Strategic Options for the Modernization of the Indian Health Service Electronic Health Record

ANALYSIS OF ALTERNATIVES

FINAL REPORT

06-Jun-2019

DISCLAIMER:
The Analysis of Alternatives (AoA) assesses options for modernization of the existing IHS HIT system. The assessment contained in this report does not constitute a decision by HHS or IHS regarding the final determination with respect to the IHS HIT modernization effort, and no specific recommendation is made on future choices.

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1.0 Executive Summary

This Analysis of Alternatives (AoA) report is presented as a key deliverable of the HHS/IHS HIT Modernization Research Project ("Project"), sponsored by the Department of Health and Human Services (HHS) Office of the Chief Technology Officer (OCTO) on behalf of the Indian Health Service (IHS). In carrying out its mission to raise the health status of American Indian and Alaska Native (AI/AN) people to the highest level, the IHS utilizes the Resource and Patient Management System (RPMS). RPMS is a comprehensive suite of applications offering a broad range of clinical, business, and public/population health capabilities aligned with IHS operations. The system was internally developed by IHS, with significant historical contributions from the Department of Veterans Affairs (VA). It is in nationwide use by all IHS directly operated facilities as well as a majority of tribal and urban Indian health care programs. A number of factors, including the decision by the VA to replace its legacy health information system with a commercial product, led to the initiation of this Project in 2018.

The HHS/IHS Modernization Research Project team defined modernization as follows:

Modernization:
An organizational endeavor which brings a health IT system to a new state that is continuously evolving. It is people- and process-centric; it is adaptive, progressive, and aims to rethink and redefine the problem to evolve a system and its capabilities to deliver value to its users and stakeholders. It is resilient, and able to withstand forces from within and without. It is synergistic with the clinical vision for the healthcare system.

The above definition is necessarily high-level and aspirational; it sets the context for subsequent in-depth analysis of the alternatives selected for consideration.

The AoA is designed to be a comparison of approaches**,** not solutions. The AoA identified and assessed high-level options for IHS HIT modernization. The modernization definition framed the analysis and findings from multiple knowledge streams of the Project, including site visits, a nationwide data call, stakeholder interviews and listening sessions, a literature review, consultation with industry experts, and a detailed analysis of current utilization of RPMS using principles of Human Centered Design (focusing on people, process and technology). The

identification and evaluation of alternatives relied upon these Project work streams as well as published previous studies, consultations with preeminent subject matter experts, in-depth analysis of options and a cost analyses.

IHS HIT Strategic Modernization Options	
Option 1: Stabilize RPMS	• Maintain current technical architecture and deployment approach • Enhance applications as needed and as resources allow, including new graphical user interfaces • Improve training and support resources to optimize utilization
Option 2: Renew RPMS	• Apply state-of-the-art methods to "wrap & renew" legacy apps with APIs/service tier • Allow creation of new functions and user interfaces using modern technologies and languages • Migrate to consolidated databases and cloud hosting
Option 3: Selective Replacement	• Identify preferred "best of breed" COTS solutions for specific domains (e.g., lab, billing, etc.) • Selectively integrate these using standards-based service tier technologies • Retain and enhance preferred RPMS apps/functions using "wrap and renew" approach
Option 4: Full Replacement	• Identify and implement preferred pre-integrated "best of suite" offerings • Determine approach to retention/transfer of legacy data to new system • Some features of RPMS unique to IHS may need to be retained or redeveloped

Appendix E contains a crosswalk between the AoA assumptions and the Data Call and Site Visit knowledge-streams. Note that the Data Call knowledge stream collected opinions from 1,381 individuals (I/T/U health care facility personnel throughout the country) about the electronic health record (EHR) system. Respondents indicated a readiness for modernization; RPMS users saw themselves as more lacking in the areas of IT staff, hardware, network capability, Wi-Fi capability, and data security.

Using this knowledge coupled with guidance published by HHS and the previous VA HIT modernization AoA, the team developed four high-level Alternatives (called Options) as well as a series of criteria to help evaluate these four categories. The identified options in table 1-1, as well as the assessment criteria, were informed by the Project's Technical Advisory Commission and Steering Committee.

Table 1-1

Assessment Criteria and Evaluation Overarching evaluation categories include business requirements, program management, technical considerations, and modernization of the environment. Within each category, specific criteria were selected and scored based on alignment with and support for the overall modernization goal.

The four evaluation categories are not equally important to the modernization effort. The following weights were assigned based upon the categories importance to the success of HIT modernization:

Evaluation Category	Weight Multiplier (sum to 100)
Business Requirements	35
Program Management	15
Technical Considerations	30
Modernization of the Environment	20

Table 1-2

The maximum score attainable is 300. Table 1-3 displays the results of the weighted assessment of all criteria in all categories. A more detailed discussion of the scoring methodology is provided in section 5.0, and an expanded view of this table appears in the Appendix 1 -- Non-Cost Scoring Table.

