HIT Innovation and Advanced Technology Development Division

IATDD

Long Range Technical Architecture Strategy

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DOCUMENT CHANGE CONTROL

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EXECUTIVE SUMMARY

Overview

The purpose of Long-Range Technical Architecture (LRTA) Strategy is to review and address the evolving strategic needs of the Defense Health Agency's (DHA) Health IT (HIT) Directorate, to include future-state requirements, new technical architectures and associated solution sets that support identified requirements. In this document technical feasibility, clinical reliability, and financial viability serve as key determining components for leveraging existing data sources to identify technical solutions and proactive investments. This document also addresses the critical factors necessary for successful implementation and sustainment of technologies through the use of mapping analyses that lay out a 10-year landscape. The document proposes areas for future investment from a 1-3, 4-6 and 7-10 year perspective, based on Industry best practice and analyses completed against specific DHA functional gaps and requirements. The document also identifies technical standards and technical architecture requirements that must be followed such that enterprise technical and financial risk can be minimized and controlled with the implementation of new solution sets. This information was then consolidated into a phased roadmap providing a blueprint for improving the state of the DHA's current technical enterprise. Please see Appendix I for a signed memorandum from the DHA's Chief Information Officer (CIO) establishing this document as the overarching digital business transformation plan for the DHA.

Approach

The analysis and recommendations presented were driven by an objective, data-driven evaluation framework within the Semantic Open Source Software (SEMOSS) tool. To do so, the LRTA Team developed a model for the technology delivery process that lead to the identification of impactful proposed solution(s), which can come from a variety of sources, including MHS stakeholders, Industry, and Academia. These proposed technologies were then mapped to select strategic drivers with estimated levels of effort created for research, development, and sustainment, per technical solution. By doing so, the enterprise is able to ensure proactive pre-planning for the funding and implementation of projects based off of their business value. The key drivers included: (1) the Office of the National Coordinator (ONC) Federal Health IT Strategic Plan for 2015-2020, (2) DHA's Quadruple Aim, and (3) existing business process functional gaps identified, validated and scored by the MHS Chief Medical Information Officers (CMIOs). These drivers directly informed the basis for the future technology landscape and allow for stakeholder validation to ensure the success of these strategic future technology investments.

Short and Long-term Technical Landscape Considerations

Specifically, the document delivers an LRTA Investment Lifecycle Roadmap, which provides a snapshot of our current state technical architecture, the analysis completed for each future state time increment (1-3, 4-6, and 7-10 years), and the resulting associated technologies which should be evaluated for adoption by the MHS enterprise.

- **Technical Architecture - Current State:** Today the DHA has a multitude of legacy healthcare systems and data stores that need to be modernized and integrated. This spectrum of systems, connected at different levels of the enterprise, has contributed to a number of complications. Based on current functional requirements and inefficiencies, the DHA must prepare its technical architecture to support or facilitate immediate enterprise priorities such as the Defense Healthcare Management Systems Modernization (DHMSM) electronic health record (EHR) implementation and the rationalization and consolidation of IT infrastructure and systems required by Department of Defense (DoD) leadership.
- **Technical Architecture - Near Term Needs (1-3 Years):** The DHA has encountered data quality and usability issues over the past decade. The opportunities for more effective and efficient data analysis lie hidden between complex and disparate systems. To address this, the DHA plans to procure a new EHR that leverages a flexible service-based implementation approach to enable real-time integration and the reuse of system data objects across multiple business processes. With this in mind, the DHA developed four Enterprise Technical Architecture (ETA) documents to serve as the MHS' approved reference architecture, which address many of the technical challenges posed within the current environment, by layer. These documents will help ensure existing and future solutions properly integrate into the new technical architecture, which requires them to adopt a service-based model in the next 1-3 years. Technical solutions for consideration include, but are not limited to: security at rest and transit; network last mile; multimedia storage optimization; natural language processing; and an Enterprise Service Bus (ESB).
- **Technical Architecture - Mid Term Needs (4-6 Years):** Over the next four to six years, the DHA and healthcare organizations will find themselves in the midst of a shift in the way that healthcare is administered and monitored. According to public, private, and academic industry research, patients will begin taking ownership of their healthcare, which will create a deep ripple effect across IT networks that enable the day-to-day activities of the DHA. Technologies in this time frame require or target a more open enterprise structure, and therefore the infrastructure itself needs to be more unified and follow a cross-divisional approach. Based on the analysis, technical solutions for consideration for this time period include but are not limited to: enterprise content management,

geospatial and location intelligence, high-performance message infrastructure, machine learning, telehealth monitoring, identity analytics and intelligence, social analytics, and cloud-computing and personal cloud.

- **Technical Architecture - Long Term Needs (7-10 Years):** Over the long-term, the DHA should look to solutions and their relation to one another to foster more effective and efficient data use. The shift from internal data creation to external data intake will provide both healthcare providers and beneficiaries with a significant increase in data knowledge and control. Based on the analysis, this document highlights technical solutions that the DHA should target for 7-10 years, which include augmented reality, real time infrastructure, quantified self, internet of things, cognitive computing, virtual personal assistants, data integrated tool suites, open data, security intelligence, machine-to-machine communications, adaptive e-textbooks, social network analysis, and prescriptive analytics, to name a few.

Way Ahead

The solutions outlined in this document pose countless opportunities for future growth for the enterprise and intend to serve as a starting point for IT evolution and planning. It is imperative that HIT work together to further review and validate current and potential technical solutions while also identifying the numerous programmatic, technical, financial, and functional dependencies. By taking a disciplined and futuristic approach to the investigation, evaluation, and incorporation of new LRTA's, the DHA will be able to realign sustainment costs to focus on new investments and improvements through more efficient and value-driven technologies. This more centralized focus will impact the enterprise in a broad and profound way by allowing transformational innovations to touch the entire range of business processes. The results of the progressive strategies described in this document will amplify the value of the DHA's HIT portfolio significantly by allowing the agency to identify and realize solutions that demonstrate immediate value based on their ability to radically improve provider and patient experiences and drive enterprise capabilities.

The DHA will also be better suited to support new architectures and solution sets through using data-driven analyses, and will be better equipped to select successful research and development projects that improve operational experiences in the future. A service-based and fluid architecture will increase flexibility and sustainability, and despite inevitable constraints, the DHA's current technical foundation is supportive of the interoperability and technological advancement necessary to achieve an ideal state in the long-term. While the proposed recommendations are dynamic and dependent on a changing environment, the methodologies supporting them will transform the DHA into a highly proactive and impactful enterprise.

1 Introduction

1.1 Overview

The Institute for Defense Analyses (IDA) reports that to keep pace with rapid technological change and to improve business results, enterprises must fundamentally refocus, reorganize, and rethink long term planning. The DHA and its stakeholders endeavor to enhance healthcare delivery, lower the total cost of ownership, and improve the technology and management needed to support healthcare operations. This is an evolving, strategic need that requires ongoing review and refinement over time in order to effectively modernize and adopt specialized technology solutions. Doing so will encourage focus on functional and capability gaps that are adversely affecting the provision of high quality health care and foster a forward-leaning focus on inserting transformational and disruptive technologies into the agency's portfolio. Additionally, as new Department of Defense (DoD) business and IT strategies are implemented and mandated throughout the enterprise, these strategies must be considered as the agency and its support functions evolve.

1.2 Document Purpose

The purpose of this Long-Range Technical Architecture (LRTA) strategy is to review and address the evolving strategic needs of the Defense Health Agency's (DHA) Health IT (HIT) Directorate, to include future-state requirements, new technical architectures and associated solution sets that support identified requirements. The document proposes areas for future investment from a 1-3, 4-6 and 7-10 year perspectives, based on Industry best practices and analyses completed against specific DHA functional gaps and requirements. In addition to evolving functionally-driven technical solution sets, the document identifies technical standards and technical architecture requirements that must be followed such that enterprise technical and financial risk can be minimized and controlled with the implementation of new solution sets over time.

Additionally, the document addresses the manner in which investments are made, such that technical architecture requirements and standards are adhered to, for minimal disruption and cost to the government. Specifically, the strategy serves as the end-to-end implementation roadmap, as seen in Section 2, and provides a roadmap for improving the state of the DHA's current technical enterprise by identifying architectures and related solution sets from a phased perspective.

Developing and maintaining such a document is vital to the DHA's HIT Innovation and Advanced Technology Development Division's (IATDD) mission, which focuses on improving the strategy, management, and execution of HIT Innovation, Advanced Technology Development, and Technical Architecture activities. Together these areas are helping drive HIT improvements that will help enhance the timely capture and exchange of health care data and services provided to our nation's service members, their families and beneficiaries.

1.3 Document Organization

The content of this document is organized as described in the table below.

Table 1: Document Organization

Section	Description
1. Introduction	This section covers the document purpose, overview, and organization. It also covers document authority and approval.
2. Setting the Stage	This section highlights some of the critical challenges facing Defense Health Agency Health IT today, specific to its technical architecture. It also provides an overview of the Technical Delivery Process that was used to analyze the weighted mix of key metrics.
3. Technical Architecture: Current Program Statement	This section covers the current problem space for technical architecture and how it relates to ongoing efforts to select and implement the future Department of Defense Healthcare Management Systems Modernization (DHMSM) Program Electronic Health Record.
4. Technical Architecture: Near-Term Needs (1-3 Years)	This section discusses how the Military Health System's Enterprise Technical Architecture (ETA) documents were developed to help accelerate the exchange of information between the MHS and its business partners using a standards and service-based paradigm. It also covers integration needs in support of DHMSM and identifies cross-divisional technical prototypes and pain points.
5. Technical Architecture: Mid-Term Needs (4-6 Years)	This section describes how over the next four to six years, the DHA and healthcare organizations will find themselves in the midst of a shift in the way that healthcare is administered and monitored. Technologies in this time frame require or target a more open enterprise structure, and therefore the infrastructure itself needs to be more unified and follow a cross-divisional approach.
6. Technical Architecture: Long-Term Needs (7-10 Years)	This section describes analysis results for long-term technical architecture needs (7-10 years). It describes how over the long-term, the DHA should look to solutions and their relation to one another to foster more effective and efficient data use. The shift from internal data creation to external data intake will provide both healthcare providers and beneficiaries with a significant increase in data knowledge and control.

7. Way Ahead	This section reiterates the importance of carefully planning for the implementation of various technologies over the next 10 years – and how such an approach will enable the DHA to be able to realign sustainment costs to focus on new investments and improvements through more efficient and value-driven technologies. It also covers a timeline of acceptance, powers of open innovation, and risk mitigation activities.
8. Additional Information: In-Depth Technical Solutions	Lastly, this section provides additional information on the various proposed technologies identified throughout the document. The technologies are more carefully defined, their impacts on the organization's strategic objectives are clearly articulated, and their unique architectural requirements are addressed.

1.4 Key Terms

The following defines terms used throughout this document, as defined by the IATDD.

- **Advanced Technology Development (ATD):** refers to research and development efforts; the models may be form, fit and function prototypes or scaled models that serve the same demonstration purpose. Projects have a direct relevance to identified military needs/functional gaps and have potential to provide tangible benefits to the military health community. *This type of research is not specific to disruptive and transformational innovations that are coordinated through the HIT Innovation Program.*
- **Defense Health Agency (DHA):** new agency that absorbs the functions of Tricare and takes over responsibility for common clinical and business processes across the military health system, effective October 1, 2013.
- **Initial Operating Capability (IOC):** by definition, IOC is a point in time where a system can meet the minimum operational capabilities for a user's stated need. For the DHA, IOC is meant to represent the official establishment of the DHA on October 1, 2013, at which time a limited number of functions and services will be available to its customers.
- **Full Operating Capability (FOC):** by definition, FOC is when a system is delivered to a user and they have the ability to fully employ and maintain it to meet an operational need. For the DHA, as time of publication of this document, FOC is October 1, 2015, at which time the organization will be able to employ and maintain a full set of functions and services to its customers.
- **Health IT Innovation and Advanced Technology Development (IATD) Division:** a division established under the DHA's HIT Directorate in October 1, 2013, which focuses on the strategy, management, and execution of its Health IT innovations, research, and long range technical architecture.

- **Health IT Innovation:** the process of rapidly collecting, assessing and, when appropriate, transitioning novel health information technologies to the DHA enterprise in a managed and transparent way. In this case, “novel health information technologies” are IT architectures, tools, prototypes, methods or devices containing or utilizing an IT component which is not currently in use within the DHA.
- **Health IT Research, Develop, Test, and Evaluation (RDT&E):** the systematic investigation, modification, and testing of early stage health information concepts or tools (generally resulting from the creation of new materials, methods, processes or theories by a third party) that will lead to the advancement of military health care. It does not involve the creation of products or services immediately available for consumption by the enterprise.
- **Innovation:** meant to refer to HIT-specific innovations.
- **IT-enabled health technologies:** for the purpose of this document, can refer to tools, architectures, prototypes, methods, or devices that contain or utilize an IT component.
- **Long Range Technical Architecture Team:** hereby refers to the staff within the DHA’s HIT Innovation and Advanced Technology Development Team under the guidance of the division chief and MHS Chief Technology Officer.
- **Pilots, projects and prototypes:** term used loosely to represent projects, programs, pilots, initiatives, ideas, etc. that run through the research process.
- **Research, Develop, Test, and Evaluation (RDT&E):** meant to refer to HIT-specific RDT&E activities.

1.5 Document Approval/Authority

Appendix I establishes this document as the overarching digital business transformation plan for the DHA, per the agency’s Chief Information Officer (CIO). This document is vital to the DHA’s HIT IATDD’s mission, which focuses on improving the strategy, management, and execution and transition of HIT Innovation, Advanced Technology Development, and Technical Architecture activities. Together these areas are helping drive HIT improvements that will help enhance the timely capture and exchange of health care data provided to our nation’s service members, their families and beneficiaries.

2 Setting the Stage

2.1 Identifying "Big Picture" Challenges

Established in 2013, the DHA was stood up to assume responsibility for select shared services, functions, and activities of the Military Health System (MHS) along with other common clinical and business processes. Initially ten shared services were identified and mapped: facilities, HIT, health plan, medical logistics, budget and resource management, contracting, education and training, pharmacy, public health, and research and development. For the purpose of this document, our focus falls within the newly established HIT shared service.

Today DHA HIT continues to face a number of critical challenges (see figure below) as it works to address its unique and evolving requirements. Currently driven by the need to improve clinical, business, and technical functionality within an environment founded on antiquated technology, the DHA must find the most optimal way to meet business and clinical needs, while remaining within its current constraints.

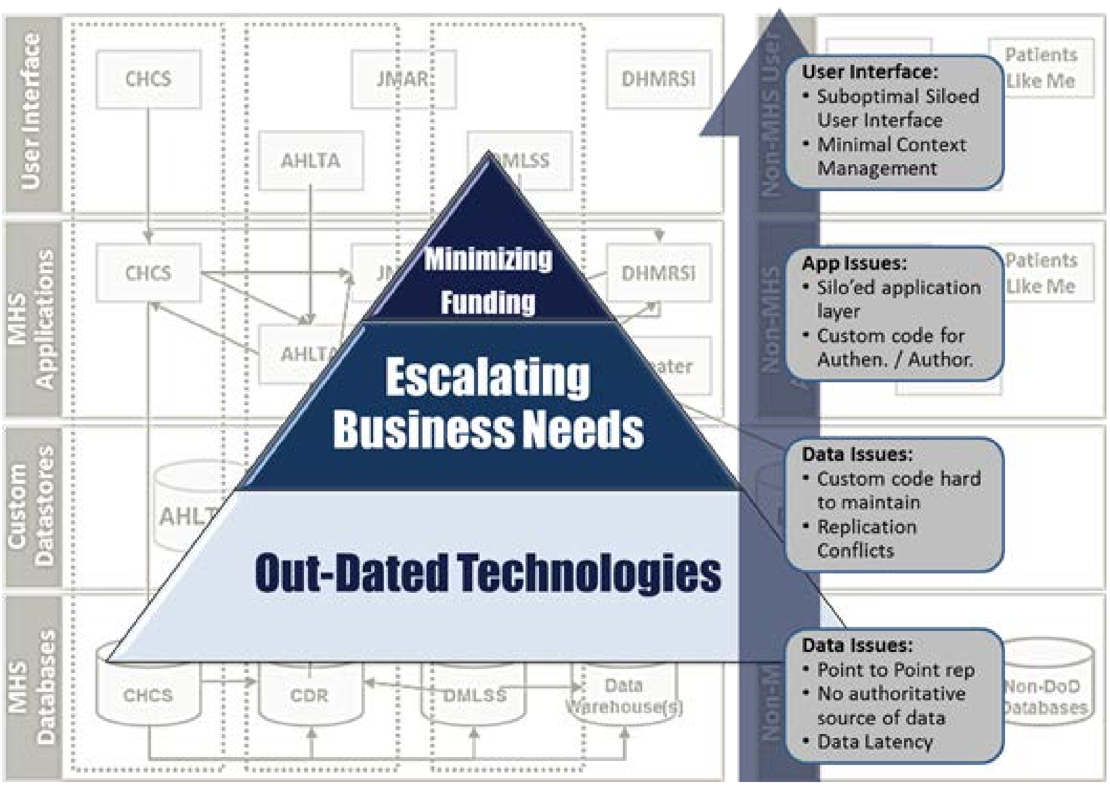

Figure 1: Aging DHA Technical Architecture Landscape

The current state of DHA HIT can be characterized as an environment that relies heavily on existing clinical and business applications, despite the fact that said applications are antiquated**,** unwieldy to sustain, and **built upon outdated technologies**. Developed beginning in the 1990's, DHA's portfolio of systems has been continuously upgraded with more storage, bandwidth, and hardware in order to be able to meet increasingly stringent business needs. Additionally, due to the need for data from a variety of primary and tertiary clinical and business systems, the DHA architecture landscape can be described as a veritable 'web' of thousands of expensive point-to-point interfaces between systems.

This aging foundation has also made it **difficult for existing systems to evolve to meet new functional/business needs and requirements**. As a result, individual systems were built to fulfill a particular need, whether it is intended for enterprise, Service-specific, or single-facility deployment. This practice is neither efficient nor effective when it comes to aiding in the modernization and consolidation of the new way forward for the military's electronic health record.

Furthermore, the nature of the **DHA's cost-constrained environment** significantly restrains the organization from upgrading the infrastructure and technology components that support existing applications and systems. Given the financial challenges associated with upgrading infrastructure, it has become even more difficult to use new, enhanced software. To compound the situation, the DHA has undertaken a massive reorganization, which includes consolidation of organizations, contracts, systems, and associated infrastructure. In its first year, this reorganization enabled the DHA to achieve cost savings and pay for initial investments in FY 2014, resulting in net savings of approximately $236 million. The MHS, driven by the functional requirement and need to modernize the foundational enterprise infrastructure, has initiated the acquisition of a new modernized clinical system, which more fully meets the needs and requirements of the functional community, despite all of the current organizational and architecture related challenges.

Today, each of these challenges contributes to the MHS enterprise's functional and technical focus areas such that new clinical and technical solutions can be researched and adopted, to the greater benefit of the organization. As we continue to move beyond the 1-3 year functional and technical outlook currently driving change, the MHS must not only consider current needs and context, but also goals and objectives which adapt to business delivery over time. Conversely, the MHS' LRTA intends to incorporate not only the more immediate needs of the organization, but also future-state objectives and policies which serve to define the future of MHS business delivery.

Based on these challenges, it is important that the DHA evaluate and leverage new and innovative technologies, ideas, tools, architectures, prototypes, methods, and solutions to enhance the MHS' patient and provider experience and ultimately, the quality of care provided to our more than 9.5 million beneficiaries. As the organization moves forward, and needs and technical abilities advance, it is critical to regularly review the requirements of the organization as well as the solution sets that could potentially reduce functional and technical issues.

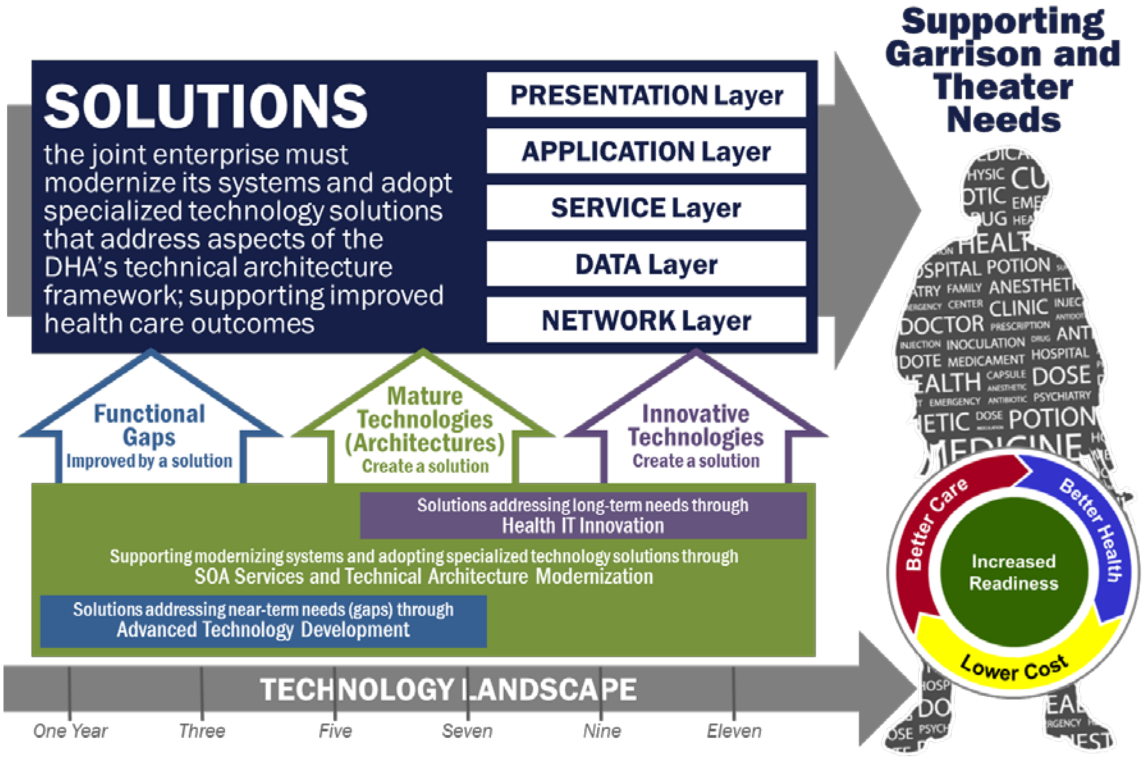

Figure 2: Developing Solutions that Span the Technology and Warfighter Landscape

From that perspective, this document intends to not only identify new technologies and associated architectures that the agency should look to invest in, but also highlight future-state focus areas based on prospective problem-sets and enterprise strategies.

