this technical complexity via high-cost, major software-intensive consolidation initiatives such as '*HealtheVet'* contributed to Congress directing VA to adopt a centralized approach to IT in 2005 (U.S. House of Representatives, 2005a; GAO, 2008;

[28] VA is one of the only major health care providers that continues to build and integrate significant amount of custom software-intensive Health IT and other business line solutions

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Walters, 2009). However, Assessment H findings suggest VA has achieved less-than-sufficient improvements with respect to these enterprise integration and modernization efforts, despite the centralization of IT authority, a perpetual VA IT priority to consolidate and integrate IT solutions (VA 2007; VA OI&T 2014), and billions of dollars in IT funding.

A.2.2 Complexity

There are too few common services and the software architecture remains insufficiently defined, implemented, and governed with respect to inter-module interfaces and rules of interactions.

VA's decentralized IT development in the 90's created a custom health IT system comprising *many different versions of many different software modules*, with *many different dependencies* between these modules. This was primarily the result of local, autonomous IT resources developing customized versions of these software modules to quickly satisfy local IT requirements for managing and furnishing health care. The *focus on 'local, small-scale' requirements* during VA's era of decentralized, autonomous software development was not consistent with the *'enterprise, large-scale' software complexity.*

While a 'Gold Standard VistA' has consolidated nearly 60 percent of these software modules (VA 2015) and is currently being deployed across the VA enterprise to consolidate the hundreds of variations that emerged during the previous era, Assessment H found that VA's IT and software infrastructure remain overly (unnecessarily) complex with a heterogeneous mix of software frameworks and technologies.

The current VA scheduling system is an example of technical complexity and its consequences. The scheduling system currently used by VA is approximately 30 years old (note that there have been repeated failed, high-cost attempts to replace this system). VA scheduling system has *over 1,000 integration points* (VA, 2014*)* which are basically locations in software where one software module depends on the functionality implemented in another software module (i.e., the dependent software module will not function without the software module its dependent on). These integration points for VA scheduling system include those from *71 separate software modules that are depending on the scheduling module*, and *31 separate software modules that the scheduling system is depending on* (VA OI&T 2014). The dependencies are actually more complicated, because there are *different versions of each of these modules* which adds compounding degrees of complexity (in other words, each of those 71 + 31 modules is a different version). The 'Gold Standard VistA' will help address the additional complexity created by all the different versions of each of the separate modules but it does not address the dependencies between the Gold Standard versions of the 71 + 31 modules that will remain.

The many dependencies between the many VA software modules have a direct impact on what is referred to as the "*cost of change*" associated with enterprise-scale software, which is considered one of the highest software-related cost factors and is closely correlated with the dependencies (seams) between all the software modules. These dependencies (seams) also impact the "cost of integration," which directly impacts the ability to integrate COTS products into the health IT system. All these complexity factors explain why replacing VA scheduling

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system remains a high-cost, highly-technical challenge. Similar 'dependency' challenges exist for other health IT applications in VA. It is also worth noting Assessment H related findings regarding the absence of a 'master integration plan' in VA's fragmented approach to IT project management (referring to their reliance on a multitude of discrete, separately managed software development efforts with no master integration schedule or plan), which aligns with GAO's repeated findings associated with VA's IT and software integration challenges.

Since the end of VA 1990s era of small-scale software development, VA has been trying to consolidate their entire collection of health IT solutions – which requires cross-cutting enterprise IT considerations for VHA, VBA, and NCA and significantly magnifies the IT and software complexity factors. This VA IT enterprise perspective is critical to understanding the scale, scope, and complexity of the technical challenges OI&T has faced in accomplishing their decade-long strategic IT objective to create a 'One-VA' (VA, 2005) that transitions VA "from disparate stovepiped processes and systems to a unified environment of integrated, interoperable business processes and technical services"(VA OI&T 2014). The approach requires special expertise and appropriate IT processes for successful large-scale, centralized IT management; large-scale software infrastructure; and large-scale software development – all of which represent a stark contrast to the expertise and processes required for the decentralized IT and local software customizations that created the successful health IT solutions in the 1990s.

Evidence of VA's ongoing struggle to transition from 'small-scale' to 'large-scale' is illustrated in Figure A-5, which provides an approximate timeline for the various infrastructure technologies VA has implemented. Instead of consolidating their infrastructure, VA has arguably increased the software complexity, creating more challenges. This evolution of technologies reflects an enterprise software anti-pattern[29] called "The Technology Alter" (Torkamani & Bagheri, 2014), where the enterprise ends up focusing on the underlying technologies instead of the business objectives. Assessment H interviews with VA stakeholders described this as "chasing shiny objects" and "bright shiny new things," referring to exactly the same concept embodied in the 'The Technology Alter' anti-pattern (chasing new technologies) with the same consequences (IT-driven, not business-driven). Further evidence of this was offered by OI&T leadership who told us that, in the absence of clear health care objectives from VHA, their IT development has been focused on building "flexibility into the infrastructure" while "[VHA] figures out what they want." Other Assessment H interviewees described the lack of defined measurable health care outcomes for driving IT investments. While VA has recently developed KPIs for driving IT development, "the approach will require implementing a process that has never been done before." These examples indicate problems ensuring business needs are driving IT investments, but OI&T's attention to increasing the 'flexibility' *of their enterprise software infrastructure is a positive finding*.

[29] Enterprise Software Anti-Patterns derive from analysis of the wide and ever-growing selection of repeated software failures in an attempt to understand, prevent, and recover from them. Anti-Patterns are a new tool that bridge the gap between architectural concepts and real-world implementations.

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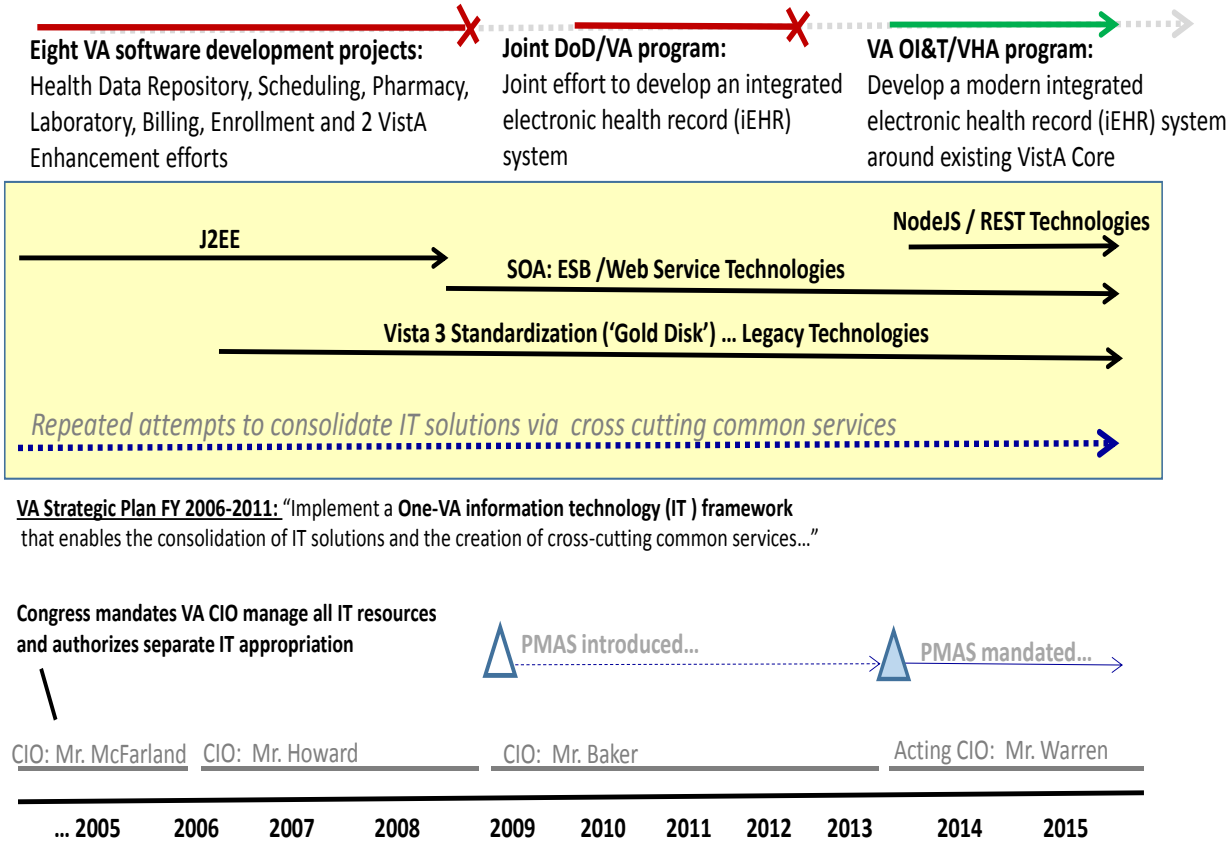
Figure A-5. Timeline for VA IT Modernization Using a Mix of Technologies



Source: MITRE rendition of data from planning documents and reports.

As a non-functional 'quality' attribute of a software architecture, flexibility does not directly impact the health care outcomes. However, the complexity described so far limits flexibility, which limits the ability to support evolving business needs. This increases the time and cost of delivering measurable outcomes exploit emerging, innovative health IT solutions – as VA was able to do so well with the inherent flexibility of the decentralized, small-scale development in the 1990s.

Assessment H revealed that VA's ongoing attempts to "*increase flexibility,*" along with their related ongoing attempts to overcome the accidental complexity created by the development of their legacy health care system, has produced the software health IT infrastructure illustrated in Figure A-6, which shows the lack of standardization created by the mix of technologies incorporated over the past decade. Note that this figure does not show the breadth and depth of VA's enterprise software infrastructure, which must incorporate many cross-cutting considerations for all VA business lines and also impacts their health IT efforts. The 'software 'stack' on the left of the diagram represents the results from VA's move towards SOA and web services; the software stack in the middle represents the legacy software, but does not show the hundreds of modules and their many different versions; and the software stack on the right shows the recent move towards a modern infrastructure technology called

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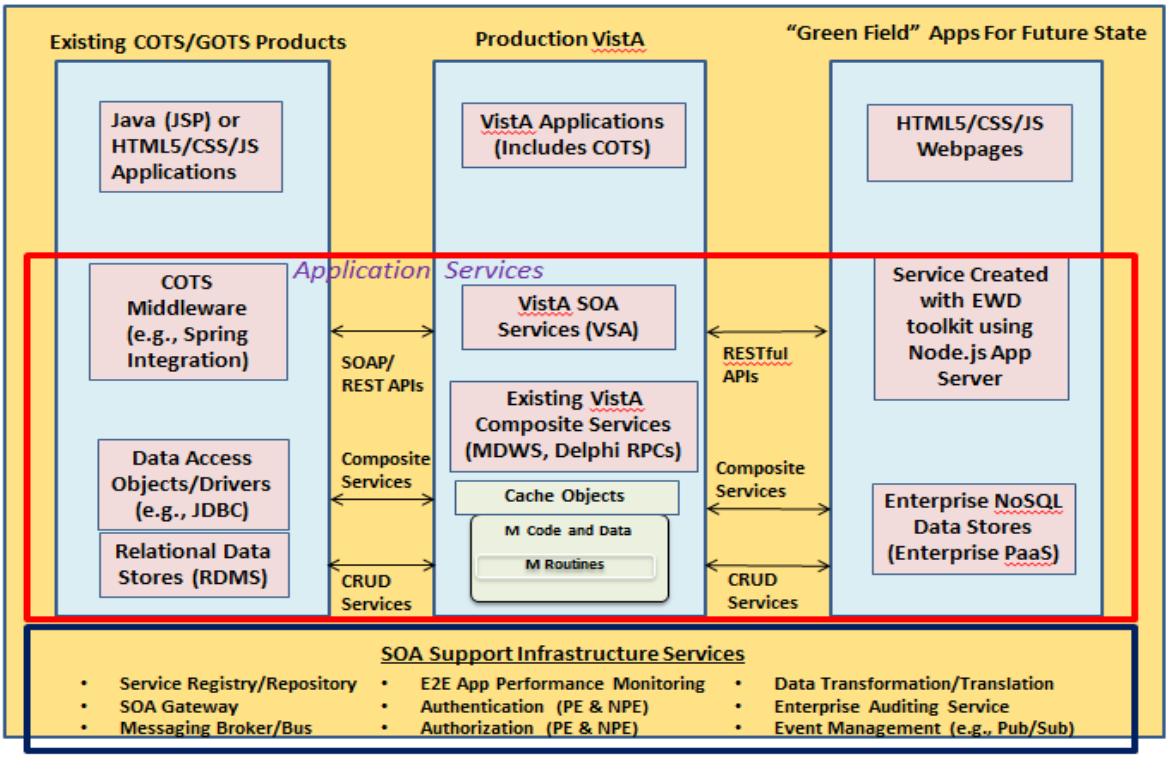
'Node.JS,' which recently emerged as one of the most popular technologies in today's global open source software community.

Figure A-6. VA's Heterogeneous Software Architecture



Source: OI&T ASD, VistA 4 Product Architecture Review Triad Meeting Winter 2015 (briefing), January 27, 2015.

This mix of software stacks reflects what is described as a 'non-standardized infrastructure,' which has been identified in case studies as a common failure factor for IT projects. (Standish Group, 2011). As noted in Figure A-5, VA's efforts to transition from 'small-scale' to 'large-scale' have increased the software complexity due to implementation of multiple software application and infrastructure technologies over a 10-year time span. Instead of consolidating their infrastructure, VA has created more challenges that impede their ability to upgrade and extend their existing software systems.

Figure A-6 illustrates in more detail this mix of software applications and infrastructure (e.g., Java J2EE Technology, SOA: Enterprise Service Bus (ESB)/web service technologies and Node.js/REST Technologies) that VA must now simultaneously maintain as a 'non-standardized infrastructure.' This type of 'non-standardized infrastructure' has been identified in academia and industry case studies as a common failure factor for IT projects.

Consequences include the exponentially increasing 'time and cost of change' due to complexity and duplication of efforts; the variety of added costs required to maintain and manage multiple skill sets -- especially those required for VA's 30-year old technologies, where the pool of skilled resources are significantly decreasing (e.g., Mumps, Delphi); and a list of challenges with

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respect to effective cyber security. Additional impacts were revealed from interviews with VA stakeholders, who described impacts from the lack of sufficiently defined and/or sufficiently implemented 'common services' required for accomplishing rapid, cost-effective development. Other stakeholders, including OI&T leadership also described the time and cost impacts related to the challenges with integrating COTS solutions into this infrastructure.

This finding also reflects a top failure factor for IT projects described as 'underestimating the technical complexities of large-scale IT infrastructure,' which is related to the inability to develop accurate cost estimates and effectively control the total software development and integration costs that emerge at enterprise scale. These impacts are reflected in several other Assessment H findings.

A.2.3 Increasing IT Maintenance Costs

VA's enterprise IT infrastructure includes the combination of hardware, software, networks and facilities required to develop, test, monitor, secure, support, and control VA's IT services. VA's annual IT spending published on the Federal IT Dashboard can be organized in four categories (SemanticInfo, 2015):

- New/Upgrades Spending for Mission Area – Program costs for new investments, changes or modifications to existing systems reported as IT investments directly supporting an agency-designated mission area.
- New/Upgrades Spending for Infrastructure – Program costs for new investments, changes or modifications to existing systems identified as IT investments supporting infrastructure, strategic management of IT operations, or a grants management system.
- Maintenance Spending for Mission Area – Spending covering maintenance and operation costs at current performance level for systems reported as Mission Area Spending.
- Infrastructure Spending – Spending reported as IT investments supporting infrastructure, strategic management of IT operations, or a grants management system.

A detailed assessment of VA's enterprise IT infrastructure and itemized annual IT O&M spending were beyond the scope of Assessment H. However, analysis of VA IT spending trends found that maintenance costs have grown almost continually since 2002, as shown in Figure A-7. More troubling, spending on upgrades or new capabilities for the VA mission now represent only 15 percent of the total IT budget. During Assessment H interviews, several stakeholders, including those directly involved with IT investment planning and funding allocations, echoed concerns that O&M funding is "eating up our development, modernization, and enhancement funding." As a result, the growing cost of maintaining the complex infrastructure reduces the availability of funding for new IT capabilities needed to manage and meet health care needs.

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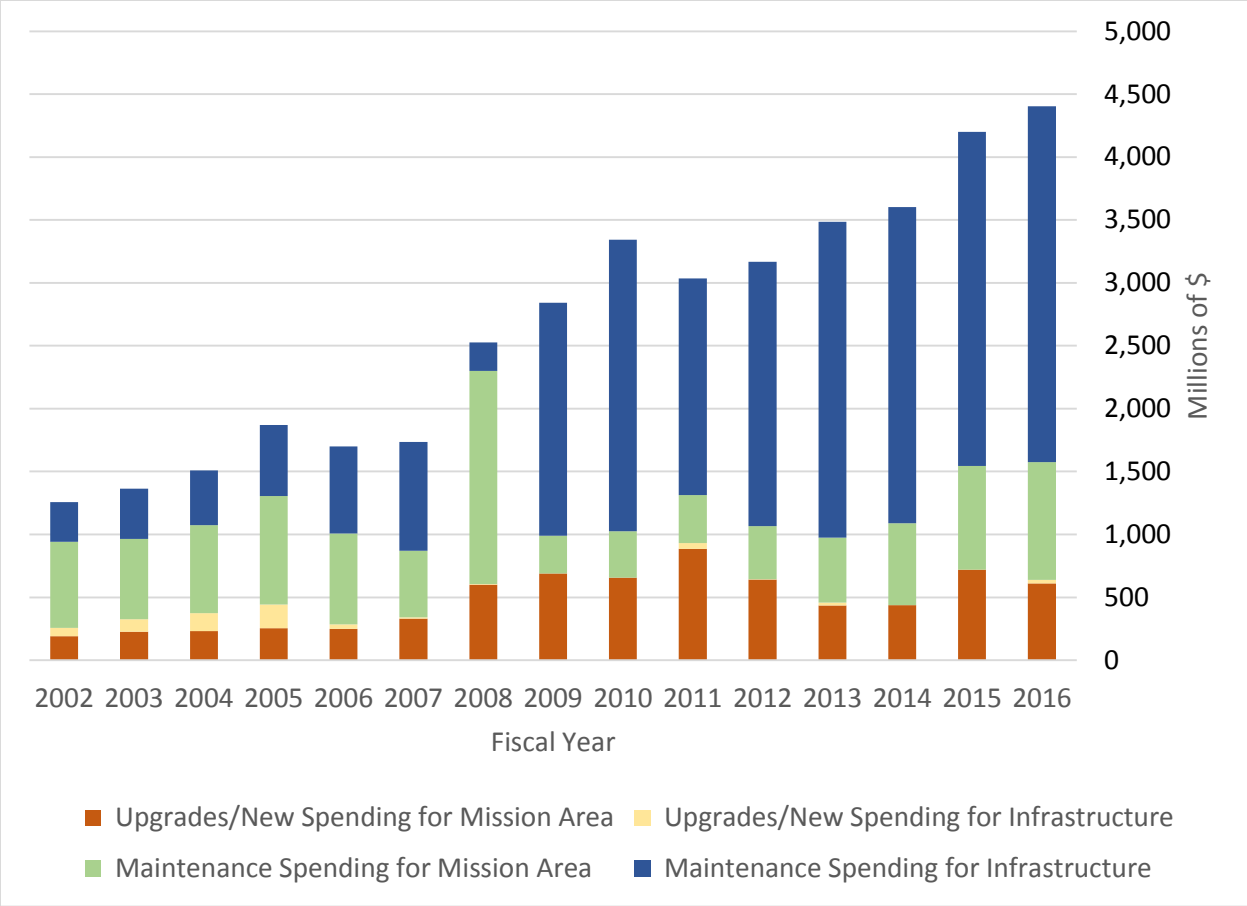
Figure A-7. VA IT Spending on Upgrades vs. Maintenance



Source: MITRE graph derived from data collected from the Federal IT Dashboard 2015, https://itdashboard.gov/

OI&T leadership identified these O&M costs as those associated with the sustainment of VA legacy systems, which corroborates our previous finding regarding the high cost associated with the 'accidental complexity' created by the initial development and ongoing evolution of VA software infrastructure.

Figure A-8 illustrates the impact of increasing IT infrastructure costs, which shows increases in total VA IT spending and IT infrastructure maintenance spending during the past five years, but a flat to declining trend in DME spending on mission areas and infrastructure improvements (software development and modernization). Because OI&T provides infrastructure and mission area capabilities for VBA, NCA, and VHA, the proportion of IT spending for health care capabilities and infrastructure are not discernible from this figure. In addition, the negligible spending on infrastructure upgrades compared to infrastructure maintenance raised questions about how OI&T categorized IT spending that could not be resolved prior to publishing of this report.

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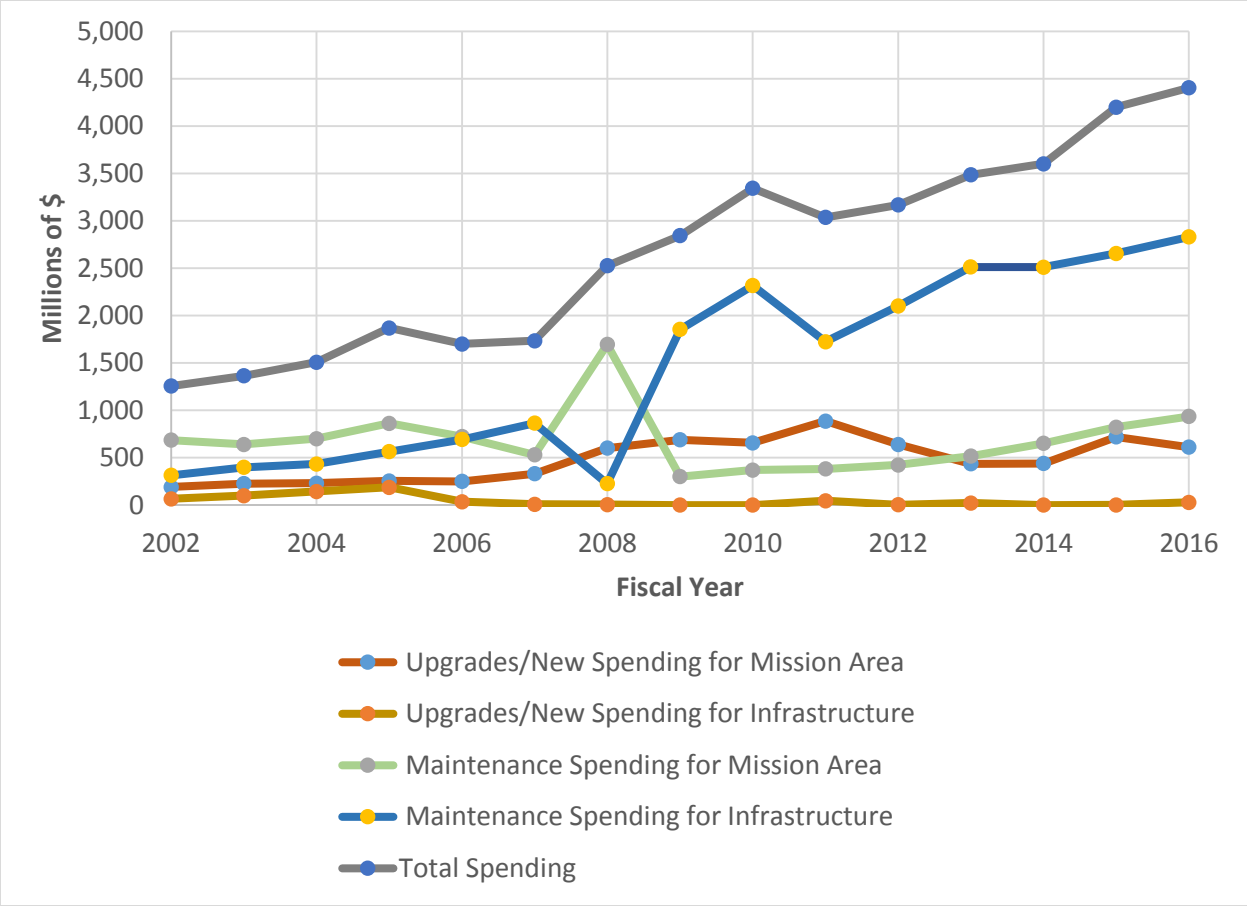
Figure A-7. VA IT Spending Trends by Year



Source: MITRE rendition of VA data.