Non-Cost Analysis		Weighted Scores			
Criteria Category	**Category Weight (sum to 100)**	**Option 1 -- Stabilize RPMS**	**Option 2 -- Renew RPMS**	**Option 3 -- Selective Replacement**	**Option 4 -- Full Replacement of RPMS**
Business Requirements	35	56.0	94.5	101.5	91.0
Program Management	15	30.0	27.0	24.0	30.0
Technology	30	30.0	60.0	78.0	78.0
Modernization	20	23.3	46.7	26.7	36.7
TOTAL SCORE (maximum 300)		**139.3**	**228.2**	**230.2**	**235.7**

Conclusions and Recommendations:

Option 1 - Stabilize RPMS - is not viable. This option would be unsustainable in the longer term and would not support the mission of IHS.

All three of the other options - **Renew RPMS**, **Selective Replacement**, and **Full Replacement** - are alternatives that can be considered by HHS and IHS. The AoA did not identify a clear distinction between these three approaches based upon their potential to support the modernization goals of the agency. The close scoring in the AoA final calculations provides IHS considerable flexibility in its path forward. Choosing between these options will require additional delineation and prioritization of functional and technical requirements, evaluation of the infrastructure landscape, and an understanding of fiscal and human constraints currently and in the future.

A number of commonalities, again informed by multiple data points across the project, will clearly have to be part of **all** of the alternatives, including Option 1:

Governance - An enterprise governance structure supported by the active engagement of informed, experienced programmatic and technical leaders is a *sine qua non* for a modern enterprise health information system. The organization must provide leadership and standardization around technical issues such as IT security policy, access controls and database management. It must establish and guide best clinical practices in configuring and using HIT systems.

Technical Infrastructure - A 21st century modernization approach requires significant infrastructure to facilitate centralized support, cloud hosting, health information exchange, telehealth services, or all of the above. The geographic realities of AI/AN communities pose stark challenges, and must be proactively addressed to minimize the significant limitations of infrastructure on IHS' modernization options.

Human Resources - The human resources necessary to optimize, configure, train and support the system on a national level must be available. These include technical as well as domain-specific resources, ranging from the front office to the pharmacy; they **must** include a cadre of clinical informaticians. The choice of the modernization solution may impact the distribution of these resources, whether central, regional, or local, but these resources will be essential for any option's success.

Funding - Recurrent funding is essential to modernization. Health information technology modernization is not a project or an event, but an organizational process that requires ongoing financial support. IHS has accessed nonrecurring appropriations in the past to make significant advances in RPMS capabilities; however, this model is unsustainable and cannot support the critical mission of the agency.

In summary, IHS is not constrained to a single approach for the modernization of its HIT system; the Agency can choose from multiple paths forward with an expectation of success. Framing the value of IHS HIT with the context of health equity, tribal sovereignty, and the IHS mission will facilitate the agency in its decision-making.

2.0 Indian Health Service

The IHS is the principal federal health care provider and health advocate for American Indian people. The agency provides a comprehensive health service delivery system for AI/AN people who are members of 573 federally recognized tribes across the U.S.[1] The mission of the IHS is to raise the physical, mental, social, and spiritual health of AI/AN people to the highest level.

The Indian health care system is comprised of hospitals and clinics directly managed by the IHS, hospitals and clinics operated by self-governance tribes, and a small number of urban Indian health centers. Collectively, these are known as the I/T/U. More detailed information on the location and types of facilities and services is available through the IHS website www.IHS.gov/aboutihs/

Table 2- 1

- **Facilities** *(as of October 1, 2018)*:

Type of Facility	IHS	Tribes
Hospital	24	22
Health Center	50	285
Health Station	24	54
Alaska Village Clinic	0	127
School Health Center	11	5
Youth Regional Treatment Centers	7	5

[1] http://www.ihs.gov/aboutihs/

3.0 Health Information Technology in IHS

Resource and Patient Management System

The RPMS had its origins in the early 1970s. RPMS is a comprehensive electronic health information system created to support the delivery of high quality patient, population and public health care services at hundreds of I/T/U health programs across the country.

RPMS consists of nearly 100 software modules used to gather, store, and display clinical, administrative, and financial information on patients served by a clinic, hospital, or remotely through the use of telehealth and/or community and home visit practices. Since the IHS adoption in the 1980s of the core database and programming technologies used by the VA, each agency has both independently and collaboratively developed its applications in response to its own internal and external requirements. Applications developed by IHS and adopted in VA include the Patient Care Component (PCC), the Health Summary, the Women's Health package, and the Immunization Tracking package. The IHS concurrently adopted a large number of infrastructure and clinical ancillary systems from the VA's VistA suite, including Inpatient and Outpatient Pharmacy, Lexicon, Text Integration Utility, Clinical Reminders, Laboratory, Radiology, VistA Imaging, and Bar Code Medication Administration, among others further detailed in Appendix C.

Information that is recorded at each of the various service points is available to all of the software applications, regardless of where the data are entered or which application is used. Clinicians and other multidisciplinary members of the health care team have quick and easy access to the information that is required to provide efficient and high-quality health care to AI/AN patients. Population and case management applications allow providers and case managers to identify and address gaps in care across populations of patients. These applications support the public health mission of the agency and the commitment to achieve health equity. Interoperability capabilities designed to facilitate the sharing of patient information among I/T/U facilities as well as with external care providers have been developed in recent years but are

currently incompletely deployed. Numerous querying and reporting tools are available to health care providers, business office managers and other administrative staff, to enable analytics, quality and performance assessment, and unique government reporting requirements.