2.2 Determining an Analysis Methodology

Given the need to quantifiably identify areas for future focus, the LRTA Team adopted a data-driven methodology to identify areas for investment and the technical architecture standards to support them. The challenge of determining a comprehensive set of technologies to invest in through the short (1-3 years) and long (7-10 years) terms requires a weighted mix of several key metrics, including: strategic goals, functional gaps, capabilities, requirements, business processes, and activities, all based on the time-frame under review. The DHA's investment lifecycle is also an important consideration due to the fact that it requires approximately four years of advanced planning. This timeframe typically includes one year of research, followed by three years of Program Objective Memorandum (POM) planning before a central investment decision can be made. Based on these planning considerations, the LRTA Team developed a meta model for the technology delivery process leveraging Semantic Open Source Software (SEMOSS), the DHA's open source analytics tool. A simplified version of this model, shown in the figure below, illustrates the most crucial components to be considered in developing and transitioning new and innovative technologies.

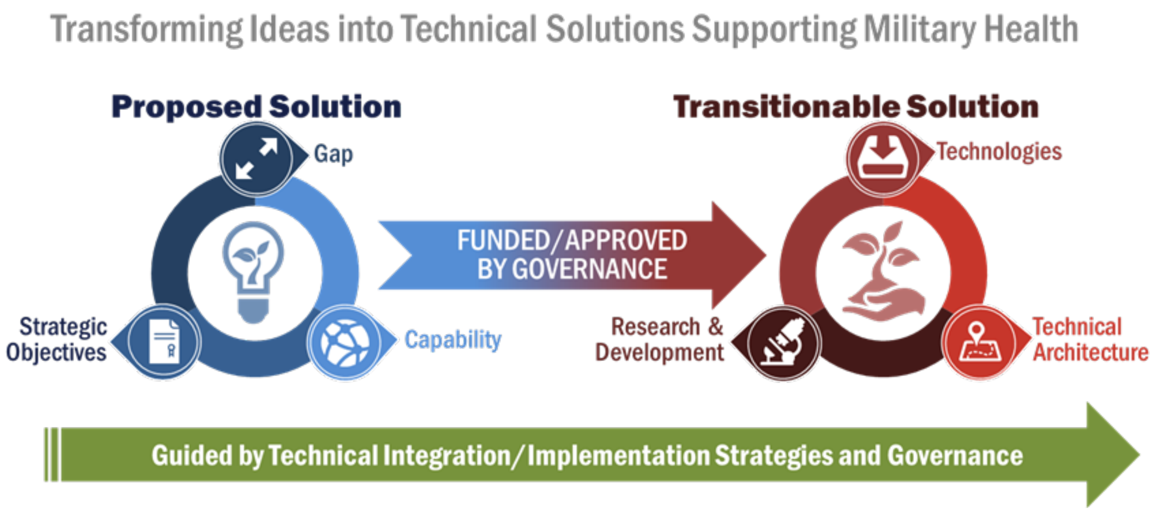

Figure 3: Transforming Ideas into Technical Solutions Supporting Military Health

Adopting this methodology leads to the identification of impactful proposed solution(s), which can come from a variety of sources, including MHS stakeholders, Industry, and Academia. Mapping the constantly changing set of technology solutions through this framework, leveraging the HIT Innovation Buckets as a conduit, develops a roadmap from need, to research effort, to transitioned solution that will have the most potential positive impact on a particular strategic goal (long-term) or functional gap (short-term). The HIT Innovation Buckets can be broken into four categories: cognitive analytics, mobile wars, cloud computing, and digital engagement, as seen in the figure below. These buckets were created through observation of both the current challenges inside the DHA enterprise and the future innovative technologies offered by the general marketplace.

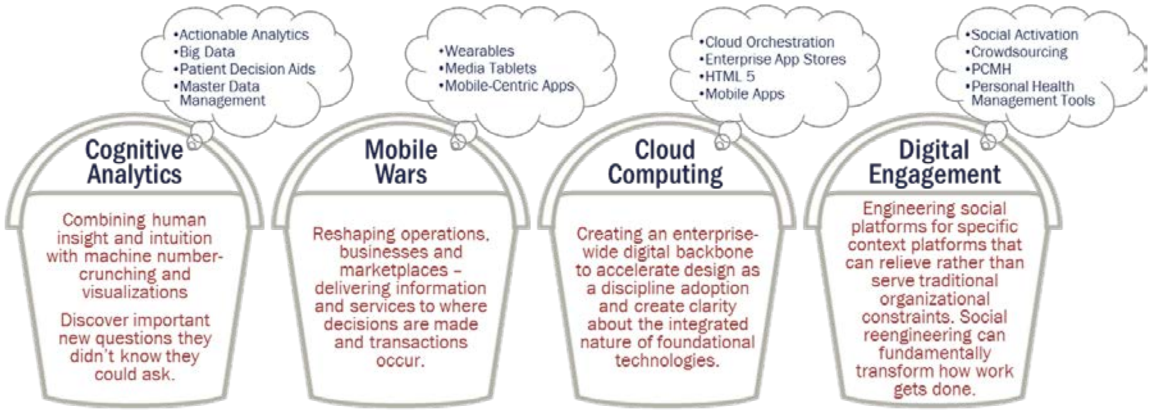

Figure 4: Health IT Innovation Buckets – Focus Areas

The LRTA team then further analyzed technology categories, beyond the scope of innovation, to yield nine areas of focus, seen in the table below. This table outlines the nine different technology buckets, demonstrating synergy and overlap between the groups. This table also describes how each bucket's technical capabilities translate to functional value, which is used in the mapping process and allows users to move from enterprise strategic goals to technical solutions transitively.

Table 2: Best Practice Technical Buckets - Focus Areas

Enterprise Technology Focus Area	Medical Use Case	Examples
IT Infrastructure and Operations	Creating and integrating new healthcare systems and treatment facilities	• Cloud Orchestration • Enterprise App Stores • HTML 5
Security Risk and Compliance	Securing patient data	• Identity Analytics • Security Intelligence
Information Management	Big data management required to collect all patient data and electronic health records effectively	• Actionable Analytics • Big Data • Patient Decision Aids • Master Data Management
Non-Conforming Innovations	3D Bioprinting for organ creation	• 3D printing of medical devices • Custom-made prosthetics

Tele-communication Services	Telemedicine and remote communication with Theater; Mobile applications and infrastructure	• Wearables • Media Tablets • Mobile-Centric Apps
Application Development	Migrating to enterprise wide machine-to-machine communication	• Digital Workplace • Internet of Things
Customer Intelligence and Experience Management	Measuring and improving level of care	• Social Activation • Crowdsourcing • Patient Center Medical Home • Personal Health Management Tools
Management and Organization	Hiring, training, and managing surgeons at each Medical Treatment Facility (MTF)	• Payment innovations • Human capital management software
Sourcing and Procurement	Properly identifying the necessary supplies based on patient condition; Multi-enterprise communication	• Enterprise Resource Planning systems • Business process outsourcing

Combining elements which model the enterprise current state, the MHS future objectives and the Enterprise Technology Focus Areas through an analytics driven methodology creates an end-to-end picture of the progression from enterprise gap to technical solution. This progression provides a means to conduct strategic planning that is specific to the needs of the MHS, while also considering the offerings of the current technology market. This framework, combined with the Semantic Open Source Software (SEMOSS) tool developed by the MHS, helps the agency identify new technologies to invest in as well as the associated technical architectures that are most beneficial to the enterprise. A high level progression through this methodology and the elements that compose it is shown in the figure below.

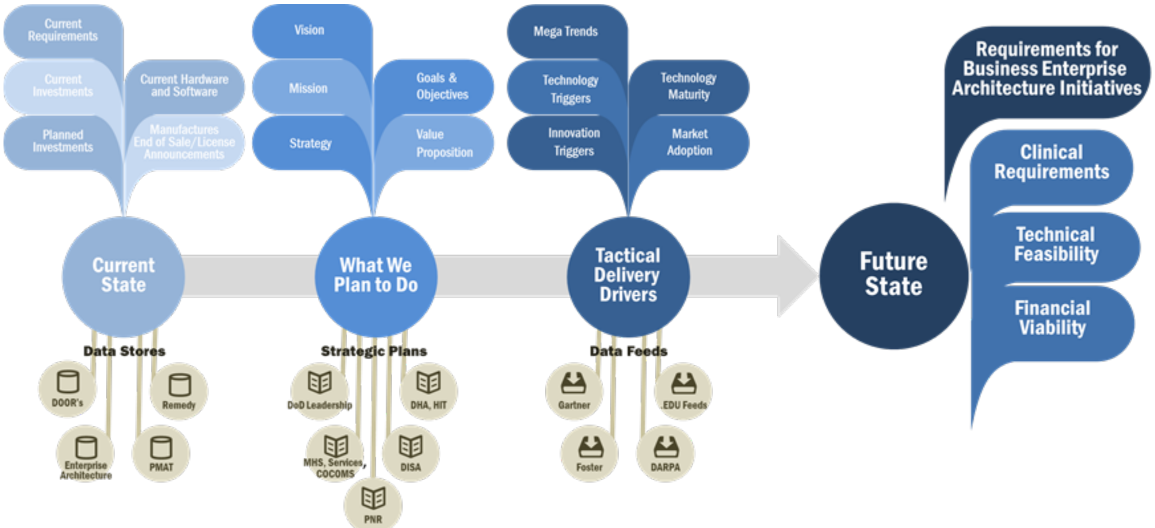

Figure 5: Simplified Technology Delivery Process Model

If we take a deeper look at the Technology Delivery Process Model, as seen in the detailed meta-model below, you can see how the framework concurrently addresses technical research and the programmatic activities required for integrating solutions into the enterprise. This framework, combined with the Semantic Open Source Software (SEMOSS) tool developed by the MHS, helps the agency identify new technologies to invest in as well as the associated technical architectures that are most beneficial to the enterprise.

The identification of new technologies for investment is performed through a steady decomposition of enterprise components, moving from the macro to the micro. First the strategic objectives are decomposed into the capabilities that are required to support them. These capabilities are then mapped to the broad technologies necessary to achieve them. At this point, the model addresses a commonly overlooked consideration, the programmatics of transitioning a technical initiative. Once a broad technical solution has been identified, and before any engineering work occurs, thought must be given to the strategy for implementation, the standards to which the solution complies and does not comply, and finally the Executing Division which will be responsible for transitioning the solution. These considerations will shape the remainder of the technical approach.

Once a proposed solution has been determined, it is necessary to further decompose the solution into the sub-technologies necessary to achieve a functional deliverable. These sub-technologies can have varying levels of maturity and it is important to give consideration to this mix. Finally, these sub-technologies are associated with specific technology buckets which align to the funding categories of the IATDD. Furthering this mapping, the sub-technologies are associated with on-going or proposed Research and Development (R&D)

efforts, allowing for an end-to-end perspective of how current R&D efforts are supporting the enterprise's strategic objectives.

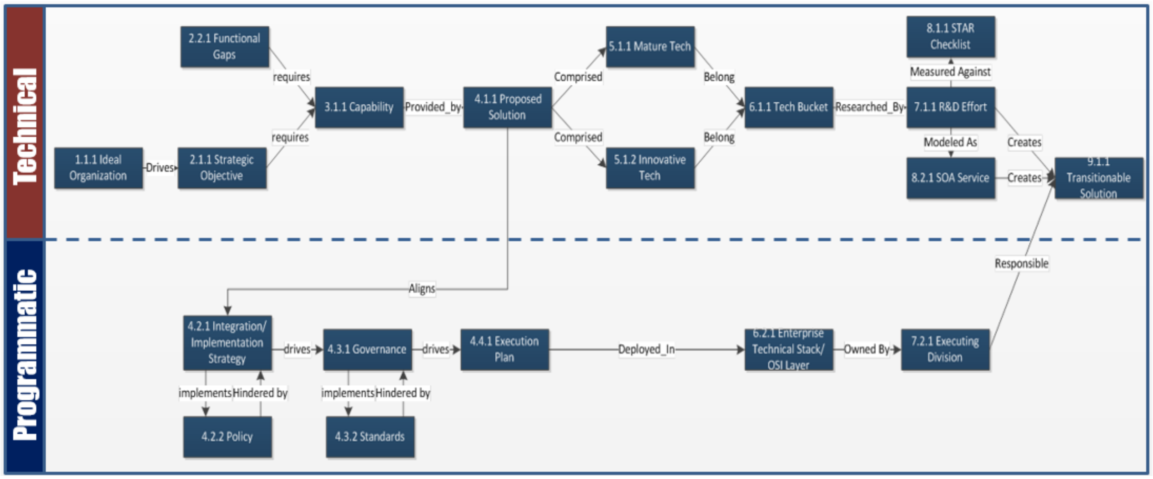

Figure 6: Detailed Technology Delivery Process Meta-Model

2.3 Plotting the Technical Architecture Landscape

Looking across the Technical Architecture Landscape picture below, it is clear that the foundation of the LRTA strategy roots itself in two sets of strategic objectives, shown on the far left. The first of these drivers is the Office of the National Coordinator (ONC) Federal Health IT Strategic Plan, for the years 2015-2020. This document focuses on widespread adoption of health IT, including new ways to disseminate knowledge quickly, securely, and efficiently, increasing the electronic collection and sharing of health information while protecting privacy, and creating an environment where interoperable information is used by health care providers, public health entities, researchers, and individuals to improve health, health care, and reduce costs. The second of these drivers is the DHA's Quadruple Aim, focused on improving integral factors that determine the overall quality of healthcare: population health, positive patient experience, and per capita cost. Finally, existing business process functional gaps, identified, validated and scored by the MHS CMIOs, drive our technical focus over the next 10 years.

The technical solutions that were scored highest as "most likely" to drive the strategy-driven future state, are shown across the remainder of the visualization. These solutions influences span from 2018 through 2024, with the next three years primarily dedicated to fulfilling current implementations and initiatives.

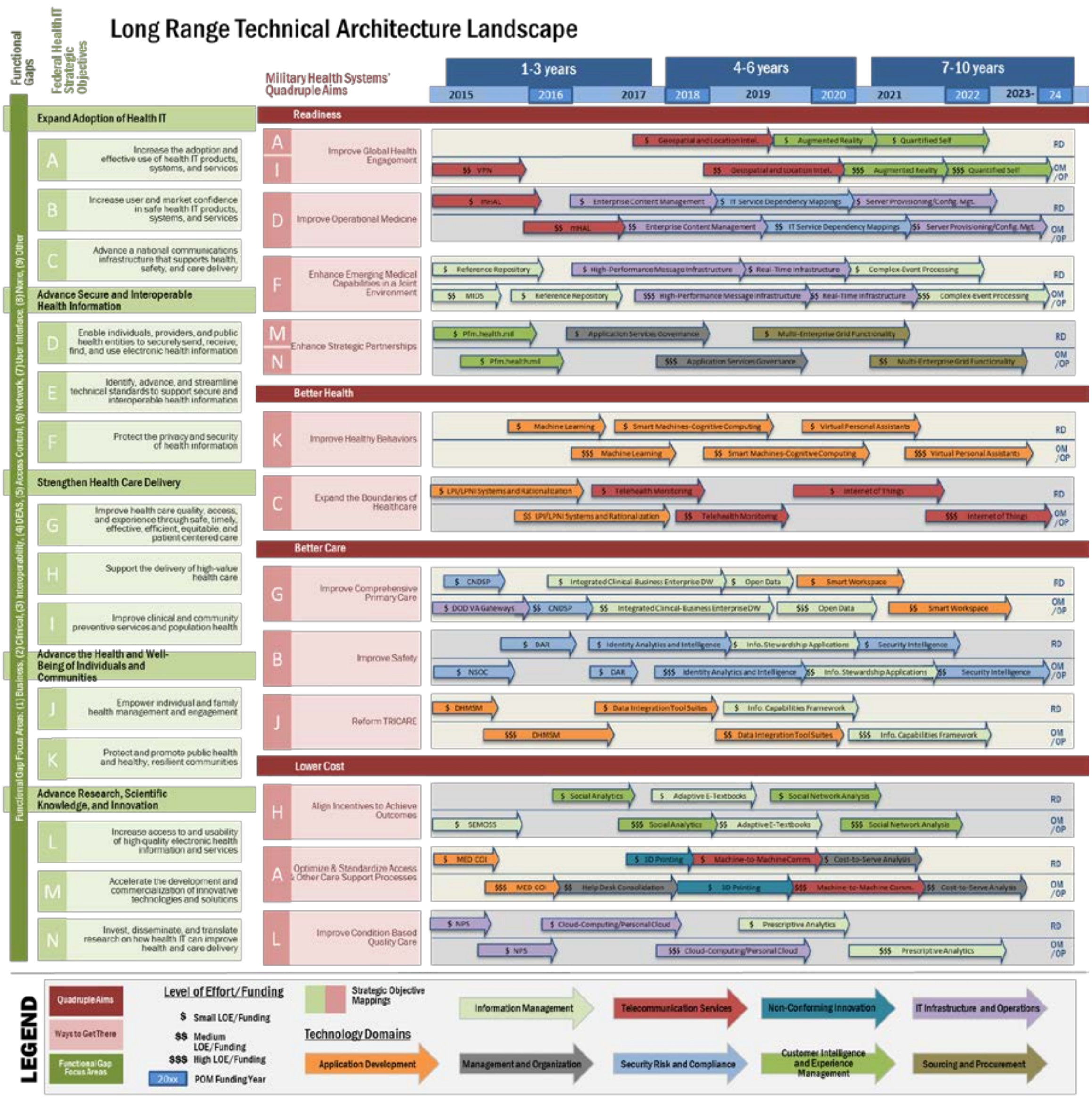

Figure 7: Long-Range Technical Architecture Landscape

Each system or technology is shown with an indicator for the estimated level of effort required for research, development, and sustainment. While it must be recognized that there are many factors, including programmatic dependencies, that may be difficult to predict or plan for, this visual is intended as a placeholder which can be leveraged as a starting point for IT evolution and planning. It is the intent of the DHA HIT to review each current state technical solution with enterprise solution owners, and validate a representative set of technologies from which to collectively evolve.

By planning for and methodically executing and measuring change, the DHA's architecture will evolve and modernize over the next 10 years. In the immediate future this means addressing the active requirements and functional gaps identified within the current business workflow. It also means preparing the DHA architecture to support or facilitate immediate enterprise priorities such as the Defense Healthcare Management Systems Modernization (DHMSM) electronic health record (EHR) implementation or the rationalization and consolidation of IT infrastructure and systems required by DoD leadership. In addition to assessing our architecture in terms of current needs and requirements, there is also a need to understand and plan for the ideal future.

2.4 Evolving the Ecosystem

Industry experts define our 10-year ‘future state’ architecture as a facilitator of interoperability on many levels, in order to enable better health care workflows, reduce ambiguity, and support seamless data transfer among EHR systems and health care stakeholders. Ultimately, an interoperable environment improves the delivery of health care by making the right data available at the right time to the right people. In order to achieve this goal, not only will the enterprise need to invest in new technologies, but it will also need to evolve the use of standards within four primary focus areas:

- How applications interact with users
- How systems communicate with each other
- How information is processed and managed
- How consumer devices integrate with other systems and applications

In order to achieve interoperability, and increased access to information and data, the current architecture needs to become more open and fluid. This means integrating individual data siloes, establishing data quality and data security at all phases of transition. Additionally, the DHA’s future focus must also consider applying stringent communication standards, and implementing successful data integration suites to support advanced analytics. All of these advancements are potential contributors to increased access to information and seamless interoperability with a wide range of stakeholders.

Figure 8: Evolving Ideal Future Ecosystem

As the enterprise continues to progress towards interoperability, the DHA's entire ecosystem will evolve. With a more central architecture, there will inherently be a more central organizational model. The image above captures this concept. The future vision for the enterprise puts the Warfighter at the absolute center of its mission and operations. Future technologies will enable this open structure, and drive more optimal interactions between its core components. Those components will consist of: Mission Partners; the Deployed Cloud, which will have more advanced theater support and communications; the newly developing Medical Campus, which will thrive off of advances like complex event processing, real-time two-way machine communications, and prescriptive analytics; the Personal Cloud, which will deliver masses of valuable data from sensors and self-tracking technologies; Commercial Providers; and most importantly, the Defense Health Enterprise Services themselves.

The DHA's complex ecosystem needs to be able to shift over time, and communicate more freely with internal and external partners, if it is to best serve both the Warfighter and the entire Joint Information Environment (JIE). It is important to realize while driving innovation that these milestones and implementations are in support of the MHS, DoD, and greater United States. In addition to using the methodologies described, the DHA must synchronize the development, installation, governance, and implementation of capabilities within the entire medical community, continuing to develop and promulgate MHS requirements and standards in the context of the JIE and its greater efforts.