The VA IT O&M cost increases have continued *despite* several ongoing IT initiatives that are specifically intended to reduce IT O&M-related costs. These cost-cutting initiatives include the following, which have not demonstrated measurable reduction in costs:

- **Physical consolidation enterprise IT infrastructure assets:** VA has been attempting to consolidate their distributed physical servers (and applications) into four regional data centers since 1998 (GAO, 1998) with planned completion by 2010 (OMB, 2008). As of 2014, this consolidation remains far from complete (VA Enterprise Centers 2014) with the cost for managing these yet-to-be-filled enterprise data centers exceeding $300M per year – the highest line item in the FY15 O&M budget. Furthermore, multiple VAMC CIOs interviewed by the Assessment H team were unaware of these consolidation plans.
- **Logical consolidation of enterprise software infrastructure**: This consolidation can be considered a form of 'logical consolidation,' which is intended to reduce development, integration, and sustainment costs by reducing total complexity, eliminating duplication of functionality (e.g., many different versions of many different software modules). Effective logical consolidation, combined with the VA CIO's explicit focus on 'increasing flexibility' as a non-functional requirement of VA's software infrastructure, should be having

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measurable impacts on both DME and O&M costs, but the Assessment H study did not find evidence of this impact.

- **Ruthless Reduction Task Force (RRTF**): This was specifically designed to eliminate hardware and software redundancies within the VA enterprise (Miller, 2011). The focus of this group included: consolidation of IT contracts where possible, IT virtualization, elimination of desk side printers, and purchase of more multi-functional devices (e.g., printers with fax capability).

None of the VA stakeholders interviewed by the Assessment H team could identify the specific root cause of these O&M increases or explain why the cost-cutting initiatives listed apparently have no measurable impact on cost cutting. Also, they could not describe an executable mitigation plan for controlling these increasing costs.

Despite increased spending on IT infrastructure, VISN sites expressed dissatisfaction with OI&T response time and overall ability to support local IT infrastructure needs.

VA stakeholders across many VISN clinical environments expressed concerns that may reflect the unintentional consequences of the transition to a centralized IT organization. This transition has moved most of the IT decision making to the regional and national levels, disconnecting the local IT organization from these decisions. The problems expressed by stakeholders at the local VISN sites include the following:

- OI&T is slow to respond to local requests.
- Local IT resources having insufficient resources to support local requirements. This included a variety of requirements, from increased bandwidth to accommodate the increased use of Telehealth to the need for scanners.
- Insufficient local IT staff to support the infrastructure growth required to support emerging health IT trends.
- VISN directors and IT staff have little or no visibility into strategic IT objectives and major IT projects that are in development or how and when these may impact their clinical environments.

A.2.4 Security and Privacy

The size and complexity of VA's enterprise IT infrastructure continues to impact their ability to effectively secure the sensitive data within their information systems; and the increased dependence on telehealth, mobile applications, and information exchange with external providers will increase their challenges with achieving an acceptable cyber security posture.

A detailed, comprehensive assessment of VA's cyber security plan and current posture was beyond the scope of Assessment H. Furthermore, VA OIG already provides annual performance audits of VA's compliance with the Federal Information Security Management Act (FISMA) with the latest report published May 2015 (VA OIG, 2015).

However, the ability to effectively secure Veteran's sensitive information is a critical cross-cutting enterprise IT concern for all aspects of VA IT strategies, especially with respect to the

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outcomes impacting Veterans (in this case, the measurable effectiveness of cyber security strategies).

VA is responsible for executing the Federal Cybersecurity Cross-Agency Priority (CAP) Goal and objectives, which the Government established to "*address the long standing challenges of tackling horizontal problems across vertical organizational silos.*" The Cybersecurity CAP Goal strategy starts by requiring compliance with the FISMA requirements.

Chronic Weaknesses and Deficiencies with Cyber Security Posture

With respect to execution of IT strategies for satisfying FISMA requirements, the 2013 audit report "*marks the 16th consecutive year the agency has failed a cyber-security assessment* (Federal News Radio 2014; Washington Free Beacon 2014)." Even more relevant to our previous findings regarding *effective IT execution* is the fact that OIG has *repeatedly identified the same weaknesses and deficiencies* in VA's information security program in their annual FISMA audit reports (VA OIG, 2011; VA OIG, 2012; VA OIG, 2013; VA OIG, 2014; VA OIG, 2015). That trend has continued in the recent 2014 FISMA audit report published May 2015 (VA OIG, 2015), which states that "*this FISMA audit continued to identify significant deficiencies related to access controls, configuration management controls, continuous monitoring controls, and service continuity practices designed to protect mission-critical systems. […] the VA has not remediated approximately 9,000 outstanding system security risks in its corresponding Plans of Action and Milestones to improve its information security posture.*"

Despite these repeated failures to meet FISMA compliance requirements, the 2015 version of the OMB report to Congress (OMB 2015) on the implementation of FISMA by Federal agencies ranked VA in the middle tier *with respect to aggregate cybersecurity compliance scores* (see Figure A-10). However, this middle-tier ranking only reflects VA's relative ability to meet basic cybersecurity compliance requirements (and may be interpreted as a negative indication of cyber security posture for Federal IT systems rather than a positive indication for VA, but these results prove that VA cannot be singled out as a poor performer in the Federal IT domain).

Critical Assets, Specific Threats, and Vulnerabilities

While Assessment H did not conduct an evaluation of VA cybersecurity posture, the team did assess VA IT strategies with respect to the following critical considerations for effective cybersecurity:

1. **Assets**, in the context of Assessment H, include the Veteran's private, sensitive information (e.g., Social Security numbers, home address, personal health information). The sensitive nature of these data and the specific threats listed below highlight *the potential impact on the Veteran.* The specific vulnerabilities described below highlights the increased *likelihood of this impact.* The inability to execute effective cybersecurity IT strategies to address the specific threats and IT-related vulnerabilities listed below contributes to our concerns expressed in this finding.

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Figure A-8. Cybersecurity Assessment Scores in OMB 2015 FISMA Report

Agency	FY 2014 (%)	FY 2013 (%)	FY 2012 (%)
General Services Administration	99	98	99
Department of Justice	99	98	94
Department of Homeland Security	98	99	99
Nuclear Regulatory Commission	96	98	99
Social Security Administration	96	96	98
National Aeronautics and Space Administration	95	91	92
Department of the Interior	92	79	92
Department of Education	91	89	79
National Science Foundation	87	88	90
United States Agency for International Development (USAID)	86	83	66
Environmental Protection Agency	84	77	77
Department of Labor	82	76	82
Department of Veteran Affair	80	81	81
Department of Energy	78	75	72
Office of Personnel Management	74	83	77
Department of the Treasury	67	76	76
Department of Transportation	63	61	53
Small Business Administration	58	55	57
U.S. Department of Agriculture	53	37	34
Department of State	42	51	53
Department of Health and Human Services	35	43	50
Department of Housing and Urban Development	19	29	66
Department of Defense	N/A*	N/A*	N/A*
Department of Commerce	N/A†	87	61

Source: OMB, 2015.

2. **<u>Threats</u>** are *parties with the intention and capabilities to exploit vulnerabilities and gain access to the assets.* The FBI has issued two specific threat warnings that elevate our concerns about VA cyber security:
   - The FBI Cyber Division issued a Private Industry Notification (PIN) that states "*Health Care Systems and Medical Devices at Risk for Increased Cyber Intrusions for Financial Gain*" (FBI Cyber Division,2014). The FBI warns about the "*transition to EHR coupled with more medical devices being connected to the internet will generate a rich new environment for cyber criminals to exploit*." The FBI report includes a reference to a SANS, Ponemon, and EMC²/RSA that states the following: "*the health care industry is not technically prepared to combat against cyber criminals' basic cyber intrusion tactics, techniques and procedures (TTPs), much less against more advanced persistent threats (APTs). The health care industry is not as resilient to cyber intrusions compared to the financial and retail sectors, therefore the possibility of increased cyber intrusions is likely*."

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- The FBI and the Department of Homeland Security issued a joint intelligent bulletin with a threat warning regarding ISIS and their call on supporters to scour social media for addresses of their family members – and to "*show up [at their homes] and slaughter them.*" The warning specifically stated this: *"The FBI and DHS recommend that current and former members of the military review their online social media accounts for any information that might serve to attract the attention of ISIL [ISIS] and its supporters."* While this threat warning was not explicitly expressed as a direct threat to the VA enterprise, this should arguably be considered a relevant cyber security threat because: 1) there is a clear focus on using cyber-based tactics to obtain Veteran's personal information; 2) the VA information systems have Veteran's personal information; and 3) the risk has very high impact.

3. **Vulnerabilities** are specific weaknesses and deficiencies in VA's ability to secure their assets against known and unknown, emerging cyber threats (e.g., secure the Veteran's data against the threats listed above). With respect to Assessment H, our specific concerns focused on the identification and mitigation of IT-related vulnerabilities (i.e., not insider threats, etc.) – especially those IT-related vulnerabilities related to the concerns described in our other findings, and concerns regarding the increasing reliance on Telehealth, mobile devices and applications, and information exchange with external providers.

   Assessment H reviews of past FISMA compliance reports described the fact that OIG *has repeatedly identified the same weaknesses and deficiencies in VA's information security program*, which already suggests vulnerabilities with respect to protecting Veterans' data against threats which include those listed above.

The identification of critical assets, threats, and vulnerabilities are essential planning activities for developing effective IT cyber security strategies. However, minimizing or eliminating vulnerabilities requires *effective execution of IT strategies*. As decades of security audits indicate, VA has significant challenges in this area. Many of these challenges stem from the complexity of the IT and software infrastructures described above (e.g., inability to establish accurate inventory of all IT assets).

While VA was ranked middle-tier in comparisons with other Federal IT systems in their aggregate cybersecurity scores, our assessment identified high risk exposure created by specific IT-related KFMs (see Table A-1) related to the Veterans' data and the threats described above.

4. **Ability to Protect, Detect, and Respond** to Cyber-based attacks. While there is clear evidence of the inability to satisfy basic cyber security compliance, with additional evidence suggesting that this is related to IT complexity. The Assessment H team was unable to ascertain the degree of strategic and tactical planning that has been focused on maximizing 'effectiveness' of VA's enterprise-wide cyber security capabilities. 'Compliance' does not ensure cyber security effectiveness, which involves a holistic, continually evolving, risk-based approach incorporating sophisticate analytics, detection, containment, and recovery strategies are on par with the assets, threats, and vulnerabilities outlined.

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Table A-1. VA Challenges with CAP Goals and Key FISMA Metrics

Key Performance Area	Description	Avg. Score	VA Score
Automated Asset Management: Detect and Block Unauthorized Software (KFM)	Percentage of applicable assets for which the organization has implemented an automated capability to *detect and block unauthorized software* from executing or for which no such software exists for the device type. The average is weighted by the total number of the organization's hardware assets connected to the organization's unclassified network(s).	69%	**0%**
Data Protection: Mobile Asset Encryption (KFM)	Percentage of *mobile assets with encryption of data* on the device. The average is weighted by the total number of mobile assets at the organization.	55%	**5%**
Data Protection: Anti-spoofing (KFM)	Percentage of *email systems* implementing anti-spoofing technologies when sending messages, and when receiving messages.	Receiving: 87%	Receiving: **0%**
TIC Traffic Consolidation CAP Goal	*Percentage of external network traffic to/from the organization's networks that passes through a Trusted Internet Connection (TIC) / Managed Trusted Internet Protocol Services (MTIPS).*	*95%*	***57%***

Source: OMB, 2015.

A.2.5 Summary

The cumulative *combination* of findings above, along with Assessment H findings related to VA's ability to effective execute IT strategies, will *continue* to have the following impacts:

- Limit VA's ability to effectively address the new and existing, long-standing IT-related vulnerabilities required to effectively secure their information systems.
- Increase the time and cost of OI&T's perpetual attempts to create an integrated, unified VA enterprise that must effectively and cost-efficiently addresses many cross-cutting IT aspects.
- Limit the ability to develop and incorporate innovative health IT solutions, since these technologies will typically need to be integrated into the enterprise software infrastructure to effectively be leveraged in the centralized IT model.
- Limit OI&T's time and funding to support traditional IT responsibilities, and decrease their software development productivity. This will have a similar impact on O&M costs by increasing the 'time and cost of change.'
- Limit the ability to accurately estimate the total time and cost to translate health care objectives into measurable outcomes.
- Limit their ability to cost-efficiently integrate COTS products that offer innovative or supplemental health IT solutions.

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- Limit VA's ability to effectively execute cost-cutting initiatives, which will continue to limit their ability to produce measurable cost-cutting results (and thereby control increasing O&M costs).

A continued trend in increasing O&M costs could create the following impacts:

- Continue to take away time, staff, and funding required for the development of IT infrastructure updates and advancements in health IT for managing and furnishing health care.
- Ultimately lead to the need to incorporate reactive measures, which are typically associated with high-cost consequences (note that a proactive approach requires the identification of root cause followed by the development of an executable plan to control these increases before they become unmanageable).

The inability to satisfy local site IT infrastructure requirements, despite the increasing IT infrastructure funding, suggests underlying problems with VA's approach to centralized IT management that may have the following impact:

- Limit ability for patient-facing clinical environments to effectively support Veterans health care using emerging technologies such as telehealth and mobile applications (e.g., inability to respond to network capacity limitations and other site-specific IT-related limitations).

A.3 EHR/VistA

A.3.1 Overview

VA's health IT Infrastructure is a large and complex ecosystem comprising several layers of applications, services, databases, and technologies to manage and deliver clinical patient information. The Veterans Health Information Systems and Technology Architecture (VistA) and Computerized Patient Record System (CPRS) applications are the core components of this system. When released in 1997, CPRS was widely acknowledged to be innovative and the best in its class. Nearly 20 years later, it is still considered by many to have functionality on par with commercially available systems.

VA has had automated information systems in its medical facilities since 1981 beginning with the Decentralized Hospital Computer Program (DHCP). DHCP was transformed into VistA in the 1990s. In 1997, CPRS was released to provide an updated graphical user interface (GUI) to complement VistA capabilities. Figure A-9 shows the timeline for implementing VistA and CPRS capabilities.

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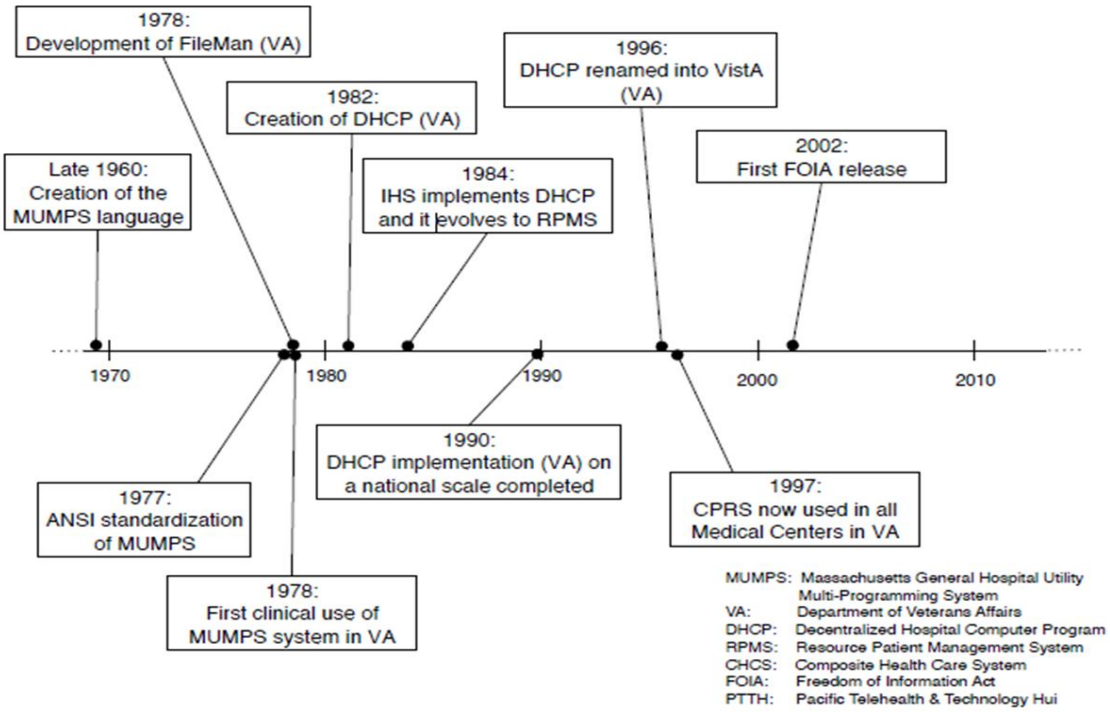
Figure A-9. VistA/CPRS Development Timeline



Source: VistA/CPRS Timeline - http://worldvista.org/AboutVistA/VistA_History

Figure A-10 shows VistA as an enterprise-wide ("Mega Suite Clinical") information system built around an EHR used throughout VA.

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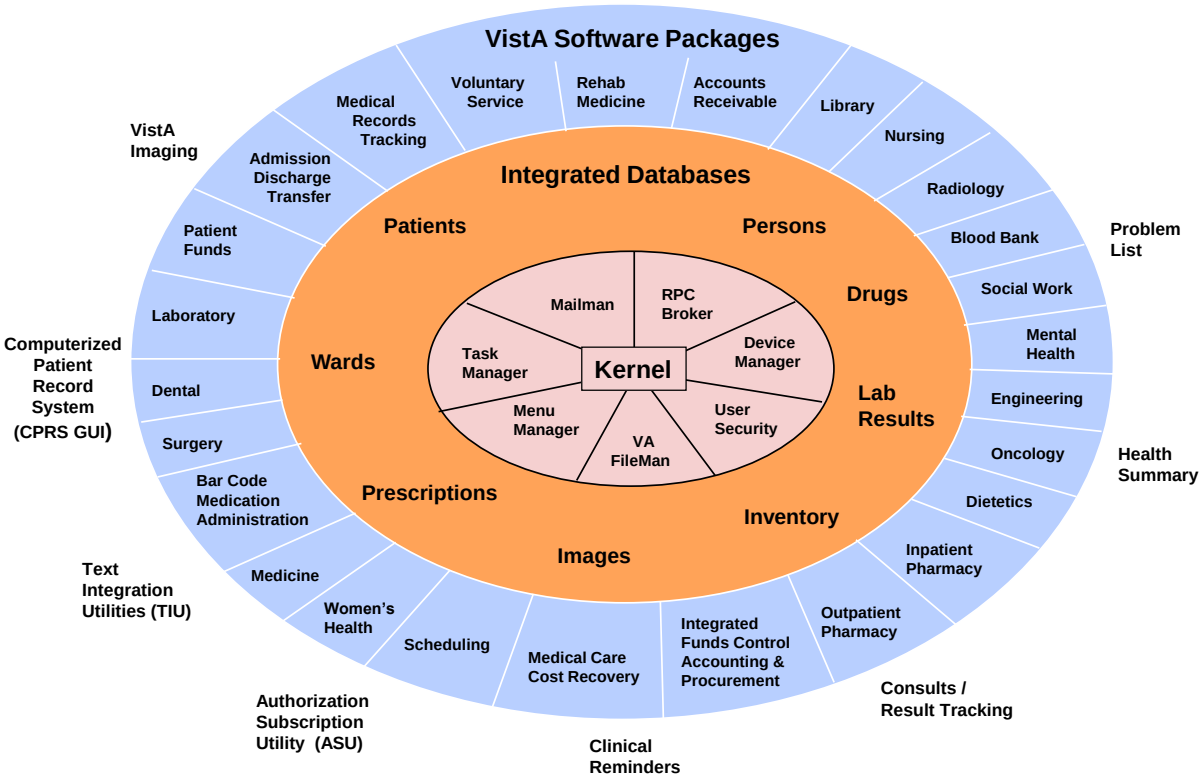
Figure A-10. VistA Technical Architecture



Source MITRE rendition of VistA technical specifications

VistA consists of application packages that share a common data store and common internal services to capture, manage and share patient information at local VA Medical Centers (VAMCs), between VA locations, with the DoD, with private providers, and with Veterans and payers. The data store and VistA kernel are implemented in the MUMPS (or M) computer language and comprise nearly 160 distinct applications/modules, 15,000 routines, and millions of lines of software computer code. VA has approximately 130 separate physical instances of VistA running the "same" version of software on centralized VA servers (in regional data centers) to support all 155 VAMCs and clinics throughout the United States.

In 2012, VA started the "Gold Disk Project" to standardize on a national version of VistA by the end of 2015. The first "gold disk" standardized 60 percent of the modules in VistA that were considered "essential" to clinical care. This instance was deployed and work on the remaining 40 percent of modules continues. The system does allow for local variations, resulting in some data elements being captured in different ways from instance to instance. Data is copied from CPRS as it is recorded and replicated into VA's Corporate Data Warehouse and Regional Data Warehouses. Differential interpretation/transformation of the data, however, sometimes results in reports being different, though the data came from "the same" data source. Figure A-11 shows the EHR/VistA technology stack, which includes kernel and core applications (i.e., Remote Procedure Call (RPC) Broker, FileMan, Device Manager) that provide the essential

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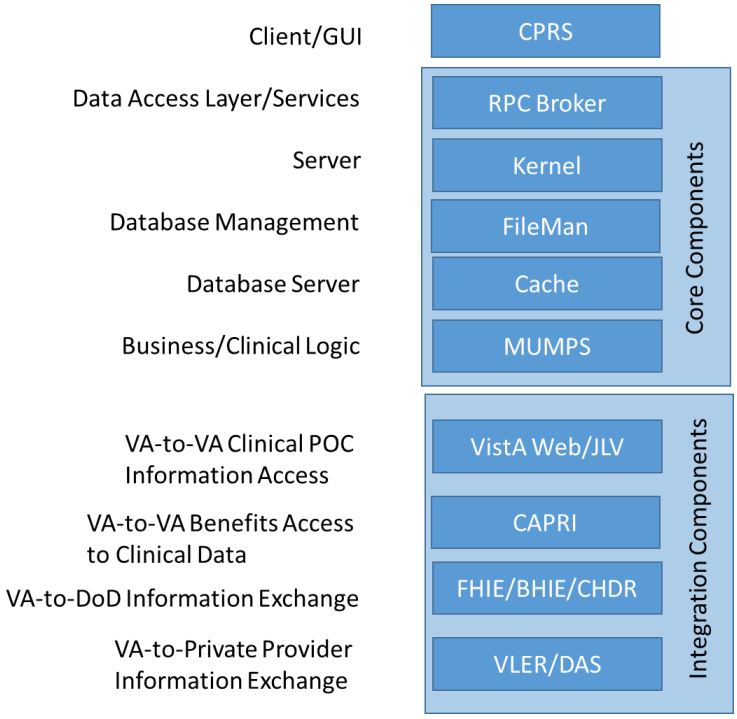
functions to capture, manipulate, and exchange patient information with VA's user applications and interoperability solutions. VistA's use of MUMPS technology tightly integrates the clinical information stored in the underlying Intersystem Caché databases with the business logic used to retrieve and manipulate that data.