Since the passage of the HITECH Act in 2009 and the numerous regulatory requirements that followed, there has been an explosion of development in the national health information technology industry, including IHS. RPMS became the only government developed system certified according to ONC criteria for both the 2011 and 2014 Editions. However, insufficient funding available to the IHS Office of Information Technology (OIT) since the five-year surge of the Recovery Act and subsequent Meaningful Use incentive payments has resulted in an inability to adequately support operations and maintenance for RPMS. The development of new capabilities and critical patient safety updates have been constrained. The system's certification has lapsed, as RPMS does not meet 2015 Edition certification requirements for participation in the Centers for Medicare and Medicaid Services (CMS) quality payment programs.

The last comprehensive Operational Analysis (OA) of RPMS was completed in 2014. Customer satisfaction ratings from the OA indicated a perception that RPMS is antiquated and in need of modernization. These findings have been reinforced by data gathered as part of the current project, most starkly by the results of the Data Call but also information from site visits and stakeholder interviews.

Many tribal and urban Indian healthcare entities have chosen HIT alternatives to RPMS. The Data Call and Site Visits knowledge streams of this project helped identify the business drivers for such moves. Reasons are diverse and include dissatisfaction with the appearance and usability of the various graphical and character/menu-driven user interfaces, a distinct lack of functionality to support multiple areas of care, and a concern that the revenue cycle applications are "leaving money on the table."

All of these factors, plus the VA modernization decision discussed below, make this an opportune time for HHS and IHS to collaborate on thoughtful consideration of IHS' HIT modernization options.

Implications of the VA Modernization Decision

In 2017, the VA announced it would transition from its legacy electronic health record (EHR) system, VistA, to a commercial off-the-shelf (COTS) solution over the course of ten years. This decision has implications for IHS; RPMS includes a number of foundational infrastructure and clinical applications derived from VistA. IHS is faced with an eventual need to assume or outsource support for these applications or replace them with alternative solutions. This fact is one of the principal drivers for the HHS/IHS HIT Modernization Project ("Project").

Many differences exist between the Indian Health Service and VA clinical care models. The organizational and political milieu that comprises the IHS/Tribal/Urban (I/T/U) healthcare ecosystem is fundamentally different than the VA. IHS and VA provide care to different populations in different settings with different health care teams, different missions, and different funding.[2] [3] The Indian health system is a diverse federation comprised of hospitals and clinics directly operated by the IHS, hundreds of facilities (including 22 hospitals) operated by self-governance tribes, and 41 small clinics serving mostly Indian people in urban areas.[4] This diversity has many consequences impacting the paths to HIT modernization. In addition, as evidenced by the following graphic, large funding per capita differences exist historically as well as currently between the two Agencies.