2.5 Highlighting Key Considerations

It is clear through recently developed investment plans that transforming and modernizing antiquated systems is a current priority for the DHA. However, the DHA must also shift its focus farther forward, and start implementing these types of changes on a proactive basis. After all, renovating an infrastructure is far more complex and costly than maintaining and evolving a fluid one.

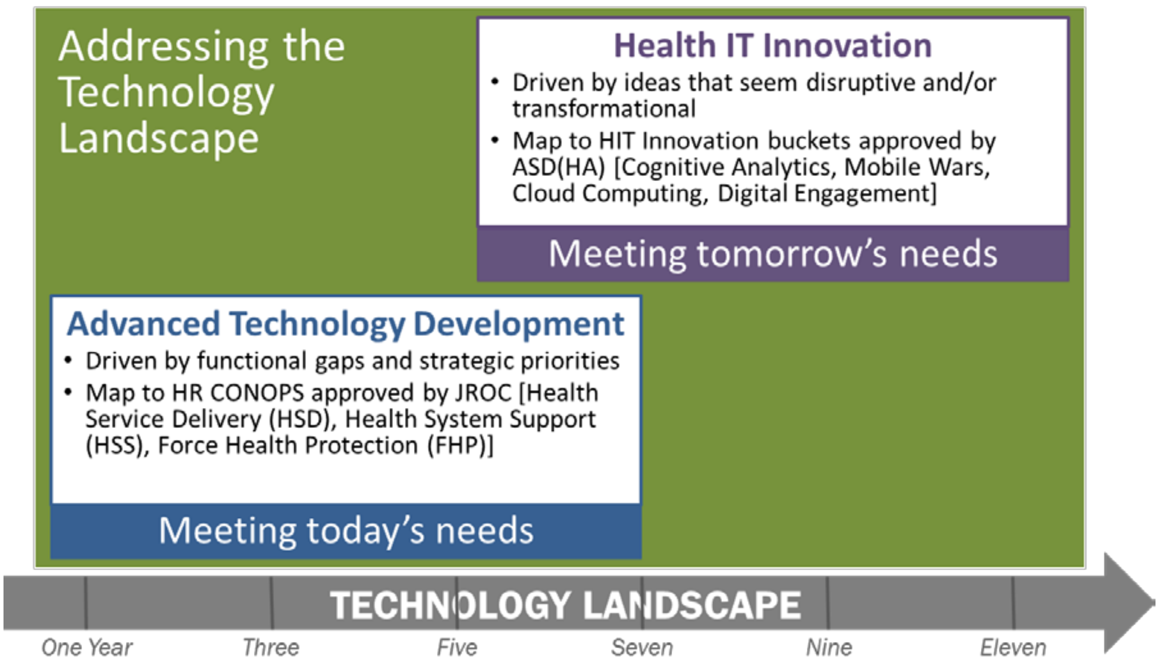

Figure 9: Addressing the Technology Landscape to Meet Evolving Needs

By using quantified analyses to predict the most strategic solution sets for implementation in the future, the DHA can address both immediate and long-term needs at the same time; ideally shifting the focus from reactive to proactive. This document uses current functional needs as near-term drivers, and connects them to emerging 'disruptive' solutions to create a more efficient model for long-term change. In this way, the MHS will be able to establish a technical backbone that better supports their evolving needs.

3 Technical Architecture: Current Problem Space

3.1 Overview

Today the DHA has a multitude of legacy healthcare systems and data stores that need to be modernized and integrated. This spectrum of systems, connected at different levels of the enterprise, has contributed to a complication of clinical care, which can be attributed to three causes:

- **A lack of adherence to the Single Source of Truth (SSOT) principal of IT design.** This has led to a time consuming and costly process to determine the true value of a system because of multiple sources or versions of the same data existing across the enterprise.
- **A lack of robust clinical requirements applied across the IT landscape.** This has led to multiple, duplicative systems, many of which have been implemented as individual solutions in stove-pipes without all stakeholders being made aware.
- **A lack of interoperability between DHA systems and external systems.** This has led to clinical complexities when storing, retrieving, and re-entering crucial clinical and medical data across systems.

The figure below illustrates the functional requirements that have revealed themselves as a result of these enterprise inefficiencies.

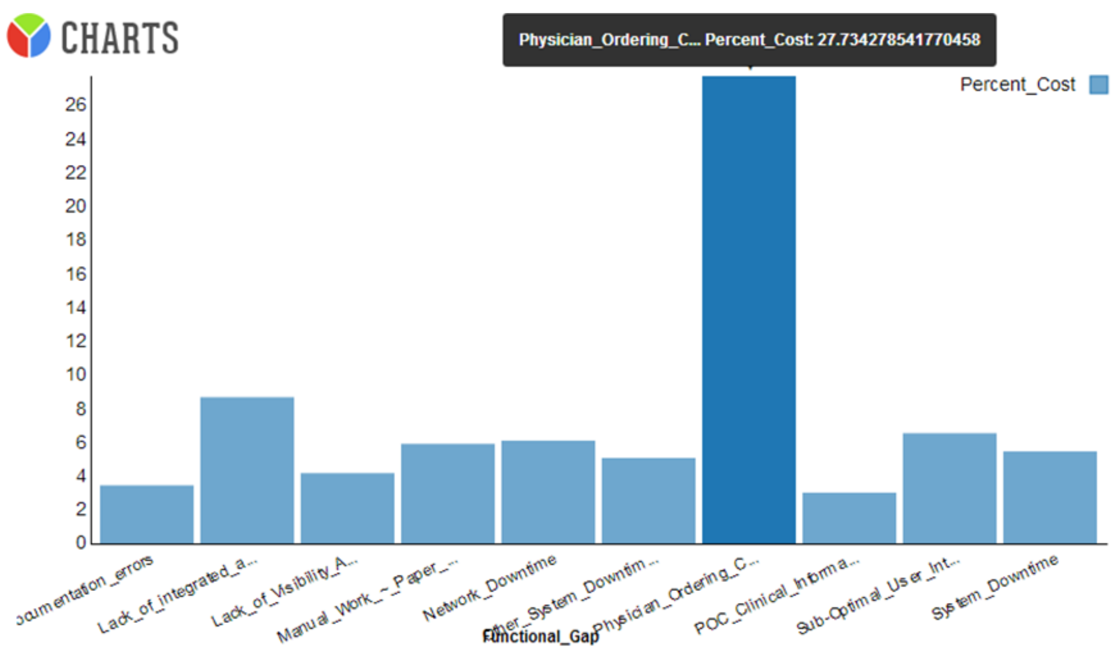

Figure 10: SEMOSS Visualization Illustrating Current Enterprise Functional Gaps

The process by which the future DHMSM Electronic Health Record is being selected and implemented focuses more on these functional requirements that are necessary to ensure high-quality healthcare delivery versus the technical requirements necessary to implement a theoretically sophisticated EHR. By leveraging a Commercial Off-The-Shelf (COTS) solution, the agency can reduce the IT complexities inherent in systems where technical design leads the strategic process. COTS systems are especially developed such that new functionality can be easily integrated rather than custom developed and integrated. In particular, areas of functional requirements have been identified and used as the basis for the EHR selection, based on capabilities outlined in the Health Readiness Concept of Operations (CONOPS) document, which further defines capabilities in Force Health Protection, Health Service Delivery, and Health System Support CONOPS.

Combined, these CONOPS outline more than 120 functional requirements for optimal military health. These focus areas for the new Electronic Health Record (EHR) are a necessary transition from the old train-of-thought, which involved thousands of technical requirements with no tangible translation to a more robust clinical requirement. This evolution from a clinical landscape to a functional-led acquisition and design better supports a module-based development. This thought process applies that of the agile development process, which says that any whole piece of software should be developed with a functional purpose in mind and is not complete until that functional goal is met.

3.2 Technical Problem Space

The DHA's technical landscape includes multiple systems for singular requirements, for instance:

- **An inability to complete some business workflows using only one system or log-in.** This has had a significant impact for some healthcare providers, in some cases requiring them to log-in to multiple systems, applications, or user interfaces in order to complete one or multiple business workflows.
- **An inability to realize improvements through the introduction of new software.** This has primarily resulted from unwieldy underlying technologies and increased storage and hardware capacity.
- **An inability to easily introduce new functionality to the user.** This has been difficult due to the existence of multiple point-to-point interfaces, making it difficult to introduce new functionality to the user or to upgrade an existing functionality with that of a new system.

In order for the DHA to contend with these technical roadblocks while ensuring a seamless integration of the new EHR, it is crucial that existing and new IT endeavors be valued from a functional perspective while ensuring adherence to a prescriptive technical architecture.

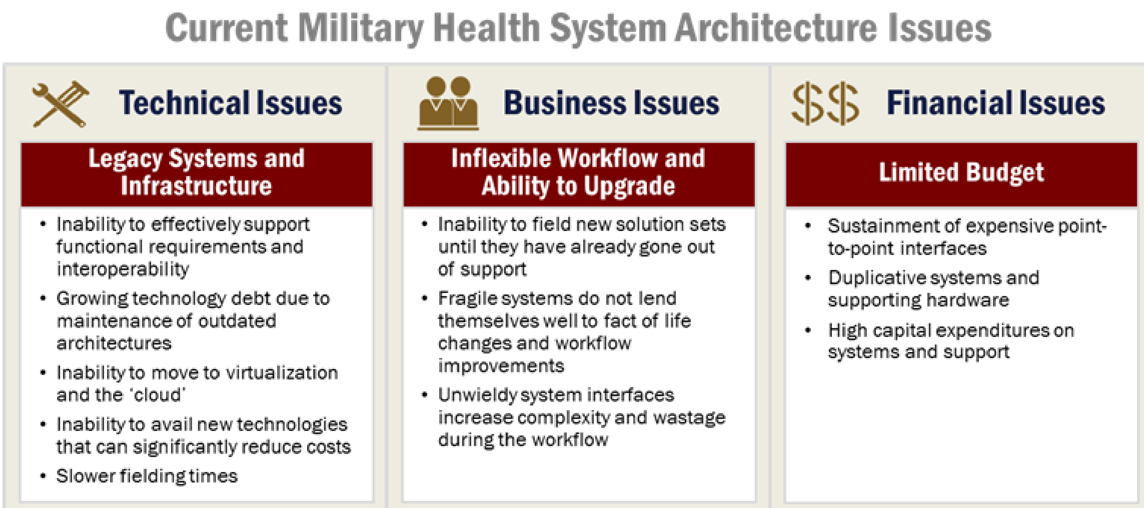

Figure 11: Current Military Health System Architecture Challenges

4 Technical Architecture: Near-Term Needs (1-3 Years)

4.1 Clinical Solution

The DHA has encountered data quality and usability issues over the past decade. The opportunities for more effective and efficient data analysis lie hidden between complex and disparate systems. To address this, the DHA plans to procure a new COTS-based EHR. This plan drives most changes in the clinical landscape over the next 3-years. The key requirements for the DHMSM strategic plan, according to the DHMSM Plan Indefinite Delivery Indefinite Quality (IDIQ) Performance Work Statement, are to centralize and align decision-making data within the DHA. These requirements stem from the need for increased data accessibility and integration as well as the need to simplify and better manage such a massive and complex system.

The future EHR will impact over 9.4 million MHS beneficiaries across the globe, in both brick-and-mortar and battlefield locations. These environments require a variety of data warehouse and governance procedures. Besides needing to communicate among this vast web of internal users, the DoD/MHS must also communicate with external users and partners, such as the Department of Veterans Affairs (VA), Federal, and private sector healthcare providers. Being able to collect and standardize current workflows for MHS users to adopt, where applicable, will reduce complexities associated with the interoperability requirements noted above. Additionally, DHMSM efforts will effectively integrate healthcare delivery and apply data standards for a better and more secure exchange of information between data users.

In order to ensure an optimal integration plan with no loss of functionality or negative impact to the provider and patient population, the DHMSM effort must anticipate and address a number of technical considerations.

4.2 Technical Solutions

Based on clinical and technical challenges, the DHA sought to adopt a flexible service-based EHR implementation approach that will enable real-time integration and the flexible reuse of system data objects across multiple business processes. The DoD’s Office of the Deputy Chief Management Officer (DCMO) “Business Enterprise Architecture (BEA) 9.0” document and the President’s Council of Advisors on Science and Technology (PCAST) report on HIT helped establish the architectural and interoperability drivers for the MHS’ four Enterprise Technical Architecture (ETA) documents, the MHS’ approved reference architecture which serves to address many of the technical challenges posed within the current environment, by layer. These documents cover:

- Enterprise Application Integration
- Common User Interface

- Data Federation
- Application Security and Access Management

The ETA documents were reviewed by technical subject matter experts from the DoD and VA under the Interagency Program Office (IPO) and subsequently by technical SMEs from the MHS and the Services under the MHS Enterprise Architecture Committee (EAC). The ETA documents were also submitted to the General Accountability Office (GAO) in 2013 as part of technical architectural submission related to integrated Electronic Health Record (iEHR) efforts.

The ETA documents provide the initial architectural blocks required to realize the integration of the next generation EHR. An architectural reference implementation, known as the Blueprint Realization, was also developed to serve as the basis for developing integration frameworks that showcase a working prototype of key technical use cases.

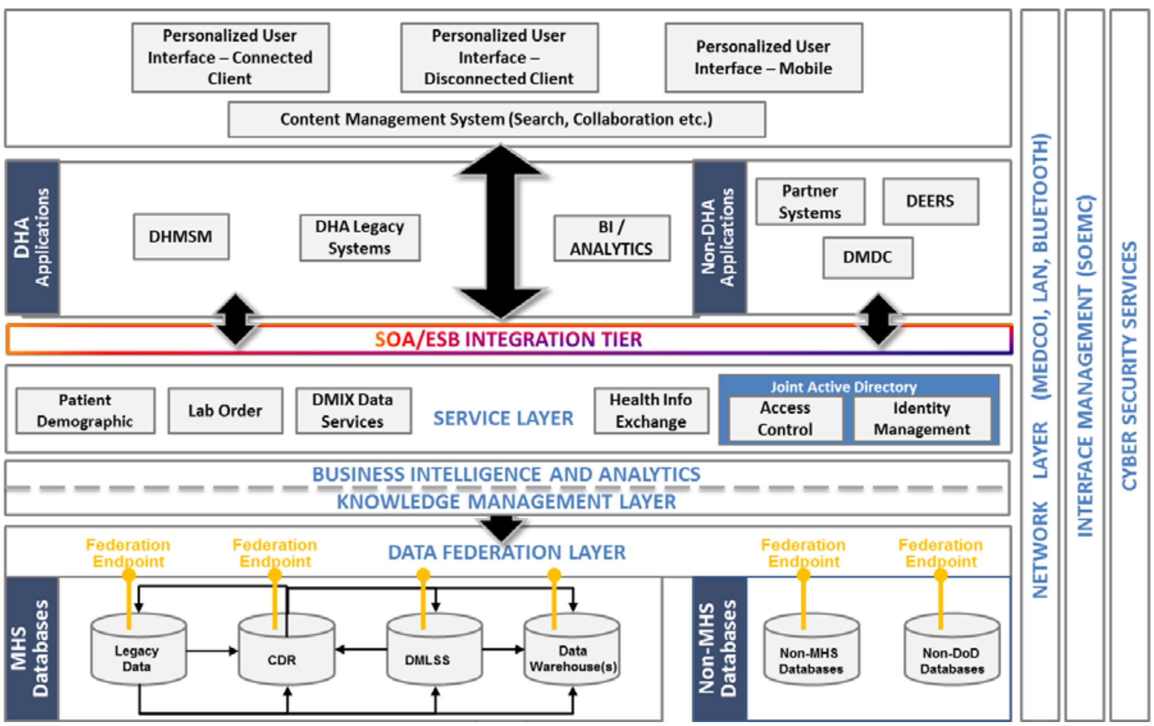

Figure 12: Integration of Enterprise Technical Architecture Model

The three main areas in which the legacy systems integration with each other and DHMSM must focus include:

- **Data Federation.** Provides a uniform, coherent, and integrated view of data that are distributed (in systems) and heterogeneous (in structure).
- **Integration.** Makes data from different systems available seamlessly though authorized functionalities.

- **Interoperability.** Allows different functionalities (in various systems) to seamlessly understand (operate upon) the same data.

Together these features serve as the foundational building blocks for the primary areas covered by the MHS' four ETA documents. Each piece of these architectures is documented within the ETA blueprints and has been demonstrated in order to prove feasibility.

4.3 Technical Architecture Standards Discussion

Over the course of the MHS' architecture evolution, technical standards must continue to advance, along with user requirements, such that new technologies can be adopted and adapted to a variety of day-to-day business processes. From this perspective, the MHS must continuously consider a common set of information, data, security, and technical standards for use in support of new capabilities and major upgrades for healthcare initiatives, which ultimately apply to enterprise-wide research and development.

As discussed, the MHS' ETA documents and associated blueprint realizations help accelerate the exchange of information between the MHS and its business partners using a standards and service-based paradigm. The four ETA documents provide blueprints for how these technical capabilities can be used in a future-state solution, system, or acquisition.

In addition to providing the foundational framework and standards for the MHS' service-based environment, the architecture's defined in the ETAs intend to:

- Support consolidation and modernization of enterprise infrastructure and leverage commoditized services for improved performance and lowered maintenance cost.
- Provide an intelligent and adaptive user interface in order to provide the users with the data they need and an adaptive, streamlined UI to enable them to do their job well.
- Provide interoperability by enabling systems to communicate with each other in a seamless fashion (physical and functional Interoperability), while maintaining the business context and meaning (semantic interoperability).
- Provide visibility of data so that assets are visible, accessible, and understandable.

An example of each of the technical architecture tiers and the technical standards applied to each layer is illustrated in the figure below.

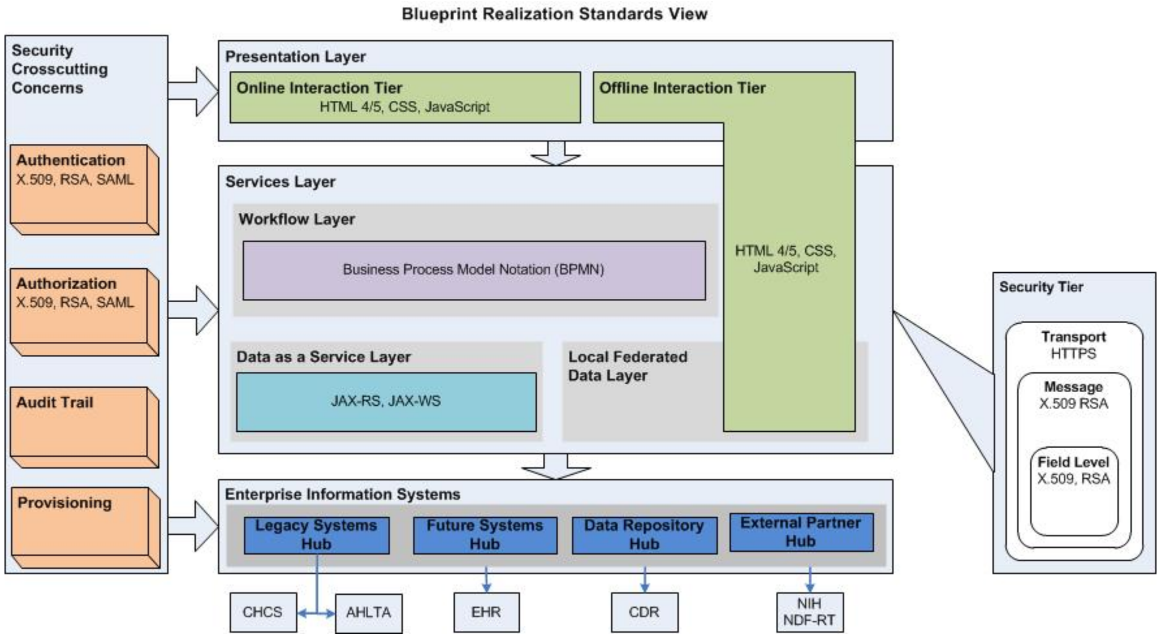

Figure 13: Blueprint Realization Standards View

As the ETA documents and associated architectures are applied to the 1-3 year immediate needs, they will need to regularly be evaluated with the advent of new functional requirements and the availability of new technologies. As a part of assessing current technology and architecture interoperability standards over the next 10 years, the DHA has developed a scoring mechanism that rates both provider (data generator) and consumer (data utilizer) on their ability to support various health interoperability content structure, technology, and coding standards based on the available system information in SEMOSS, the DHMSM acquisition plan, and the expected capabilities over the next number of years. Each rating for various standards is provided in 3, 5, and 10 year increments in order to address technical goals and prospective future needs over time. All current and future system development and research initiatives and projects have to refer to this document (Appendix III) for guidelines and must comply with the interoperability ratings outlined within it. The guidelines in Appendix III were developed in response to a tasker for use case ratings of Functional Advisory Council (FAC) endorsed DoD Interoperability standards. The IATDD team completed these ratings, which received approval by the 2015 DHA HIT Chief Information Officer (CIO).

4.4 Integration Needs

In the figure below, the interface analysis necessary to ensure continuity following the DHMSM implementation is depicted. Specifically, the systems with a low probability of being replaced by DHMSM, based on the data and business logic that they provide, are depicted. Due to the fact that these systems will not be replaced, they will need to communicate back and forth with the DHMSM system even after it reaches maturity. Essentially, they will need to be integrated into the new technical architecture. In order to integrate properly, they must adopt a service-based model in the next 1-3 years.