Figure A-11. EHR/VistA Technology Stack



Source: VA OI&T, 2015b.

To simplify data access, VistA employs FileMan as VistA's database management system. The majority of VHA clinical data is stored in VA FileMan files and is retrieved and accessed through VA FileMan user interfaces. FileMan utilities allow the definition of data structures, menus and security, reports, and forms, allowing a person to set up applications without tremendous experience in the MUMPS programming language.

Patient Information is retrieved from the current VistA's InterSystems Cache data store using existing MUMPs procedures (MUMPS RPC interface) based upon business triggers (such as an appointment, admission, Integration, or patient search).

Figure A-12 shows the CPRS user interface. CPRS is a desktop client application (i.e., a "fat" client) that provides VA's health care professionals with a single Windows-style interface for health care providers to review and update any patient information, to place orders, including medications, special procedures, x-rays, patient care nursing orders, diets, and laboratory tests stored and managed in the VistA EHR.

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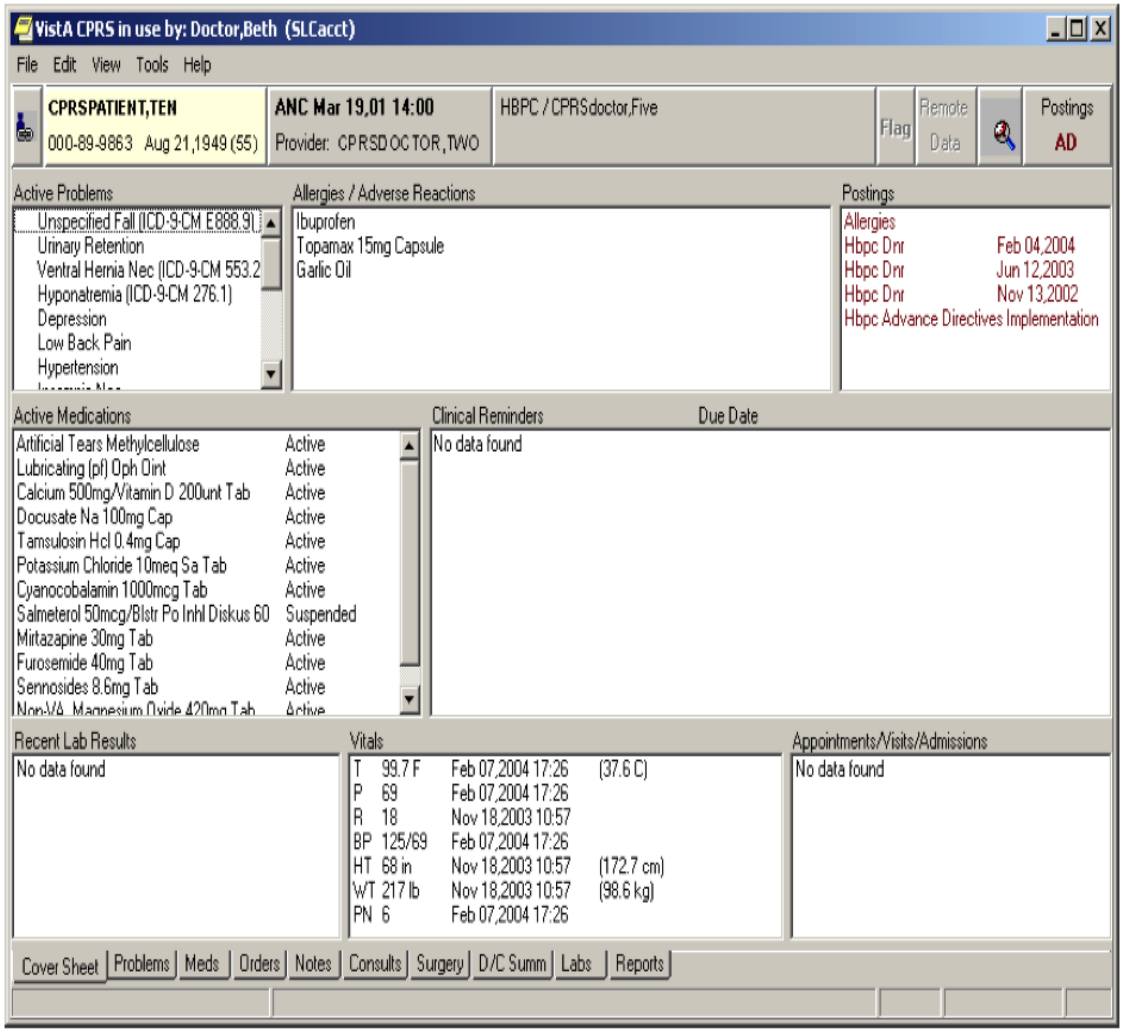
Figure A-12. CPRS User Interface



Source: CPRS User Interface – https://en.wikipedia.org/wiki/VistA#/media/File:VistACPRScover.png

A.3.2 EHR Integration

VistA supports the ability to communicate and interact with other systems at multiple levels: applications may be tightly integrated with VistA code or loosely integrated via application programming interfaces (APIs), medical devices may be connected, and patient data may be shared between providers.

For custom or commercial applications that require tight integration with the VistA database or business logic, the interface of each VistA package is documented, identifying both the code routines and the data fields owned by the package. VistA supports a library of published interfaces that provide access to VistA data and logic for a wide variety of functions through VistA's RPC Broker module. This is the mechanism used by CPRS to call the underlying business logic in VistA. The RPC interface provides separation between the mainline VistA applications and the clinician-facing GUI. Some web-based applications interface with VistA via the RPC

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library using newer software architecture that allows for newer software technologies (i.e., JavaScript-based development).

In addition to internal programming interfaces and outward-facing web services interfaces, many VistA applications communicate via standard Health Level 7 International (HL7) messaging protocols. HL7 messages provide for application-to-application communication and enable data exchange with external data repositories. HL7 messaging provides the fundamental mechanism for medical devices to interact with VistA. The Clinical Procedures package provides an interface between medical devices and VistA. Data from the device is saved according to the particular application. VistA supports both a data repository for clinical device data and a report viewer to format the data for clinical review. Numerous devices, from Picture Archiving Communications Systems (PACS) imaging to Intensive Care Unit (ICU) equipment, interface with VistA in this manner.

A.3.3 EHR Interoperability

Assessment H interviews indicated that widespread device integration is limited due to the time required to gain security accreditation and lack of programmer (MUMPS VistA) integration skills within VA. The Assessment H team was unable to identify a medical device strategy or inventory of device interfaces requests and approved interfaces. However, a sample of 20 New Service Requests for “New Device Interfaces” from OI&T’s Innovation and Development Request Portal (IDRP) database indicate that only one is complete (submitted 9/8/14), one is under development and test (submitted 12/13/12), three were rejected, and the remaining 15 (75 percent) were “Not Opened - Pending NSR Acceptance” or “Accepted for review.”

To be useful the EHR must expose and share information with external providers, administrative applications, and benefits organizations to service Veteran's needs. The four primary paths of information exchange to fulfill these roles are described in Table A-2.

Table A-2. VA Clinical Information Exchanges

Information Exchange Profile	Current Systems	Data Exchanged
VA-VA	VistA Web	Remote patient information found in VistA, the Federal Health Information Exchange (FHIE) system, and the Health Data Repository (HDR) databases
	JLV	Medications, progress and discharge notes.
	CAPRI	Veteran’s entire VA health record including progress notes and discharge summaries, Compensation and Pension (C&P) exam requests and results, FHIE data

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Information Exchange Profile	Current Systems	Data Exchanged
VA-DoD	BHIE	Real-time read-only viewing of DoD and VA patient clinical data (i.e., Consultations, patient history and physical reports, theatre clinical data)
	FHIE	Monthly transfer of discharged Service members' clinical data from DoD to VA (i.e., Pharmacy, radiology, lab results)
	CHDR	Two-way exchange between DoD and VA of actionable outpatient (pharmacy medication, allergy, and allergy reaction) data for beneficiaries that use both DoD and VA health facilities, allowing the information to become part of the patients' permanent medical records.
VA-Private Provider	VLER DAS	Veterans external partner data
	eHealth Exchange	Veterans external partner data (Populated Summary of Care Document (C32), Populated Unstructured Document Component (C62) data domains
VA-Veteran	My HealtheVet	Veteran Web Portal
	BlueButton	Veteran medical records in C32 Continuity of Care document format

Figure A-13 shows a simplified view of a patient's encounter with the current VA and DoD health care systems.

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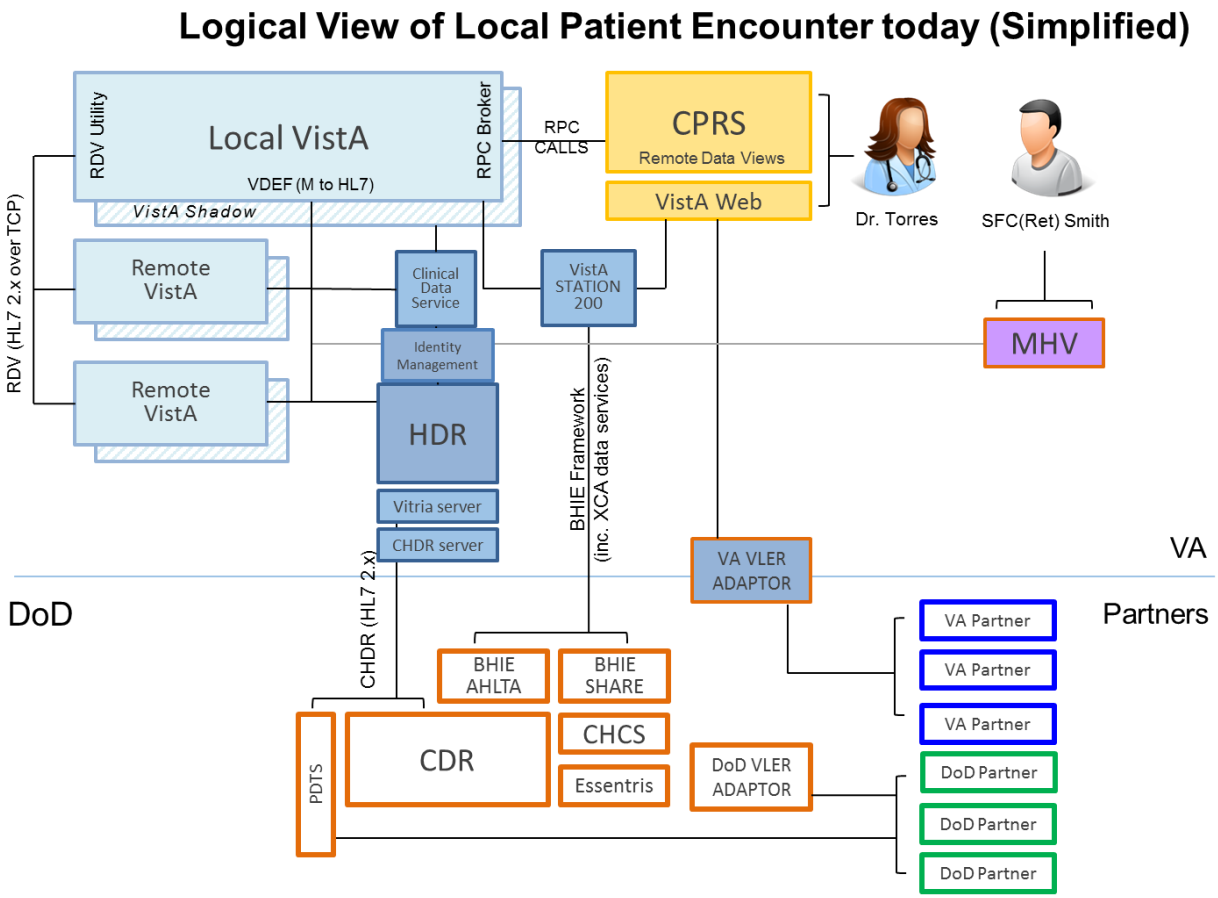
Figure A-13. Current View of Patient Encounter with VA and DoD Health Care Systems



Source: OI&T ASD, VistA 4 Product Architecture Review Triad Meeting Winter 2015 (briefing), January 27, 2015.

VA-VA Information Exchange

VistA Web and the recently updated Joint Legacy Viewer (JLV) are intranet web applications that clinicians use to review remote patient information found in VistA, the Federal Health Information Exchange (FHIE) system, and the Health Data Repository (HDR) databases. To a large extent, VistA Web mirrors the reports behavior of CPRS. An updated version of the JLV that provides the ability for both VA and DoD user to view health record data to meet the increasing need for seamless interoperability of standards-based health data was released in FY15Q1.

A clinician in Palm Springs, who is looking at a record from a Veteran who received care in Northport, NY, will view that record through VistA Web and also through the JLV. The clinician is not actually able to copy that record in Northport and put it in the Palm Springs instance—they are viewing the record in a web viewer, whose data reside in the Northport instance.

VA-DoD Information Exchange

VA clinicians have been able to access DoD data (i.e., medications, progress, and discharge notes) for many years through VistA Web using the same workflow for accessing data from

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other local VA systems. JLV, also allowed Health Information Exchange (HIE), starting in 2013 and was recently updated in FY15Q1 and is the first major phase to modify the viewer capability. JLV provides a read-only interface for patient data aggregated from DoD, VA, and external partners. JLV provides an integrated view of both DoD and VA health information on a single screen for providers of both Departments. It obtains its data from the DoD's newer data services (currently called the DoD Adaptor) and from all of VA's VistA systems (currently via its "VistA Data Services" component).

The following three major backend applications are used to transfer information between DoD and VA to populate VistA and supply data to JVL and VistA Web:

Federal Health Information Exchange (FHIE) has been in use since 2002 and is the oldest and simplest exchange between the DoD and VA. The FHIE architecture is essentially a one-time data transfer of data from the DoD to VA triggered by a Service member's separation from Active Duty. The FHIE Repository (aka BHE Repository) sits within the BHIE Framework within the VA networking enclave.

Bidirectional Health Information Exchange (BHIE) is a middleware hardware and software framework that builds on FHIE. BHIE provides a secure, bidirectional, real-time interagency exchange of clinical Personal Health Information (PHI) data and patient demographics sharing between DoD and VHA. BHIE allows both DoD and VA care providers to view records on shared patients receiving care from both Departments.

Clinical Health Data Repository (CHDR) is a semantically interoperable solution that generates standards-based, bidirectional, real-time computable electronic health data for outpatient pharmacy and drug allergies. CHDR data enable drug/drug and drug/allergy order checks for active ADC Veterans, Service members, and dependents eligible to receive health care services from both agencies.

VA-Private Provider Information Exchange

The purpose of the Virtual Lifetime Electronic Record (VLER) project is to facilitate data exchange between VA and the private sector using national standards. The project has been in development for roughly five years and exchange includes eHealth Exchange[30], Direct Secure Messaging, and exchange through Health Information Handlers (HIH). External partner data are now included in JLV. The eHealth Exchange (formerly known as the Nationwide Health Information Network) was originally launched by DoD and VA Interagency Program Office (IPO) to support the VLER initiative.

Future plans include FHIR and public APIs. VA is currently partnering with 50 external organizations through eHealth Exchange and has several active and planned use cases for secure messaging. VA providers may also be approved to access partners' HIE data through local health exchange organizations that are not currently participating in eHealth Exchange.

[30] Formerly known as the Nationwide Health Information Network, the NHIN or NwHIN, is an initiative for the exchange of healthcare information. It is operational and securely exchanging data. It was developed under the auspices of the U.S. Office of the National Coordinator for Health Information Technology (ONC), and now managed by a non-profit industry coalition called HealtheWay.

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VA-Veteran Information Exchange

All consented Veterans are able to use the "Blue Button" mechanism through the My HealtheVet portal to download their entire record from My HealtheVet in an electronic format of the C32 Continuity of Care document. VA's Blue Button support is built upon web services that perform the extraction of Blue Button information from VistA, the composition of Continuity of Care Documents, and the system management required to provide on-demand patient access to current Blue Button information.

A.3.4 VistA Evolution Program

VA established the VistA Evolution program in 2014, to oversee modernization of VA's EHR system. VistA Evolution is the third EHR modernization program in 10 years. VistA Evolution is a joint program of VA's OI&T and VHA organizations and will provide interoperability with DoD EHR systems and with other health care partners to promote improved outcomes in quality, safety, efficiency, and satisfaction in health care for Veterans, Service members, and their dependents. The first product version, VistA 4, will use modern software technologies to build a new web-based interface around the existing VistA core.

This approach is also driven by the FY 2014 NDAA (section 713) that requires any enhancements to VistA to result in an EHR that *"...at the point of deployment...must be at a generation 3 level or better for a health information technology system"* as described by Gartner.

A 2011 Gartner report states that while Gartner did not complete a formal Generations Assessment of VistA, the organization estimates that VistA is definitely more than a Generation 1 EHR and may in fact be Generation 2 EHR, but is definitely not a Generation 3 EHR.

A 2007 Gartner report identifies five generations of CPRS systems as follows:

- Generation 1 systems allow the clinician electronic access of clinical data that may have been scattered across several paper record systems;
- Generation 2 systems build upon on the Generation 1 functionality by offering documentation capabilities;
- Generation 3 systems further help the clinician with basic care management and decision support;
- Generation 4 system incorporates greater decision support capability and intuitive workflow capabilities; and
- Generation 5 systems are envisioned as true 'colleagues' that can assist the clinician in all facets of care.

The VistA Evolution Roadmap shown in Figure A-14 defines a five-year period over which the VistA 4 Product will be delivered as a series of feature sets with Full Operational Capability (FOC) to be delivered in 2018 and it is expected to achieve and exceed Generation 3 capabilities. The roadmap details how VistA Evolution will evolve through time not merely as replacements for VistA/CPRS but as a complex clinical system that provides decision support, capable of not only catching potential errors and alerting clinicians but also of guiding clinicians in the implementation of improved treatment methodologies.

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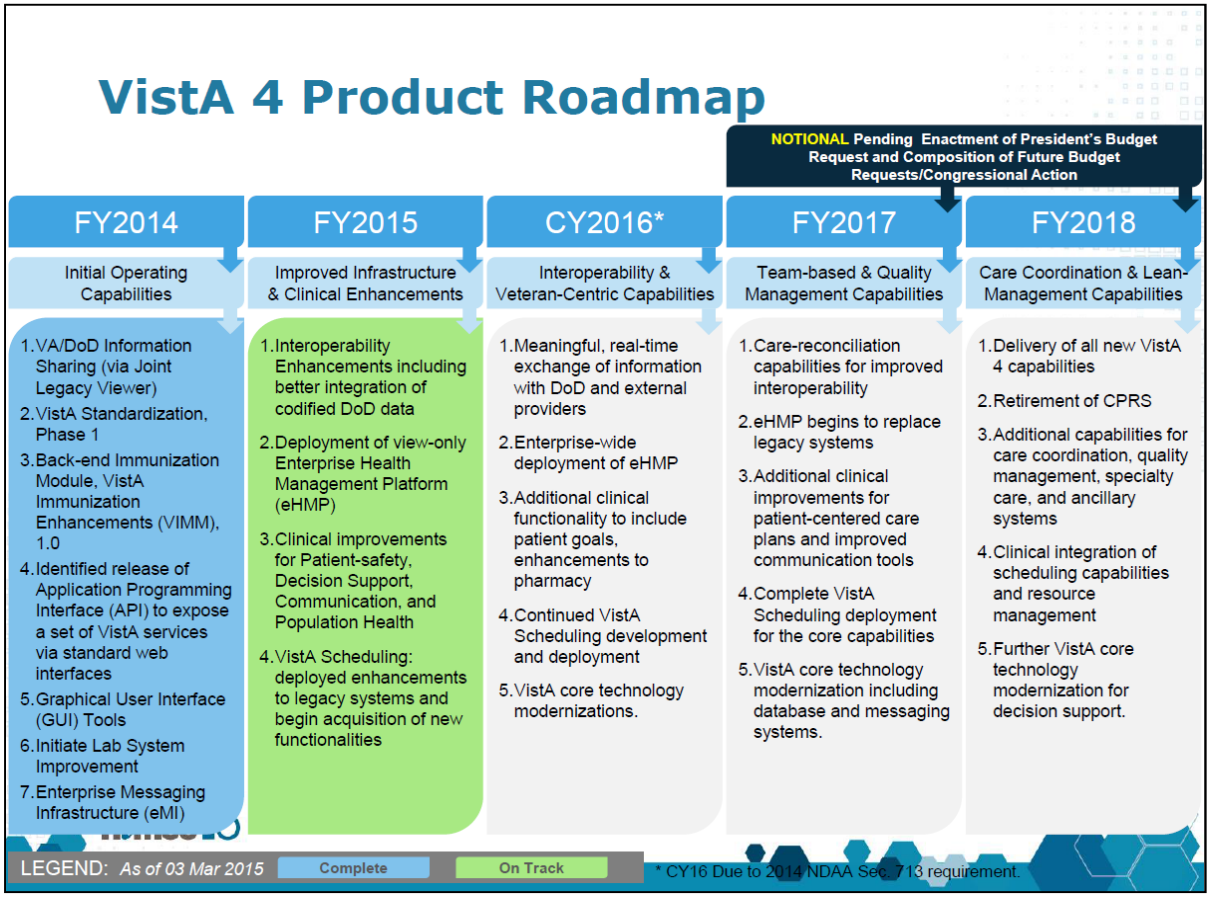
VistA Evolution is responsible for developing an entirely new user interface, clinical workflows and business logic, data access layers, terminology translation services, ancillary services and supporter interfaces to improve interoperability with DoD and private provider networks. The program is supported by the VistA Evolution Triad (described in Section 5 of this Assessment H report) which has oversight to develop several major components (i.e., eHMP, VistA Exchange, VSA, EMI) across 30-40 VA Independent Project Teams and DoD.

The current VistA/CPRS operating environment must be maintained while the VistA Evolution program simultaneously modernizes key components of those legacy systems and integrates them with newly developed software applications across the enterprise. As explained in Figure A-14, VistA Evolution will develop and deploy capabilities in four major feature increments over 5–6 years completing in FY 2018. All the interdependent technical project components must come together to achieve the health outcome described in the *Blueprint for Excellence* EHR objectives. (VA, 2014c)

Figure A-14. VistA Evolution Roadmap



Source: Drew & Nebeker, 2015.