[2] https://fas.org/sgp/crs/natsec/IF10530.pdf

[3] https://www.va.gov/vetdata/docs/pocketcards/fy2019q3.PDF

[4] https://www.ihs.gov/newsroom/factsheets/ihsprofile/

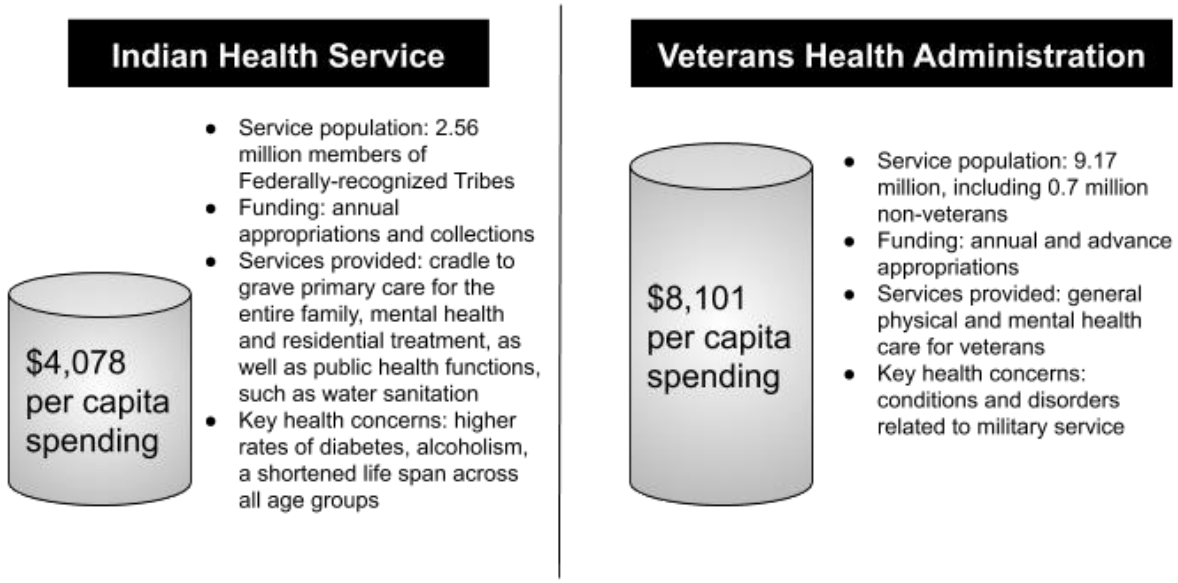


Figure 3-1

Inpatient	Facilities	Admissions/Yr	Adm/Site/Yr
IHS/Tribal	46 (~1,200 beds)	39,367 (2017)	856 (2.3/day)
VA	170 (>20,000 beds)	699,000 (2015)	4112 (11.3/day)
Ambulatory	**Facilities**	**Visits/Yr**	**Visits/Site/Yr**
IHS/Tribal	609	13.75 million (2018)	22,578/yr 62/day
VA	1243	95.2 million (2015)	76,589/yr 210/day

Table 3-1 Comparison - IHS/Tribal and VA Healthcare Facilities

Characteristics Unique to IHS

IHS facilities provide cradle-to-grave care. The IHS HIT systems support care that is normally not offered at VA including:

- Pediatrics including well child care
- Complex childhood immunization tracking and reporting
- Prenatal, and at many locations, obstetrical care

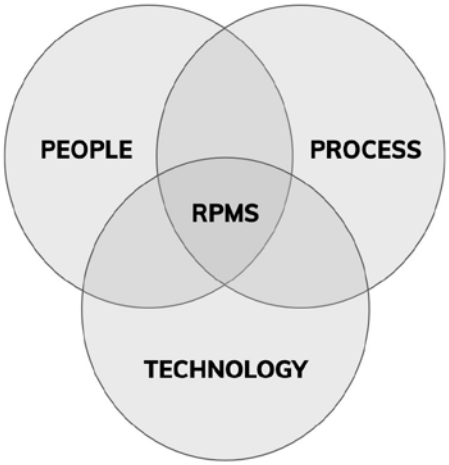
Overall, IHS and tribal health care facilities are fewer in number, smaller in size, and more rural compared to the VA. Ten of the 46 IHS and tribal hospitals are certified Critical Access Hospitals. The small size and staffing constraints of hospitals in Indian country often creates challenges for implementation, training, and management of complex inpatient information systems.

I/T/U facilities are dependent upon third-party reimbursement, including Medicare, Medicaid, VA, and private insurance. These facilities must have capable systems in place to maximize their ability to support billing and collections.

IHS facilities participate in a variety of Quality Payment Programs (QPP) sponsored by the CMS. IHS and tribal organizations have historically benefited financially and clinically from using ONC certified HIT systems as well as reporting on various QPP measures.

IHS utilizes a community-oriented primary health care model, including integration of community-based services such as jail and school-based clinics, sanitation facilities, rabies mitigation, etc., into the care delivery system. IHS is committed to supporting the Patient Centered Medical Home (PCMH) model at IHS ambulatory care facilities. Any HIT solution for IHS must support these care models, as well as appropriate integration and communication of relevant community-based activities to health care teams. IHS HIT solutions have historically been attentive to the realm of social determinants of health (SDOH) data sets, and ensured that these data fields were developed and included in the HIT approach to public and population health.

4.0 Objectives of the IHS HIT Analysis of Alternatives



Advances in delivery and utilization of health information technology -- cloud services, mobile devices, third party apps, interoperability resources such as HL7 FHIR5, precision medicine and genomics -- are transforming the national HIT landscape. The decision to evaluate alternatives to meet the current and future HIT needs of IHS was driven by a desire to leverage these advances, the dissatisfaction with RPMS noted above, and the recent VA decision to transition away from VistA in favor of a commercial HIT suite. The framework adopted for the Project followed a Human Centered Design paradigm.

People and Process

The IHS HIT modernization initiative engaged key stakeholders to ensure their needs are understood and included in the analysis of alternatives. Tribal organizations such as the National Indian Health Board and the Tribal Self Governance Advisory Council as well as the National Council for Urban Indian Health were consulted to help inform the Project's engagement with tribes. The Data Call team created an electronic questionnaire and distributed it to HIT end users across the I/T/U, creating the opportunity to provide input on electronic health record functionality, satisfaction, and readiness to make change. Over 1,000 participants completed this questionnaire. Collectively the responses indicated that there is dissatisfaction with existing

[5] Health Level Seven (HL7) Fast Healthcare Interoperability Resource (FHIR) - http://www.hl7.org/FHIR/

HIT, overwhelming desire for increased interoperability, reporting functionality, and usability, and readiness for modernization, despite noted challenges.

Site visits were conducted by the project team at healthcare facilities that are representative of the I/T/U landscape. In-person listening sessions, shadowing sessions, and interviews were conducted with various end user individuals and groups. These sessions helped inform how the field perceives modernization. The visits included users of RPMS as well as those who transitioned from RPMS to a COTS system. During the site visits, the team identified priorities, successes, and pain points of system users who administer care as well as those who support the technology. The site visit team analyzed and synthesized these reported end-user experiences. End users desire a multitude of improvements to existing HIT, including usability, interoperability, improved functionality, and mobility; they also report a need for changes to the surrounding sociotechnical environment, such as training, staffing, and support.