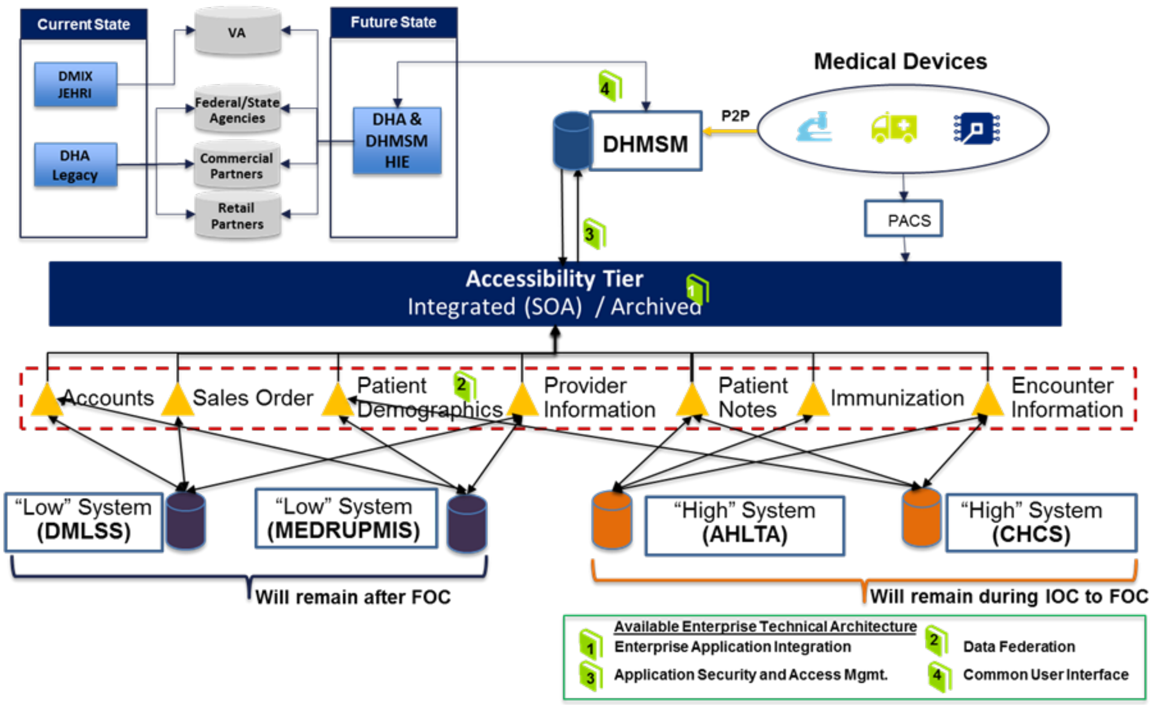

Figure 14: DHMSM Integration Representation

Low-probability systems will need to remain following the implementation of DHMSM as the DHMSM system will not produce data and business logic that each of the LPI systems produce. The process of applying this model to legacy systems includes analyzing existing environments, designing an executable solution architecture, and developing blueprint realizations. Within the analysis phase, a data dictionary and interface specifications document will be created. These will be supported by data collected, and designed to comply with necessary governance and standards policies, as well as development, strategic planning, and testing timelines.

Every major determination regarding these interface integrations needs to be reviewed and validated by the program offices of the systems whose interfaces they influence. This will ensure enterprise-wide support and technical alignment. Each activity owner will also be expected to update other DHA HIT Leadership on the progress of their activity on a periodic basis in order to ensure overall alignment and support across organizations in the enterprise.

4.5 Cross-Divisional Technical Prototypes and Pain Points

Considering the need for data federation, integration, and interoperability with the advent of DHMSM, there are a number of additional technical pain-points that must be addressed prior to or at the same time as the DHMSM implementation. In 2014, each of these pain-points were raised during the cross-divisional HIT Technical Working Group (TWG) and subsequently briefed to and accepted by the HIT Deputy Director as critical focus areas for pre-integration.

Based on the cross-organizational analysis and approach completed by the LRTA Team, it is recommended that the HIT research community plan for and pursue the areas surrounding these pain-points in support of the enterprise's needs in the next 1-3 years.

Table 3: Areas to Plan for and Pursue in Immediate Term

Issue	Description	Next Steps
Security at Rest and Transit	Securing data as it travels across the wire and data that is stored in the devices, databases, file systems etc. Focus on securing data rather than devices will enable MHS embrace democratization of data safely.	• Identify appropriate process, policies and tools for protecting data at rest • Identify appropriate process, policies and tools for protecting data in transit • Identify an appropriate Data Loss Prevention software solution • Analyze the requirements for each data object that needs to be protected. These data objects can be provided by a system and consumed by other systems • Design appropriate level of encryption for each type of data objects (rest and transit) • Consider data federation part of the strategy to implement security
Network Last Mile	Lower capacity, short distance conduits/plumbing that connects the MTF to the router/switch (Local Area Network – LAN for example) is typically not efficient in throughput compared to the high capacity long distance networking.	• Assess network infrastructure and estimate bandwidth requirements at local MTFs and inventory the applications/systems that are being actively used in those MTFs • Find how many of these systems will be replaced by new EHR Core and how many will still remain and need to be modernized • Consider higher bandwidth wireless or optical fiber technology from the communication backbone to the local users in MTF

Multimedia Storage Optimization	The biggest reason for Clinical Data Repository (CDR) bloat is the storage of multimedia data as Binary Large Objects (BLOBs) in an Relational Data Base Management Systems (RDBMS) Store, the multimedia files in Hadoop clusters (or other appropriate file storage based technologies), and the associated metadata in RDBMS.	• Assess multimedia information stored in CDR and Essentris – MHS Inpatient Solution • Formulate a data strategy and solution (using Hadoop – open source framework for distributed storage and processing for example) • Develop a prototype to extract multimedia files from Oracle tables to a data store • Develop a framework to provide read/write access to legacy applications
Natural Language Processing (NLP) to enhance Patient Record	Analyze the patient notes using NLP tools to capture doctor diagnosis, symptoms, treatment information and other relevant clinical data to develop an enhanced patient record.	• Identify NLP tools • Extract a sample set of patient notes data from RDBMS • Build a concept map for the patient notes using the NLP tool
ESB for Transformation & Mediation	Use an Enterprise Service Bus (ESB) solution (like MirthConnect) to expose MTF level data services.	• Finalize MHS Common Services list through appropriate governance processes • Develop data/business logic service prototypes for systems with “low” probability of replacement by DHMSM • Enable Service Oriented Architecture (SOA) constructs for legacy systems (systems not being replaced by EHR Core) integration with new DHMSM • Implementation can be controlled in increments/phases based on Integrated Management Schedule (IMS) • Micro ESB strategy/construct for Medical Devices

5 Technical Architecture: Mid-Term Needs (4-6 Years)

5.1 Overview

Over the next four to six years, the DHA and healthcare organizations will find themselves in the midst of a shift in the way that healthcare is administered and monitored. According to public, private, and academic industry research, patients will begin taking ownership of their healthcare, which will create a deep ripple effect across IT networks that enable the day-to-day activities of the DHA. The DHA network has traditionally been an internal network where all point-to point-interfaces are well-defined and governed, but the future DHA and DHMSM efforts will require an IT infrastructure to regularly communicate with external sources managed by patients.

This trend is also noticeable from the IT solutions presented below, which have been taken from industry research and then mapped to the enterprise through the Federal Health IT Strategic Objectives, the MHS Quadruple Aim and internal processes, functional gaps, and the Best Practice Technology Focus Areas established for the enterprise. Many of the technologies, all featured in the figure below, require or target a more open enterprise structure, and therefore the infrastructure itself needs to be more unified. This is reflected in the evolved view of the architecture presented below, which is clearly cross-divisional in nature.

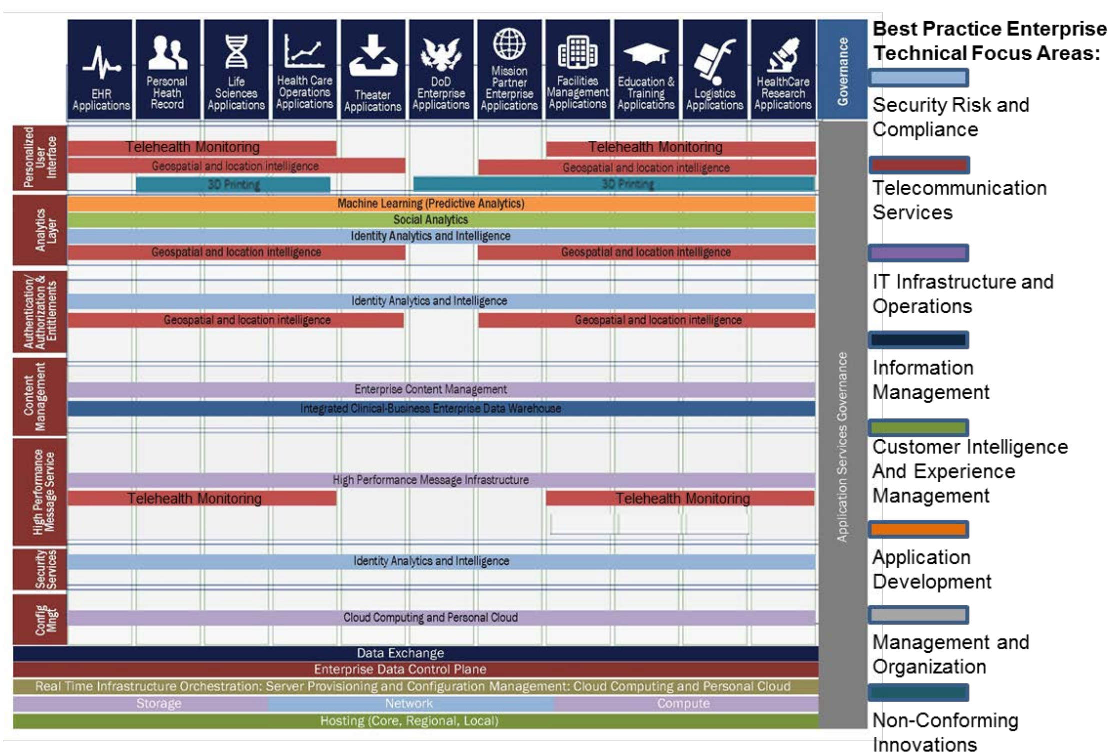

Figure 15: LRTA - 4-6 Year Future Architecture Landscape Roadmap

The data storage and exchange layers shown across the bottom of the figure represent the establishment of more effective data federation, and the ability for each service to communicate freely with others, as their data permits. There is a lack of separate data warehouse siloes now, which shows the shift to one central and shared data repository. Another important development is information security. Security becomes an overarching layer, with several new innovations in Security Risk and Compliance enhancing the enterprise's ability to apply cross-cutting and effective access and authorization management.

Referring to the descriptions of each technology below, and then identifying that technology in the figure above, provides a sense of the future landscape for the DHA. The technologies drive the functions, rather than conforming to a stiff and isolated infrastructure. This gradual migration will support the needs of more long-term implementations and requirements. Therefore, it is important to take a proactive approach towards the innovations presented, so that they can ease future transitions and increase the enterprise's ability to benefit from their long-term counterparts. Even standing alone, however, the top ten technologies proposed for the next 6 years address over 80 percent of the MHS' strategic objectives, and over 84 percent of the current enterprise functional gaps.

5.2 Technical Solutions Driving the MHS Quadruple Aim

The subsections below organize each technology in the figure previously above by the MHS Quadruple Aim component that it most strongly impacts, based on the analysis performed. Their individual descriptions provide the number of years until that technology is predicted to plateau, its general definition, Best Practice Technology Focus Area, and narrower Internal Process of the Quadruple Aim that it most impacts. A more in-depth description of each solution's benefits and implications is presented in Chapter 9.

5.2.1 Readiness

Enterprise Content Management (To Plateau in 3 Years): often a centrally managed repository of electronic documents in healthcare, bridging the gap between the administrative and business systems and clinical systems, such as EHR systems, used to store structured healthcare information. This technology is in the IT Infrastructure and Operations technology bucket and maps to the Improve Operational Medicine strategic objective.

Geospatial and Location Intelligence (To Plateau in 4 Years): includes applications, infrastructure and tools that enable access to and utilization of geospatial and location data for referenced information analysis and improvements and optimization of decisions and performance. This technology is in the Information Management technology bucket and maps to the Improve Global Health Engagement strategic objective.

High-Performance Message Infrastructure (To Plateau in 4 Years): consists of software or appliances that provide program-to-program communication with high quality of service, including assured delivery and security. This technology can support interoperability needs. This technology is in the IT Infrastructure and Operations technology bucket and maps to the Enhance Emerging Medical Capabilities in a Joint Environment strategic objective.

Application Services Governance (To Plateau in 4 Years): manages the life cycle of Service Oriented Architecture (SOA) services and Application Program Interface (APIs), and sets and enforces policies for their definition/design/usage by applications to create unification. This technology is in the Management and Organization technology bucket and maps to the Enhance Strategic Partnerships strategic objective.

5.2.2 Better Health

Machine Learning (To Plateau in 4 Years): allows software components to be synthesized from data without being explicitly programmed. Eventually, the machine can make predictions or decisions about data, which is valuable for data processing. This technology is in the Application Development technology bucket and maps to the Improve Healthy Behaviors strategic objective.

Mobile Health (Telehealth) Monitoring (To Plateau in 5 Years): is end-user targeted, information and communication technologies that use embedded processing and sensor technologies in wearable and/or mobile devices. The benefit is patient data that can be collected and sent to providers from any place and time. This technology is in the Telecommunications Services technology bucket and maps to the Expand the Boundaries of Healthcare strategic objective.

5.2.3 Better Care

Integrated Clinical-Business Enterprise Data Warehouse (To Plateau in 6 Years): enables large communities of users to develop/receive reports and dashboards/queries, and to perform data discovery around core patient care and business processes and outcomes.

Identity Analytics and Intelligence (To Plateau in 5-7 Years): encompasses a variety of technologies used for collecting, correlating, analyzing and reporting from identity, entitlement, activity and event data. Combined with other disciplines, including security engineering, the multiple controls facilitated by this technology provide an opportunity to proactively address security. This technology is in the Security Risk and Compliance technology bucket and maps to the Improve Safety strategic objective.

5.2.4 Lower Cost

Social Analytics (To Plateau in 4 Years): Social analytics is an umbrella term that includes a number of specialized analysis techniques. Social analytics is used to track and predict trends based off of social media data. This technology is in the Customer Intelligence and Experience Management technology bucket and maps to the Align Incentives to Achieve Objectives strategic objective.

Cloud-Computing and Personal Cloud (To Plateau in 4 Years): Cloud computing is a style of computing in which scalable and elastic IT-enabled capabilities are delivered as a service using Internet technologies. This will allow for gathering of information about consumers to provide customized access to care. This technology is in the IT Infrastructure and Operations technology bucket and maps to the Improve Condition-Based Quality Care strategic objective.

3-Dimensional Printing (Bioprinting and Medical Devices) (To Plateau in 4-9 Years): 3D printing or additive manufacturing is the process of building custom three-dimensional objects from digital models. While there are many uses of 3D printing, the two most relevant uses for the DHA are medical device 3D printing and 3D bioprinting systems. These technologies are in the Non-Conforming Innovations technology bucket and map to the Optimize and Standardize Access and Other Support Processes strategic objective.

6 Technical Architecture: Long-Term Needs (7-10 Years)

6.1 Overview

This analysis reveals the technical solutions with the most strategic impact on the DHA's long-term (7-10 years) future-state. Each technology has been analyzed using public, private, and academic data for user benefit, technological maturity, user adoption, and level of effort, to realistically account for the necessary resources and changing environment of healthcare delivery as it relates to the enterprise over the next ten years.

The top 23 technologies presented in this section would address 90 percent of the current enterprise functional gaps. Referring to each technology's description and then examining its place in the architecture presented in the figure below, makes it clear that the technologies continue to drive the long-term infrastructure and operations. In fact, they become the primary forms of communication and data intake from DHA patients.

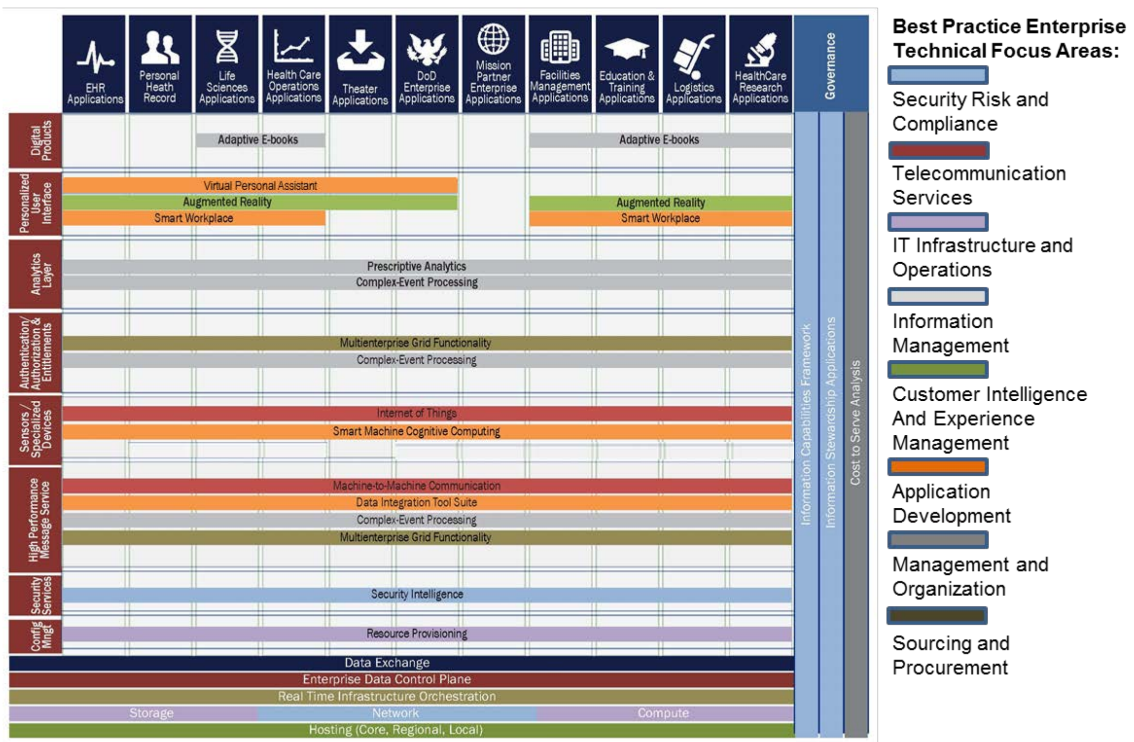

Figure 16: LRTA - 7-10 Year Future Architecture Landscape Roadmap

All of these solutions and their relation to one another foster more effective and efficient data use. The shift from internal data creation to external data intake will provide both healthcare providers and beneficiaries with a significant increase in data knowledge and control. Medicine will become more individualized, but the systems holding the data will become more open and flexible. Apply to that the advanced analytics enabled by emerging machine capabilities, and the power to decipher the cause and effect of any condition or treatment becomes very accessible. Additionally, with more powerful logistical analysis, the ability to track and identify the highest quality vendors in the most efficient manner will eliminate excess waste from across the enterprise; it will also heighten the synergy currently realized from the DHA's relationship with its mission and other internal partners.

6.2 Technical Solutions Driving MHS Quadruple Aim

This section organizes the proposed technologies, featured in the landscape roadmap figure above, in the same format as the previous section; by the MHS Quadruple Aim component that they most strongly impact. Their individual descriptions once again provide the number of years until they are predicted to mature, their general definitions, Best Practice Technology Focus Areas, and the narrower Quadruple Aim Internal Processes that they most impact. More in-depth descriptions of the solutions' and their benefits and implications are presented in Chapter 8.

6.2.1 Readiness

Augmented Reality (To Plateau in 7 Years): real-time use of information in the form of text, graphics, audio and other virtual enhancements integrated with real-world objects and presented using a heads-up display-type display or projected graphics overlays. AR aims to enhance users' interaction with the environment. This technology is in the Customer Intelligence and Experience Management technology bucket and maps to the Improve Global Health Engagement strategic objective.

IT Service Dependency Mappings (To Plateau in 7 Years): discovers, documents and tracks relationships by leveraging blueprints or templates to map dependencies among infrastructure components and applications in physical, virtual and cloud environments to form an IT service view. This technology can help with the maintenance of an accurate and up-to-date view of IT infrastructure. This technology is in the Security Risk and Compliance technology bucket and maps to the Improve Operational Medicine strategic objective.

Server Provisioning and Configuration Management (To Plateau in 7 Years): subset of the larger server automation category. These tools manage the software configuration life cycle for physical and virtual servers. The main functions include: provisioning, application provisioning and configuration (binaries), patching, inventory and configuration compliance. This technology is in the IT Infrastructure and Operations technology bucket and maps to the Improve Operational Medicine strategic objective.

Real Time Infrastructure (To Plateau in 7 Years): a shared IT infrastructure in which business policies and SLAs drive the dynamic allocation and optimization of IT resources. Real Time Infrastructure provides the elasticity, functionality, and dynamic optimization and tuning of the runtime environment based on policies and priorities across private, public and hybrid cloud architectures. This technology is in the IT Infrastructure and Operations technology bucket and maps to the Enhance Emerging Medical Capabilities in a Joint Environment strategic objective.

Complex-Event Processing (To Plateau in 8 Years): a computing technique in which incoming data about what is happening (event data) is processed as it arrives to generate higher-level, more-useful, summary information (complex events). Complex events represent patterns in the data, and may signify threats or opportunities that require a response from the business. This technology is in the Information Management technology bucket and maps to the Enhance Emerging Medical Capabilities in a Joint Environment strategic objective.

Multi-Enterprise Grid Functionality (To Plateau in 9 Years): unique set of capabilities that emerge when a community of buyers and suppliers aggregate and share data. Provides the ability to analyze producers in real-time generating preemptive warnings about possible shortage or price hikes. This technology is in the Sourcing and Procurement technology bucket and maps to the Enhance Strategic Partnerships strategic objective.