The enterprise Health Management Platform (eHMP) project is the CPRS replacement and is the core of the VistA Evolution program. From a clinical perspective, eHMP will provide the full range of EHR functionality to support ambulatory and inpatient care documentation, including

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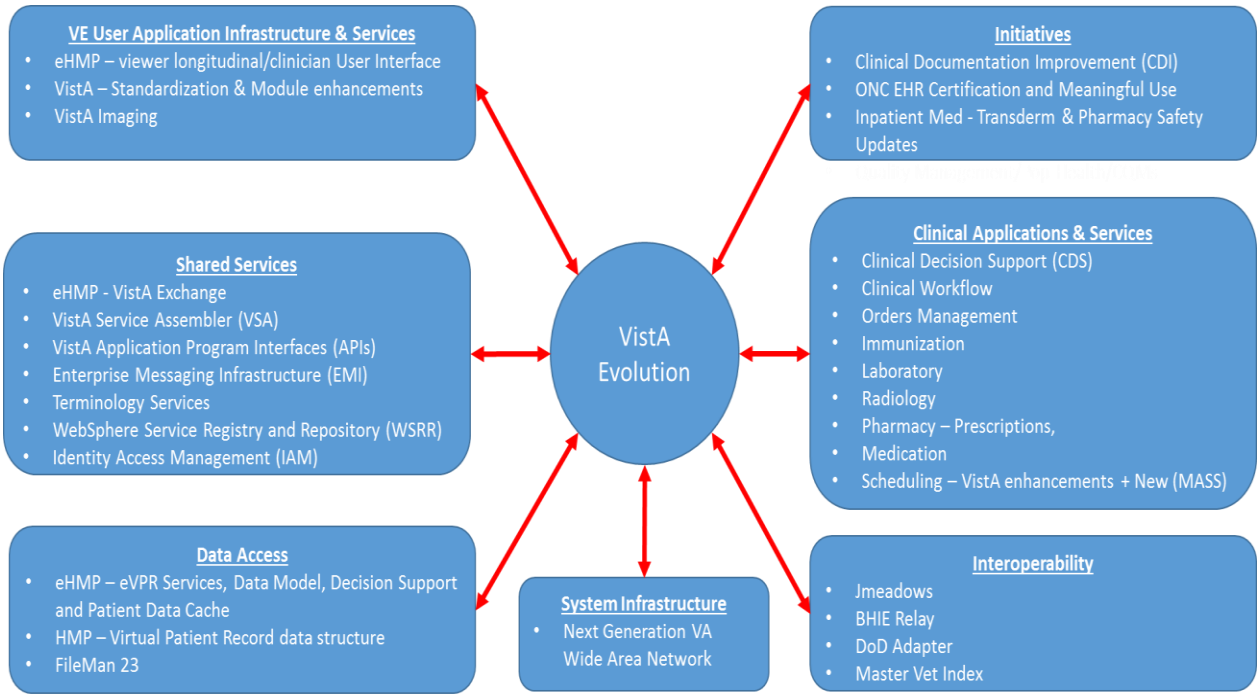
workflow and activities management, clinical orders, encounter documentation, and clinical decision support.

This multi-year effort will develop a modern service-oriented EHR platform around the existing MUMPs and CACHE VistA system internals. The eHMP project provides several new capabilities including:

- New web-based user interface
- Clinical data services that assembles patient clinical data from federated VistA repositories and DoD data sources into an Enterprise Virtual Patient Record (eVPR)
- Synchronization system to handle all of the backend system to system data synchronizations
- Standard APIs, data services and Software Development Kit (SDK) interfaces to support open integration with other enterprise and external applications.

Figure A-15 shows the VistA Evolution program components.

Figure A-15. VistA Evolution Program Components



Source: MITRE rendition based on VE team interviews and VA, 2015i.

The eHMP web application (i.e., GUI) is being developed from the ground up (Java, JavaScript, and HTML 5) to support a clinician at the point of care and will ultimately perform the functions of CPRS and more. The system is unique in that it will provide a longitudinal view of patient data provided by eHMP's VistA Exchange synchronization engine.

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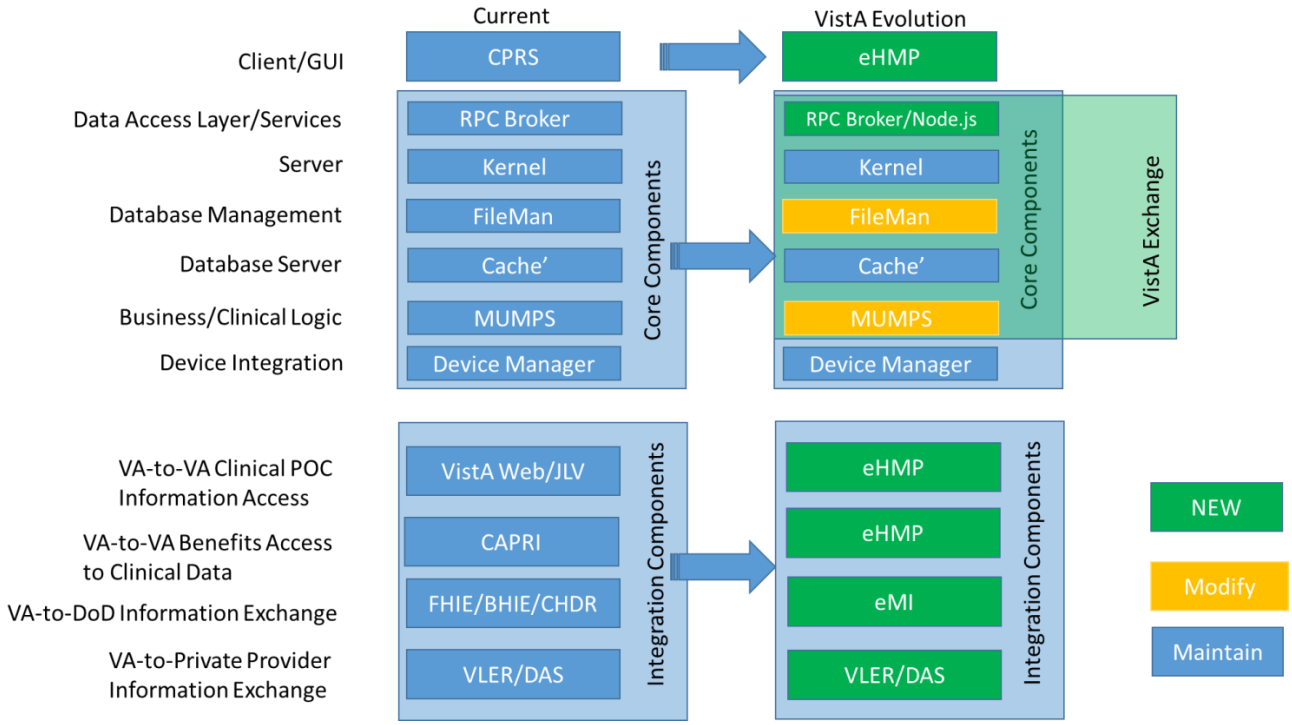
The web application is developed as a single page application with behavior logic contained within the web client, avoiding unnecessary communications across the network to improve performance and the user experience. As of March 2015 human-machine interface details were still being defined. The detailed interface design rules, inputs, outputs, and navigation hierarchy are being developed in accordance with a defined feature schedule but the detailed designs are subject to change as additional customer review cycles are held.

The eHMP web-based GUI is using an iterative design approach starting with functionality existing in the current patient record viewers (i.e., JLV, VistA Web). eHMP must build to the existing viewer features before it can migrate users to the new platform. eHMP V1.1 is the first step to incorporate existing software with read-only capabilities of patient records in the local VistA system. Future versions will evolve the application to become a full read-write application to replace CPRS and provide a view across all patient-centric actions and data sources. eHMP services will include: Clinical Decision Support (based on the openCDS initiative), Context Persistence, Orders Selection Service, Orders Management Service, Data Annotation Service, Clinical Workflow, Documentation and Text Search Services. Figure A-16 depicts the VistA Evolution transition in terms of changes in major system and software components.

Figure A-16. VistA Evolution Transition



Source: MITRE summarization of architecture and design descriptions from VA (2015b), VA (2015i), and OI&T eHMP System Design Document, March 2015, V2.8.

VistA Evolution Access Services

VistA Exchange (VX) is a new software system component being developed that provides eHMP with a patient's longitudinal enterprise record by retrieving and combining data from one or

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more of the existing approximately 130 VistA instances. As part of the synchronization services, VX will normalize incoming clinical data to meet VA data standards using standardized terminologies prior to being stored in a VistA Evolutions temporary data store.

VX is not a new data source, it retrieves data from the current VistA InterSystems Cache data store using existing MUMPs procedures (MUMPS RPC interface) based upon business triggers (such as an appointment, admission, or patient search). Additional logic will allow the system to identify other sources of patient data and route requests to those systems for the information through other VA integration systems.

VX is also developing web service APIs to standardize the way applications retrieve a patient record. VistA Evolution will provide both custom and HL7 standards-based FHIR web services and will integrate with a number of enterprise system services. Figure A-17 shows the planned VA service oriented architecture and enterprise system services to be implemented by the VistA Evolution program. The services are expected to provide a valuable way for developers to access the existing M-based data and business logic in VistA and other data sources using mainstream languages. They should also provide a potential pathway for VA and other open source developers to replace M-based implementations, module by module, with identical API functionality using mainstream languages.

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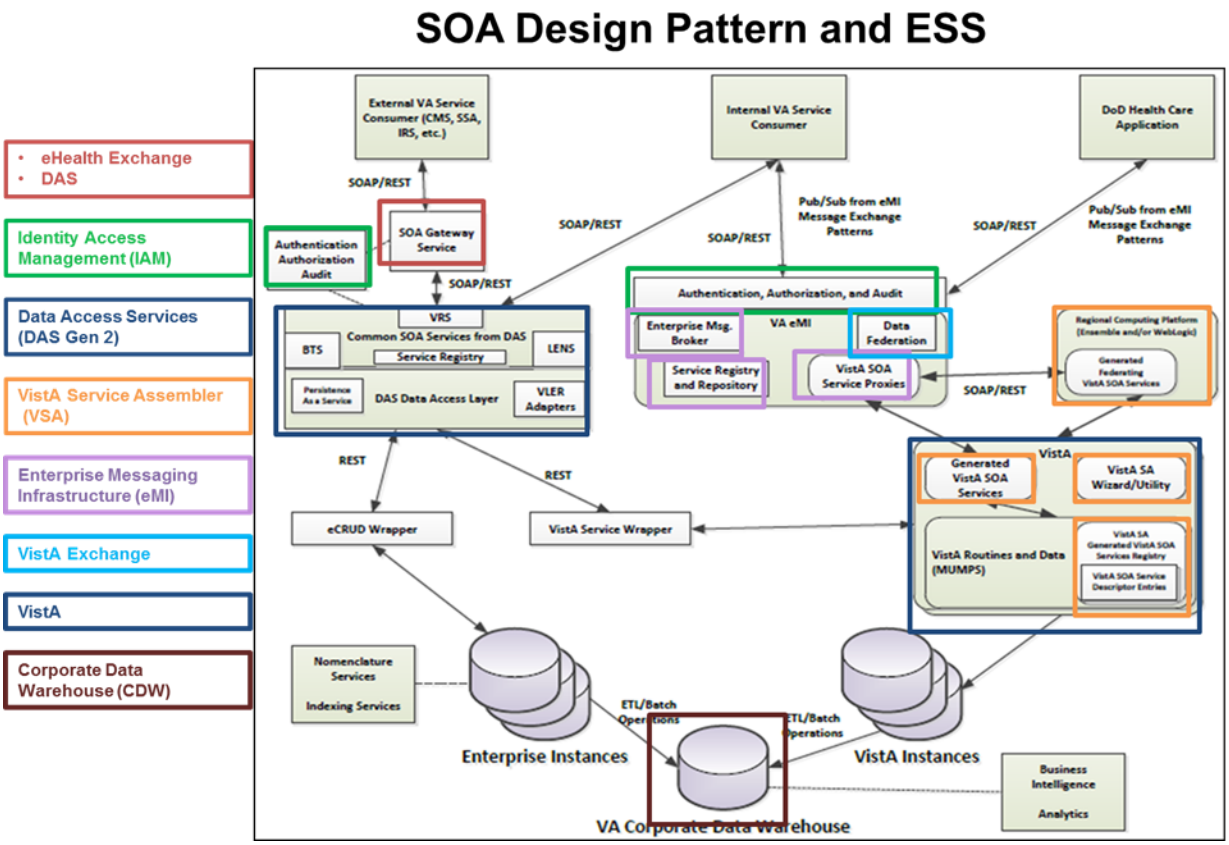
Figure A-17. VA SOA Design Patterns and Enterprise System Services



Source: - SOA Design Patterns for VistA Evolution: COTS Applications Office of the Chief Technology Strategist (TS) Architecture, Strategy, and Design (ASD) Office of Information and Technology (OI&T) Version 1.2, Date Issued: 15 April 2014.

The eHMP architecture and designs for patient health record access, user interface, data integration and access, and DoD/VA interoperability are in the process of being assessed and finalized. They must take into account the millions of lines of code and hundreds of VistA M-based modules. Several attempts have been made in the past to convert VistA in its entirety to more mainstream development environments and have failed, both within VA and in the open source community. (GAO, 2008) The tight coupling between M the language and the built-in M database provide unique and difficult challenges when translating M code into other programming languages. To address the data access complexity, VA plans to implement capabilities in four phases:

1. Read only local VistA system - Synchronization process initiates a subscription or checks for published events from VistA. It will connect to local VistA using a direct connection to the existing RPC Broker for a specific patient.
2. Read only local and remote VistA systems - Retrieval of patient data from remote VistA hosts. The subscription process performs a request by invoking a web service which in turn, invokes other VistA instances to retrieve data for that patient.

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3. Read and write using MUMPS API - VistA Exchange will utilize a direct RPC connection for performing writes. These writes will cover the domains of allergies, vitals, and problems. All of these writes will be to VistA.
4. Under a future release when VistA Service Assembler (VSA) is available, it is expected to migrate the writes from direct RPC Broker connection to utilize VSA.

This architecture requires eHMP data requests to cross several system boundaries and layers to access VistA data (VX to VSA to VistA MUMPS Interfaces) using several different software technologies (Java, JavaScript, MUMPS) and a new standard (VPR, FHIR). This greatly increases the complexity of the solution architecture and forces teams to maintain close integration and configuration management across three disparate projects (MUMPS API, VX, and VSA) without the support of a VistA Evolution lead integrator.

The following two observations provide detailed examples of this complexity and possible impact to performance and scalability.

Stateful session management in eHMP is a concern for system performance and scalability: An example of a software session is when a clinician connects using their web browser interface to write notes and orders for a patient. In a stateful session the system maintains information on the status of each communications to match the clinician request to the data exchanges with the system. In this manner each subsequent activity (request or reply) relies on the result (i.e., state) of the previous activity. There are several activities that occur during a session to achieve an objective and once that is accomplished, the session is dissolved. Currently, CPRS is the client that creates a stateful connection to VistA that remains open during the entire session. As a Windows-client, CPRS communicates through a proprietary stateful protocol so it is not burdensome to keep the connection open.

Web-based systems have moved away from stateful sessions to resolve scalability problems that result from managing the context across enormous numbers of activities. The *stateless* architecture used by web-based systems has enabled its tremendous scalability. As eHMP moves to a web-based system, it will need to support an unprecedented number of users through mobile, telehealth, and other planned enhancements. Keeping stateful sessions open is expensive and may not scale. eHMP depends on VSA, which uses VistA's RPC Broker, the stateful mechanism used by CPRS to call the underlying business logic in VistA. VSA also provides the common federator logic within services to connect two of the VistA hosts and is another dependency for scalability. Stateful session management may not provide the performance and reliability to meet Veteran needs at scale.

eHMP will initially have a small user set as the transition from CPRS to eHMP begins so stateful sessions will not be an issue at first. However, when eHMP scales to thousands of users (perhaps millions with mobile and telehealth), stateful sessions will become unmanageable and require a significant architectural overhaul with the added complexity of a heavily used production environment.

The VSA team is scheduled to have a product ready to integrate with eHMP around the September 2015 timeframe. eHMP version 1.0 is using RPC Broker and is targeting integration with VSA in version 2.0. eHMP partially addresses the stateful session issue through limited

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data write capability. Assessment H interviews and reviews of project risk documentation indicated that the project recognizes this is not a good long-term solution as the ability to create and update patient records is a vital capability.

eHMP is moving to a relatively new technology, Node.js, to mitigate scalability and integration issues: eHMP is using a Node.js-based solution to provide an interface (wrapper) around VistA's MUMPS packages that can potentially provide a mechanism to address the scalability issue raised by the VistA RPC Broker. Additional open source software will be used to integrate Node.js with the underlying database, allowing MUMPS data to be accessed from JavaScript.

Node.js is an open source JavaScript-based web server platform rapidly gaining popularity, based upon Google's V8 JavaScript engine, with an emphasis on non-blocking, event-driven I/O. JavaScript application interface libraries and utilities (i.e., Node) are available to work with VA's InterSystems Global and Caché products that provide VistA's underlying data capabilities.

Assessment H interviews indicated that very little is understood regarding the optimization that will be required to handle the load for a web-based system with data aggregation from multiple systems verses a single instance today. eHMP engineering teams have developed preliminary approaches to conduct end-to-end testing. They are conducting acceptance and integration testing now which includes all integrated tests related to functionality but not performance. eHMP is standing up a performance testing platform, trying to gain access to the enterprise testing center, and promoting development of joint, centrally funded, VistA Evolution test and production test environments. The VistA Evolution program needs to develop an end-to-end approach to address issues related to stateful sessions now before additional design decisions become difficult to address before eHMP adoption increases.

A.3.4.1 Improving Internal and External Sharing of Veteran Records

A key objective of the VistA Evolution Program is to enhance cross-Agency (DoD/VA) interoperability by providing all clinically relevant data at the point of care for Veterans. Improved interoperability will enhance communication among VA health care partners by ensuring that authorized beneficiary and medical data are accessible, usable, shared, secured and sufficient to meet the needs of Veterans and their care team in real-time (VA, 2015h).

VistA Evolution defines interoperability as "the ability of different EHR systems or software to meaningfully exchange information in real time and provide useful results to one or more systems." Interoperability capabilities will be achieved within the overarching VistA Evolution product delivery schedule. The path to interoperability evolves and builds upon existing progress year by year, with a goal to meet the FY 2014 NDAA directive to provide "seamless electronic sharing of medical health data" between VA and DoD by December 31, 2016. This seamless electronic sharing of data involves the creation of a unified lifetime health record for Veterans and Service members that can be accessed by clinicians at any point in time and regardless of where the information is stored.

The VistA Evolution program will evolve VA from its current forms of health information exchange to a more consolidated, centralized, and integrated design to minimize duplicative

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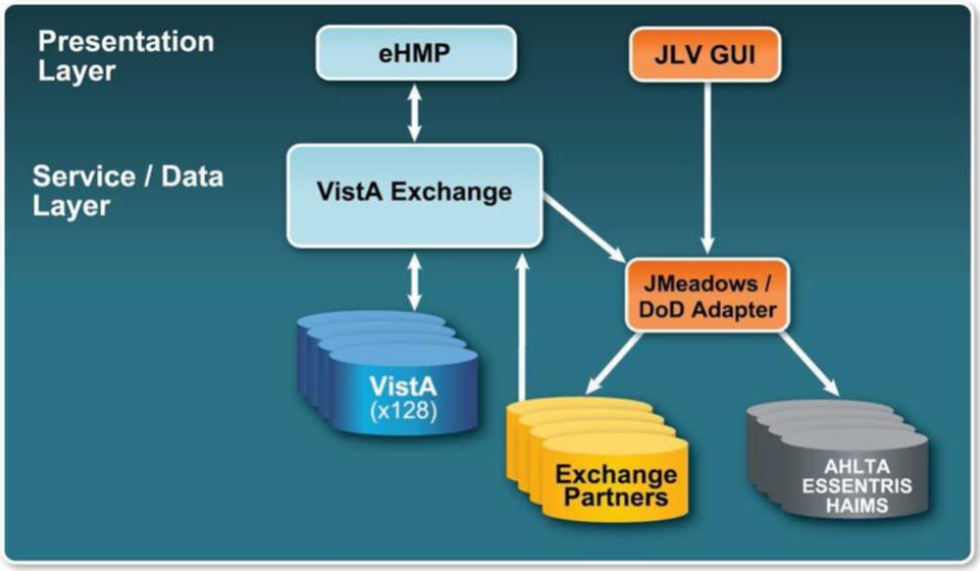
functionality. VistA Evolution integration within VA, is briefly described below and in more detail in Assessment B, which assessed HIE as a capability to improve Veteran access to care.[31]

Current VA-VA Information Exchange

At present, using CPRS, most VA clinicians have access only to patient data that reside at a single VistA location. Figure A-18 shows how VA clinicians will be able to access patient data in other VistA locations.

Figure A-18. VA-VA Information Exchange Architecture



Source: VA, VistA 4 Product Architecture, January 27, 2015 Version 1.0.

Clinical data within each VA system are stored in a unified medical record and easily accessible to any facility within that region, which is similar to other large provider organizations. However, there are approximately 130 separate physical instances running the "same" version of VistA software on centralized servers. Data sharing across regions is currently available through the Remote Data Viewer (RDV), VistA Web, and most recently by the JLV (VA OI&T, 2014g).

Current VA-DoD Information Exchange

As shown in Figure A-19, VA clinicians have been able to access DoD data for many years through VistA Web and the CPRS portal using the same workflow that accesses data from other local VA systems. The JLV also enables HIE starting in 2013. JLV is a cloud-based medical records system that allows DoD and VA EHR data to be displayed on one screen. The data include medications, progress notes, and discharge notes. The FY15Q1 JLV deployment is the first major

[31] OI&T, 2 Apr 2015. "VistA Evolution – Draft DoD/VA Interoperability Transition Plan (Primary Focus on BHIE)." Working draft, pre-decisional –Internal VA Use Only.

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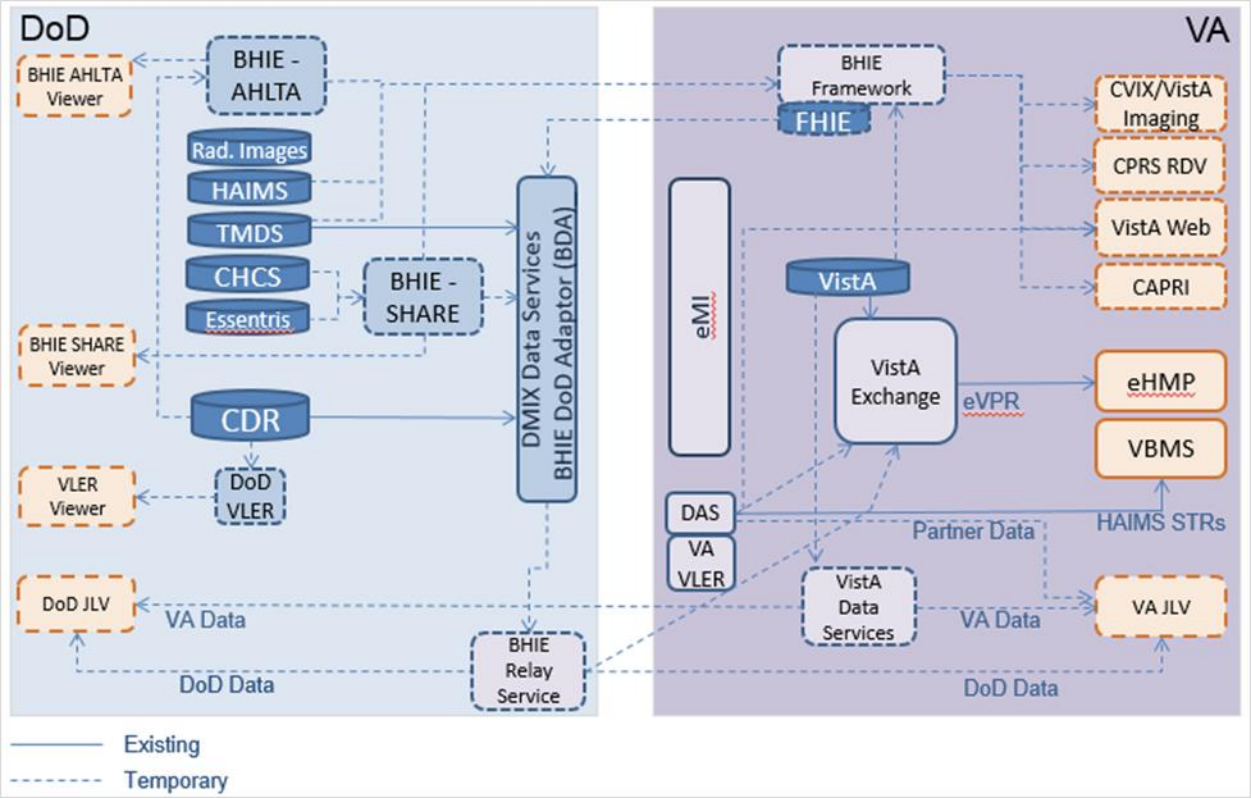
phase to modify the viewer capability. However, usage and usability data have not been captured or published since the application is still in the early stages of deployment and use.