Efficient and effective comprehensive clinical processes improve patient outcomes and the wellness of the community served. The goal of successful IHS HIT modernization is to meet these priorities through supporting the delivery of safe and consistent care to members of Federally-recognized Tribes and to provide a satisfying work experience for clinicians and staff.[6] Identifying appropriate workflows and the technology that supports these workflows is critical. The site visits, data call, and group listening sessions helped identify the essential components of improving care through HIT, as well as opportunities for change.

Technology

Another major component of the Project to date has been the Legacy Assessment (LA) work stream. The experts assigned to the LA work stream were tasked with a detailed assessment of the legacy system - RPMS - and asked to respond to two questions:

[6] https://www.healthit.gov/topic/safety/implementing-health-it

Can RPMS be modernized given its current state, functional scope, and known risks and constraints?

If RPMS can be modernized, what are the options to achieving such modernization while protecting the confidentiality, integrity, and availability of the longitudinal patient healthcare data stored in the system?

As with the other knowledge streams of the Project, the LA was framed within the People, Process and Technology paradigm. The LA team coordinated with the site visit team, resulting in visits to multiple locations, numerous stakeholder interviews across the development, support and consumer spectrum, and in-depth examination of the technologies underlying RPMS. The result was a comprehensive report detailing issues with RPMS as currently deployed and supported, as well as responses to the above questions.

The LA concluded that RPMS is a candidate for modernization. Such a project would not be trivial and a detailed technical roadmap was out of scope for the work stream, but confidence in the opportunity was sufficient to warrant renewal of RPMS as a legitimate alternative for consideration in this analysis.

Knowledge Gained

Table 4-1 describes the conclusions, at a high level, from the various project knowledge streams. These findings helped inform the analysis presented in this document. Appendix E contains additional findings from the Site Visit and Data Call knowledge streams.

Table 4-1 Conclusions Gleaned from the Project Knowledge Streams		Work stream Team
Knowledge Point 1: **MODERNIZATION**	Individuals are ready for modernization.	Data call
	New mobile technology, improved connectivity, and system reliability were also commonly identified themes to further support HIT users in providing comprehensive patient care.	Site Visit, Legacy Assessment

Knowledge Point 2: **BUSINESS PROCESS CHANGE**	Individuals believe their hospitals and clinics are ready to take on the challenge of modernization.	Data call
Knowledge Point 3: **INTEROPERABILITY**	A modern health information technology system for IHS must improve interoperability.	Data call
	Racial and ethnic minority patients report increased desire for electronic access to health records.	Literature Review
	Providers and other clinical staff need to be able to view healthcare data as soon as possible no matter where their patients receive their care.	Site Visit
Knowledge Point 4: **MUST MEET END USER NEEDS**	End users are generally unsatisfied with RPMS.	Data call
	Usability of HIT is commonly denoted as the primary barrier to its adoption. Populations with heightened need for patient portals and HIT are often the same populations that are undereducated on how to use the HIT systems.	Literature Review
	Users often regard RPMS as extremely difficult to master, highlighting the need for any solution to be intuitive and promote self-sufficiency in their work by incorporating HIT into their health care processes.	Site Visit
Knowledge Point 5: **RESOURCES REQUIREMENT (FISCAL AND HUMAN)**	Modernization goes beyond the electronic health records but will require additional resources.	Data call
	Substantial gaps exist with electronic health record adoption in resource-constrained areas. Cost, technical issues, lack of IT support, security, and changes to workflow are among the greatest barriers for electronic health record/ HIT adoption within underserved populations. Resource-constrained regions face a lack of expertise and support in the vendor selection process as well as lack the technical skills to support implementation and meaningful use.	Literature Review, Legacy Assessment
	Any HIT solution for Indian Health must include a comprehensive, reliable training program and ongoing support for all end-users.	Site Visit

Knowledge Point 6: **SUPPORT FOR SUCCESS**	Federally-funded health centers supported by the Health Resources and Services Administration have enjoyed high rates of successful electronic health record implementation with the majority using advanced electronic health record functionalities.	Literature Review
Knowledge Point 7: **UNIQUE HEALTH CARE SYSTEM**	Any new system must be patient-centered, nimble, and able to provide care for a historically under-resourced, transient population. Unique requirements and characteristics exist among the I/T/U healthcare facilities.	Site Visit, Legacy Assessment

Approach

The Analysis of Alternatives initially relied upon *Managing Capital Investments at the Indian Health Service – A How-To Guide for An Analysis of Alternatives*[7] as a guide to the HIT Modernization AoA approach. Six steps in conducting an analysis of alternatives study are identified in the guide and displayed in the graphic below. This approach was subsequently adapted based on the needs of this AoA. The AoA was informed by qualitative (site visits informed by Human Centered Design), quantitative (data call), and academic (literature review) factors, and the RPMS Legacy Assessment. This AoA was also influenced by the AoA that was conducted on behalf of VA by Grant Thornton and published in 2017.[8]

[7] https://www.ihs.gov/cpic/includes/themes/newihstheme/display_objects/documents/IHS_4_AoA_HowToGuide.pdf

[8] Grant Thornton, Report on the Strategic Options for the Modernization of the Department of Veterans Affairs Electronic Health Record, May 1, 2017

Analysis Objective and Scope

This AoA is vendor-agnostic. It is designed to identify and evaluate various options for an approach to HIT modernization at IHS. The findings of this AoA will be useful to IHS, focusing and informing the subsequent market research that will be undertaken as part of the path forward, including a robust requirements analysis process.