Quantified Self (To Plateau in 9.5 Years): promotes the use of self-monitoring through a wide variety of sensors and devices. This allows for the recording and consolidating of patients' daily activities and conditions, leading to advanced prescriptive analytics. This technology is in the Telecommunication Services technology bucket and maps to the Improve Global Health Engagement strategic objective.

6.2.2 Better Health

Internet of Things (To Plateau in 9 Years): refers to a phenomena where digital devices and sensors collect information from their environment, enabling data collection points to be interconnected through the network. This allows for large volumes of data to be collected in real-time and responses to be sent back to the different devices and providing endless opportunities for data analytics and decision making. This technology is in the Telecommunication Services technology bucket and maps to the Expand the Boundaries of Healthcare strategic objective.

Smart-Machines and Cognitive Computing (To Plateau in 10 Years): ability of a computer to take on human-like characteristics in its analysis of data. Smart machines allow for strategically driving individual health behaviors, through an increased focus on self-health. This technology is in the Application Development technology bucket and maps to the Improve Healthy Behaviors strategic objective.

Virtual Personal Assistants (To Plateau in 10 Years): observes its user's behavior, and builds and maintains data models, with which it draws inferences about people, content and contexts to predict user behaviors and needs, build trust and, eventually, with permission, act autonomously on its user's behalf. This technology is in the Application Development technology bucket and maps to the Improve Healthy Behaviors strategic objective.

6.2.3 Better Care

Data Integration Tool Suites (To Plateau in 7 Years): allows for convergence in data integration technology submarkets as vendors organically extend their capabilities by adding other data integration styles and as larger vendors acquire technology to address the range of capabilities. This technology is in the IT Infrastructure and Operations bucket and maps to the Reform Tricare strategic objective.

Information Stewardship Applications (ISA) (To Plateau in 8 Years): the process of monitoring, controlling, analyzing and enforcing the implementation of approved information governance policies and standards across applicable business areas and processes. These developing solutions represent and organize information in such a way that business users can use them efficiently. This technology is in the Information Management technology bucket and maps to the Improve Safety strategic objective.

Open Data (To Plateau in 9 Years): data that is made freely available, without discrimination, by individuals, businesses or government organizations for others to use, combine and redistribute as they wish without strict intellectual property restrictions. Open data technology will allow for the usage of open data sources and streams to launch new products, services and businesses models. This technology is in the Information Management technology bucket and maps to the Improve Comprehensive Primary Care strategic objective.

Information Capabilities Framework (To Plateau in 9 Years): a conceptual model that describes the set of information management technology capabilities needed to define, organize, integrate, share and govern an organization's information assets in an application-independent manner to support its enterprise information management goals. This technology is in the Information Management bucket and maps to the Reform Tricare strategic objective.

Security Intelligence (To Plateau in 10 Years): a set of concepts and methods that enables the interaction of various security technologies, as well as analysis of integrated and correlated security and contextual information to improve the protection of assets against attacks and enhancing security and risk management efforts. This technology is in the Security Risk and Compliance technology bucket and maps to the Improve Safety strategic objective.

Smart Workspace (To Plateau in 10 Years): enables embedded programmability to the physical work environment that surrounds employees, such as meeting rooms, cubicles, in-building open spaces, home offices or mobile settings, whether they are physically and/or virtually together. This technology is in the Application Development technology bucket and maps to the Improve Comprehensive Primary Care strategic objective.

6.2.4 Lower Cost

Machine-to-Machine Communications (To Plateau in 7 Years): encompasses integrated and managed infrastructure, application and IT services to enable enterprises to connect, monitor and control business assets and related processes over a fixed or mobile connection. Machine-to-Machine solutions can greatly impact the success of almost all operational technologies and dramatically improve the efficiency of device management. This technology is in the Telecommunications Services technology bucket and maps to the Optimize and Standardize Access and Other Care Support Processes strategic objective.

Cost-to-Serve Analysis (To Plateau in 8 Years): analyzes end-to-end supply chain costs and their relationship to services provided internally and to customers. Cost-to-Serve Analysis provides fact-based insight into the "real" costs of supporting varying supply chain complexity levels for different customers, products and routes to markets. This technology is in the Management and Organization technology bucket and maps to the Optimize and Standardize Access and Other Care Support Processes strategic objective.

Adaptive E-Textbooks (To Plateau in 8 Years): personalizes the learning process in higher education, offering customization through digital content based on individual and aggregate achievement data plotted against a learning map. The benefit of an adaptive e-textbook is that it utilizes personnel data to create a personalized lesson plan for effective learning and training. This technology is in the Adaptive E-Textbooks technology bucket and maps to the Align Incentives to Achieve Objectives strategic objective.

Social Network Analysis (To Plateau in 8 Years): analyzes patterns of relationships among people. SNA involves collecting data from multiple sources, analyzing the data to identify relationships, producing graphic visualizations and then mining it for new information. This technology is in the Customer Intelligence and Experience Management technology bucket and maps to the Align Incentives to Achieve Objectives strategic objective.

Prescriptive Analytics (To Plateau in 9 Years): describes a set of analytical capabilities that specify a preferred course of action. Prescriptive analytics tools can consume information about in-facility care episodes coupled with telehealth data and research information to recommend the most effective treatment plans. This technology is in the Information Management technology bucket and maps to the Improve Condition-Based Quality Care strategic objective.

7 Way Ahead

7.1 Timeline of Acceptance

The DHA must plan carefully for the implementation of various technologies over the next 10 years. Based on conducted analysis, investments must be planned a minimum of four years prior to central portfolio implementation. Additional factors that must be considered include DoD policy and changing strategic focus areas.

It is the intent of the DHA HIT to review each current state technical solution with enterprise solution owners, and validate a representative set of technologies from which to collectively evolve. In order to plan for the organization’s technical evolution, the LRTA team will work with program owners to plan for technology evolution, which begins with a robust R&D effort. Working hand in hand with the program offices and enterprise stakeholders, the IATDD with validate findings and enable an Open Innovation process where new ideas and technologies can be more easily diffused into the military health IT ecosystem.

In support of each of the future state technical evaluation areas, the DHA will support enterprise stakeholders by identifying and establishing testing labs, vehicles and agreements with a wide variety of commercial and Federal partners in order to leverage research and provide methods to develop and test new solutions. In addition to established relationships and associated resources, the IATDD will utilize a systematic approach to identify and manage incoming ideas. Campaigns and Broad Agency Announcements (BAA) will serve as tools for ideation generation, as well as solution generating mechanisms.

7.2 Opportunities for Improvement

The solutions outlined in this document pose countless opportunities for future growth for the enterprise. However, they also bring to bear potential issues that must be addressed in order to successfully implement recommended solutions. In some cases, these issues are owned by others within the enterprise and/or are external factors that must be dealt with. In these situations, the DHA will have to plan accordingly in order to avoid issues and mitigate/transfer risks to other parties, as illustrated in the figure below.

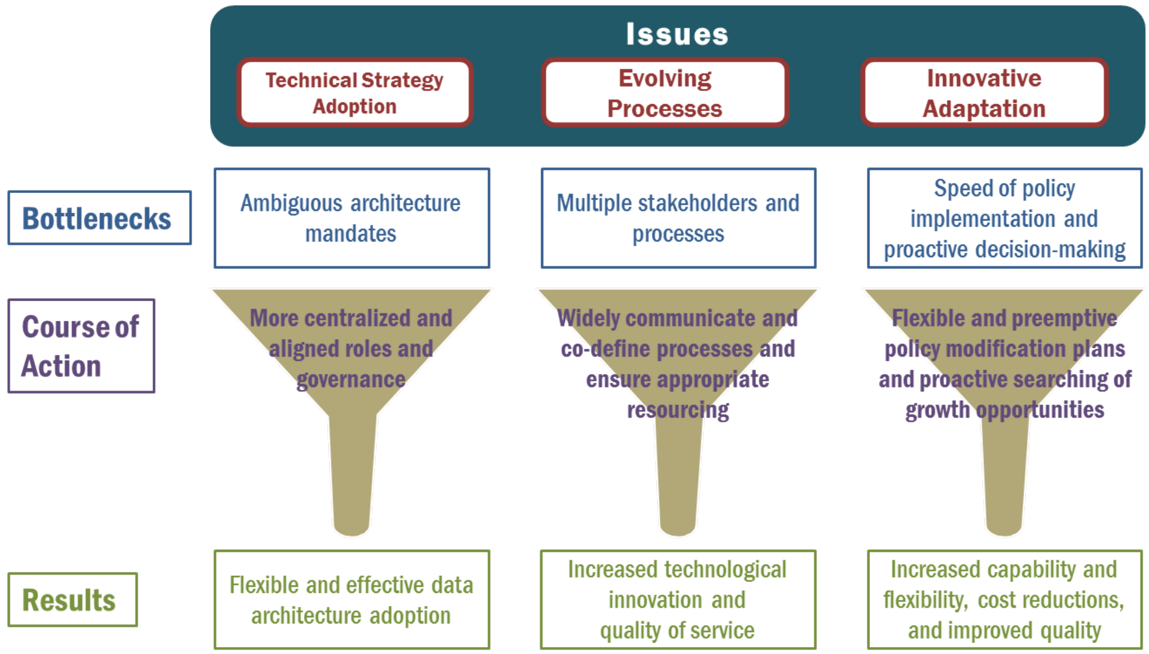

Figure 17: Risk Mitigation Strategy for Implementation

The first issue that needs to be addressed is the lack of forward movement with regards to the strategic adoption of the DHA's Technical Architecture. Once completed, it is currently difficult to ensure adoption and implementation of technical architecture given the ambiguity of responsibilities within the organization and lack of centralized technical governance. This leads to inefficient and ambiguous decision-making, outdated data architecture and a lack of support for new and improving technologies. Establishing clear lines of organizational authority for strategic technical architecture within the enterprise along with a central governance board for technical management would help to alleviate this issue.

Another issue that needs to be addressed is program funding and the process by which funding is put in place, a project is developed, and the acquisition is executed. As addressed earlier, the POM cycle requires significant pre-planning in order to obtain the funds for the initiative at the appropriate time. The acquisition and program timelines all require significant interdependencies between aspects of the organization and a coordinated cross-organizational process. Many of these concerns are intended to be addressed through the IATD's Innovation Lifecycle Development Process, which focuses on creating process efficiencies between organizations such that new technical investments move forward without being delayed by organizational process needs and stakeholders. While the intentions for the process are good, they cannot sufficiently be supported without participation from the rest of the organization and/or availability of the appropriate resources within the organization.

Finally, the lack of proactive adaptation throughout the enterprise hinders overall innovation and performance. This occurs in two main ways. First, the speed that the larger DoD and DHA progresses its policies to accommodate the growth of technical solutions should be more proactive. This is an issue that could easily be managed through more flexible and preemptive policy modification plans. Second, the inability to proactively determine which technologies to invest in unnecessarily limits the advancement of solutions. Future growth opportunities should be actively searched for and analyzed in order to maintain and improve the DHA's technological maturity, and allow for more cost-worthy and painless strategies. Analytics can help to mitigate this risk, if used properly in a more preemptive and aggressive mode. Both issues, if improved, lead to increased capability and flexibility, providing cost reductions and quality improvements across all sectors.

7.3 Conclusion

By taking a disciplined and futuristic approach to the investigation, evaluation, and incorporation of new LRTAs, the DHA will be able to realign sustainment costs to focus on new investments and improvements through more efficient and value-driven technologies. This more centralized focus will impact the enterprise in a broad and profound way by allowing transformational innovations to touch the entire range of business processes. The results of the progressive strategies described in this document will amplify the value of the DHA's HIT portfolio significantly by allowing the agency to identify and realize solutions that demonstrate immediate value based on their ability to radically improve provider and patient experiences and drive enterprise capabilities.

The DHA will also be better suited to support new architectures and solution sets through using data-driven analyses, and will be better equipped to select successful research and development projects that improve operational experiences in the future. A fluid architecture will increase flexibility and sustainability, and despite inevitable constraints, the DHA's current technical foundation is supportive of the interoperability and technological advancement necessary to achieve an ideal state in the long-term. While the proposed recommendations are dynamic and dependent on a changing environment, the methodologies supporting them will transform the DHA into a highly proactive and impactful enterprise.

8 Additional Information: In-Depth Technical Solutions

Sections 4-7 presented a high-level view of the proposed technologies and their impacts to the enterprise over the next ten years as a result of the functional and technical analysis described in Section 3. This section provides the same results, but at a much more detailed level. The technologies are more carefully defined, their impacts on the organization's strategic objectives are clearly articulated, and their unique architectural requirements are addressed. Additionally, each section is organized first by the time period that its technologies are predicted to mature, and then by the MHS Quadruple Aim that its technologies would most impact according to the analysis performed.

8.1 Mid-Term Solutions Driving Quadruple Aim (4-6 Years)

8.1.1 Readiness

Enterprise Content Management (ECM) (To Plateau in 3 Years): used to create, store, distribute, discover, archive and manage content (such as documents, email, reports, images and office documents), and, ultimately, manage policy to ensure relevant content is available to users where and when they need it. In healthcare, ECM is often a centrally managed repository of electronic documents, bridging the gap between the administrative and business systems and clinical systems, such as EHR systems, used to store structured healthcare information. Information management within an ECM refers to the process of storing and organizing business documents and providing a consistent mechanism for people to find relevant information. It enables control over the life cycle of documents, including how they are created, reviewed, published, disposed of or retained.

ECM systems can provide value to the DHA by directly enabling the agency to target its strategic objective of improving operational medicine. ECM systems assist in improving process efficiency in everyday business through the use of workflows to automate and streamline processes through familiar desktop applications, email, or web browsers. Human and system workflows are integrated for orchestration, exception handling, and automation. By implementing an ECM, DHA can increase productivity while providing security and reliability. Policies which are enforced and audited within ECM systems can demonstrate compliance with well-designed records management and e-Discovery solutions. These policies can augment dedicated clinical systems as needed by providing an important buffer between clinical data and non-clinical line of business data. ECM capabilities can provide DHA the ability to dispose of out-of-date items, manage versions, apply retention schedules, declare records, and place legal holds across traditional content, web content, or social content. Content can be delivered across the enterprise at significantly lower cost.

Overall, an ECM can improve content control, structure, and compliance for the DHA.

In order for the DHA to implement an ECM, the DHA must perform an ECM assessment to determine its current state and gaps in current capabilities. Included in this assessment should be the future state architecture envisioned for the DHMSM program of record and the interface strategies systems of use within DHA. To retain the benefits of ECM systems without compromising the integrity of clinical iEHR systems, DHA must ensure iEHR interfaces support a simple, standards based, well defined interface for non-clinical business systems. To enhance ECM capabilities DHA should develop common electronic workspaces which are available through on-premises and web (cloud)-based services and can support sophisticated custom collaborative applications. Collaborative workspaces extend beyond the firewall and integrate unstructured collaboration with structured business processes and data. To consolidate information for the DHA enterprise, DHA should combine content publishing efforts for intranet, extranet, and internet sites in a way that is both automated and federated allowing DHA components to focus on their specific missions, but within the DHA enterprise framework. A hybrid portal infrastructure can also seamlessly connects mission partners outside the organization.

Application Services Governance (To Plateau in 4 Years): essential part of service lifecycle management in a Service Oriented Enterprise (SOE) and is vital to the success of a SOA implementation. It involves aspects of IT governance, Architecture governance and business governance to ensure that IT solutions are driven by business needs. An effective governance should put equal focus on people, process and technology to create an organizational framework for instilling, governing, and evolving the culture of 'reuse' and 'sharing' of enterprise SOA assets for improved interoperability and agility in the delivery of health care data. It envisions the establishment of a management center within the enterprise to monitor the compliance with the applicable policies and to govern the service lifecycle.

Applications Service Governance for the DHA focuses on the objective of enhancing strategic partnerships. DHA's SOE strategy leverages the Open Group Service Integration Maturity Model (OSIMM). The Model introduces 7 levels of maturity with 1 being the lowest and 7 being the highest. The target level is dependent on the organization's needs. OSIMM additionally defines 7 dimensions, with each dimension representing a view from an aspect of the business. The 7 dimensions are defined in the table below.

They provide insight into the state of an organization for a given maturity level. The views and maturity levels can be thought of as a matrix where the Maturity levels comprise the columns and the Dimensions are represented as rows. The intersection of Maturity level and Dimension is a statement of the status of the enterprise. DHA has developed a SOA Roadmap that lays out the steps needed to get the enterprise to an initial target maturity level of 4 with the ultimate goal being an OSIMM maturity level of 5. Once the level 4 metrics have been achieved, the enterprise will undergo the transition to level 5 during subsequent iterations.

Table 4: OSIMM Maturity Dimensions

Dimension	Description
Business	Focused on the business architecture; i.e., the organization's current business practices and policies; how business processes are designed, structured, implemented, and executed.
Organization and Governance	Focused on the structure and design of the organization itself and the necessary measures of organizational effectiveness with respect to SOE and SOA governance.
Method	Focused on the organization's maturity around the Software Development Lifecycle such as the use of requirements management, design methodologies and techniques, and tools for designing solutions.
Architecture	Focused on application style, structuring of the application and uniform use of best practices and patterns including enterprise schemas and service models.
Application	Focused on the enterprise-wide structure of the architecture which includes topology, integration techniques, architecture decisions, standards and policies, and services adoption level.
Information	Focused on how information is structured, how information is modeled, the method of access to enterprise data, and data transformation capabilities.
Infrastructure and Management	Focused on the organization's service management, IT operations, IT management and IT administration.

The successful migration to a SOE will allow DHA to increase the speed to market for delivering capability solutions by reusing the services available enterprise wide. A properly implemented SOE can reduce the duplication of functionality and promote reuse by providing constructs such as Service Registry to provide enterprise wide visibility of the existing SOA assets, so a consumer can check to see if a functionality is already available before deciding to build a new one. The governance center can accelerate the adoption of the SOA and maintain consistency in implementation by providing reference architecture and software development tool kits as well as frameworks and training.

Moreover interoperability and streamlined external partner interaction will be improved because of the Enterprise-wide practices and policies to allow consistent data sharing with minimal additional investment. The DHA CTO office has done a lot of ground work in terms of establishing draft policies and a charter for the management center. The next step for the organization is to formalize these policies and charter so that the management center can be established and governance can be applied to the enterprise.

Geospatial and Location Intelligence (To Plateau in 4 Years): includes applications, infrastructure analytics will serve as an important tool for enabling the DHA to provide more relevant and efficient service offerings based on customer intelligence and consumer management and tools, and best practices that enable access to and utilization of geospatial and location data of people, things and information for location-referenced information analysis to improve and optimize decisions and performance. GLI data sources include imagery, mapping, and location data which may be collected by satellite or aircraft, or directly from Global Positioning System waypoints, altimeters, or radar. GLI information is then combined with other data from functional maps, local government databases, census information, population health data, facility schematics, or any data that have or can be combined with location data. The use of sophisticated GLI is already a major U.S. technical advantage on the battlefield providing ground, sea, air and even cyberspace pictures to coordinate operations. The tremendous potential of GLI to benefit health care is just now beginning to be realized as the commercial industry takes the technology main stream. Costs to field GLI capabilities have dropped significantly while their potential uses continue to expand. Improved readiness, better health, better care and lower cost objectives are all supported in some way by the availability of GLI.

DHA can improve its strategic objective of global health engagement by using GLI to provide localized information for the health of a population including access to water, food, and health care. U.S. Army Soldiers used GLI to support relief efforts at the epicenter of the outbreak in Liberia. GLI enhances strategic partnerships by targeting care to the point of need and coordinating care across multiple agencies through the assignment of local responsibilities. In the case of a catastrophe, such as massive terrorism event, coalition partners, police, fire, hospitals, and ambulance workers can respond better as a coordinated team with full knowledge of the other team players. Another major area GLI can improve is operational medicine. Real-time tracking of personnel and resources combined with scheduled locations allow clinicians to efficiently control medical equipment and guide support personnel to their planned locations. Interactive hospital kiosks, signs, and multimedia engage patients and staff at every point of service. Resources such as blood, medicine, and support personnel can be pre-positioned and monitored. GLI data analysis can also expand the boundaries of healthcare by identifying gaps in care and providing the ability to forecast future needs. New insights into factors influencing health conditions can be discovered by mapping areas of crime, disease, and injuries to determine where we can intervene in a proactive way to help create a healthier community. GLI are a key component of health information management and the benefits will help improve health care from almost every perspective.

The DHA must address the doctrine, organization, training, materiel, leadership, and education (DOTMLPF) necessary to effectively use and field GLI capabilities. Tracking an individual's location surfaces privacy concerns as does the retention of 'patterns of behavior' which may be accessed by personnel with access the GLI information systems. DLI information must be fully integrated into DHA's data strategy and governance practices. Tools and expertise must be acquired to take advantage of the information. Geo-spatial data may be integrated into semantic web analysis tools and analyzed for opportunities by a variety of health professionals. One clear mission partner for DHA is the National Geospatial-Intelligence Agency (NGA). As a DOD combat support agency and a member of the Intelligence Community, NGA provides GEOINT, in support of U.S. national security and defense, as well as disaster relief. Ultimately, the DHA must provide a means for entities to capture, create and publish location data based on operational role and facilitate privacy controls where necessary so that new and innovative applications can take advantage of GLI data.

High-Performance Message Infrastructure (To Plateau in 4 Years): consists of software or appliances that provide program-to-program communication with high quality of service, including assured delivery and security. These products use innovative design concepts and in-memory computing to support higher throughput (hundreds of thousands of messages per second), lower latency (less than 10 microseconds for local message delivery), or many orders of magnitude more message producers and consumers than traditional message-oriented middleware products. With the advent of technologies such as Internet of Things and Big Data, growth of social media and mobile technologies, there is an explosion in the amount of data that is available for consumption. This leads to an ever increasing demand for data to be delivered closer to real time which in turn generates the need for a high performance messaging infrastructure that can meet this demand on data from a latency and scaling perspective. Moreover, when message senders and receivers are on the same server, the communication is done through in-memory, interprocess communications, thus avoiding the network protocol stack. These products are somewhat faster and more scalable than earlier high-performance message-oriented middleware products, and much faster and more scalable than conventional MOM or standard wire protocols, such as unadorned TCP/IP and HTTP.