Figure A-19. Current DoD-VA Information Exchange Architecture



Source: VA OI&T, 2014g.

Figure A-20 shows the Future DoD-VA information exchange architecture. The joint goal of the Interoperability Enterprise Plan is to lay out a modernization process that is focused around the now legacy BHIE Framework set of systems. The plan lays out a step-by-step process to fully transition from this legacy BHIE Framework-centered environment to the new interoperability platforms that DoD and VA have established. The plan incorporates existing DoD and VA strategies and plans for DoD-VA interoperability data services and viewers into a single joint plan. Upon completion of the Interoperability Enterprise Transition, the infrastructure is expected to be greatly simplified with full semantic interoperability.

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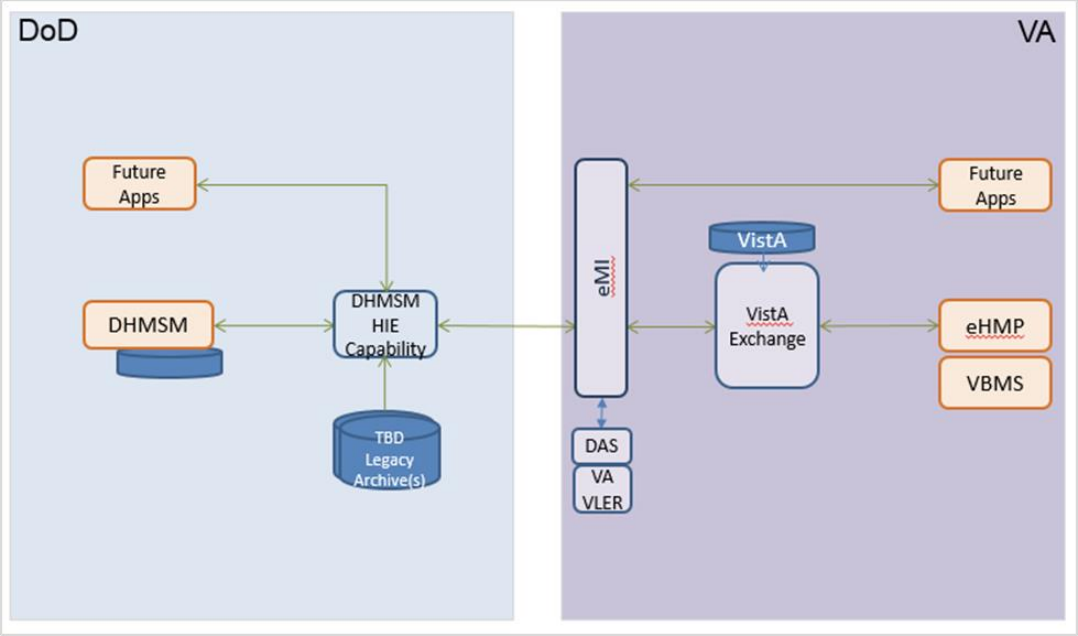
Figure A-20. Future DoD-VA Information Exchange Architecture



Source: VA, 2015e.

Current VA-Private Provider Information Exchange

The purpose of the Virtual Lifetime Electronic Record (VLER) project is to facilitate data exchange between VA and the private sector. The project has been in development for roughly five years, and includes eHealth Exchange,[32] Direct Secure Messaging, and exchange through Health Information Handlers (HIH). Future plans include FHIR and public APIs. VA is currently partnering with 50 external organizations through eHealth Exchange and has several active and planned use cases for secure messaging. VA providers may also be approved to access partners' HIE data through local health exchange organizations that are not currently participating in eHealth Exchange.

The VLER initiative is attempting to become a mature HIE initiative and a national leader in developing interoperability standards and standards-based information exchange. Several articles indicate that it has high user Veteran acceptance and high VA clinician acceptance and experience. (Byrne, 2014) However, It is difficult to evaluate the VLER project based on usage data because of the incomplete state of HIE usage measures, the poor evidence of value brought by HIEs, and the lack of user satisfaction metrics. There are a number of barriers to VA-private sector data exchange through VLER, several of which are discussed in Assessment B.

[32] Formerly known as the Nationwide Health Information Network, the NHIN or NwHIN, is an initiative for the exchange of healthcare information. It is operational and securely exchanging data. It was developed under the auspices of the U.S. Office of the National Coordinator for Health Information Technology (ONC), and now managed by a non-profit industry coalition called HealtheWay.

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These include patient consent, time to retrieve documents through eHealth Exchange, and record matching rates needed to exchange information.

Based on inputs from VHA's Office of Informatics and Analytics, Strategic Investment Management Implementation of CCDA, 2011 standards commonly used in health record exchanges today had been delayed and generation and display of a full C-32 (older standard) has also been delayed. The 2011 standard is still not implemented; the older C-32 standard is not correctly implemented; as a result, exchange with private partners is not functioning, which, leads to the following issues:

- Of the 24 current active sites, only three have more than 100 transactions per month, and 13 have fewer than 25 transactions per month. Four of the active sites are at risk of shutting down. This reflects extremely low usage.
- Based on the VLER Health 2014 assessment report (June 2014) page 19, "Of particularly concern was the low frequency of VLER Health usage, approximately 5 retrievals per 1000 veteran encounters." Additionally from the report: "VLER Health program is in a high risk situation, as evidenced by both the average assessment score of 3.8 [out of 10 possible], and the fact that every metric category scored in the high risk range."

Based on Assessment H interviews and reviews of test reports, it is estimated that the VLER Exchange website generates approximately 800 incoming transactions and 3375 disclosures per month. The goal is to onboard 100 new partners at an average of 8.3 partners/month (linear growth assumption). The objective is to generate 1,125 total new transactions/month.

Through interviews, the Assessment H team was able to confirm several existing VLER performance issues originally identified in a May 2015 Capacity and Performance Engineering (CPE) Capacity Evaluation Report. The report observed that known performance issues between the eHealth Exchange and its interfacing systems remain unresolved as a Tiger Team continues to work the problems. The initial issue was outlined in a 30 September 2014 CPE Capacity evaluation report (OI&T/ESE, 2014). The report refers to an email from the Director of VFA/Service Integration Office (08/15/2014) stating that:

> VLER eHealth Exchange has been having infrastructure issues and other issues as they try to 'on-board' and move partners into production. Recently, they had to 'back-out' a brand new partner due to performance problems… We have lost tremendous credibility with our external partners because of these issues.

The report goes on further to state a concern that "The causes of disappointing VLER eHealth Exchange performance are many and complex, from architecture/implementation deficiencies to timeout issues, among other things. But one nagging concern persists: a lack of performance testing to ensure the system functions as designed. For example, since December 2009, we found about 80% of releases had no performance testing."

Unless the VLER project teams address this shortfall, VA could jeopardize its ability to deliver expected capabilities to support Veterans' needs, and significant risks remain that upcoming VLER releases could continue encountering challenges on-boarding external partners.

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Summary of Future VA Health Information Exchange

The goals of VistA Evolution are to improve the technical infrastructure for health data interoperability while reducing overall system complexity, converting to standards-based services, formats, protocols and data models, and enabling expanded and improved data exchange with partner providers. The VistA Evolution program has been analyzing alternatives and has developed a draft Interoperability Enterprise Transition Plan that outlines an approach to transition of system components and data exchange services for DoD-VA interoperability through an iterative approach.

In developing the strategy and enterprise architecture for interoperability, VA and the VistA Evolution Program have decided to utilize a SOA, an Enterprise Service Bus (ESB) and RESTful services. This approach entails a significant shift in the current health information exchange architecture. Multiple changes to the overall HIE architecture will occur in rapid sequence over the next five years. The future high-level architecture is defined; however, there are numerous design decision that still need to be developed and agreed upon.

The final solution will retire the current clinical application's user interfaces (CPRS, VistA Web and JLV) and migrate to the eHMP. There are several stages of interoperability enhancements that will occur in VistA Evolution feature sets. VistA 4 feature sets 2 through 4 will incrementally make Interoperability enhancements to the health data information exchanges between VA and DoD, and between VA and external health care partners, improving the speed and accuracy of clinical decision making and ensuring that authorized medical data are accessible, usable, shared and secure. (VA, 2015e)

These enhancements will set the framework for data from all available sources to be integrated so that VA clinicians can easily access a patient's entire medical history. This transition of legacy DoD-VA query/response interoperability systems can be summarized in the following high level steps:

- Move consumers/users to new viewer/applications and data services
- Move unique content and required services off of legacy platforms
- Shut off legacy systems.

Figure A-21 shows a notional sequence of events to replace the current components with newly developed VistA Evolution and enterprise service capabilities.

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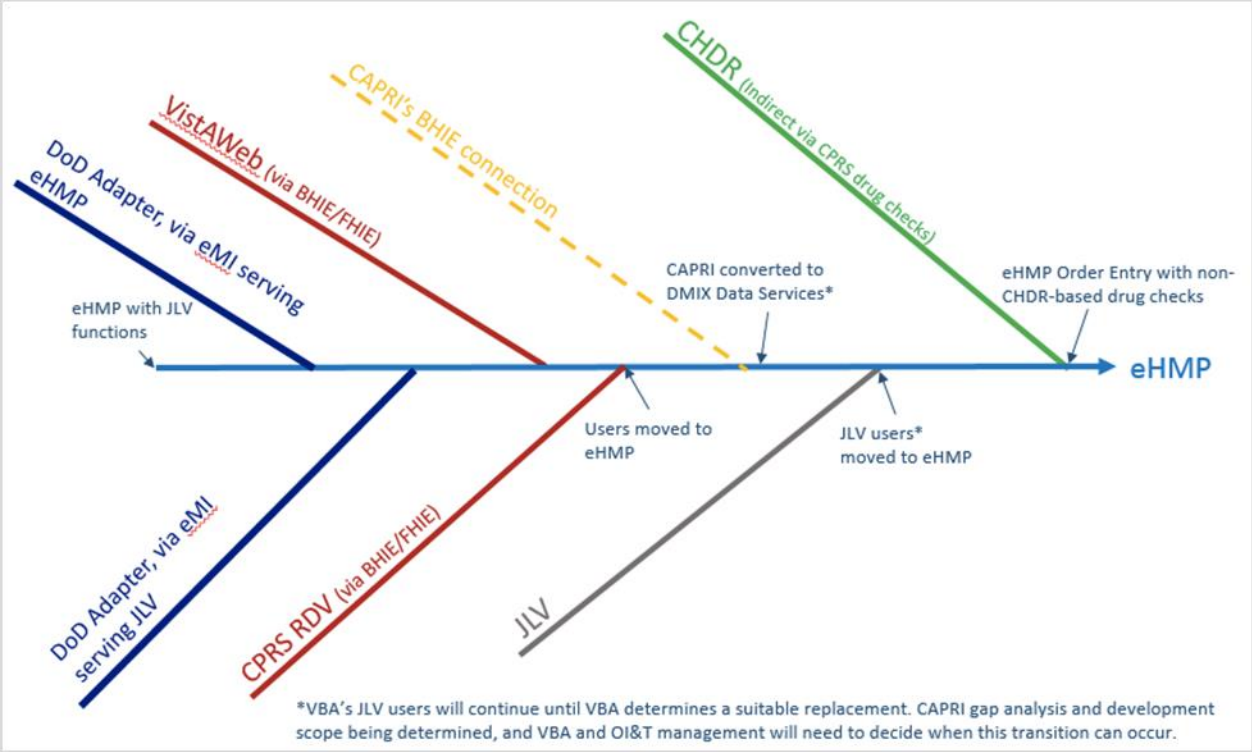
Figure A-21. VA Interoperability Transition from Legacy Systems to eHMP



Source: VA, 2015e.

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Appendix B Assessment H Support Data

B.1 Industry Outreach

B.1.1 Overview

Eighteen technology leaders from both health care and non-health care institutions were interviewed to collect their insights on providing effective information technology services for large organizations. The list of CIOs who were interviewed can be found in Table B-1. These experts were selected because they developed and implemented innovative IT solutions. They provided valuable insights, lessons learned, and best practice IT strategies. Their thoughts provided some of the basis for assessing the Department's IT effectiveness.

Table B-1. Health Care Technology Leaders Interviewed

Organization Name	Interviewee	Title
Beth Israel Deaconess Medical Center	John Halamka, MD	Chief Information Officer
Brigham and Women's Health Care	Cedric Priebe, MD	Chief Information Officer
Citizens Memorial Hospital	Dennis McColm	Chief Information Officer
	Karrie Ingram	HCIS Manager
	Sherry Montieone	Network and Support Manager
Edward-Elmhurst Healthcare	Bobbie Byrne, MD	System Vice President & Chief Information Officer, Vice President, Facilities, Construction & Cancer Center Services
Georgia Regents University and Health System	Charlie Enicks	Vice President and Chief information Officer
Johns Hopkins Health System, the Johns Hopkins University, Johns Hopkins International	Stephanie Reel	Chief Information Officer
Legacy Health	John Jay Kenagy, PhD	Senior Vice President and Chief Information Officer
The MITRE Corporation	Joel Jacobs	Chief Information Officer

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Organization Name	Interviewee	Title
Northwestern Memorial Hospital	Jay Anderson	Vice President, Quality and Safety
	Carl Christensen	Chief Information Officer, Northwestern Health System
Oregon Health and Science University	Bridget Barnes	Vice President and Chief Information Office
Partners Healthcare	Jim Noga	Chief Information Officer
Sparrow Health System	Michael H. Zaroukian, MD, PhD	Vice President & Chief Medical Information Officer
Surescripts	Mark Gingrich	Chief Information Officer
University of Iowa Health Care	Lee T. Carmen	Associate VP for Information Technology, Chief Information Officer
Vanderbilt University Medical Center	Thomas (Tom) Fricks	Interim Deputy CIO

The following sections contain the major comments and guidance from these health care technology leaders about effectively running a large health care system.

B.1.2 Planning and Governance

Strategic Planning

For strategic planning, most of these health care organizations develop a three to five year vision, which provides a high level of understanding and coordination for executing an associated one-year tactical plan. Nearly all organizations recognize that the three to five year strategic vision will change significantly in response to rapidly evolving information technologies and new clinical policies and approaches. Even with a rolling three-year strategic plan, the pace of change with technology usually requires changes to the plan after the first 18 months.

Investment Decisions

For the purposes of planning new health IT capabilities, the overwhelming majority of the industry leaders described a repeatable and well-understood process for prioritizing and executing investments. These processes and outcomes were widely communicated throughout their organizations. Further, their organizations provided a clear chain of command for assigning individuals to be responsible for the strategic outcomes, incremental improvements,

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and operations. The organization's CIO was frequently in charge of communicating the IT plan throughout the organization.

The investment processes all included some form of requirements collection, and the CIO was typically responsible for developing the final blueprint explaining how the clinical and business requirements would be implemented into the IT systems. The CIO was typically responsible for communicating investments that were rejected and the rationale.

Most organizations allow the submission of requirements for new capabilities from anyone in the organization, not just physicians. Most hospitals included a type of steering committee to review the submissions for new health IT capabilities. The steering committees typically included representatives from across the services areas, such as hospital, ambulatory, long term care, and assisted living. When reviewing and prioritizing the requirements, most organizations prioritized improvements in the patient engagement including, patient relationships, reliability, outcomes, and satisfaction. Most of the health care organizations view their patients as "customers" who may go elsewhere if they are not satisfied with their health care experience.

The investment processes all included a public and repeatable schedule for making and communicating the investment decisions. Most organizations make large capital and initiative investments on an annual basis. Most organizations have a monthly meeting to review investment decisions, measure and manage risk, and potentially modify or terminate initiatives. The CIOs are expected to understand a significant amount of detail about high visibility and large investments to manage risk. For these annual investment processes, the CIO is frequently the final authority on the process to prioritize and sequence current and future projects. These decisions are made in collaboration with other executive leaders, such as the CMIO of the organization. However, the CIO is typically accountable for the final decision and the success of the implementation.

Escalation

Many of the leaders indicated their organizations needed to have a clear escalation process for IT investment requests. Escalation can be requested by anyone at any point in the process, with the organization CEO being the final decision maker. Although projects are rarely escalated to the highest levels of the organization, the existence of a documented, formal process provides a clear understanding regarding the roles and responsibilities of the champions of initiatives and the decision makers.

B.1.3 Electronic Medical Record (EMR) Adoption

When planning for capabilities, the CIOs at two large health systems had achieved “Stage 7” of the Healthcare Information Management Systems Society (HIMSS) Analytics EMR Adoption Model (EMRAM). Only 3.7 percent of U.S. health care organization have achieved this level of a virtually paperless system. One of the core principles of one organization was to use the latest version of the EMR provided by their COTS vendor. Since the COTS vendor releases one major version per year, this principle entails an annual update of the EHR. Because the new EHR version requires testing and validation, the organization usually needs about 6 months to

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implement the annual upgrade. During the upgrade period, the IT organization typically implements no major new functionality (except for the features and capabilities inherently included in the new version of the EHR). Once the version is installed in production and stable, the IT organization may implement new features.

COTS EHR

The overwhelming majority of the leading health care hospitals are in the process or have completed a transition to a COTS EHR system. The primary reason provided for this change was to reduce the O&M costs of existing EHR systems, to comply with rapidly advancing federal regulations, to reduce the cost to upgrade infrastructure for future programs and policies, and to enable their IT staff to spend less time maintaining their EHR capabilities and to spend more time developing innovative capabilities. The interviewees indicated the majority of the internal resources used to support homegrown EHR solutions were allocated to support capabilities, which were viewed as neither transformative nor innovative for the organization. For example, the Meaningful Use program and its associated requirements for EHR technologies were widely viewed as an excessive burden for any internal development organization to implement in their EHR. The CIOs also emphasized that a single COTS EHR reduces the challenge of interoperability of health data. Although a COTS EHR does not ensure interoperability across a broad set of heterogeneous set of systems, COTS EHRs tend to greatly improve the exchange of patient data within an organization.

For those organizations that are either moving to or have moved to a COTS EHR, most CIOs say they will adopt commercial technology without customizing it to their needs. It may be tempting to customize the COTS EHR, but maintaining the changes as new versions of the EHR are released can be very expensive. Most COTS EHR vendors understand the need for flexibility and allow clinicians control to configure the user interface and workflow to meet their unique processes and needs. The most successful COTS EHRs accommodate this need as a configuration adjustment capability rather than require the development of software customization for each client. For one large health care organization, the plan to transition to a COTS EHR involved over 5000 clinicians in the configuration and deployment. The vendor selected by this organization introduced a disciplined approach to build an example workflow to a large audience of clinicians.

One organization found that their internally developed EHR system they created consumed all of their development funding just to maintain compliance with the bare minimum requirements for the large "Meaningful Use" program. This organization was unable to implement other needs such as upgrading to the ICD-10 coding system, and they were unable to introduce innovative new clinical capabilities. A COTS EHR vendor was able to demonstrate that the COTS EHR would provide all of the "Meaningful Use" requirements and still allow for organization-specific customization for a specific site's needs. This hospital made the strategic decision to shift their developers to configuring the COTS solution, which was less costly than maintaining their internally developed EHR.

The downside of a COTS approach is that these organizations no longer have direct control of their EHR. The vendors provide a distributed, complex governance process in partnership with other medical centers using the EHR. Currently, requests for most changes and configuration

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enhancements can be addressed without long delays. But, change from the prior expectation of local control by the physicians was a rude awakening for some physicians. With an enterprise-wide EHR, some changes simply cannot be implemented if the priorities are not shared by other stakeholders. Under the new governance process, requests for changes enter a queue and this organization fully anticipates a backlog that may grow to months, or even years, to see new capabilities fully addressed. With that understanding, the organization implemented a communication and education program to provide expectation management with the clinicians.

Clinician Burden from New IT Systems

When reviewing IT requirements, one organization attempts to minimize the burden on physicians of new systems. The Meaningful Use program was cited as a burden on physicians because the processes require extra data entry and alter the physician's normal workflow. These changes reduce the physician's time with the patient. As a result, the data entry and workflows are reviewed to maximize data entry by administrative staff and maximize time with patients by physicians.

System response time metrics were also measured for physicians. One hospital discovered that a response time of greater than two seconds for any health IT application was considered unacceptable by physicians working directly with patients.

The CIOs interviewed did not have a consistent approach to measuring user satisfaction. One organization meets monthly with 10 to 20 "power users" that are effective in driving change. Another organization abandoned the collection of feedback from user groups because of an inability to implement the changes requested by the users. Most organizations did collect feedback through the use of surveys. For example, upon the closing of each help desk request, a user may be sent an email requesting feedback on the timing and adequacy of the fix.

Return on Investment (ROI)

Most of the CIOs indicated that measuring the return on investment (ROI) for health IT is very difficult. Some organizations are attempting to measure ROI and may speak of "soft returns" as well as "hard dollar returns" on their IT investment. Cost avoidance is one of the easiest returns to measure if processes can be automated. However, improvements in safety and patient satisfaction were also seen as valuable, albeit difficult to quantify financially.

Analytics

The workload for clinical reporting and analytics is growing for most organizations with the adoption of EHRs and a greater abundance of data to analyze. Because advanced analytics can create a substantial computer processing load and require analysts with advanced skills, one hospital outsources the data processing and report preparation to generate the Clinical Quality Measurement results.

Patient safety metrics was a common consideration that was readily identified by the leaders of almost all our hospitals. Patient safety measure anomalies become the highest priority to resolve. Patient safety and patient risk attributes are incorporated both during project work shaping, prioritization, development, operations, and even de-commissioning.

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In particular, the electronic capture of health data allows organizations to become accountable to keep people healthy instead of just treating their health conditions. This is increasingly supported by increased visibility into population health.

Technical Reference Model

Some organizations have enacted rules to limit the technical platforms they use for all health IT systems. For instance one organization has assumed a prescriptive posture to only use web and mobile applications for all their health IT capabilities. This means no thick client applications are supported throughout that organization, allowing the IT to have more latitude in introducing future changes to the computer platforms used within the health care organization. Further, this organization ensures their web applications are browser neutral and always conform to standards. This approach also supports mobility to cloud-based hosting of these systems, again providing more flexibility for the CIO to introduce future change. For future planning of homegrown solutions, engineering guidelines on how to architect systems aligned with capabilities are well understood and accessible throughout most organizations.

Homogeneous health IT systems are always the desired approach by health care organizations, primarily because of inherent integrated capabilities. Heterogeneous systems are almost always a detriment for health IT as well as IT. These organizations consistently plan to move towards a homogenous set of tools that avoid duplication of functionality across the enterprise, to have a less complex IT environment resulting in lower O&M costs.