The analysis is scoped along four broad domains of capability and risk, each comprised of a number of evaluation criteria. The selection of these four areas was informed by and vetted in consultation with Project team members, the Steering Committee, and the Technical Advisory Commission. The evaluation domains include:

1. Business Requirements - the likelihood that the alternatives can deliver the scope of clinical and business functionality required by IHS, especially those capabilities that are specific or unique to the IHS healthcare environment
2. Program Management - the degree of difficulty or complexity that the alternative is likely to impose on overall management, both of the initial modernization transition and beyond
3. Technical - the likelihood that the alternative will be able to deliver on a variety of technical capabilities that IHS will need

4. Modernization of the Environment - the ability of each alternative to contribute to a truly modernized, forward-looking health information technology ecosystem serving the I/T/U; this perspective seeks to resolve current state factors with anticipated future needs

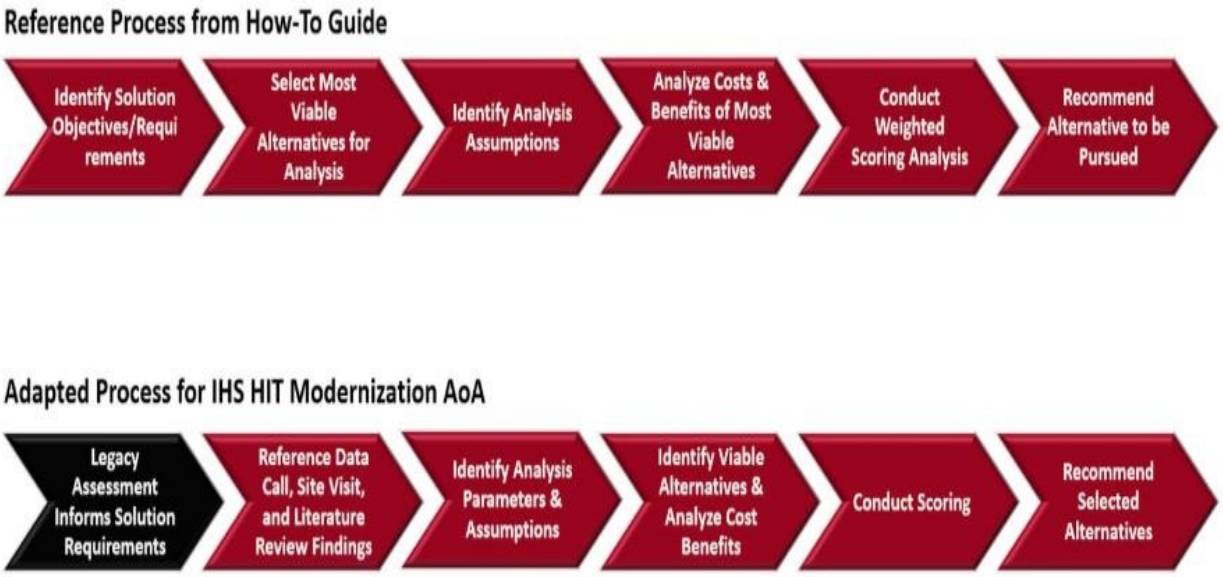


Figure 4-2

Assumptions

Viable options should:

1. Support an integrated model of care within a national enterprise that includes comprehensive clinical, population and public health both within the facilities as well as community based care.
2. Be responsive to new clinical and patient safety requirements in a timely manner.
3. Preserve existing (including historical) data and ensure that it is integrated in a clinically useful way with the new system's data and functions. Data integrity, confidentiality and availability must be maintained.
4. Support local differences in clinical and business operations and workflows.

5. Support the full range of business operations in IHS, including referral-only offices, ambulatory clinics of varying sizes, and very small to medium-sized inpatient facilities as well as unique health insurance options.
6. Be highly interoperable between EHR systems both within and external to the agency, and built on open messaging standards to facilitate connection and expansion. The HIT system should have ability to connect (natively) to third party products using current and novel standard transport protocols such as HL7 v2[9] and FHIR.[10]
7. Offer a unified and actionable view of single patient data and population data across all organizational units that have implemented the new solution.
8. Ensure support for key VistA-derived applications in the next 7-10 years, and longer if the alternative includes retention of VistA components.
9. Enable asynchronous data collection and subsequent integration into the database.
10. Respond in an agile and timely manner to new statutory and regulatory reporting requirements as they are published.