High performance messaging infrastructure components can play a key role in DoD Global Information Grid infrastructure to support key business needs such as interoperability to meet the strategic objective of enhancing medical capabilities in a joint environment. For example, the Enterprise Service Bus (ESB) provides the mechanism for integrating different applications that are both internal to the enterprise and with its external business partners to enable secure data exchanges. Using the ESB infrastructure, applications can exchange data by means of standards based messages thereby insulating them from the underlying technologies of the application platforms. In addition the ESB provides features such as synchronous/asynchronous messaging using a variety of protocols, event-driven messaging, intelligent routing, protocol mediation, message transformation, policy based auditing capabilities, policy based error handling, fault tolerance and policy based quality of service mechanisms including secure messaging (encryption and signing), assured message delivery, and transaction management.

As far as implementation is concerned, the DHA has already acquired some of the components of standing up a high performance messaging infrastructure such as the Layer 7 Secure Span Gateway appliance and the IBM Message broker for ESB under the earlier iEHR program. DHA needs to fund prototyping activity to build software development toolkits and frameworks to accelerate the adoption of these technologies with in the enterprise and to ensure that effective return on investment can be achieved from these investments.

8.1.2 Better Health

Machine Learning (To Plateau in 4 Years): enables systems or applications to gain intelligence that has not been explicitly programmed by the developer. Essentially, the original code becomes more advanced, without any additional human interaction. This is possible because of a process called training, in which the programmer inputs data sets as examples, and either includes explicit terms for their target outputs, supervised learning, or generalized ones, unsupervised learning. The program repeats the process of converting these inputs into outputs, until it finds the correct algorithm that obtains the target value. Once this occurs, the programmer can use validation sets to further fine-tune the system model to understand and classify data more precisely. Eventually, the machine can make predictions or decisions about data, without a specified target output or programmed instructions. This is valuable for data processing. While machine learning is actually a 3 to 4 decade old discipline, it is now gaining new momentum thanks to an increase in demand correlating to the increase in data complexity, or the datasets surge. By implementing a form of software programming that actually learns to become more advanced, and correctly process and reach decisions regarding complex data, healthcare providers can retrieve value from all of this new information to produce the greatest impact from its meaning.

As machine learning evolves, more and more of the power to work with this data will be held in computers. This means that programs, not people, will be the most trust-worthy decision-makers guiding individual, daily healthcare. This focus on being better-informed supports universal better health. Other valuable medical use cases are already emerging, including Human Genome and cancer research. Machine learning allows for complex data processing, encouraging making point-of-care decisions from the web of information available. This makes it possible to process data surrounding particular medical cases, and more accurately predicting what pattern a disease might take, or what effect a treatment will have. This presents a new power for healthcare providers. This technology will allow the DHA to more efficiently and effectively benefit the warfighter in the coming generations.

In order to implement this technology, the DHA needs to be in position to accept changes in the technological landscape and improve from them. The influx of data coming in from external sources will need to be stored and shared efficiently. This will require a fluid and flexible enterprise data warehouse that can scale to fit the masses of big data that will continue to fill it. Applications need to be able to communicate with each other via services, and everything needs to be stored in a central location, where it can be used in its most complete state. Segregating data is no longer a plausible option if the enterprise wishes to provide a complete picture for its applications. Additionally, the DHA needs to develop deeper in-house software engineering capabilities in order to grow and support machine learning. Expertise will need to shift to be in unison with the methods used to excel in future healthcare.

Mobile Health (Telehealth) Monitoring (To Plateau in 5 Years): an end-user-targeted, information and communication technology that uses embedded and after-market processing and sensor technology. The key benefit is patient data that can be collected and sent to providers from any place at any time. Other applications are being studied or developed for monitoring water and air pollution, for medical informatics and health care, and for distance learning. Ford Motor Company, for example, has announced a series of health and wellness in-car connectivity solutions designed to empower people with self-help information while they drive. Ford envisions an array of health aids in its Health and Wellness connectivity portfolio, like glucose monitoring devices, diabetes management services, asthma management tools, and Web-based allergen alert solutions.

Telehealth Monitoring will support the DHA's efforts to expand the boundaries of healthcare. Over the past 10 years, the rapid development of mobile communication networks has changed telematics, enabling many new applications including health and emergency medical services. Consumers are finding new ways to access healthcare and health services outside of traditional channels. The health care continuum has spread to the Internet of Things of which mobile health devices are a major platform. The collection of sensors and telecommunication capabilities in connected networks make them prime candidates for investment. Telehealth Monitoring enables the DHA to improve global health engagement, through applications which allow medical personnel to connect, convey status, and obtain real-time patient information no matter what conditions the patient is in. Another benefit should be the realized integration of new health services and information intake into systems to ensure near real-time access to care at all times. Overall expanding boundaries of care, telematics and the surrounding Internet of Things enable the individual to take health into their own hands, supplementing previously fragmented physician interactions with data-driven personalized applications that really know us and our behaviors.

It is recommended that DHA approach telemedicine and mobile health monitoring as one technology stack. The telecommunication systems and network standards used to carry telematics will likely continue to rely heavily on commercial mobile wireless communications. As with other telecommunication related technologies, DHA must include telematics information in its data strategy, and provide protection and distribution services to support it. Since telematics information is so closely related to Mobility Policy and Strategies it can easily be addressed as part of DHA's Mobility Policy and support infrastructure. The DHA Mobile Application Framework and Policy already address a majority of the requirements. Deployed telematics services should likewise follow the tactical network standards already developed for the battlefield. Because telemedicine is evolving so rapidly and can take in input from multiple sensors, to remotely collect and transmit that data to a secondary site or location, its technology can be used in a host of other products opening a whole new realm of possibilities.

8.1.3 Better Care

Integrated Clinical-Business Enterprise Data Warehouse (To Plateau in 6 Years): includes an architecture, data model and systems that can incorporate at least EHR, claims/revenue cycle, ERP, cost accounting and patient experience data (most commonly satisfaction survey data, but also social media feedback). The EDW enables large communities of users to develop/receive reports and dashboards/queries, and to perform data discovery around core patient care and business processes and outcomes. The enormous amount of data being collected by EHRs has found additional value when integrated and stored in data warehouse(s). The EDW allows all data from an organization with numerous inpatient and outpatient facilities to be federated, integrated and analyzed.

As per Oracle, the estimated long term value of the identified levers is around $200 Billion savings on national health care spending. Some of the estimated and potential value and impact also includes predictive modeling to determine allocation of R&D resources, clinical trial design, and personalized medicine, as well as comparative effectiveness research, for clinical decision support systems and dashboards for transparency into clinical data. Lastly, the impact would include advanced algorithms for fraud detection, performance based drug pricing and efficiency in business and logistics support systems, public health surveillance and response systems, and aggregation of patient records to provide datasets and insights. The McKinsey Global Institute even stated that analysis integration across the data pools within an enterprise/system is the key for discovering new patterns.

The primary purpose of the EDW is to collect, collate, de-identify and expose both structured and unstructured patient population information. This information is then consumed by a variety of researchers, bio-informatics, scientists, and clinical providers to determine Population Health through dashboards, reporting and visualization, support Clinical Decision Support systems by facilitating a 360 of a patient through data virtualization, and provide pre-defined rule based health alerts to the population by running deep analytics through massively parallel processing.

MHS is an "undiscovered laboratory" for health services research. This is due to a large and diverse patient population, an operating environment that facilitates integration of care and a health information system linking the components of the clinical environment. Clinical-Business Data warehouse can leverage these strengths by modeling a combination of biological, clinical, purchased care claims, patient demographics and outcomes data in a single large collection. Over the past couple of years, MHS has to invest significant efforts into modeling clinical data data for "secondary use" (secondary to the EHR) by means of clinical data warehousing best practices. This means that the data is optimized for historical storage in one place, and optimized for a particular secondary use in another. The combination of the scope of MHS data, and the efficient portability of the data for research use, will make MHS Data warehousing systems a unique and powerful tool to support both clinical and health services research.

Identity Analytics and Intelligence (To Plateau in 5 to 7 Years): key for helping maintain identity management and information security. Current generations of intrusion detection and intrusion protection products rely on analytic processing of information to ascertain security attributes such as identity. Expert systems play a role in extracting meaningful results from audit file. Most notably, the Intrusion Detection Expert System (IDES) is described in the 11th National Computer Security Conference paper of the same name. Likewise, the first published rules to detect computer viruses, suitable for an expert system are documented in the 14th National Computer Security Conference (NCSC) paper. It is expected advancement will continue.

Identity analytics and intelligence supports the DHA objective to improve safety, because unknown vulnerabilities and exploits can be discovered by applying proper rules and artificial intelligence. Combined with other disciplines, including security engineering, the multiple controls provide an opportunity to proactively address security. For instance, a capability to violate access control, referred to as break the glass, provides medical staff with the ability to access patient medical records. Exercising this feature expands on the audit capability. Proper analytics could determine unusual activity and halt the activity, possibly by redirecting the bad actor to a honey pot. In turn, this could provide the forensics necessary to identify the bad actor and perhaps prevent the release of breached information.

To implement proper use of this technology, the DHA will need to be at the forefront of analytics advancement. This requires the DHA to focus on identity management and information security as key areas for safety improvement. The DHA will also need to understand how analytics could determine the presence of bad actors and prepare for handling corruption. It will be important for the DHA to implement analytics technologies for improved safety and protection for patients and healthcare records.

8.1.4 Lower Cost

Social Analytics (To Plateau in 4 Years): process of collecting, measuring, analyzing and interpreting the results of interactions and associations among people, topics, ideas and other digital content types. Instead of purchasing data alone, firms can track social media data (Facebook, Twitter, etc.) and website keystrokes to more clearly understand site usability, user habits, and user needs. For example, the federal health insurance marketplace Healthcare.gov employees multiple monitoring services, including Chart Beat, to improve their content on fly1. Chart Beat's website explains that "our data gives teams instantly understandable insights based on users' emergent behavior. The content might not have existed yesterday, might not be looked at tomorrow, but today is driving your site2." All firms using socially-enabled analytics use it in order to monitor, respond, amplify, and lead the consumer journey. This type of tool would enable the DHA to collect social data and predict and plan for behaviors.

The focus of social analytics on tracking and predicting trends based off of social media data, will directly encourage data driven decision making. This data driven decision making will hearten strategic healthcare efforts driven by predicted behaviors of consumers/patients.

For the DHA to properly make use of social analytics, the agency will be required to be actively involved in social media platforms. The DHA will need to align user information with predictive health behaviors. Mechanisms for data tracking and storing are required as tools. In addition to social media data monitoring tools and capabilities, the DHA needs to plan for the growth of social media and increasing data inputs. The enterprise needs to align with the future of changing social communication and its value in driving need based services.

Cloud Computing and Personal Cloud (To Plateau in 4 Years): a style of computing in which scalable and elastic IT-enabled capabilities are delivered as a service using Internet technologies. Personal cloud is the individual's collection of digital content, services and apps, which are seamlessly accessible across any device. Personal cloud is a virtual amalgamation of different services that users assemble, either explicitly or implicitly, based on their personal needs, tastes and work styles. Once assembled, a personal cloud serves as a repository for users' data. The next phase of evolution of personal clouds is cognizant computing. Each stage of cognizant computing deals with more personal and commercial information about a consumer. Over the coming years, we expect an increasing amount of consumer apps to sync information with the cloud, rather than simply storing information solely in the app. This will create an increasing amount of traffic to the cloud, while making it easier for app developers and brands to gather information about consumers, their apps and their content usage.

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[1] (The Christian Science Monitor, 2013)
[2] (Chart Beat, 2014)

It is important for the DHA to implement a personal cloud because it will create a larger pool for users within their ecosystems, and lead to improvements in condition based quality care. Many users will access content and services from multiple service providers and use devices from multiple equipment manufacturers. IT organizations will be just one of the service providers delivering content to a user's personal cloud, and they must be prepared to integrate users' chosen environment with minimal disruption or administration. The personal cloud will also have a direct impact on IT organizations designing applications that must coexist in the personal cloud to gain acceptance.

The DHA can implement personal cloud through to help ensure the end user can access the items they plan to use, as well as allow for the integration of internal items from the DHA that are necessary to maintain security and performance. The personal cloud can be a disruptive and transformational technology to the DHA environment, but the necessary steps to implement will be critical to its overall success.

3-Dimensional Printing (Bioprinting and Medical Devices) (To Plateau in 4-9 Years): 3-D printing or additive manufacturing is the process of building custom three-dimensional objects from digital models. While there are many uses of 3D printing, the two most relevant uses for the DHA are medical device 3D printing and 3D bioprinting systems. Medical device 3D printing involves fabricating objects that will repair, replace or control functions within or on the body. It also involves creating prototypes, presurgery planning tools, alignment jigs, and surgical cutting templates. 3D bioprinting systems produce tissue and “products” that function like human organs. The process is directed by medical imaging data and software that specifies the design of living tissue and organs, plus the printing device to create usable tissue or a functioning human organ from and individual’s own or other cells.3D printing for medical devices is seen in a number of arenas, but these stages are at different maturity levels. In the arenas of manufacturing intricate subassemblies or final parts and the fabrication of personalized medical devices the maturity level is considered to be in the adolescent stage.

3D printing will contribute to achieving the Federal Health IT strategic objective of expanding the adoption of health IT by increasing the adoption and effective use of health IT products, systems, and services. 3D printing will help the DHA achieve lower costs by optimizing and standardizing access and other care support processes. The DHA needs to adopt this technology because 3D printing can drastically improve the time it takes to provide implants, prosthetics, and organ donations to beneficiaries and significantly reduce the cost to do so. 3D printing also has the ability to create customized devices in a more efficient and standardized way. 3D printing can create an environment where a doctor has the ability to print a custom implant outside the operating room and then implant it in a short time frame.

Adopting 3D printing technology will require the DHA to acquire medical device 3D printing and 3D bioprinting systems. Along with the technological support needed to adpot medical device 3D printing and 3D bioprinting systems, the DHA will need to prepare policies and legal infrastructure surrounding 3D printing services. 3D bioprinting for medical patient application is an arena with very complex scientific and adoption challenges to overcome, and very profound potential impact when they are conquered due to the standardized care it would provide. Long-Term Solutions Driving Quadruple Aim (7-10 Years)

8.2 Long-Term Solutions Driving Quadruple Aim (7-10 Years)

8.2.1 Readiness

Augmented Reality (To Plateau in 7 Years): a “live” direct or indirect view of a physical, real-world environment whose elements are augmented (or supplemented) by computer-generated sensory input such as, text, graphics, audio, video, or GPS data, and other virtual enhancements. AR leverages and optimizes the use of other technologies such as mobility, location, 3D content management and imaging and recognition. It is especially useful in the mobile environment because it enhances the user's senses via digital instruments to allow faster responses or decision-making. With the help of advanced AR technology (e.g. adding computer vision and object recognition) the information about the surrounding real world of the user becomes interactive and can be digitally manipulated. Artificial information about the environment and its objects can be overlaid on the real world. Augmented reality has brought about a significant change in the healthcare industry. There are different applications of this technology in the medical sector, from providing assistance during surgeries to improving medical training. Apart from saving patients’ lives, existing processes in healthcare organizations can be made more efficient and precise with augmented reality.

For the DHA, the use of AR technologies will allow the organization to meet its strategic objective of improving global health engagement. AR technology contributes to improved patient care and management, through the use of device applications. Details of patients who are admitted to the hospitals can be registered with smart-glasses instead of manually entering the data into the system. This can reduce overheads, decrease the chances of human mistakes and improve the overall care management process. AR can reduce the risks associated with surgery, by projecting patient information to assist during procedures and providing required information to surgeons for complex procedures. With AR, all the information is directly onto the task at hand, thereby reducing overall risks. AR can be used to project medical imagery and serve as a valuable medical learning tool to get the related signs of any illness and diagnose patients accordingly. AR apps allow for more integrated learning.

For the DHA to implement this technology, the DHA will have to remain at the forefront of evolving AR technology applications. This will require the DHA to prioritize AR technology innovations and maintain funding for acquiring applications. AR technology will also need to be integrated into commonplace healthcare procedures, requiring updated procedural plans to incorporate and benefit from AR capabilities. There are risks that can occur using AR technologies, thus it will be important to take necessary legal precautions to account for the AR projections. Overall, AR technologies provide a platform for greatly enhancing effectiveness and efficiency of healthcare across global settings.

IT Service Dependency Mapping (To Plateau in 7 Years): discovers, documents and tracks relationships by leveraging blueprints or templates to map dependencies among infrastructure components (like servers, networks and storage) and applications in physical, virtual and cloud environments to form an IT service view. The tools provide various methods to create blueprints for internally developed or custom applications. Key differentiators are breadth of blueprints, mainframe discovery and depth of discovery across physical, virtual and cloud infrastructures.

SDM tools will enable the DHA to improve upon the strategic objective of operational medicine. Currently, the DHA is struggling to maintain an accurate and up-to-date view of the system and application dependencies across IT infrastructure components that make up IT services, usually relying on data manually entered into diagrams and spreadsheets that may not reflect a timely or real-time view of the environment. Existing inventory and discovery tools do not provide the necessary hierarchical relationship information regarding how an IT service is configured. Without the stakeholders (e.g., application development or support, system administrators, and business liaisons) working together, identifying and blueprinting custom applications, it is not possible to identify the complete application or IT service. Although SDM tools provide functionality to create the application or IT service blueprints, the task of validating the relationships remains labor-intensive, this is slowing DHA wide adoption of the tools beyond their primary use of discovery.

To maximize the benefit of SDM tools, the DHA will have to socialize the tools and gain acceptance for quicker validations. The SDM tools are still most often adopted as a jump-start or companion to IT service view configuration management database (CMDB) projects, but there are new use cases where they are acquired stand-alone: data center moves, consolidations or transitions; disaster recovery planning; and as a complement to audit compliance for change control. A good opportunity to adapt SDM is when MTFs receive tech refresh for the new EHR program so that Directory Management/Enterprise Services (DM/ES) is standard across all MTF networks. The DHA would have to prioritize SDM technology in order to effectively make use of its benefits.

Real Time Infrastructure (To Plateau in 7 Years): represents a shared IT infrastructure in which business policies and SLAs drive the dynamic allocation and optimization of IT resources so that service levels are predictable and consistent despite unpredictable IT service demand. RTI provides the elasticity, functionality, and dynamic optimization and tuning of the runtime environment based on policies and priorities across private, public and hybrid cloud architectures. In instances of constrained resources, business policies determine how resources are allocated to meet business goals. Logically, RTI can be composed of multiple, complementary technologies that can be leveraged to achieve incremental business value.

By enabling unified Data Center Infrastructure Management (DCIM), RTI will allow the DHA to reduce costs while increasing agility and quality of service, enabling the organization to meet its strategic objective of enhancing medical capabilities in a joint environment. There is a significant and growing gap between well-managed and poorly-managed infrastructure that has been highlighted in Federal and DoD strategic planning and priorities. Virtualization and software defined networking are direct enablers or stepping stones towards RTI maturity, and virtualization priorities are directly asserted in multiple DoD Policies. Across the DHA Mission Space, alignment, consolidation and transition of the DHA Centrally-managed portfolio demands the ability to scale and transition in a flexible and agile manner. When RTI is mature, it will represent the opportunity for DHA to leverage the efficiencies while delivering a “unified” DHA capability, when and where required, in the most cost effective way to meet technical requirements.

While still considered “adolescent” by Gartner, many of the building blocks for RTI are either mature or rapidly moving towards robust solution sets. Virtualization of applications and alignment of virtualization hosting locations continues to remain a critical priority that aligns with Federal and DoD Priorities and Policies. Additionally, functional requirements for DHA leveraged, virtualized hosting providers should explicitly include the ability for DHA to directly shape and provision in support of objectives for a unified and seamless customer interaction. Software Defined Networking is a rapidly maturing solution space that will allow the implementation of routing and protections within and across the virtualized environments. While the solutions allow for more efficient delivery/processing of protections and directly provide the opportunity to standardize business rules and the implementation of IA Standards, the paradigm may represent a challenge for traditional Assessment and Authorization (A&A) approaches. RTI capabilities will continue to mature, and DHA should continue to focus on the stepping stones of RTI to achieve incremental value while striving for the end state of RTI. These stepping stones continue to migrate from vendor-specific implementations to standards-based approaches, and DHA should deliberately assess each capability set for both value vs vendor-lock in/standards to ensure the ability to leverage as many service providers as are practical to support the DHA Mission.

Server-Provisioning and Configuration Management (To Plateau in 7 Years): manages the software configuration life cycle for physical and virtual servers. Some vendors offer functionality for the entire life cycle; others offer specific point solutions in one or two areas. The main functions include: provisioning, application provisioning and configuration (binaries), patching, inventory and configuration compliance.

The use of server provisioning enables the DHA to meet the objectives of improving operational medicine. It is beneficial for the DHA to implement server provisioning and configuration management tools because they help automate many server tasks, thereby lowering the cost of IT operations, enforcing standards, and increasing application availability and the speed of modifications to software and servers. It also provides a mechanism for enforcing security and operational policy compliance. Server provisioning and configuration management tools can be implemented to support physical, virtual and cloud infrastructures. The use of server provisioning allows for increased efficiency, thereby improving operational procedures and increasing quality of care.

There are many considerations necessary for the DHA to appropriately implement this technology. Besides increasing quality, these tools can reduce the overall cost to manage and support patching, rapid deployments and VM policy enforcement, as well as provide a mechanism to monitor and enforce compliance. The tools will help DHA gain efficiencies in moving from monolithic imaging strategies to a dynamic layered approach to incremental changes.