One hospital in Chicago views better health care data standards as the key to addressing gaps in health care data interoperability. In particular, they believe the FHIR standards from HL7 holds promise. A transport standard that was also cited was the DIRECT protocol for securely sending and receiving health data.

Accountable Care Organizations

Accountable Care Organizations (ACOs) are groups of doctors, hospitals, and other health care providers, who come together voluntarily to give coordinated high quality care to their patients. The goal of coordinated care is to ensure that patients, especially the chronically ill, get the right care at the right time, while avoiding unnecessary duplication of services and preventing medical errors. When an ACO is successful in delivering quality care and spending health care dollars carefully, it will share in the savings it achieves *(CMS,* http://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/ACO/index.html).

One of the leading ACOs in the country reiterated how critical it is for health IT systems to support a unified view of quality and risk of individuals and the population. The core of a successful ACO model is a focus on care management, quality of care, and cost of care, through risk modeling and risk adjustment using health IT. This needs to be tracked from the population level to the individual patient view.

This organization does not worry if a patient is part of an ACO, at risk, fee for service or uninsured, “we manage patient to the medical needs of a population” (i.e., the sickest). Health IT provides data to create registries with the information to identify these populations needing continued care.

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One hospital cited the primary reason they are consolidating on Epic is to allow them to do full population management analysis and reporting for their ACO contracts.

Another describes IT capabilities necessary to support seven key processes necessary for an organization to function as an ACO:

1. Care Coordination
2. Cohort Management
3. Relationship Management
4. Clinician Engagement
5. Financial Management
6. Reporting
7. Knowledge Management.

This organization may perform a "gap analysis" between their current state IT systems and the capabilities described in *A Health IT Framework for Accountable Care* (CCHIT 2013).

B.1.4 Industry Leader Suggestions for VA

Broader Requirement Sources

When considering users' requirements and whether or not your services are meeting the users' requirements, the organizations interviewed have suggested that VA should consider measuring the user experience of a trusted community so that you can react to the needs and not whims. We have found help desk tickets are a significant source of collecting a wider spectrum of users' feedback.

Restrict Local Customizations

When asked about how much latitude should individual hospitals within VA have to implement their own capabilities, a large federated group of hospitals suggests VA be prescriptive and permit minimal to no latitude here. This federated set of hospitals has a 50 person meeting to aggressively monitor changes. Ticket information is analyzed to look at trends and help drive decisions. Sites are allowed to customize but they must go through a review process and receive explicit approval. This requires a well-defined and strict governance model. It cannot take 30 days to review and approve these types of requests. This organization has found that 95 percent of the requests can be "routinized" and don't need to be "local customizations". An example was provided that, "The infection control team wanted to buy a best of breed system citing its superior capabilities than the COTS vendor. The board asked them to take a hard look at that vendor's solution and determine why it couldn't meet their needs and wouldn't work. The team came back and determined that the vendor's option would be the better choice because of data integration across partners."

Meaningful Use Compliance

One expert commented that it merits some attention that VistA is still not a Meaningful Use certified system, yet there are numerous commercial EHRs supporting the Meaningful Use

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program. This leader suggested that VA progress with MU certification is a lot slower than he would have expected, and that VA should understand why it has been difficult to see their health IT systems certified for the Meaningful Use program.

Software Development

At one organization software developers embrace highly tested procedures for everything they do. No software goes into production without meeting these processes and is highly tested. Failures with the internally developed capabilities are very painful, and trump all else with the organization's developer staff. Testing of software capabilities and integration with services is critical to their internal developer shop of 20 engineers.

Another hospital leader asked to highlight to VA that the Core VistA was designed to determine the Veterans eligibility level and optimize scheduling according to that eligibility. He suggests stopping wrapping clinical functionality around this outdated system. In particular, he encourages VA to move towards COTS and standardize where the patient is shared among areas (hospitals and clinics). This would allow better physician collaboration. Further, he feels VA should focus on informatics instead of software development, allowing for innovation in care delivery and then studying the outcomes to do comparative effectiveness and optimization.

Experimentation and Testing

After selecting and deploying COTS solutions, there is often still some level of modification and exploration with these external systems. Some industry leaders see some adoption of the notion of a "sandbox" with anonymous patient data. This sandbox is available to stakeholders with ideas to run a silent implementation and observe it before implementing a function. Several COTS solutions support this to allow for changes in the customization of their product to be explored without impacting the existing clinical workflow. If an idea does demonstrate some utility with this "sandbox," there is a process agreed upon with the COTS contractor to introduce new configurations and customizations to introduce this concept more broadly across the health care organization's enterprise. This ability is clearly defined in the COTS contract prior to selection of a tool by a health care organization.

VA Interoperability and Interaction

One hospital in the Midwest shared difficulty when exchanging data with VA systems. This is particularly difficult when a new VA patient is referred to them for services. Since they do not have the data, they need to re-document the patient status. Moving to data exchange in real time is critical to provide quality care to the Veteran.

When residents rotate thru a VA hospital in Chicago, some residents have gone out of their way to express a liking for the VA user interface with CPRS.

One hospital found the process to be a VA CHOICE Partner to be difficult and lengthy.

Transparency

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Another hospital believes VA should strive for total transparency on access for patients, where patients can see the schedule and request, like airlines allow you to try to find times and open seats. This type of transparency would help build back trust in the VA community.

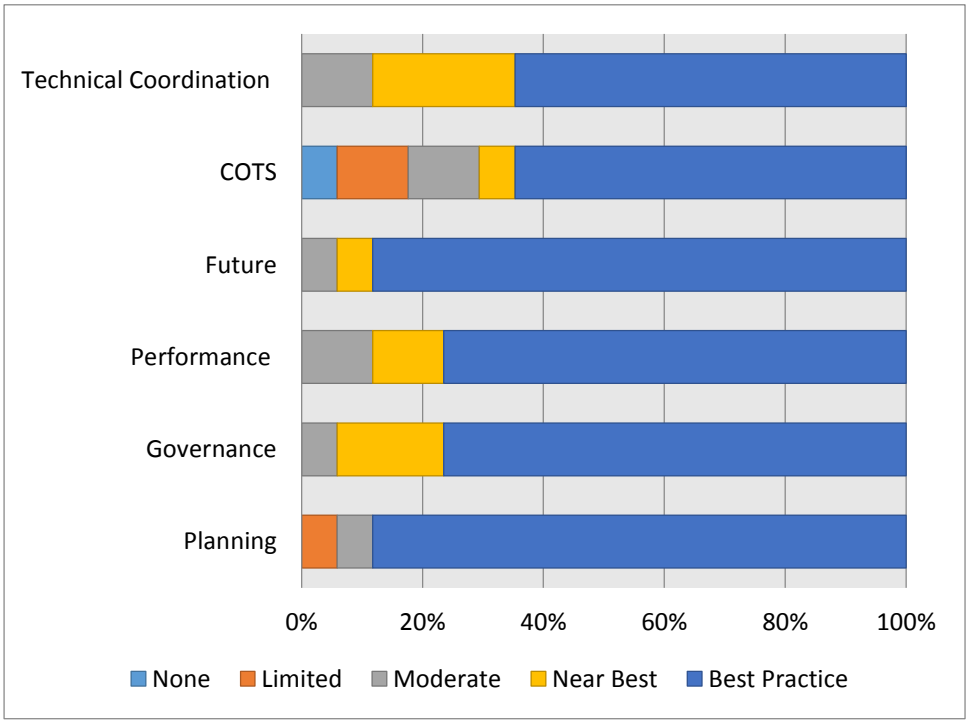
Academic Medical Centers

One industry leader felt that VA should consider developing relationships with the Academic Medical Centers so that health care data are more frequently exchanged and interoperability is expanded with non-VA commercial health IT systems. There is only a small window of time when the Veteran is transitioning from active duty that they need to interact with DoD. Academic Medical Centers can provide longer-term collaboration for the Veteran's needs.

B.1.5 Summary

As part of Assessment H evaluation, we reached out to hospitals and high performing health care systems to assess and document how they manage the challenges of providing health IT in their environments. They shared this information in support of VA and Veterans Choice Act Assessments. While we found variations in some practices, almost all reported a tight alignment between the strategic goals of the organization and the funding and priorities of for their health IT plan. Figure B-1 depicts the high level of best practices achieved by these organizations summarized in six IT function areas of planning, governance, performance, future, COTS and technical coordination.

Figure B-1. Industry Outreach: Adoption of Best Practice Measurements



Source: MITRE rendition of industry data.

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B.2 Common Failure and Success Factors for Large-Scale EHR Systems

B.2.1 Introduction

Adopting an electronic health record (EHR) is a huge undertaking for a health care provider. It involves more than just installing technology, it requires the practice to transform how it provides care in order to be successful. The Office of the National Coordinator suggests a six-step process for an EHR implementation (HealthIT.gov, 2013):

1. Assess Practice Readiness
2. Plan Your Approach
3. Select/Upgrade Your EHR
4. Conduct Training and Implement EHR
5. Achieve Meaningful Use
6. Continue Quality Improvement.

During each step of the EHR implementation process, there are factors that can lead to success or failure of the project. The goal of this paper is to summarize the main types of failures and success factors to mitigate failures as found in our literature review. We will categorize each of the failure and success factors by stage of the EHR implementation.

B.2.2 Literature Review

To support the Assessment H evaluation of EHR system implementations, we conducted a peer-reviewed literature search for articles related to health IT implementation success and failures. Our search yielded 14 articles which were read for insights on IT project failures and 15 articles that provided insight on successful, large EHR implementations.

B.2.3 Types of Implementation Failures

Our literature review found numerous types of implementation failures. The primary source of failure issues revolves around the planning phase of EHR implementation (Abouzahra, 2011). Failures post implementation are extremely troublesome as they impact patient welfare. (Abouzahra 2011) We removed the last two steps, as there were seen as not applicable to VA.

Table B-2 summarizes types of failures and successes at various stages of EHR system implementation.

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Table B-2. Failures and Successes at Stages of EHR Implementation

Implementation Stage	Type of Failure	Type of Success
Assess Practice Readiness	Lack of Executive Support (Standish Group, 1995; Abouzahra, 2011; Glaser, 2005; Gauld, 2007)	Strong Leadership (Jones, 2006; Mooney & Boyle, 2011) Presence of a Champion (Jones, 2006)
Plan Your Approach	Lack of Resources (Standish Group, 1995; Abouzahra, 2011; Glaser, 2005)	Resources to Match Goals (Mooney & Boyle, 2011; Jones, 2006)
	Unrealistic Expectations/Time Frames (Standish Group, 1995)	
	Unclear Objectives (Standish Group, 1995)	Well-Defined Metrics for Success (Jones, 2006)
	Inadequate/Lack of Planning (Standish Group, 1995)	
Select/Upgrade Your EHR	Content Deficiencies/ Lack of User Input/ Technology Incompetence (Standish Group, 1995; Abouzahra, 2011)	Identify Requirements from All Stakeholders (Kaplan & Harris-Salamone, 2009) Clear articulation of desired functionality (Mooney & Boyle, 2011)
	Incomplete/Changing Requirements & Specifications (Standish Group, 1995; Abouzahra, 2011)	Adequate control of scope and changes (Noblin, Cortelyou-Ward & Ton, 2011)
Conduct Training and Implement EHR	Cost Overrun (Standish 1995; Abouzahra, 2011)	Control scope and changes (Noblin, Cortelyou-Ward & Ton, 2011).
	Time Overruns (Standish Group, 1995)	

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Implementation Stage	Type of Failure	Type of Success
	Communication issues (Abouzahra, 2011)	Communication of vision and goals (Jones, 2006; Kaplan & Harris-Salamone, 2009)

B.2.4 Assessing Practice Readiness

When assessing practice readiness, a common failure is a lack of executive support (Standish 1995; Abouzahra 2011), which can cause project failures throughout the lifecycle of EHR implementation; it is, therefore, imperative to ensure support early on. Particular to VA, it is important to mitigate the amount of political interference in decision making, as that has been found to be a source of project failure, due to organizational and political complexities (Gauld 2007). In addition, it is important to get clinical support as well to ensure user acceptance of the new technology (Gauld 2007). Finally, project leaders need to avoid invisible progress to ensure executive support throughout the project (Glaser 2005); interim milestones and incremental stages that can showcase progress are crucial to keeping support.

Conversely, strong leadership is a key success factor in large-scale implementations. Leadership plays a key role in ensuring sensitivity to the needs of all stakeholders and ensuring adequate financial resources are dedicated to the implementation (Jones, 2006). Ensuring these resources are committed to the implementation is also key in subsequent steps of implementation. Senior leadership must communicate the goals and vision of the project relative to patient safety, quality, and efficiency. (Jones, 2006) Fully engaged leadership is described as a nonnegotiable during implementation. (Mooney & Boyle, 2011).

B.2.5 Planning the Implementation Approach

During the planning phase, there are four types of failure that need to be addressed. Once project leadership ensures appropriate resources are secured for the project to succeed, it is also important to ensure clear objectives are delineated so that resource planning is as accurate as possible (Standish 1995; Abouzahra 2011; Glaser 2005). Second, realistic expectations and timelines need to be set early in the project (Standish 1995). Third, it is important when setting timelines to anticipate short-term disruptions and incorporate that into your timeframes (Glaser 2005). Finally, as with all planning, it is important to respect uncertainty with your plans, recognizing that many decisions that need to be made are not known when you initial start the project (Glaser 2005).

To overcome the types of failures, success factors in this implementation step include developing well-defined metrics, developing the plan, and ensuring resources meet the metrics. Metrics for success should be defined before implementation begins and feedback on those metrics should be provided on a continuous basis (Jones, 2006). Once leadership identifies what they want to achieve from implementing an EHR, resources should be evaluated to ensure they

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are sufficient to achieve success; not that resources needed may vary depending upon the identified metrics (Mooney & Boyle, 2011).

B.2.6 Selecting the EHR System

There are two major categories of failure when it comes to selecting or upgrading the EHR: content deficiencies and incomplete/changing requirements. Content deficiencies can arise from a number of failure factors. A lack of user input is most important in larger settings, such as hospitals, as there are numerous groups that all need to use the technology – such as doctors, nurses, clerks, patients, and visitors – and each has their own needs and requirements (Abouzahra, 2011; Peute, 2010). Frequent communication can help avoid a design-reality gap (Heeks, 2006) between users and designers. EHRs can collect data that are new and may not be directly related to patient care but more for management, so it is important to get clinical approval (Gauld, 2007). Finally, it is important to ensure that the EHR reflects an understanding of the current clinical workflow or that any changes to clinical workflow incorporate adequate redesign and testing (Peute, 2010).

The other major category of EHR selection/upgrade failures is incomplete or changing requirements and specifications (Standish Group, 1995; Abouzahra, 2011). Implementers to be certain that the product is appropriate for the task (Gauld, 2007). They need to define the problem and ascertain if the EHR is best equipped to answer the problem (Cresswell, 2013). It may be possible that new technology is not the answer for the problem, so they need to determine if the EHR can support these strategic goals and whether other approaches may also need to be considered (Cresswell, 2013). Similar to the other main category, if the project objectives and the needs of the users are not well defined, it leads to too much uncertainty or a misspecification of the requirements for the new system and thus a failed implementation (Gauld 2007).

Success factors were also identified to help mitigate failures when selecting and/or upgrading your EHR: identification of requirements from all stakeholders; articulation of desired functionality; and, control of the project scope. When identifying requirements from all stakeholders involved, individuals may not include all the necessary people within an organization, or these individuals may not know how to effectively communicate their desired requirements (Kaplan & Harris-Salamone, 2009). Stakeholders have their own ideal requirements and expectations for a system, so it is important to gather requirements from all stakeholders. Finally, project leadership needs to effectively control the scope based on requirements (Noblin, Cortelyou-Ward, & Ton, 2011).

B.2.7 Conducting Training and Implementing the EHR System

Finally, there are a number of failures possible when implementing the EHR and training users on the EHR. At this point, cost overruns can be a source of failure with an underestimation of the amount of integration needed between systems, especially in larger systems, a main cause of overruns (Standish 1995; Abouzahra 2011). The data may require processing prior to integration and needs to be accounted for; time overruns such as these are also a source of failure at this stage (Standish 1995).

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To ensure success in this stage, carefully controlling the scope can help. Human resources are a large share of project costs due to the unique IT needs of implementation. Specialized team members are highly compensated and in high demand; therefore, maximizing their time and expertise is crucial to success (Noblin, Cortelyou-Ward & Ton, 2011). Project managers can control costs by monitoring human resources, investments in additional hardware, and other infrastructure (Noblin, Cortelyou-Ward & Ton, 2011).

B.3 Return on Investment in Health Information Technology

B.3.1 Introduction

In May 2014, the news media reported that a number of Department of Veterans Affairs (VA) Medical Centers were having problems scheduling appointments for Veterans. Other leadership and process issues surfaced in the following months. In August 2014, Congress passed the Veterans Access, Choice, and Accountability Act of 2014 (hereafter, the "Choice Act") to address many of these issues. Section 201 of Title II – Health Care Administrative Matters of the Choice Act calls for 12 assessments, identified as Assessments A through L. Recommendations from these assessments are intended to highlight areas in which services to Veterans can be improved.

Assessment H focuses on the assessment of VA's health IT strategies, including the weaknesses in, and opportunities provided by, the technology used by the Department, especially those related to clinical documentation of hospital care, as well as medical and other health care services, furnished by the Department in VA or non-VA facilities. Under Assessment H, clinical documentation includes images and associated text reports.

In typical assessments of health IT strategies, return on investment (ROI) is often included as an important factor to consider. For Assessment H, ROI in health IT is particularly important given the level of VA's IT expenditures. Thus, the purpose of this paper is to identify health IT financial benchmarks, as well as ROI models and metrics. Health IT benchmarks and ROI metrics identified in this paper can be compared against those which VA uses for its own purposes. Such comparisons can lead to refinements in their benchmarks and metrics and perhaps better measurement of the outcomes of their health IT strategies.

B.3.2 Methods

RTI conducted a search of the professional and grey literature (largely Google searches for the latter). In addition, we searched for relevant materials posted in the knowledge repositories of the American Health Information Management Association (AHIMA), American Medical Informatics Association (AMIA), and the Health Information Management and Systems Society (HIMSS). The search produced different types of artifacts, including comprehensive reviews of the literature; peer-reviewed articles, trade publications, and slide presentations reporting a single organization's costs and benefits of health IT; tool kits; and vendor reports and web pages of professional reviewers describing health system, hospital, or provider IT expenditure benchmarks at an aggregate level.

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Though professional articles on ROI in health IT date back to the 1970's, we focused our literature search to cover the years 2000 to the present day. It is in this time period that relevant ROI information can be found for key systems (e.g., electronic health records [EHRs] and computerized physician order entry [CPOE]) and technologies (e.g., mobile health). In addition, though much of the literature we found focused on ROI in EHRs, we made deliberate attempts to gather information on other systems and technologies, so that this report is truly on ROI in *health IT*, not just EHRs.

Many of the artifacts described health IT implementation in a variety of settings, including national programs; health information exchange; as well as health system, large and small hospital, and large and small physician practice, implementations. Admittedly, not all of these settings are comparable to VA. Consequently, the actual figures they report (e.g., dollars or time saved) may not be directly applicable to VA's case. However, in those instances it is not the actual figures, but the metrics they report, that are important here. VA can apply these metrics to various levels of their system (i.e., VISNs, medical centers, or clinics), and are thus appropriate for VA to consider.

Most of the artifacts described individual costs and benefits of health IT in monetary terms, rather than return on investment—i.e., a single numeric figure representing the ROI benefit (numerator) over cost (denominator) ratio (see Figure B-2), or the difference between benefits and cost. Some of the artifacts contained non-monetary benefits, such as time savings. Admittedly, with additional effort, initially reported non-monetary benefits can be translated into dollars. However, in almost every instance the authors of the respective artifacts did not attempt to do so. Where benefits were not translated into monetary terms, we kept them in the category of non-monetary benefits.

The monetary and non-monetary benefits found in the artifacts we reviewed are too numerous to include in a synopsis paper. We selected the more salient metrics and organized them by monetary and non-monetary benefits, and summarized other key metrics in tables in the Supplemental Data section at the end of this article.

B.3.3 Results

ROI Models

Excellent models for calculating ROI, or identifying its components, exist. Each of these models follow the same general principles: (1) determine the goals of the organization and what technology could be implemented to achieve those goals; (2) determine how the organization will measure the impact; (3) determine the source of the data to calculate the estimates, including data needs that may be external to the organization; (4) collect the data; and, (5) compare the pre- and post-implementation data to determine ROI. Each of the models we found are different in format because they accomplish different objectives.

Garrido, et al. (2004), for example, describe a long list of ROI metrics to consider, following item (2) above. At the same time, HIMSS (2013) offers a Health IT Value Suite—essentially, a framework of metrics for Satisfaction, Treatment/Clinical (Care), Electronic Information/Data, Prevention and Patient Education, and Savings (STEPS) (see Table B-3).

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Table B-3. HIMSS's Health IT Value Suite

	Health IT Value STEPS™ and Subtypes	Documented Examples
S	**Satisfaction:** Patient; Provider; Staff; Other	Improved communication with patients; improved patient satisfaction scores; improved internal communication
T	**Treatment/Clinical:** Safety; Quality of Care; Efficiency	Improved patient safety; reduction in medical errors; reduced readmissions; improved scheduling
E	**Electronic information/Data:** Evidence Based Medicine; Data Sharing and Reporting	Increased use of evidence-based guidelines; increased population health reporting; improved quality measures reporting
P	**Prevention and Patient Education:** Prevention; Patient Education	Improved disease surveillance; increased immunizations; longitudinal patient analysis; improved patient compliance
S	**Savings:** Financial/Business; Efficiency Savings; Operational Savings	Increased volume; reduction in days in accounts receivable; reduced patient wait times; reduced emergency dept. admissions; improved inventory control

Source: HIMSS, 2013.

Wang and Biedermann (2010) provide formulae to calculate ROI, following item (5) above. Similarly, the formula in the tool from the Health Information Technology Resource Center (HITRC, 2015) concisely accounts for a number of ROI components, as shown in Figure B-2. The HITRC tool calculates cost, as well as monetary (in dollars and percent reductions or gains) and non-monetary benefits depending on the numerator component in the formula.

Figure B-2. ROI Formula from the Health IT Resource Center

$$ROI = \frac{Benefits(Quality + Safety + Efficiency + Profitability + Quality\ of\ Work\ Life)}{Costs(Acquisition + Implementation + Annual)}$$

Source: HITRC, 2015.

In their review of 42 ROI studies, Bassi and Lau (2013) describe in depth the difficulties in comparing results when different assumptions, methods, and metrics are used. As a potential solution, Adler-Milstein, et al. (2014) provide a model that is both visionary, yet practical, in addressing those difficulties. As health care in the United States evolves more and more into a

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learning health system (IOM, 2007), Adler-Milstein, et al. (2014) argue that a standard model for assessing ROI in EHRs becomes increasingly important. It is only through a standard model that comparisons of costs and benefits of EHRs and health IT can be made across different institutions, implementations, and technologies.

VA's methods for calculating ROI might be informed by the various models above, particularly the IOM's standard model. For VA's ease of use, we have extracted key ROI metrics found in our literature review and organized them using the IOM's standard model (see the tables in Supplemental Data).