Options Selected for Analysis

The following four options were down-selected as the alternatives to be considered based on a review of the selected analysis domains as well as the assumptions.

Alternative	Description
Option 1 - Stabilize RPMS	1. Maintain current technical architecture and deployment approach 2. Enhance applications as needed and resources allow, including new graphical user interfaces 3. Improve training and support resources to optimize utilization
Option 2 -	1. Apply state-of-the-art methods to "wrap & renew" legacy apps with application programming interfaces (APIs)/service tier

[9] https://www.hl7.org/implement/standards/product_brief.cfm?product_id=185

[10] https://www.hl7.org/fhir/overview.html

Renew RPMS	2. Allow creation of new functions and user interfaces using modern technologies and languages 3. Migrate to consolidated databases and cloud hosting
Option 3 - Selective Replacement	1. Identify preferred "best of breed" COTS solutions for specific domains (e.g., Lab, billing, etc.) 2. Selectively integrate these using standards-based service tier technologies 3. Retain and enhance preferred RPMS apps/functions using "wrap and renew" approach
Option 4 - Full Replacement of RPMS	1. Identify and implement preferred pre-integrated "best of suite" offerings 2. Determine approach to retention/transfer of legacy data to new system 3. Some unique IHS/RPMS features may still need to be retained or redeveloped

Table 4-2

Details of Alternatives

Option 1 – Stabilize RPMS

The first option is stabilization of RPMS and optimization of the use of the system nationwide. This alternative includes a significant investment to address many of the issues identified over the course of the Project. Legacy RPMS provides inadequate functionality needed to support clinical and business process at IHS sites. The electronic health record user interface is confusing and difficult to learn; there has been no concerted national effort to adopt, standardize and share best practices for user interface configuration. Specific users (e.g., pharmacy, lab, radiology) are unhappy that their application interfaces are still roll-and-scroll.

The system is certified according to 2014 Edition health IT certification requirements published by the Office of the National Coordinator for Health Information Technology (ONC). However, it does not meet ONC requirements for 2015 Edition certification. 2015 ONC certification is presently being pursued through a modular approach.[11] Interoperability with other systems is

[11] https://www.healthit.gov/topic/certification-ehrs/about-onc-health-it-certification-program

inadequate. There is limited sharing of information between patients and other providers; these capabilities were developed as part of a personal health record in 2014 but never fully implemented. Training users and troubleshooting issues are consistently reported as challenges; available training resources are inadequate and relevant knowledge-bases are limited. Tribal programs are continuing to actively abandon RPMS in favor of COTS solutions. In Option 1, the approach would be to move specific applications into a graphical user interface environment with icons and other visual indicators via enhancements to the current architecture and to provide adequate resources for training, support, and local optimization that would improve RPMS performance.

However, this approach does not address many deficiencies identified by users, including the user experience and missing functionality. Further analysis is available in the Legacy Assessment work stream of this project.

Option 2 – Renew RPMS

This alternative maintains the functional capabilities developed over decades to support IHS, as well as the rich repository of patient data. Renewing RPMS moves the suite into a modern technical architecture that supports browser/web enabled user interfaces and application development accessible to a new generation of programmers. This approach supports selective introduction of interoperable third party applications, as described in the Legacy Assessment Final Report. This approach requires the creation of application programmer interfaces (API), exposing data to a new service tier (part of which already exists in RPMS), allowing for new application development as well as extension of existing application functionality, without modification to the legacy code (a small cadre of M developers would continue to maintain the legacy code/database as needed). Critical steps include moving roll-and-scroll applications to browser-enabled user interfaces, transitioning electronic health record components to the new framework, and addressing certification requirements. The Legacy Assessment (LA) work stream of this project indicated that this is possible using a variety of approaches described as “wrap

and renew." While the LA identified broad steps required to achieve this option, the LA did not specify the technical details and complexities of a comprehensive RPMS renewal effort.

Option 3 – Selective Replacement of RPMS Components

The Selective Replacement alternative includes creation of a new services tier for legacy RPMS as described above as well as a supported messaging platform. This architectural tier would facilitate integration of standards-compliant third-party applications (laboratory, billing, etc.) as well as smaller, more specifically-focused "apps" including mobile apps for patient access and communication, community health representatives and public health nurses. "Best of breed" solutions would be identified, offering a variety of solutions that can be implemented based on individual facility characteristics (size, tribal vs federal, etc.). This approach positions the agency to take advantage of the inevitable evolution of health IT and electronic health records to a more componentized, app-based ecosystem.

Some authorities believe that the traditional approach to electronic health records will be obsolete in a few years, with a move toward independent but interoperable applications and more patient-centricity to the data. This option would satisfy both the clinical need for improved quality of care and the business need for reduced costs of administrative labor and avoiding redundancies.