Complex-Event Processing (To Plateau in 8 Years): a computing technique in which incoming data about what is happening (event data) is processed as it arrives to generate higher-level, more-useful, summary information (complex events). Complex events represent patterns in the data, and may signify threats or opportunities that require a response from the business. One complex event may be the result of calculations performed on a few or on millions of base events (input) from one or more event sources. Fundamentally, the volume of data generated by event management is overwhelming. To compound the difficulty, there is very little indication of which events are significant and which are not. CEP automates the correlation of events into patterns that may represent a threat or an opportunity to provide analyses and the orchestration of subsequent actions as a response. CEP is becoming increasingly important in business decision making for healthcare. CEP is a basic component of a type of real-time business analytics used in continuous intelligence. Information contained in business events is extracted and analyzed to provide insight into the changing conditions in an enterprise and its environment. It enables business decisions to be made and actions taken within milliseconds, seconds or minutes of receiving new event data regarding current conditions. Thus CEP is used to improve situation awareness, which is defined as “knowing what is going on so you can decide what to do”.

The use of CEP technologies encourages the strategic objective of enhancing emerging medical capabilities through its strategic decision making capabilities. CEP targets the use of event streams at very high levels of business management and decision making. Healthcare is a growth area for event processing applications. Progress towards a unified electronic healthcare delivery system has been slow. Currently many different specialized systems are employed, each with part of a patient's treatment record, and no central system with a complete history. As a result, a lot of relevant information is never included in evaluating a patient or a treatment plan and costs of medical care have not been reduced as necessary. There are many event-driven processes in hospital operations. Such types of events input to a care management system will vary from the events output by medical equipment monitoring a patient's vital life signs, the results of medical tests from laboratories, and status changes of medical equipment, to the disposition of operating theatres and other critical hospital resources, the location and disposition of medical staff on duty.

Next steps for the DHA include creating a vision of the future healthcare landscape with comprehensive care across the DoD, VA and other private health care providers. One goal of the system would be to automate the coordination and delivery of a warrior's medical treatment over his or her entire lifetime. Another goal is to enable remote medical diagnosis and treatment by consultants and specialists who may be far away from a patient's location. Everything must be done in real-time. And all relevant information must be immediately available to those service providers who need it. These systems will be event-driven. The DHA should field an event processing management system built from smaller specialized systems. The long term goal of developing this kind of system is to improve the deployment of medical staff and equipment, reduce errors, such as in prescribing drugs in treatment plans or reduce duplication of tests, and ultimately help to reduce the costs of healthcare.

Multi-Enterprise Grid Functionality (To Plateau in 9 Years): Multi-enterprise Grid Functionality is a unique solution in that it must be shared between a set of producers and suppliers. It represents the unique set of capabilities that emerge when a community of producers and consumers aggregate and share information. In specific, data such as tasks, orders, supply levels, producer prices and market trends may be tracked, analyzed and synthesized to create more efficiency and effectiveness in the marketplace. In the healthcare industry this capability will manifest itself as valuable mostly through the logistical complexities inherent in healthcare.

With the DHA being a government organization it is held to a more stringent standard when it relates to acquisition. In hopes of increasing reliability and minimizing cost while adhering to these standards, it is necessary to form strategic partnerships with suppliers of medical equipment. To achieve this goal, the DHA could implement a multi-enterprise grid functionality (MGF) that incorporates all current suppliers as well as those not currently being considered for miscellaneous reasons. With the MGF infrastructure in place, the DHA could begin to implement comprehensive analytics into the procurement process. In specific, MGF provides the ability to analyze producers in real-time generating preemptive warnings about possible shortage or price hikes. This will afford the

MHS time to adjust as necessary, minimizing any adverse impact to the enterprise.

To field a capability such as MGF will require a mixture of technical architecture and policy modifications. With regards to the technical architecture, the complexity arises from the need to interface with multiple organizations external to MHS. To successfully complete this goal the DHA will need to analyze existing external connections and determine an appropriate accreditation and certification process that will work for all vendors since the communication portal will be universal. Beyond security, interoperability will also be an issue. Any situation where data is being created under different organizations with different standards will require research into the best means for standardization. Only once standardized will this data be useful for analysis.

Quantified Self (To Plateau in 9 years): Quantified-self technologies, also known as “life-logging” or “self-tracking” technologies, while still considered emerging, have already made massive impacts on the healthcare community. As the name indicates, this set of tools empowers patients to perform their own health monitoring. For instance, if a patient has Cystic Fibrosis, a sensor or wearable technology can collect and transmit data on the quality of surrounding air, the regulation of the patient’s exercise routine, and the quality of his or her nutritional intake. All of these factors limit a patient’s lung damage and can potentially extend their quality of life. Self-tracking technologies can also enhance and personalize warfighter training routines, or improve a patient’s Post-Traumatic Stress Disorder by monitoring and influencing brain patterns. These sorts of capabilities will cultivate more rapidly over the next five to ten years, and as more data is acquired, more knowledge will be available to extract.

Recording and consolidating extensive data on patients’ daily activities and conditions will allow hospitals and research centers to perform advanced prescriptive analytics on the entire life cycle of a particular condition. New analyses will allow the DHA to examine cause and effects at the micro-level, identifying complex connections that would otherwise be undiscoverable. As quantified self develops, it will be able to track the effects of exploratory treatments, uncover new symptoms, discover more efficient and proven pathways to cures, and accelerate the development of preventative medicine. Other more common use cases will include monitoring compliance to treatment regimens and encouraging better lifestyles. All of these scenarios have the power to save lives, as well as significantly reduce long-term healthcare costs.

In order for the DHA to effectively use this technology, however, the influx of new data needs to be compatible with and comparable to legacy data and EHRs that the DHA maintains. This means collecting data from a variety of diverse external sources and integrating them into a single, more robust and comprehensive data repository. The DHA can achieve this goal by migrating to a centralized and federated data store, or “data lake”. Currently, the DHA operates at the beginning stages of data lake maturity. The majority of data is housed in individual data warehouses and run on separate applications. Through DHMSM and other large-scale integrations, however, shared databases and data exchanges are becoming a fulfilled priority. Over the next five years these integrations should continue, until the creation of separate data warehouses is nearly obsolete. All new systems should instead be built around and/or communicate through a virtual data lake using enterprise technical architecture standards, such as Resource Description Framework (RDF). RDF is a data model that describes two data elements as well as their relationship, allowing different applications to exchange and merge their data even when they are not completely similar. This will allow legacy systems to semantically communicate with the main data lake, thereby accessing and running other applications' elements. Individual warehouses should only be created or maintained in situations that require exclusive security or governance and conversely, general security and governance measures should begin to be built into the structure of the data lake itself.

8.2.2 Better Health

Internet of Things (To Plateau in 9 years): The Internet of Things refers to a phenomena where digital devices and sensors collect information from their environment. These data collection points are interconnected through the network, allowing for large volumes of data to be collected in real-time and responses to be sent back to the different devices. This interconnectedness enables endless opportunities for data analytics and decision making. The applications for IOT technology in healthcare center around two domains, the hospital and the home. Within the hospital, IOT entails connecting previously unconnected processes and tools to the network. Connecting medical devices to a hospitals IOT network, enabling two way communication with the EHR is an example of how opening the conduit between previously disparate data sources can increase opportunity for data analysis and therefore patient safety. This scenario would allow the IOT to analyze the dosage administered by the medical device against the patients past medical records, raising red flags if conflicting drugs were planning to be administered. Within the home, the use of devices such as network connected glucose monitors provide an added layer of security for the patient while minimizing the time required by nurses and other supporting medical personnel.

IOT enables the DHA to strategically expand the boundaries of healthcare services it offers. The DHA stands to gain a disproportionately large benefit from IOT technology due to a number of factors: Firstly, the DHA has a very geographically dispersed population with limited central MTFs to treat the large patient set. This situation requires an enterprise that can expand the boundaries of healthcare to the home. By enabling the connection and analysis of remote telematics data, patients will have the same secure monitoring previously available only at the MTF. Utilizing the two-way communication indicative of the IOT paradigm, providers at the MTF will be notified when monitoring devices fall out of line, raising red flags. This notification can prompt activities such as a live video-chat (telemedicine) or an automatic change in the drugs being dispensed from the patients at home drug dispenser, also linked to the DHA's IOT. Secondly, the DHA's requirement to provide medical support in the theatre domain raises many DHA specific complications which lend themselves well to IOT solutions.

In order to research, field and benefit from the capabilities provided by IOT the DHA and commercial organizations have a number of technical hurdles to overcome. The most imminent is the issue of standardization. Currently, many different IOT technologies exist but a lack of standardized communication protocols limit the ability for these devices to communicate in a meaningful way. In order to overcome this issue the National Institute of Standards and Technology (NIST) has sponsored an initiative focusing on the progression of technologies related to the Internet of Things (IOT). In specific, NIST hopes to highlight the standardization complexities through prototyping real-world IOT networks. The DHA, seeing the value of IOT, has joined this initiative specifically with the healthcare team. Partnering with research institutes and private companies the DHA is actively working to determine what standards would best apply to IOT inside the healthcare industry. As these standards are solidified over the following three to five years the DHA will be in a knowledgeable position to begin implementing available IOT suites.

Smart Machines - Cognitive Computing (To Plateau in 10 Years): Cognitive computing is the ability of a computer to take on human-like characteristics in its analysis of data. Such characteristics include recognizing the importance of context, changing one's mind as new information is exposed, weighing decisions in light of conflicting information, and understanding ambiguity or uncertainty. This is possible through the computation of context. That is the system measures and weighs all of the influencing factors such as time, place, and personal history to arrive at the best solution for that specific scenario. Therefore, there may be more than one outcome to the same problem, depending on the situation. A cognitive system does not provide a definitive or universal answer, making the machine more human-like. In healthcare, a diagnosis may be completely different for two people who are displaying the same symptoms, because of their varying medical histories, or lifestyles. Smart machines are a form of embodiment of cognitive computing that brings emotional intelligence to working machines. This deeper layer of analysis and understanding allows a robot to perform an active and repetitive task, while also navigating through the current moment and responding to changes in its immediate environment. All of this requires the ability to process information in real-time, understand and resolve ambiguity, delve through masses of data to find meaningful patterns, re-direct courses of action based on new information, and change end goals mid-way through operation. It is a development that goes hand-in-hand with machine learning, yet surpasses it on its way to achieve human-like situational analysis and prescriptive analytics.

Smart machines allow for strategically driving individual health behaviors, through an increased focus on self-health. One of the most valuable opportunities for cognitive machines is their ability to become a centralized source of expertise within any medical field. If a physician could access all of the available information and research regarding a certain medical field, as well as every obscure condition within it, and meticulously compare this data to your symptoms, taking into account your unique medical history and background, all at the point of care, this would improve the DHA's medical facilities' diagnostic accuracy radically. It would even save the enterprise millions of dollars in misguided care or malpractice. This technology also drives healthy behaviors, in support of the DHA's strategic goal to "Improve Healthy Behaviors", by scaling and sharing this expertise with patients and warfighters to increase their access to self-care. In the move towards the "Internet of Things", smart medical devices are meant to enable the consumer to become more independent and self-diagnosing. This is particularly important for the warfighter who is in theater and does not have access to traditional facilities or resources. Smart machines scale the expertise of cognitive computing, and make it available in-field or at home. The ability to provide this open-access personalized care to patients and warfighters, will inevitably make the DHA more valuable to its consumers. Additionally, making the "expert" so readily available will help both patients and doctors be better informed. Overtime, this increased knowledge and insight will augment the human capability as it improves the healthy behaviors of patients and enhances the skillsets of doctors. This particular emerging technology, coupled with the cloud, quantified-self, telemedicine, and the Internet of Things will have the most radical and lasting impacts on healthcare research and development over the next few decades.

Cognitive computing and smart machines are predicted to hit the healthcare industry first, over next two years. Therefore, it is something that the DHA needs to prepare for immediately to realize its full benefits. Cognitive computing will eventually drive the Internet of Things, in-home diagnostics, personalized medicine, and many other transformational healthcare innovations. Specifically, it is predicted that the Internet of Things' system automation will be reliant on cognitive computing. It is also predicted that most cognitive technologies will be pre-packaged as solutions, and will not require users to develop machine learning from scratch. Rather, it will demand a customization skill set. Major companies are building the underlying models, so that users can adapt and run various applications on them. Running these applications requires a massive computing infrastructure, because they are automating, augmenting, and scaling analyses on large amounts of complex data. Most emerging healthcare technologies also benefit from or require implementation of cloud solutions, and current research supports its use within the DHA. Therefore, the transition to cloud-hosting is inevitable and already in place. The most important changes that will need to be prepared for are not technical, but rather functional. Smart machines are destined to interfere with current workforce models. Therefore, policy-makers will have to consider the impact of the new “digital workforce”, and the DHA will have to expand its skillsets to meet more futuristic requirements.

Virtual Personal Assistant (To Plateau in 10 Years): Virtual Personal Assistant (VPA) is an intelligent software assistant, also called an intelligent software agent, cognitive assistant or cognitive agent, which performs a task with minimum specific directions from users. It evolves from the concept of virtual personal assistant, a cognitive assistant that learns and organizes. Intelligent software assistant combines traditionally isolated approaches to artificial intelligence to try to create a personal-assistant program that improves by interacting with its user. In today's health care setting too much of the clinician’s time is spent on administrative tasks, taking away from their main duty of safeguarding the health and well-being of people. Through the use of VPAs, support can be provided to clinicians to simplify interactions and address data-entry into electronic health records (EHRs), provide real-time insight on patients, and even prompt patients for more information when the record does not contain the level of detail needed to ensure first-rate care.

Applications for VPAs within the DHA are valuable and assist the enterprise in strategically addressing improvement of healthy behaviors. VPAs utilize natural language processing and artificial intelligence; cognitive assistants guide patients through a number of healthcare processes. This technology can help answer questions about insurance, find doctors, track personal goals, support adherence to treatment regimens, suggest healthy food choices, send reminders, share lab results, and communicate basic, important pieces of health information all through a mobile device. A VPA solution reduces the amount of time patients and care providers need to spend communicating, allowing both parties to focus on improving health from both a care and behavior standpoint.

In order to realize the full benefits of VPA technology, the DHA will be required to actively plan with developers for full VPA capability. The possibilities aren’t limited to screens or devices; they are limited only by what developers can create to interact with the devices. The DHA will need to plan for and have the requisite technology for the upcoming changes in the voice technology landscape. VPAs can provide value to the DHA and bring the focus from healthcare to health.

8.2.3 Better Care

Data Integration Tool Suites (To Plateau in 7 Years): Data integration tool technology covers diverse styles of integration such as extraction, transformation and loading (ETL), data federation/virtualization, messaging, and data replication/synchronization, which can enable intra-enterprise data sharing. The data integration tool market has traditionally been of a siloed nature. Convergence continues in data integration technology submarkets as vendors organically extend their capabilities by adding other data integration styles and as larger vendors acquire technology to address the range of capabilities. Buyers of data integration tools increasingly seek a full range of capabilities to address multiple use cases since their data integration requirements have become very diverse. Converged tools will include the core elements of data integration, but with the added ability to deploy these elements in a range of different styles, driven by common metadata and modeling, design and administration environments. The goal is to model integrated views and data flows once and to be able to deploy them in various runtime styles — from batch to real time, from bulk to granular, from physical to virtualized.

The use of this technology will allow the DHA to support Tricare Reform within the organization. Data integration tool suites will bring value to the DHA by enabling business intelligence, federated/virtualized delivery of data, master data management, system migration, inter-enterprise data sharing, and the synchronization of data between EHRs (AHLTA, CHCS, Essentris, new COTS product) in real time through interaction with message queues and an enterprise service bus. Today, the DHA has limited stove-piped integration between AHLTA and CHCS with the expensive proprietary product iCANN (formerly eGate). Current gaps exist between Essentris, CHCS and AHLTA. A large gap in theater integration exists between AHLTA and AHLTA-Theater such that providers in the field using AHLTA-Theater, who have connectivity, cannot download a patient’s medical history from the CDR to their local AHLTA-Theater system. This limits the ability of a provider to know the medical history of his/her patient. When the new EHR (COTS product) is stood up beside CHCS and AHLTA, data sharing will be paramount in order to enable the use of and transition to a single EHR system.

Otherwise, providers will still need to use the existing AHLTA and CHCS systems for data that the new COTS system does not have. The cost savings, productivity improvements and flexibility provided by data integration tools will bring substantial benefits to the DHA through sharing and managing data throughout all of its suite of applications including outside Service applications (MEDPROS, MODS, AFCITA, etc), Theater applications (AHLTA-T, TC2) and the new COTS EHR. If the DHA does not select a tool set to enable a standardized methodology of integrating data, it will end up with a hard to maintain, undocumented and costly one-off stove pipes between specific applications without the ability to easily plug in a new system.

The DHA has purchased and invested in an Enterprise Service Bus based on IBM’s WebSphere product. Some next steps are to identify the systems that should communicate with one another based on provider’s workflows (ex. CHCS, AHLTA, Essentris, AHLTA-T, TC2, etc), and then determine the trigger events and the data elements to move between those systems. Existing interfaces should be considered for each system identified. A prototype can be built in the PJITC lab that mimics the desired DHA’s “to-be” architecture, including the federated systems of CHCS and AHLTA to remote AHLTA-Theater and TC2 systems with connectivity. This will provide an ideal environment to build and test data translation services to meet the DHA’s data integration needs.

Information Stewardship Applications (To Plateau in 8 Years): Information Stewardship Applications assist business users who control information assets in an organization to enforce the governance policies on those assets. These applications automate policies and ease the process of monitoring, controlling, analyzing, and enforcing approved standards across business areas and processes. Rather than business users or data stewards shouldering the load of policy enforcement for access to business information assets, Information Stewardship Applications provide a structured, automated environment for access and for compliance with applicable business rules. Use of Information Stewardship Applications increases compliance with information asset governance policies and produces more efficient work on the part of information stewards.

Information Stewardship Applications enable the DHA to improve safety through providing controls for governance policies. The DHA utilizes information and data stewards across its enterprise to enforce its information asset policies. Information Stewardship Applications can maximize the efficiency with which its data stewards operate, allowing the organization to redirect resources to other parts of its global health mission. Additionally, the improved compliance with information security policies provided by Information Stewardship Applications minimizes the human element of accessing information assets, allowing the organization better protect its information. Automated processes within Information Stewardship Applications can ensure that the right people have the right access to the right information, and that only those people will access DHA information assets. This is especially important in the DHA environment, which houses Personally Identifiable Information (PII), Health Insurance Portability and Accessibility Act (HIPAA)-protected information, and protected Department of Defense (DoD) information.

In order to properly field such applications, DHA needs to understand the roles of information stewardship in its enterprise and the capabilities of the current applications on the market. Gartner studies indicate that information stewardship applications are a relatively immature product in today’s market: existing products focus on the needs of IT departments rather than full business entities. Gartner predicts the market will mature sometime in the next 5-10 years. The current technology immaturity presents an opportunity for DHA to engage industry in research and development efforts to tailor the applications to a healthcare-centric environment in order to support its mission.

Information Capabilities Framework (To Plateau in 9 Years): Information Capabilities Framework (ICF) introduces a new way of thinking about an organization’s IT architecture. It eschews the traditional application-centric approach to IT architecting, focusing on the use cases for an organization’s information assets. Emerging use cases and changes to existing use cases drive a need to have the same information assets available across several use cases. The ICF calls for organizations to view their information as a strategic asset on par with more tangible assets such as applications and business processes.

Because of this, organizations must view their information management technologies as a coherent set of capabilities that utilize information assets. This coherent set of capabilities enables the organization to use the same information assets for the widest range of use cases, with distinct applications for healthcare through a focus on.

DHA's IT architecture is currently driven by the many applications currently supporting its strategic objective towards a global healthcare mission. In order to move toward the Gartner ICF, DHA would need to reject this application-centric focus and instead focus on the many various types of data that its users collect. Transactional data from clinic visits, image data from radiology departments, text data from doctors' notes, and documentation data from medical records make up a very small part of the DHA's pool of information assets, but they provide good examples of the types of data in the environment. The ICF calls for DHA to look at these types of data and construct an information management architecture that provides six common capabilities: description, organization, integration, sharing, governance, and integration. As the architecture becomes more robust, it will allow specialized capabilities based on these six common capabilities and will be able to support a broad range of use cases for information consumption.

In order to move toward adopting the ICF, Gartner recommends standardizing information management capabilities in support of closely related initiatives. The emergence of DHA as the unified center of DoD healthcare is a perfect opportunity to engage in such standardization. Leveraging ongoing rationalization efforts, DHA can identify the various information management products and processes that it employs. From there, it can work towards aligning similar tools and processes and identifying and filling capability gaps. Over time, DHA can begin to shift from an application-centric view of its IT architecture to a data-driven view.

Open Data (To Plateau in 9 Years): Open data is data that is made freely available, without discrimination, by individuals, businesses or government organizations for others to use, combine and redistribute as they wish without strict intellectual property restrictions. Open data conditions, at most, generally only require attribution of the original source and sometimes require that any derivative works are also designated as "open." Open data mandates from many national and local governments during the past few years have created a flood of information suitable for economic development, transparency, improved services and safety, public-private partnerships and even the development of new products and services. Open data is important for healthcare, as it directly relates to data sources necessary for innovations and preventative health services.

The use of open data technology allows the DHA to meet the strategic objective of improving primary comprehensive primary care. Open data technology because it will allow the organization to take advantage of open data sources and streams to launch new products, services and businesses models. This technology will aid the agency in supporting the delivery of high-value health care and improving clinical and community preventive services and population health. DHA can expect to better understand its markets at a macro level, glean correlative and even causal relationships between its own business events/performance and external factors, and identify emergent trends earlier. These insights can lead the DHA to improve product and service innovation, better external collaboration and improve customer service. In addition, open data can provide the raw materials for creating new information-based products and services.