Health IT Financial Benchmarks

Health IT financial benchmarks typically consist of a few key metrics, such as total IT expense and capital budgets as a percent of the institution's total budget. In rare instances, hospitals and health systems will report their ROI or individual cost and benefit metrics. Those which we were able to find are discussed below. Normally, hospitals and health systems do not want their competitors to know their actual figures to these metrics. Therefore, they will only disclose them for aggregate reporting where they can compare their figures against those of a cohort group. Thus, it may be difficult to compare VA's figures in these metrics with *identifiable* health systems of comparable size, such as Kaiser (including Kaiser Permanente, Kaiser Mid-Atlantic, etc.), Tenet Healthcare, and Hospital Corporation of America (HCA).

Aggregate health IT benchmark reports are generally produced as a member benefit by those entities that have access to a number of hospitals or health systems, such as group purchase organizations (GPOs)—including Premier, Inc. and University HealthSystem Consortium (UHC)—and HIMSS. The *2013 Annual Report of the U.S. Hospital IT Market* from HIMSS Analytics (2013) contains the typical health IT benchmarks (see Table B-4).

Table B-4. Health IT Benchmarks

	% of Total IT Operating Expense/Total Hospital Operating Expense-Overall			% of Total IT Budget/Total Hospital Expense–Overall			% IS Capital Expense/Total Hospital Capital Expense–Overall		
	2010	2011	2012	2010	2011	2012	2010	2011	2012
Average	2.40%	2.39%	2.74%	2.77%	4.87%	3.21%	17.32%	17.89%	20.22%
Median	1.93%	2.11%	2.27%	2.26%	3.92%	2.66%	10.27%	12.14%	14.10%
N	471	475	400	469	436	479	211	300	244

Note: The columns are derived from Tables HB1, HB2, and HB3, page 6 of the *2013 Annual Report of the U.S. Hospital IT Market* from HIMSS Analytics (2013).

It should be noted that annual increases in IT budgets is a clear trend. All 2012 IT budgets have increased from 2010. The only exception is Percent Total IT Budget (middle set of columns) where 2011 IT budgets were greater for 2011 than in 2012, yet 2012's budgets are still greater than the budgets for 2010. The spike in 2011 is attributed to the need for hospitals to prepare for Meaningful Use. IS Capital Expenditures (last set of columns) should also be noted. In a Premier survey, 49 percent of hospital executives report that their largest capital investment for 2015 will be in health IT (Gregg, 2014b). Further, whereas the IT Capital Expense as a Total of the Hospital Capital Expense is 20.22 percent for 2012 (see upper right most cell in the table above), a Standard and Poor's executive estimated that current IT capital budgets now range

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from 25–35 percent (Herman, 2014). In addition, Byrne, et al.(2010) examined similar benchmarks and found that VA's spending levels to be higher than the private sector, with the exception being IT capital spending to total spending. The likely cause is that, at the time of the study, VA was already implementing and maintaining their system whereas the health care industry was still in the early stages of adoption of certified HIT.

The above three metrics are broken down in the HIMSS Analytics (2013) report by three individual factors: bed size, type of hospital (e.g., academic vs. non-academic medical center, rural vs. urban, etc.) and region of the country. However, there are no nested break downs (e.g., bed size by region). These breakdowns are too numerous and lengthy to discuss in a synopsis paper. Nevertheless, VA may find these breakdowns quite useful in comparing its IT spending levels against the private sector bed size, type of hospital, and region benchmarks reported in the survey.

In their review of the state of health IT, Becker (2014b) reports other important findings relevant to VA:

- About half of all health care providers dedicate 3 percent or less of their IT budgets to information security and related systems (HIMSS, 2014).
- IT budgets for non-profit and government-owned hospitals were relatively consistent over the past four years. IT budgets for for-profit hospitals varied widely and increased significantly. The difference is attributed to the notion that for-profit organizations "are more vulnerable to 'disruptive events,' such as the implementation of the health care reform law."
- The total cost of purchasing and installing an EHR varies significantly, from $15,000 to $75,000 per provider, depending on whether an in-office EHR or a cloud-based EHR is installed. Total cost of ownership for cloud-based systems is less than in-office systems after five years (HealthIT.gov, 2015). A hospital review website reported that Duke University Health System reportedly paid $700 million for its EHR system and Kaiser Permanente paid $4 billion (Gregg, 2014a).

ROI Metrics

As previously mentioned, most artifacts report costs and benefits rather than a single ROI figure, perhaps because many organizations find measuring ROI too difficult to attempt (Baldwin, 2009). Below are ROI metrics broken down by monetary vs. non-monetary benefits.

Monetary Benefits

Monetary benefits can accrue to any health care stakeholders, most notably the patient, clinicians, provider organization as a whole, and relevant payers. Examples include:

- Reduced drug costs (Wang, 2003; Girosi, 2003; MedicaLogic, 2015; Fischer, 2009)
- Reduced lost inventory (Ekahau, 2013)
- Improved charge capture (Wang, 2003; Grieger, 2007; MedicaLogic, 2015; Miller, 2005)
- Increased patient volume (Grieger, 2007; Keshavjee, 2001; MedicaLogic, 2015; Miller. 2005; Garrido, 2005)

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- Reduced transcription costs (Wang, 2003; Grieger, 2007; Girosi, 2005; MedicaLogic, 2015; Miller, 2005; HIMSS, 2007).

Non-Monetary Benefits

A number of non-monetary benefits were reported in the artifacts we reviewed. As previously mentioned, these benefits can be quantified, and with additional effort, translated into financial benefits (e.g., time savings in terms of dollars saved). However, the feasibility of recouping these benefits depends on how they are realized. For example, time savings may be sufficient to reduce staff and thus payroll. Yet, the time saved as a benefit of health IT implementation may be diverted to other activities that need to be performed within the clinical or office environment. Both the time saved as a result of health IT implementation and the increased productivity from time diverted to other activities would have to be calculated. However, both sides of this metric were not regularly reported in this manner.

Examples of non-monetary benefits include:

- Improved quality of care
  - Reduction in adverse-drug events (Wang, 2003)
  - Improved adherence to quality of care measures (MedicaLogic, 2015)
  - Improved vaccination rates (Jha, 2003; MedicaLogic, 2015)
- Time-Savings
  - Reduction in chart pulls (Wang, 2003; Grieger, 2007; Keshavjee, 2001; Girosi, 2005, MedicaLogic, 2015)
  - Reduction in prescription filling time (Grieger 2007, MedicaLogic, 2015)
  - Reduction in prescription renewal time (Corley, 2003; MedicaLogic, 2015; Keshavjee, 2001)
  - Reduction in referral generation time (MedicaLogic, 2015)
- Overall Productivity (Alemi, 2011).

Although difficult to measure, other important non-monetary benefits are those realized by patients. As examples, electronic health records (EHRs) and other health IT products provide many benefits that patients appreciate, such as printed medication lists and care plans, improved access to their own health records, and facilitated communications with providers.

Both qualitative and quantitative benefits can be achieved utilizing health IT. Qualitative benefits are typically those that cannot be reduced to a number—e.g., improved patient satisfaction, improved work-life balance, better on-call record availability, better flexibility in chart location, and improved patient education (Baldwin, 2009).

There are also a number of costs that need to be captured for the denominator of the ROI equation. Many studies only include part of the costs, typically the cost of acquiring the system. Those acquisition costs typically include (Williams & Samarth, 2010):

- Hardware (e.g., computers, servers, printers, scanners, internet service, wireless network, maintenance costs)

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- Software (e.g., customization, patient portals, annual fees).

However, other costs should be included, such as those associated with the installation of the systems (examples below):

- Initial planning & procurement (Williams & Samarth, 2010)
- Contract negotiation (Williams & Samarth, 2010)
- Staff training costs (Williams & Samarth, 2010)
- Paper records to EMR conversion (Fleming, 2011)
- System migration (Williams & Samarth, 2010)
- Installation (Williams & Samarth, 2010)
- Redesigning workflow to accommodate the EHR (Chaudry, 2006; Fleming, 2011)
- Support for launch (Fleming, 2011)
- Technical deployment (e.g., networking) (Fleming, 2011)
- Project management (Fleming, 2011).

B.3.4 Discussion

Unfortunately, except in rare instances (as reported below), it is difficult to obtain publicly available data on the ROI in health IT achieved by large organizations. Many organizations find measuring ROI to be too difficult to attempt (Baldwin, 2009). Perhaps the most complete study in the past few years was conducted by Adler-Milstein, et al. (2013). They found that the average physician adopting an EHR would lose roughly $44,000 over five years. Further, only 27 percent of the practices achieved a positive return on investment. An additional 14 percent achieved a positive return due to the bonuses from the EHR Incentive program. Practices that focused on using the EHR to improve revenue, primarily through seeing additional patients or improved billing, were the ones that had achieved a positive ROI.

The results from the Adler-Milstein, et al. study, however, should be considered with some circumspection. Their sample represented primarily smaller practices (four or fewer physicians) than what is typical of VA. In addition, the practices were using a range of EHR vendors rather than one system as is the case at VA. Finally, the practices each had their own motivations and intended usage of the system, in particular improved revenue generation that may not be applicable in a closed system like VA. More importantly, Adler-Milstein, et al. did not consider other types of benefits as part of their ROI equation. As Alemi, et al. (2011) stated "[s]elective inclusion leads to contradictory situations, where some costs, e.g., cost of training, is included and other related costs, e.g., cost of employees sitting in training sessions, is ignored. The resulting ROI ratio is a rosy forecast of what might happen."

ROI studies should thus include a wider range of benefits and costs. Byrne, et al. (2010), for example, examined ROI for VA from four different angles: IT spending benchmarks, IT adoption benchmarks, IT quality benchmarks, and cost and benefit estimation. For the IT spending benchmarks, they found that VA's spending levels to be higher than the private sector, except for IT capital spending to total spending. The likely reason for higher VA spending is that, at the

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time of the study, VA was already implementing and maintaining their systems, whereas the health care industry was still in the early stages of certified health IT adoption. In support of that argument, the authors found that VA had a much higher level of health IT adoption than the rest of the industry. VA also had higher quality of care when compared to the Medicare HMO plans. Finally, the authors estimated the net value of the health IT for a subset of benefits related to CPRS (particularly CPOE), PACS, bar-code medication administration, and laboratory electronic data interoperability. Their models estimated the benefits to be three times greater than annual costs.

HIMSS (2001, 2004a, 2004b, 2011) provides a wealth of ROI information in their Annual Davies Award manuscripts. Since 2000, several of the awardees have reported the benefits they accrued after implementation of enterprise-level HIT. Such benefits include:

- Reduced duplicative testing and diagnostic procedures
- Avoidance of drug related adverse events
- Allergy checking
- Clinical and financial decision support
- Decreased transcription costs
- Better measurement of care and identification of opportunities for improvement.

The majority of sites reporting benefits have implemented systems from Epic™ Systems Corporation. We report here on a few such sites.

Allina Health

Allina Health is an 11-hospital, 65-clinic system in Wisconsin that began implementing Epic's Enterprise EHR in 2004. It is now used in all of its facilities. Its largest hospital at the time, then known as Evanston-Northwestern, with revenue of $700 million, recorded $24 million in clinical benefits and $31 million in revenue cycle improvements from 2005–2007. Its largest single clinical benefit was a $4.8 million decrease in adverse drug events, and its largest financial benefit was a $15.5 million decrease in denials.

Multicare

Multicare is a four-hospital system in the Tacoma, Washington, area that began its implementation of Epic in 2005. It reported a net benefit of $42.6 million from 2007 to 2009. Reported clinical improvements included a 13-percent decrease in adverse drug events, a 24-percent decrease in the time needed to fill stat orders, and an estimated 108 lives saved among diabetic patients. Financial benefits included $12 million in improved collections and a $5 million reduction in denied claims.

Sentara Health

Sentara is a seven-hospital system in Southeastern Virginia and North Carolina with 1,730 beds that began implementation of Epic at all of its hospitals in 2008 and went live in six of its facilities by the end of 2009. Anticipated (budgeted) benefits in 2009 were $16.6 million. Actual benefits realized totaled $37.3 million. The two largest categories were reduced length of

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stay/reduced adverse drug events ($9.4 million) and increased unit efficiency/nursing retention ($9.4 million).

Table B-5 summarizes benefits for these health systems.

Table B-5. Financial Benefits after Implementation of an Epic Enterprise System

	Epic Enterprise Adopter				
Clinical, Operational & Financial Benefits	Allina (2004)	Multi-Care (2005)	Evanston Northwest (2001)	Sentara (2011)	Average
Clinical & Operating Efficiencies (Adverse drug, duplicate testing, drug utilization/cost, documentation workload, order processing HIM					
Clinical Process Improvements	12,400,000	3,721,000		4,900,000	
Reduced Hospital Acquired Conditiond		1,140,000			
Reduced Adverse Drug Events	4,800,000				
Reduced Medical Records/Transcription Cost	6,400,000	310,000	1,274,000	3,600,000	
Reduced IT Maintenance		640,000	1,161,000	3,600,000	
Operational Workflow Improvements	1,200,000		7,287,000	11,400,000	
Duplicate Testing	800,000				
Drug Utilization Cost	600,000			3,000,000	
Sub-Total Expense Reduction	$ 26,200,000	$ 5,811,000	$ 9,722,000	$ 26,500,000	$ 11,700,000
Revenue Cycle Improvement - Reduction in A/R, # FTE's, denial reduction, data quality, time to billing	31,537,000	10,524,000	2,682,000	9,000,000	
Estimated Annual Benefits	$ 57,737,000	$ 16,335,000	$ 12,404,000	$ 35,500,000	$ 121,476,000
Annual Revenues- 2009	$ 2,220,000,000	$ 1,100,000,000	$ 1,530,000,000	$ 2,500,000,000	$ 7,350,000,000
Expense Saving % of Revenue	1.2%	0.5%	0.6%	1.1%	0.7%
Revenue Increase % of Revenue	1.4%	1.0%	0.2%	0.4%	0.9%
Total % Improvement	2.6%	1.5%	0.8%	1.4%	1.6%

Source: HIMSS 2001, 2004a, 2004b, and 2011.

These analyses did not factor in certain costs required to obtain these benefits. Thus, they do not represent a true ROI. Nonetheless, these analyses provide some insight, albeit incomplete, into the types and magnitude of benefits that can be achieved.

Returning to the general case, the discussion is not complete without noting that the reimbursement model utilized has an effect on ROI, and can skew the results. An extreme example would be the following: Imagine an instance where an allergic reaction to a medication is avoided because of information available in the integrated system. Few would argue that avoiding an allergic reaction is not an improvement in care, yet the net impact on the hospital's revenue may be negative. While this is an extreme example, many of the benefits achieved by an integrated electronic health record produce no direct economic benefit in our current fee for service model. This could soon change. With payment reform we may soon be compensated on a more global basis for the quality and cost of the care rendered. In such models, costs avoidance becomes an opportunity for greater net revenue and the improved quality achievable with such systems and a basis for a more direct assessment of ROI.

B.3.5 Conclusion

There are many ways in which a provider can measure the ROI of its health IT investment—quantitative and qualitative, monetary and non-monetary. In addition, there are a number of models that can be used to calculate ROI, each with differing costs that can be included in the

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calculations. Despite this, much of the published literature centers on a positive ROI regardless of how it is measured.

Based on the discussion in the Results section above and the Supplemental Data below, numerous individual cost and benefit metrics have been developed. None of the published metrics can be considered benchmarks for health IT as they have not been systematically used for comparison purposes. But that does not belie their usefulness as measures.

Prior research (i.e., Byrne, et al., 2010) found that VA achieved a positive ROI for its health IT. However, as that study was done five years ago, VA can embark on an updated study at the present time. An updated study can encompass the full range of health IT in use throughout VA today. For example, recent implementations such as the Blue Button can be included in ROI calculations. At a minimum, individual cost or benefit metrics can be used.

B.3.6 Supplemental Data

Key ROI metrics found in the documents reviewed for this assessment report are summarized below. The metrics are broken down into quantifiable health IT expenses and benefits. Table B-6 and Table B-7, which describe the metrics, follow the standardized framework put forth by the Institute of Medicine.[33]

Quantifiable Health IT Expenses

Expenses to estimate ROI are identified by category, including productivity loss, staffing and consulting costs, technology costs, maintenance, and training. These expense categories are organized into two types, initial implementation and ongoing, to differentiate between the one-time costs that are incurred upon initial investment, and those that will be ongoing expenses. These expense categories and descriptions are primarily based on EHRs but are applicable to all types of health IT projects.

Table B-6. Expense Types by Category for ROI Estimates

Category	Description (examples primarily based on EHR)
Expense Type: Initial Implementation	
Reduced Productivity	Implementation of the health IT decreases clinician productivity (both in inpatient and outpatient settings) until clinicians are able to “master” the new system, resulting in lost revenue due to lost throughput or increased staffing costs necessary to maintain historical volume during the learning period
Staffing Costs Related to Setting Up	Upfront staff time (both clinical and administrative) spent optimizing the health IT and incorporating it into clinical workflows and administrative

[33] Adler-Milstein J, Gregory D, Grossmann C, Mulvany C, Nelson R, Pan E, Rohrbach V, Perlin J. (2014). Return on information: A standard model for assessing institutional return on electronic health records. Institute of Medicine (IOM), Washington, DC.

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Category	Description (examples primarily based on EHR)
System Configuration	processes (i.e., billing, decision support). Includes staffing costs for data migration and mappings/remappings.
Consulting Cost	Expense related to consultant assistance during implementation (if not included in hardware/software costs) or if they are an incremental expense related to integrating EHR into clinical workflows and administrative processes
Hardware Cost	Additional servers, routers, cabling, desktops, local area networks, and other items required to implement HIT
Software Cost	Licenses for EHR and other software and associated analytical tools for data extraction, report writing/distribution and integrating with other systems (i.e., registration, billing, scheduling, lab)
IT Staff Cost	Staffing costs associated with health IT implementation, including project management, content development/customization, system interfaces (both internal and external), workflow mapping, building/quality assurance of interfaces, IT help desk and technical deployment
Networking Cost	Initial costs associated with connecting/integrating EHR/HIT with sites of care within a system and other providers within the community
System Design/ Product Evaluation Cost	Upfront costs for articulating the business goals and incorporating them into the system design. This includes both staff and consultant costs, associated research and evaluation of available alternatives, and staff travel and lost productivity related to specifying requirement development/gathering and product selection/design phase of implementing HIT.
Training Cost	Cost of initial staff training during system implementation. Includes salaries of trainers (newly hired or repurposed), opportunity cost for trainee staff time, and costs related to development of training materials.
Transition Cost	Cost of uploading existing medical records into the EHR. Includes non-labor costs for data migration and mappings/re-mappings.
Hardware Cost	Hardware costs associated with specific technologies that complement an EHR or other health IT (i.e., data warehouse environment, patient portal environment, etc.)
Software Cost	Software costs associated with specific technologies that compliment an EHR or other health IT (i.e., data warehouse environment, patient portal environment, business intelligence tools)
Reduced Productivity	Implementation of the health IT reduces revenue cycle productivity until new data and work flows are established. This results in lost revenue due to lost throughput or increased staffing costs necessary to maintain historical productivity during the learning period.

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Category	Description (examples primarily based on EHR)
Expense Type: Ongoing	
Physical Plant Cost	Space in the server room and other IT-related square footage required host/support the HIT
IT Cost	Costs associated with disaster recovery plan and "downtime" support
Software Cost	Annual license renewal and/or upgrades for EHR/HIT software and associated analytical tools for data extraction and report writing/distribution and integrating with other systems (i.e., registration, billing, scheduling, lab)
Staff Costs Related to Changing Workflow	Ongoing staff time (both clinical and administrative) spent optimizing the health IT and incorporating it into clinical workflows and administrative processes (i.e., billing, decision support)
IT Staff Cost	Post-implementation IT staff required to support/maintain operations and associated technology investments (BI tools, data warehouse, patient portal)
Hardware Maintenance Costs	Cost for replacement or upgrades of servers, switches, etc.
Networking Cost	Ongoing costs associated with integrating the EHR/HIT with other providers within the community
Training Cost	Ongoing training for new capabilities or new clinical staff. Includes salaries of trainers (newly hired or repurposed), opportunity cost for trainee staff time, and costs related to development of training materials
Staff for Newly Created EHR/HIT Related Functions	Application coordinators, clinical content maintenance, reporting/data extraction
Knowledge Management	Includes costs related to knowledge management for development and maintenance of clinical decision support tools
Staff for Newly Created EHR-Related Functions	Costs associated with "medical scribes" (may even be nurses) replacing transcription
Performance Improvement	Costs associated with newly hired business process improvement teams
Utilities	Increased costs associated with electricity for powering and cooling the server room

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Category	Description (examples primarily based on EHR)
Software Cost	Upgrade/replacement/licensing costs associated with specific technologies that complement an health IT (i.e., data warehouse environment, patient portal environment, business intelligence tools)
Hardware Cost	Replacement/upgrade hardware cost associated with specific technologies that compliment a health IT (i.e., data warehouse environment, patient portal environment, etc.)

Source: Health IT benefit strategic goals, types, and descriptions, based on Adler-Milstein et al., 2014

Quantifiable Health IT Benefits

Benefits are categorized by overall core strategic goals, including improved clinical performance, reduced overhead, improved operational performance, reduced inappropriate utilization, and support of clinical trials. These are then categorized by the type of benefit, such as reduction in administrative cost or improved use of disease management strategies. These include some benefits that can be easily attributed as directly to an EHR or other system (e.g., avoiding redundant lab tests), and others for which the EHR works importantly, but less directly, in achieving the improved outcome (e.g., reduced readmissions). It is recognized that the ability to capitalize on these benefits may differ based upon reimbursement type. For example, benefits may accrue to the provider based on reimbursement type, such as per diem or shared savings.

Estimates of ROI are based on adding the total quantifiable costs of the benefits for the specific health IT and comparing it to the total costs to implement, upgrade, or maintain the health IT. In addition, benefits can be reported as measures or metrics, independent of the costs. Examples of these metrics are provided in Table B-7. These measures typically reflect the marginal change due to the health IT, often reflecting reductions in costs associated with efficiencies, workflow improvements, less costly therapies, and avoided health care utilization costs due to the health IT.

Table B-7. Benefit Types by Category and Strategic Goals for ROI Estimates

Benefit Type	Description	Measures/Metrics Examples from Published Studies[34]
Core Strategic Goal: Improved Clinical Performance		
Supply-Chain Management	Health IT such as CDSS facilitates identification of less-expensive pharmaceutical alternatives	• Pharmaceutical costs, overall, per patient (e.g., due to increase in generic drugs prescribed) • Costs per new or refilled prescription

[34] Common metrics for costs are per episode, discharge, covered life, enrollee, patient, and by setting.

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Benefit Type	Description	Measures/Metrics Examples from Published Studies[34]
Improved Workflow—Staffing	EHR and other health IT can decrease clinician time spent on workflow such as documentation, allowing more patients to be seen in a day	• Time spent on documentation, improved efficiency • Calls for test results by patients (due to access to EHR data) • Average pharmacy department costs per patient due to CPOE
Improved Clinical Outcomes	Improved effectiveness of quality improvement projects that result from improved data gleaned from EHRs	• Estimated change in inpatient costs for preventable adverse drug events caused by inpatient medication administration errors • Average LOS
Patient Safety Initiatives	EHR/HIT can facilitate process improvements that reduce "never events" (i.e., medication errors, patient falls, pressure ulcers, wrong site of surgery) that typically aren't reimbursed and substantially increase episode costs and reduce cost to remediate harm	• Number of medication errors prevented • Inpatient costs for preventable ADEs caused by outpatient medications. • Estimated savings due to averted ADE-related utilization

Core Strategic Goal: Reduce Inappropriate Utilization		
Appropriate Site of Care or Therapeutic Pathway	• HIT such as CDSS facilitates ability to suggest therapeutic alternatives (i.e., watchful waiting for lower-back pain vs. immediate surgery) • EHR enables the use of phone and e-mail visits to address relatively minor issues that otherwise would have required an office visit • Data from a health system's EHR can identify	Costs associate with changes in utilization by: • Rates of ED visits • Rates of primary care visits • Rates of specialist visits Measures below are by number of visits/enrolled patients • Rates of red blood cell transfusions (overall or in settings such as pediatric ICU)

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	the highest-value (lowest cost for a given level of quality) setting to provide care for patients with certain conditions. Patients can then be routed to the most appropriate care setting.	• Costs as a result of increased use of alternative therapeutic approaches • Costs related to antibiotics prescribed, hospital antimicrobial costs
Reduce Duplicative Services	EHR and HIE info available on previous tests reduces laboratory and radiology costs for redundant and unnecessary tests	Costs associated with change in medical tests: • Rate of lab tests • Rate of diagnostic tests • Rate of radiology tests • Tests per patient over unit of time (e.g., tests per patient- day)
Disease/ Population Management Strategies	• HIT allows for development and management of clinical registries to improve care delivery and coordination • EHR facilitates automated reminders and alerts identifying those with chronic disease(s) and enables optimal care of these patients based on predefined protocols	• Average costs per patient (e.g., frequent ED user, nursing home resident with specific condition) • Rates of ambulatory sensitive ED visits and admissions per enrollees/patients
Core Strategic Goal: Overhead Reduction		
Offsetting	If health IT replaces existing systems that performed similar functions, the health IT ongoing maintenance costs should be offset by the legacy system maintenance costs	Change in IT maintenance costs
Core Strategic Goal: Improved Operational Performance		
Supply-Chain Management	EHR/HIT enables decision-support tools to identify less-expensive/ more-effective supply alternatives, reducing supply costs	Reduced supply costs

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Supply-Chain Management	EHR/HIT can enable auto restocking/ ordering to support pre-defined par levels	Average supply costs per admission, discharge, visit, etc.
Reduced Capital Expenditures	EHR could reduce demand for imaging and lab services to a point that it reduces the need for new/replacement capital assets (CT machines, X-ray machine, lab equipment)	Capital costs avoided by reallocating space previously used for radiology, labs, MR, CT to other uses that would have otherwise required new space to either be built or leased
Reduced Operating Costs	EHR reduces need for printing X-rays and related radiological film supply costs	Costs in x-ray and radiology film supply costs with radiology system
Improved Workflow—Reduced Capital Expenditure	Clinical protocols/ pathways embedded in the EHR can enable reduced variability in care delivery in all settings, allowing facility to make greater use of fixed capacity (i.e., available beds through decreased average length of stay (ALOS), magnetic resonance imaging (MRI) machines, and surgery suites)	• Average inpatient LOS • Charges per discharge • ED LOS
Improved Workflow—Staffing	Clinical protocols/pathways embedded in health IT such as EHR, CPOE can enable reduced variability in care delivery in all settings allowing the facility to make greater use of step-fixed staffing resources (i.e., free-up floor staff through decreased ALOS, MRIs, surgery suites)	• Changes in patient flow such as admit to bed assignment, bed assign to ED exit, total ED boarder cycle time (LOS in minutes) • Rates of ED patients leaving without treatment • Inpatient transfer cycle • Average time from medication order written to med administration • Staff time to prescribe medication with health IT vs. no HIT • Change in time to make referral
Payer Management	Allows for decreased administrative costs related to payer prior authorization and utilization management/review activities	• Charges per discharge, covered life, encounter, patient • Average inpatient costs • Appropriate billed charges per patient, covered life, encounter, discharge • Claims denials

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Reduce Repeat Hospitalizations	EHR can facilitate improved discharge process and improve care coordination across providers, reducing unnecessary readmissions	• Readmission ratio (actual/expected readmission rates) • Associated costs from avoided admissions attributable to HIT, avoided admissions times average cost per admission
Core Strategic Goal: Network Management		
Increased Labor Efficiency	Enables de-skilling strategies allowing organizations to take advantage of clinicians performing at the "top of their license"	Labor costs (per episode, patient, enrollee covered life visit, admission, etc.)
Improved Clinical Outcomes	EHR allows for provider profiling	Accurate and sensitive provider profiles

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Core Strategic Goal: Overhead Reduction		
Reduced Capital Expenditures	Reductions in need for space with EHR/HIT and electronic information	Floor space related to radiology film library and medical records/chart rooms
Reduced Operating Costs	EHR reduces operating costs required to manage information that is not electronically stored	Film-processor and related maintenance costs due to reduced radiology tests
Improved Workflow—Staffing	EHR reduces need for staffing for pulling charts, transcription, laboratory order processing by technicians, as examples	• Time spent pulling charts, reduced transcription costs, time spent on laboratory order processing by lab techs • Inpatient nursing time
Administrative Costs	HIT-enabled quality-improvement efforts decrease medication errors and other "never events," leading to a reduction in malpractice premiums	Malpractice premiums (reduction)
Core Strategic Goal: Improved Quality Metric Reporting		
Metric Development/ Management	EHR allows for automation of quality reporting, reducing the need for manual chart abstraction	Chart abstraction (reduction)
Core Strategic Goal: Opportunity Costs		
Service Line Management	Data from a health system's EHR/HIT can better identify underperforming service lines and determine whether the quality/cost point can be improved or the organization should discontinue the service and pursue other opportunities with its resources	Changes in operating margin resulting from a reallocation of resources
Core Strategic Goal: Support Clinical Trials		
Revenue Opportunity/ Halo Effect	More easily provides data to support clinical trials conducted at the organization	• Changes in efficiency of clinical studies • Staff time to recruit participants

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	or increases the opportunities for organizations to participate in clinical trials	

Source: Health IT benefit strategic goals, types, and descriptions, based on Adler-Milstein et al., 2014.

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Appendix C Assessment H Sites Visited

The Assessment H team visited five VISNs, nine VAMCS, and two CBOCs. At a high-level, the objectives were to understand the impact of the health IT strategies and systems on Veteran access to care, quality of care, and satisfaction with their care.

C.1 Objectives

The team's detailed objectives were to understand the site's views on:

- The effectiveness of health IT (HIT) strategies and systems in supporting Veteran access to care, quality of care, and satisfaction in their care to the clinical end users.
- The effectiveness of HIT strategies, systems and processes in supporting clinical documentation improvement (CDI).
- To what extent site users and planners are engaged in the design and development of new systems
- The most critical HIT requirements to meet local and strategic health objectives.
- How their critical HIT requirements are solicited and addressed.
- How the design, development, and deployment of IT systems could be improved.

C.2 Sites

We visited sites in rural areas in addition to urban areas and covered different regions of the country.

- VISNs
  - 1
  - 4
  - 11
  - 18
  - 19
  - 22.
- VAMCs
  - Boston/West Roxbury, Massachusetts
  - Carl T. Hayden – Phoenix, Arizona
  - Eastern Colorado – Denver, Colorado
  - Erie, Pennsylvania
  - John D. Dingwell – Detroit, Michigan
  - Lexington-Cooper, Kentucky
  - Long Beach, California
  - Togus-Augusta, Maine

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  - Oscar G. Johnson - Iron Mountain
  - Palo Alto, California
  - Pittsburgh, Pennsylvania.
- CBOCs.
  - Menominee, Michigan
  - San Jose, California

Note: Site visits to VISN 4, and VAMCs at Erie and Pittsburgh were primarily for the review of processes utilized by this site enabling them to be among the top performers at VHA and not as part of the Assessment H site visits.

C.3 Approach

Interviews were conducted with key personnel who could represent the various stakeholders impacted by health IT strategies and systems in accordance with the methodology and research questions outlined in Section 2 of this Assessment H report. Each interview lasted between 30 and 60 minutes. Interviews were requested and held with staff in the following roles:

- Director
- Associate Director
- Medical Chief of Staff
- Chief of Nursing
- Chief of Biomedical Engineering
- Lead for Clinical Engineering
- Chief/Director of Health Information Management
- Chief Health Information Officer (CHIO)
- Chief Information Officer (CIO)
- Chief Nursing Informatics Officer
- Department Chief (e.g., Chief Hospitalist, Chief of surgery, Chief of mental health)
- Representative group of providers (e.g., medical, surgery, cardiology, internal medicine, radiology)
- Representative group of nurses (e.g., ED, ICU, medical/surgical)
- HIM staff (e.g., medical records administrators, medical coding, documentation specialists)
- Quality managers, finance managers, and researchers using clinical data
- Clinical Applications Coordinator
- Telehealth Coordinator

Interviews were not conducted with this complete list of staff at each site because they were unavailable or the role did not exist at the VISN-level or CBOC-level. .

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Sample interview questions were:

- What are the highest priority, measurable health care objectives? How do the current systems help you achieve these outcomes?
- What specific new health care capabilities have been deployed (at enterprise scale) in the past 5 years, and what was the measurable impact on the ability to manage and furnish health care?
- What are the major advantages/limitations of the current clinical systems?
- What are your top clinical system requirements?
- What and where is the 1-year, 2-year, and 3-year future states for IT defined, and what are the specific measures of effectiveness defined for verifying a measurable improvement to Access to Care and Quality of Care?
- How are "Users" engaged to identify and develop IT requirements to address gaps and for managing and furnishing health care?
- From an operational (clinical) perspective, has there been sufficient allocation of resources and sufficient planning associated with the incremental deployments (e.g., training)?

Additional data and documentation requested from the sites included:

- Clinical documentation improvement reports
- Help desk tickets for the health IT systems
- Strategic Plans.

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Appendix E Acronyms

AAMI	Advancement Association of Medical Technicians
ACAP	Access and Clinic Administration Program
ACI	Accelerated Care Initiative
ACO	Accountable Care Organization
ACP	Acceptance Criteria Plan
ACSC	Ambulatory Care Sensitive Condition
ADC	Association of Defense Communities
ADE	Adverse Drug Event
ADK	Application Development Kit
ADUSH	Assistant Deputy Under Secretary for Health
AEMS	Automated Engineering Management System
AERB	Architecture Engineering Review Board
AHIMA	American Health Information Management Association
AHLTA	Armed Forces Health Longitudinal Technology Application
AHRQ	Agency for Healthcare Research and Quality
aka	also known as
ALOS	average length of stay
AMIA	American Medical Informatics Association
ANSI	American National Standards Institute
AoA	Analysis of Alternatives
API	Application Programming Interface
App	Application
APT	Advanced Persistent Threat

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ASD	Architecture, Strategy, and Design
ASMR	ASM Research
BCA	Business Case Analysis
BCMA	Bar Code Medication Administration
BDD	Behavior Driven Development
BHIE	Bidirectional Health Information Exchange
BI	Business Intelligence
BISL	Business Intelligence Service Line
BLUF	Bottom-Line Up Front
BMS	Bed Management Tools
BOE	Basis of Estimate
BPE	Business Process Engineering
BPFE	Blue Print for Excellence
BRAMP	Business Requirements and Architecture Management Plan
BRD	Business Requirements Document
BRP	Blue Ribbon Panel
C&P	Compensation and Pension
CAC	Clinical Application Coordinator
CAMH	CMS Alliance to Modernize Healthcare
CAP	Cross-Agency Priority
CAPRI	Compensation and Pension Record Interchange
CAO	Chief Acquisition Officer
CBO	Chief Business Office (VHA)

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CBOC	Community Based Outpatient Clinic
CBX	Computer-Based Examination
CCDA	Consolidate Clinical Document Architecture
CCHIT	Certification Commission for Health Information Technology
CCMB	Clinical Capability Management Board
CDC	Centers for Disease Control and Prevention
CDI	Clinical Data Interface or Clinical Documentation Improvement
CDS	Clinical Decision Support
CDSS	Clinical Decision Support System
CDW	Corporate Data Warehouse
CEO	Chief Executive Officer
CFO	Chief Financial Officer
CH	Connected Health
CHDR	Clinical Health Data Repository
CHIO	Chief Health Informatics Officer
CIO	Chief Information Officer
CLIN	Contract Line Item Number
CM	Contract Management
CMIO	Chief Medical Information Officer
CMMI	Capability Maturity Model Integration
CMS	Centers for Medicare & Medicaid Services
COBIT	Control Objectives for Information and Related Technology
COE	Center of Excellence

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COTS	Commercial off-the-shelf
CPE	Capacity and Performance Engineering
CPOE	Computerized Physician Order Entry
CPRS	Computerized Patient Record System
CPU	Central Processing Unit
CQM	Clinical Quality Measures
CRB	Contract Review Board
CRUD	Create-Read-Update-Delete
CSS	Cascading Style Sheet
CT	Computed Tomography
CTO	Chief Technology Officer
CVT	Clinical Video Telehealth
CVX	Clinical Vaccines Administered
DAS	Data Access Service
DBA	Database Administrator
DECC	Defense Enterprise Computing Center
DHCP	Decentralized Hospital Computer Program
DHMSM	DoD Healthcare Management System Modernization
DHS	Department of Homeland Security
DICOM	Digital Imaging and Communications in Medicine
DISA	Defense Information Systems Agency
DME	Development, Modernization, and Enhancement
DoD	Department of Defense

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DQM	Document Quality Management
DSS	Decision Support System
EA	Enterprise Architecture
EAI	Enterprise Application Integration
eCQM	Electronic Clinical Quality Measures
ED	Emergency Department
EDIS	Emergency Department Integration Software
EE	Enterprise Edition
eHMP	Enterprise Health Management Platform
EHR	Electronic health record
EIA	Electronic Industries Alliance
EIPT	Executive IPT
EMI	Enterprise Messaging Infrastructure
EMM	Enterprise Mobility Management
EMR	Electronic Medical Record
EMRAM	EMR Adoption Model
EP	Eligible Provider
ER	Emergency Room
ESB	Enterprise Service Bus
ESE	Enterprise Systems Engineering
ESS	Enterprise Shared Services
ETA	Enterprise Technical Architecture
EUCOM	European Command
EVM	Earned Value Management

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eVPR	Enterprise Virtual Patient Record
EWD	Enterprise Web Developer
EWL	Electronic Wait List
FBI	Federal Bureau of Investigation
FDA	Food and Drug Administration
FEMA	Federal Emergency Management Agency
FFRDC	Federally Funded Research and Development Center
FHIE	Federal Health Information Exchange
FHIR	Fast Health Interoperability Resources
FISMA	Federal Information Security Management Act
FITARA	Federal IT Acquisition Reform Act
FLS	Financial and Logistics System
FOC	Full Operational Capability
FTE	Full Time Equivalent
FTEE	Full-Time Equivalent Employees
FY	Fiscal Year
GAO	Government Accountability Office
GOTS	Government off the shelf (software solution)
GPO	Government Publishing Office
GPS	Global Positioning System
GSA	General Services Administration
GUI	Graphical User Interface
HCA	Hospital Corporation of America
HCIS	Healthcare Information Systems

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HDR	Health Data Repository
HEDIS	Healthcare Effectiveness Data and Information Set
HeV	HealtheVet
HHS	Department of Health and Human Services
HI	Health Informatics
HI2	Health Informatics Initiative
HIE	Health Information Exchange
HIH	Health Information Handlers
HIM	Health Information Management
HIMSS	Health Information Management Systems Society
HIPAA	Health Insurance Portability and Accountability Act
HISP	Health Information Service Provider
HIT	Healthcare Information Technology
HITRC	Health Information Technology Resource Center
HL7	Health Level Seven International
HMO	Health Maintenance Organization
HPHS	High Performing Health Care Systems
HSR&D	Health Services Research & Development
HTML	Hyper-Text Markup Language
HTTP	Hyper-Text Transfer Protocol
HW	Hardware
IAM	Identity Access Management
ICD	International Classification of Diseases

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ICS	Internal Controls Service
ICU	Intensive Care Unit
IDRP	Innovation and Development Request Portal
iEHR	Integrated Electronic Health Record
IETF	Internet Engineering Task Force
IG	Inspector General
IMS	Integrated Master Schedule
IOC	Initial Operational Capability
IOM	Institute of Medicine
IPM	Initiative in Precision Medicine
IPO	Interagency Program Office
IPT	Integrated Product Teams
ISIL	Islamic State of Iraq and the Levant
ISIS	Islamic State of Iraq and Syria
ISO	International Standards Organization
ITIL	Information Technology Infrastructure Library
IT	Information Technology
ITLB	IT Leadership Board
ITSM	Information Technology Systems Management
JDBC	Java Database Connectivity
JLV	Joint Legacy Viewer
js	javascript
json	Java Simple Object Notation
JSP	Java Server Page

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KFM	Key FISMA Metrics
KM	Knowledge Management
KPI	Key Performance Indicator
KPP	Key Performance Parameter
LHS	Learning Health System
LOB	Line of Business
LOINC	Logical Observation Identifiers Names and Codes
LOS	Length of Stay
MAE	Mobile Application Environment
MAGB	Mobile Application Governance Board
MARA	Mobile Application Reference Architecture
MAS	Mobile Application Store
MD	Doctor of Medicine
MASS	Medical Appointment Scheduling System
MDM	Mobile Device Management
MDWS	Medical Domain Web Services
MERS	Medical Equipment Reporting System
Mgmt	Management
MHED	Mobile Health External Development
MHV	My HealtheVet
MOCHA	Medication Order Check Healthcare Application
MOU	Memorandum of Understanding
MR	Magnetic Resonance
MRI	Magnetic Resonance Imaging

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MSP	Medical Scheduling Package
MTIPS	Managed Trusted Internet Protocol Services
MU	Meaningful Use
MUMPS	Massachusetts General Hospital Utility Multi-Programming System
MVAT	Managing Veterans Access Via the Telephone
MVC	Minimally Viable Capabilities
NCA	National Cemetery Administration
NCPDP	National Council for Prescription Drug Programs
NCS	National Cemetery System
NDAA	National Defense Authorization Act
NEJM	New England Journal of Medicine
NHIN	Nationwide Health Information Network
NIST	National Institute of Standards and Technologies
NLP	Natural Language Processing
NMCI	Navy Marine Corps Intranet
NRC	National Research Council
NRM	Non-Recurring Maintenance
NSD	National Service Desk
NSOC	Network and Security Operations Center
NSR	New Service Request
NTGB	National Telehealth Governance Board
NTTHD	National Telehealth Technology Help Desk
NVTC	Northern Virginia Technology Council

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NUMI	National Utilization Management Integration
NwHIN	Nationwide Health Information Network
O&M	Operations and Maintenance
OA	Operational Analysis
OAP	Operational Acceptance Plan
OAR	Operational Analytics and Reporting
OCR	Office of Civil Rights
OED	Office of Enterprise Development
OEM	Office of Emergency Management
OHI	Office of Health Information
OI&A	Office of Informatics and Analytics, Veterans Health Administration
OI&T	Office of Information and Technology, Veterans Affairs
OIG	Office of the Inspector General
OIS	Office of Information Security
OMB	Office of Management and Budget
OneVA EA	OneVA Enterprise Architecture
ONC	Office of the National Coordinator
ONS	Office of Nursing Services
OPES	Office of Productivity, Efficiency, and Staffing
OPM	Office of Personnel Management
OR	Operating Room
OSEHRA	Open Source EHR Alliance
OSS	Open Source Software

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OTS	Off The Shelf or Office of Technology Strategies
PaaS	Platform as a Service
PACS	Picture Archiving Communication Systems
PATS	Patient Advocate Tracking System
PCECS	Portland Center for the Evaluation of Clinical Services
PCP	Primary Care Physician
PCS	Patient Care Services
PD	Product Development
PDF	Portable Document Format
PDUSH	Principal Deputy Under Secretary for Health
PE	Product Effectiveness
PEO	Program Executive Office
PGP	Pretty Good Privacy
PHDSC	Public Health Data Standards Consortium
PHI	Personal Health Information
PHR	Personal Health Record
PIC	Portland Informatics Center
PIN	Private Industry Notification
PIT	Program Integrity Tool
PKI	Public Key Infrastructure
PM	Program Manager
PMAS	Project Management Accountability System
PMO	Program Management Office
POC	Point of Care

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PPBE	Programming, Planning, Budgeting, and Execution
PPM	Product and Platform Management
PSCI	Patient Safety Center of Inquiry
PSI	Product Shippable Increments
PWS	Project Work Statement
QA	Quality Assurance
QIT	Quality Inspector Tool
QM	Quality Management
QSV	Quality, Safety and Value, The Office of the Assistant Deputy Under Secretary for Quality, Safety, and Value
RACI	Responsible, Accountable, Consulted, Informed
RATSR	Risk Analysis and Testing Scope Report
RDBMS	Relational Database Management System
RDV	Remote Data Viewer
RFC	Request for Comments
RFI	Request for Information
RFP	Request for Proposal
RMC	Resource Management Committee
ROI	Return on Investment
RPC	Remote Procedure Call
RRTF	Ruthless Reduction Task Force
RSA	Replacement Scheduling Application
RSD	Review Services Division
RSMR	Risk Standardized Mortality Rate

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RSRR	Risk Standardized Readmission Rate
RTI	Research Triangle Institute
RTM	Requirements Traceability Matrix
SAFe	Scaled Agile Framework
SAIL	Strategic Analytics for Improvements and Learning
SAM	Scaled Agile Methodology
SDD	System Design Document
SDE	Service, Delivery and Engineering
SDK	Software Development Kit
SDLC	Software Development Life Cycle
SEI	Software Engineering Institute
SFS	Scholarship for Service
SHEP	Survey of Healthcare Experiences of Patient
SLA	Service Level Agreement
SME	Subject Matter Expert
SNOMED	Systematized Nomenclature of Medicine
SOA	Services Oriented Architecture
SOP	Standard Operating Procedure
SPC	Scheduling Program Council
SPSC	Scheduling Program Steering Committee
SUMPM	Safety Updates for Medication and Prescription Management
SW	Software
TACM	Telephone Access and Contact Management
TBD	To Be Determined or To Be Decided

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TCO	Total Cost of Ownership
TCT	Telehealth Coordination Technician
TH	Telehealth
TIC	Trusted Internet Connection
TIU	Text Integration Utilities
TLS	Transport Layer Security
TPMG	The Permanente Medical Group
TRM	Technical Reference Model
TSS	Telehealth Scheduling System
TTPs	Tactics, Techniques and Procedures
UAT	User Acceptance Testing
UHC	University HealthSystem Consortium
UMA	User Managed Access
USAF	U.S. Air Force
USC	United States Code
USH	Under Secretary for Health
UX	User eXperience
VA	Department of Veterans Affairs
VACAA	VA Choice Act Assessment
VACI	VA Center of Innovation
VACO	VA Central Office
VAi2	VA Innovation Initiative
VAMC	VA Medical Center
VAMF	VA Mobile Framework

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VAP	Veteran's Authorization and Preferences
VASI	VA Sensitive Information
VBA	Veterans Benefits Administration
VFA	Veteran Facing Applications
VHA	Veterans Health Administration
VHU	Vet Health University
VIMM	VistA Immunization Enhancements
VINCI	VA Informatics and Computing Infrastructure
VISN	Veterans Integrated Service Networks
VistA	Veterans Health Information Systems and Technology Architecture
VLER	Virtual Lifetime Electronic Record
VP	Vice President
VPR	Virtual Patient Record
VSA	VistA Service Assembler
VSE	VistA Scheduling Enhancements
VX	VistA Extension
WAN	Wide Area Network
WBS	Work Breakdown Structure
WSRR	WebSphere Service Registry and Repository
WWW	World-Wide Web
XML	eXtensible Markup Language

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