As a business resource, information has the benefit of being inexpensively curated, cheaply stored and transported, and easily combined. Open data, however, lacks the unique quality of scarcity and depletion that other resources do. So those developing new products or services based on open data must realize that others can easily replicate their ideas. Because open data is a critical component of most advanced analytic solutions; that is, those that target diagnostic, predictive and prescriptive outputs, DHA should ensure a sufficient level of awareness about the range of open data sources available, and their potential by designating a "data curator" role. Data curators should be aware of the various directories of open data; for example, Data.gov in the U.S. (and similar sites for other countries), and services such as Programmable Web, Quandl, DataMarket and Windows Azure Marketplace. DHA should be cautious regarding the expectations that may be set (or assumed) about the data's recurrent periodic availability, accuracy/validity and completeness. It is imperative for DHA to take care not to expose publicly identifiable data about individuals, either directly or indirectly, in such a way that data sources can be triangulated or matrixed. This can be done by carrying out a risk assessment, and establishing controls that govern the way that data (intended as open data and connected with open data) is created and consumed. This should be implemented by DHA during open data planning, and on an ongoing basis.

Security Intelligence (To Plateau in 10 Years): Security Intelligence comprises a set of concepts, tools, and methodologies to analyze integrated and correlated security and contextual information from various sources with an objective to improve an organization's overall security posture. The goal of Security Intelligence concepts are to consume and analyze data from a number of disparate security appliances, analyze the data across the entire security footprint, and provide a holistic view of the vulnerabilities in a computing environment to efficiently direct actionable tasks. Such concepts are Security Information and Event Management (SIEM), Anomaly Detection, Vulnerability Management, Log Management, and Forensics. With an enterprise focus, Security Intelligence tools will play a major role in the DHA's future Cyber Security efforts. Security Intelligence provides three key areas of benefit for the DHA Enterprise.

Security Intelligence tools provide both proactive and reactive benefits to the enterprise, ultimately enabling the DHA to meet its strategic goal of improving safety. Security Intelligence Tools proactively monitor the entire IT enterprise, model IT behaviors, and provide threat analysis. DHA's global IT enterprise requires constant vigilance and utilizes a plethora of monitoring technologies. Based on the network and system models, Security Intelligence tools provide real-time alerting when anomalous behavior is detected. When alerted, DHA personnel can effectively perform triage activities, restrict access, or disconnect affected systems or networks, and engage other incident response tactics in a near real-time manner. Security Intelligence tools can provide a basis for communication and reporting across the global DHA IT enterprise. Centrally managed tools will provide a holistic view of DHA's technology landscape, and comprehensive monitoring and alerting systems will allow leaders to understand the enterprise's security posture.

To fully utilize these technologies, and to ensure the highest assurance of data availability, integrity, and confidentiality, DHA must implement a consolidated Security Intelligence capability into all its programs and systems. Implementing a converged and consolidated capability will streamline the DHA security decision support system across the Global Enterprise. As vulnerabilities are uncovered, leaders will need to communicate with those responsible for vulnerable systems and networks to ensure that proper mitigation strategies are in place. In turn, local IT staffs will need to communicate their mitigation strategies to leadership to assist in DHA's overall Security Intelligence.

Smart Workspace (To Plateau in 10 Years): Smart Workspaces represents an environment where employees interact with programmable devices within their environment. Example elements include meeting rooms, cubicles, digital displays, medical equipment and mobile devices, all programmable and interactive. The capability utilizes many of the same basic technical components as the internet of things. It requires a high level of protocol interoperability. This means that the different devices within a particular workplace must all communicate using a unified protocol. Alternately, devices could communicate using a central application that can conduct translation, commonly known as an ESB. Within healthcare this capability would support functionalities such as descriptive equipment. When a user approaches a piece of medical equipment, the device could access its schedule and notify the user when it is available or when it is scheduled for maintenance next. Smart workplaces will also greatly improve safety concerns in healthcare. Due to the fast paced nature of healthcare within hospitals the use of augmented reality devices connected to the network could alert doctors to matching issues such as administering a drug to the wrong patient.

The Smart Workspace enables the DHA to meet its strategic goal of providing more comprehensive primary care. Within the DHA, Smart Workspace technology has the capability to supplement the immense knowledge of primary care physicians and assist in the difficult triaging process of primary care. Imagine a hospital environment where a nurse can use augmented reality glasses to triage a skin rash by comparing pictures shown in a heads up display (HUD). Once determining what specialty doctor is needed, the nurse uses the in room system to find an available doctor and dials him in over Bluetooth headphones to get concurrence on the diagnosis. Finally, the doctor is able to project a pre-compiled presentation of next steps for the patient. The entire process was documented by in-room cameras that automatically filtered out sensitive footage. This type of connected work environment will provide an immense improvement in comprehensive primary care by increasing the fluidity of technology support within the MTF.

In order to research, field and benefit from the capabilities provided by Smart Workspace, the DHA and commercial organizations have a number of technical hurdles to overcome. The most imminent is the issue of standardization. Currently, many of the different technology devices that would make up this IoT within the workplace either have proprietary interfaces or no interface at all. In order to overcome this issue the DHA and commercial companies looking to offer Smart Workspace technology must work together to create software development kits (SDKs). This will require a significant investment on the part of the device producers and will inevitably result in proprietary functionality. To address this, a micro-ESB architecture may be needed to implement at the Military Treatment Facility level.

8.2.4 Lower Cost

Machine-to-Machine Communications (To Plateau in 7 Years): Machine-to-machine communication, or M2M, is a general term for a type of technology that allows multiple devices to communicate with one another. These devices can either be wired or wireless. The more recent developments have been surrounding wireless communication, due to increased interest in mobility and telemedicine. M2M technologies play a supportive role, rather than a leading one. Effective M2M solutions are absolutely critical to the success of the Smart City and Internet of Things initiatives, which rely on interconnected medical devices and distant two-way communication. Other technologies that rely on M2M are smart grid technologies, connected smart grid sensors, and real-time monitoring of distributed networks. The ability to communicate between points of care, and more importantly between medical devices at those points of care, is one of the main duties of the DHA’s medical facilities. M2M solutions can greatly impact the success of almost all operational technologies and dramatically improve the efficiency of device management, therefore they must be planned for and implemented carefully. M2M solutions are becoming increasingly more specialized for their respective industries, and at the forefront of this trend is the healthcare industry.

For the DHA, M2M solutions serve as a mode for reaching the strategic objective of optimizing and standardizing healthcare access and care processes. M2M solutions will make up the logistical backbone of the Internet of Things and Smart City technologies. As more medical devices emerge, the method with which they communicate with one another becomes more complex. Today, devices exist that can comfortably record micro data on human beings on a daily basis, as well as interpret mass amounts of data, create meaning from it, and communicate real-time medical decision support to patients in-home. Technology is advancing rapidly, and devices are becoming capable of almost anything, but this rapid innovation will be of no use until the new data that is revealed can be properly and securely transferred between data consumers. In wartime, soldiers require immediate care from the other side of the globe, in very low or no-communication areas. It is the DHA's responsibility to not only advance medical capabilities at home, but to find the solutions necessary to bring real-time advanced medicine to theater as well. As medical devices and medical data become more complex, it is increasingly necessary to be on the forefront of machine communication, as it controls the DHA's ability to bring medical innovation to the consumer, be it a Warfighter in field, or a veteran at home.

While M2M technologies have been a topic of research and development for quite some time, there is still much progress to be made. A major factor hindering mass implementation of M2M communication solutions is lack of standardization. M2M devices must be of the same or similar type in order to communicate with each other properly. As the capabilities and complexities of medical devices increase, so does the diversity between them, and the limitations on their ability to properly merge with other devices. This is an issue that needs to be addressed in order to realize the full benefits of this technology. While some components of M2M technologies are already maturing; for instance RFID, short-range communication, and mobile technologies, there are still many logistical gaps preventing M2M services from being both cost-effective and easily deployable. Balancing a machine's simplicity, for the purpose of standardization and ease of communication, with its advanced capabilities and complex data networks is a challenge that needs to be considered at each stage in the design phase as the DHA enters the age of Quantified Self and Internet of Things.

Adaptive E-Textbooks (To Plateau in 8 Years): An adaptive e-textbook offers a learning experience that personalizes the learning process in higher education. Powered by technology, an adaptive e-textbook offers customized student interactions with the digital content based on individual and aggregate achievement data plotted against a learning map. Adaptive learning is being implemented in classroom learning, distance learning, and tutoring scenarios. Today companies offer adaptive learning systems and applications, making this form of personalized learning relatively mainstream. The key elements of adaptive learning done through interactions with e-textbooks are learning or subject-specific knowledge maps, content, achievement data (individual and aggregate) and algorithms that create individual matches of content and student. This technology is currently in the emerging level of maturity. The benefit of an adaptive e-textbook is that it utilizes personnel data to create a personalized lesson plan for effective learning and training.

It is important for the DHA to implement adaptive e-textbooks because it can drastically improve training for employees and personalize the learning process to close any existing knowledge gaps that may exist at the individual level.

Closing these knowledge gaps will contribute to achieve the Federal health IT strategic object of strengthening healthcare delivery and support the delivery of high-value healthcare. This technology can lower costs for the DHA by aligning incentives to achieve outcomes. Adaptive e-textbooks create more efficiency in the learning process through standardization, but at the same time still provide personalized support to the user by identifying and assessing their knowledge of the curriculum. These adaptive e-textbooks are also more affordable than buying textbooks. As a result, the DHA will see lower costs for education materials and increased knowledge from personnel.

The DHA can implement adaptive e-textbooks successfully by planning to identify data policies and create a content vision. Security is a big concern for adaptive e-textbooks, and IT leaders must remain vigilant in safeguarding personnel data until proper measures are put in place that offer security and assurances that data will not be used for anything other than adaptive learning applications. Data policies should identify the amount of data necessary for successful implementation and statistical validity and the privacy safeguards that need to be implemented. Content vision can be formed by speaking with leaders in the adaptive space to gauge the impact of current learning materials and what can be done to evolve material into becoming adaptive-ready. From there the DHA would need to build uniform platforms to create, deliver, and assess new adaptive material and understand its interaction with current learning management system investments.

Cost-to-Serve Analysis (To Plateau in 8 Years): Cost to serve (CTS) is the analysis of end-to-end supply chain costs and their relationship to services provided internally and to customers. CTS provides fact-based insight into the "real" costs of supporting varying supply chain complexity levels for different customers, products and routes to markets. Until now, few companies have attempted full CTS analysis and in most cases, companies have used Microsoft Excel and off-the-shelf business intelligence platforms to support these exercises. In recent years, Gartner has seen the emergence of more packaged tools that can support full, early-stage CTS efforts. This directly relates to healthcare services, as CTS has the ability to track and relay complex healthcare costs and can aid in cost-driven decision making processes. CTS tools are an important technology because they convey the operations/supply chain modeling side and try to marry it to the specific supply chain cost drivers. This helps to derive costs that are more representative of what actually happens in the supply chain as products and customer orders travel along it.

For the DHA CTS tools enable optimization and standardize to access and other care support processes, by providing detailed supply chain analysis to address processes and associated costs. CTS tools will help DHA to increase access to and usability of high-quality electronic health information and services, as well as accelerate the development and commercialization of innovative technologies and solutions. CTS analysis can also reveal if DHA is over-serving some customers while underserving others. Short-term benefits will quickly accrue from getting visibility of the baseline cost model and the associated, easily attainable opportunities, such as distribution flow models, strategic sourcing, postponement opportunities, product and customer portfolio changes, as well as pricing and promotional changes. Longer-term benefits will come from areas such as targeted capital investment in the supply chain, higher-quality input into annual budgeting and strategic planning exercises, and by supporting a segmented supply chain strategy.

To date, most CTS initiatives rely on Excel to perform basic analysis. However, CTS capabilities, often supporting more mature sales and operations planning (S&OP), have been emerging during the past couple of years, frequently as part of a co-development program between early adopters and the vendor. DHA will benefits from vendors with strong supply chain modeling capabilities that can also bring detailed costing and financial analysis to bear on those operational models. Despite the relative newness of CTS technology (beyond traditional ABC), it warrants being evaluated by companies that have grown out of their Excel-based solutions. With the right data, processes and organization, this technology can provide immediate benefits to the DHA by making effective supply chain decisions at the strategic level and re-evaluating such strategic decisions on a timely basis.

Social Network Analysis (To Plateau in 8 Years): Social Network Analysis (SNA) tools are part of an emerging subgenre of Social Analytics that maps patterns of relationships among people on social media sites and, more importantly for IATDD, on internal employee networks. These tools allow organizations to understand the formal and informal communication structures supporting users in order to better engage with and potentially modify behaviors. Gartner estimates that, by 2016, 50% of large organizations will have internal Facebook-like social networks yet so far companies have made only limited progress towards developing methods for deriving insights from social network analysis activities inside the enterprise. SNA involves collecting data from multiple sources (surveys, emails, blogs, networks, and other electronic artifacts), analyzing the data to identify relationships, producing graphic visualizations, and then mining for new information such as the quality or effectiveness of communication patterns. Research points to tangible benefits of SNA for the MHS including the exposure of informal decision making structures, discovery of causal relationships, increased transparency into communication channel effectiveness, and the pinpointing of employees that serve as information bottlenecks or accelerators.

SNA tools will support the DHA in reaching its strategic objective to align incentives to meet objectives. Within IATDD specifically, SEMOSS will serve as the critical infrastructure for accelerating the use of Social Network Analysis. By building upon our existing capabilities to visualize duplicative project work, SEMOSS could be enabled to measure interactions among MHS employees, contractors, and employees as we host and grow ideation outreach campaigns. By analyzing which users are posting, liking, or commenting on various ideas, we can build better campaigns in the future by more directly pinpointing the informal subgroups which are most interested in a particular topic. Moreover, by building and piloting SNA tools for outreach campaigns, IATDD can serve a pivotal role in developing SNA capabilities for the MHS overall. By conducting analyses on the communication between providers, patients, and doctors in the MHS enterprise, SNA can enable the government to cut costs, increase communication effectiveness, and accelerate technology diffusion into the HIT ecosystem.

To implement the usage of SNA tools, the DHA will be required to be actively engaged with social media outlets. The DHA will need to align user information with predictive health behaviors. Mechanisms for data tracking and storing are required as tools. In addition to social media data monitoring tools and capabilities, the DHA needs to plan for the growth of social media and increasing data inputs. The enterprise needs to align with the future of changing social communication and its value in driving need based services.

Prescriptive Analytics (To Plateau in 9 Years): Prescriptive analytics were discussed briefly earlier in the document, with reference to the four to six year time frame, but it is predicted to make an even stronger presence by 2023. It is the third and final stage in the progression of analytics capabilities. Traditionally, organizations begin with descriptive analysis, reviewing expenditures for example. Organizations next move to a predictive capability, forecasting expenditures so that budgets can be properly allocated. Prescriptive analytics is the growth on this analysis to actually make decisions, taking in information about goals, objects and available funds and recommending how to effectively allocate expenditures over a given time period. To achieve this goal prescriptive analytics marries computer science, statistics and math to implement machine learning techniques on troves of enterprise data. In healthcare, the data crunched and outcomes decided can be around both the patient’s health and the organizations operating capabilities. Analyzing a patient’s EHR data could one day create comprehensive care plans by coupling the information with medical research and similar cases inside the same institute. On the other hand, healthcare operations are notoriously complex and therefore stand to benefit a great deal through automated capabilities such as optimized scheduling, capacity planning and future investment strategies.

The MHS has made it a strategic priority to improve condition-based quality of care. Prescriptive analytics provides a means to achieving this goal by offering providers a recommended treatment plan which is more effectiveness and achieves better patient satisfaction. Prescriptive analytics tools can consume information about in-facility care episodes coupled with telehealth data and research information to recommend the most effective treatment plan specific to that patient. At a more macros level, this same ability to learn from the past and apply to the goals of the future can be useful to the complex resourcing problem afflicting an organization with over 400 locations around the globe. Similar to how shipping companies have adopted complex prescriptive analytics models to analyze past shipping patterns and recommend future plans, the MHS can analyze the use of people, machines and facilities with the goal of increasing efficiency and effectiveness. The key to prescriptive analytics is access to organized data. This data does not necessarily need to be in one location but it must be standardized and connected in a logical fashion. The use of data architectures such as SOA and Logical Data Warehouses will enable prescriptive analytics applications to query the data necessary to run complex models. These architectures are advantages to prescriptive analytics because they promise a SSOT. This means that for any particular piece of information, a patient's date of birth, there is only one place it can be retrieved from. It ensures that the data is both clean and not contradictory.

APPENDIX I: LONG RANGE TECHNICAL ARCHITECTURE STRATEGIC IMPLEMENTATION MEMORANDUM (11/19/2015)

MEMORANDUM FOR: SEE DISTRIBUTION

SUBJECT: Long Range Technical Architecture Strategic Implementation

In accordance with the authority in Department of Defense (DoD) Directive 5144.02, the Defense Health Agency's (DHA) Chief Information Officer (CIO) is hereby establishing the attached Long Range Technical Architecture (LRTA) Strategic Plan as the overarching digital business transformation plan for the DHA. The strategy establishes an Information Technology (IT) framework for current and future Defense Health Program (DHP) investments for the DHA Health Information Technology Directorate's (HIT) Area of Responsibility (AOR). The strategy was developed keeping in mind key drivers including the (1) Office of the National Coordinator (ONC) Federal Health IT Strategic Plan for 2015-2020, (2) the October 2014 Military Health System (MHS) Strategic Plan, and (3) existing business process functional gaps identified, validated and scored by the MHS Chief Medical Information Officers.

The LRTA Strategic Plan was developed using a data-driven analytics approach that will allow HIT to better predict the most strategic solution sets for implementation in the future, while addressing both immediate and long-term needs, thereby shifting the focus of change in our enterprise technical architecture from reactive to proactive. The LRTA uses current functional needs as near-term drivers and enterprise strategic objectives as long-term drivers, connecting the two with emerging 'disruptive' solutions that will more efficiently help the DHA reach its long-term goals. In this way, the MHS will be able to establish a technical backbone that better supports its evolving needs.

As of the release of this memorandum, the DHA CIO directs that all HIT Divisions leverage the LRTA for technology investment and architectural implementation alignment. The MHS Chief Technology Officer (CTO) will be reaching out to HIT Divisions to actualize and facilitate adoption of the LRTA by linking existing technologies and systems to the recommended technical portfolio identified. After identifying specific technical use cases, the CTO's office will work with stakeholders to architect and plan for future state technical transition. HIT Division Chiefs will prepare their technical resources to participate in this exercise and support LRTA actualization.

This memorandum applies to the HIT and IT market spaces that fall under the DHA HIT's AOR and their respective DHP IT investments.

Responsibility for the attached LRTA resides with the MHS CTO, Mr. Mark Goodge. Mr. Goodge may be reached at (703) 681-6746, or Mark.Goodge.civ@mail.mil.

Signed by David M. Bowen
Director, Health Information Technology
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DEFENSE
HEALTH AGENCY

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David M. Bowen
Director, Health Information Technology
Chief Information Officer

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Long Range Technical Architecture

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Deputy Director, Health Information Technology Directorate
Innovation and Advanced Technology Development Division
Portfolio Management and Customer Relations Division
Infrastructure and Operations Division
Solution Delivery Division
Information Delivery Division
Cyber Security Division

APPENDIX II: ACRONYMS

A	
A	Advanced Technology Development
API	Application Program Interface
ASD	Assistant Secretary of Defense
B	
BAA	Broad Agency Announcement
BEA	Business Enterprise Architecture
BLOBs	Binary Large Objects
C	
CHCS	Composite Health Care System
CONOPS	Concept of Operations
COTS	Commercial Off-The-Shelf
CUI	Common User Interface
D	
DCOM	Deputy Chief Management Officer
DHA	Defense Health Agency
DHMSM	Defense Healthcare Management Systems Modernization
DMLSS	Defense Medical Logistics Standard Support
DoD	Department of Defense
DOTMPH	Doctrine, Organization, Training, Materiel, Leadership, and Education
E	
EAC	Enterprise Architecture Committee
EHR	Electronic Health Records
ESB	Enterprise Service Bus
ETA	Enterprise Technical Architecture
F	
FOC	Full Operating Capability
G	
GAO	General Accountability Office
GLI	Geospatial and Location Intelligence
H	
HA	Health Affairs
HIT	Health Information Technology
I	
IATD	Innovation and Advanced Technology Development

IDA	Institute for Defense Analyses
IDIQ	Indefinite Delivery Indefinite Quality
iEHR	Integrated Electronic Health Record
IMS	Integrated Master Schedule
IOC	Initial Operating Capability
IPO	Interagency Program Office
ISA	Information Stewardship Applications
J	
JIE	Joint Information Environment
L	
LAN	Local Area Network
LRTA	Long Range Technical Architecture
M	
MHS	Military Health System
N	
NGA	National Geospatial-Intelligence Agency
O	
OSIMM	Open Group Service Integration Maturity Model
P	
PCAST	President's Council of Advisors on Science and Technology
POM	Program Objective Memorandum
R	
R&D	Research and Development
RDBMS	Relational Data Base Management Systems
RDT&E	Research, Develop, Test,
S	
SEMOSS	Semantic Open Source Software
SOA	Service Oriented Architecture
SOE	Service Oriented Enterprise
SSOT	Single Source of Truth
T	
TWG	Technical Working Group
V	
VA	Department of Veterans Affairs

APPENDIX III: REFERENCES

Contact DHA.IATDD@mail.mil for a list of references.

APPENDIX IV: TECHNICAL STANDARDS FORECAST

Please email DHA.IATDD@mail.mil for the latest version.