Option 4 – Full Replacement of RPMS

The final alternative is complete replacement of the electronic health records and related systems with a suite offered by a single vendor. Consolidation in the traditional electronic health records industry has resulted in a number of vendors offering so-called "best of suite" options, where the agency would replace virtually all of RPMS with a pre-integrated suite of applications. Because of certain unique features and business requirements of IHS ,most sites report that certain legacy functions of RPMS would need to be retained (possibly using "wrap and renew" methodologies as described in the Legacy Assessment report) or redeveloped for compatibility with the replacement system. Examples of such functions include: (a) initiation, prioritization, management, payment, and reporting requirements for external consultation and referrals

funded by Purchased Referred Care (PRC) appropriations; (b) easily assembled standing and *ad hoc* panel and population views for clinicians and case managers such as those provided by the RPMS iCare application; (c) options for Community Health Representatives (CHR) and others to document encounters with and services provided for patients in the community; (d) ability for clinicians and other users to easily query the transactional database to identify patients with particular conditions, needs or gaps in care, as presently available through the RPMS Query Manager (QMan) and other tools.

The VA plan for transitioning to a COTS system includes maintaining VistA for a ten-year period to ensure that the COTS solution can be extended to meet comprehensive VistA functionality. One would expect a similar situation with RPMS, depending upon the option chosen. An RPMS Monograph is being developed, similar to the monograph published by VA that describes the full VistA suite.[12] This detailed report of RPMS applications will help identify which modules will require redevelopment and/or replacement. This monograph is being developed to assist IHS in its ongoing evaluation.

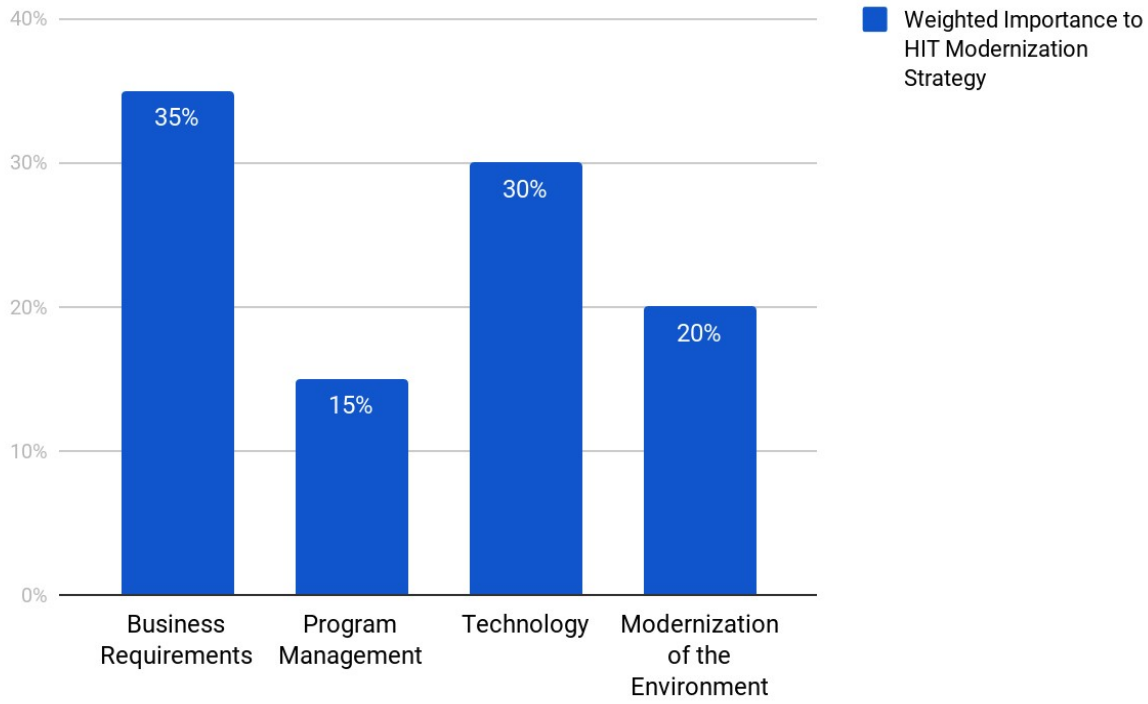
[12] [12] Kruse CS, Stein A, Thomas H, Kaur H. The use of Electronic Health Records to Support Population Health: A Systematic Review of the Literature. Journal of Medical Systems [Internet]. 2018 Sep 29 [cited 2019 May 12];42(11):214. https://www.google.com/url?q=https://www.va.gov/va_monograph.htm&sa=D&ust=1559087189296000&usg=AFQjCNGWr6paJ-Cd5liPn6Aqg8ljhQBAoA

5.0 Non-Cost Analysis Framework and Evaluation

As discussed in section 4.5 above, each identified alternatives was evaluated using four domain categories that reflect the proposed strategic evaluation framework. Within each category, selection criteria were assessed in accordance with their likelihood to deliver benefits, mitigate risk, limit the degree of difficulty, and enhance the system capability. Cost is an independent variable that is evaluated separately.

The four domains are weighted in accordance with their proposed relative importance to the overall HIT modernization strategy, as follows:

Figure 5-1



Analysis and Scoring

The analysis process was informed by the following sources:

- The multiple knowledge streams noted above, including site visits, data call, literature review, and legacy assessment
- Interviews with IHS leadership and end users
- Technical and domain expertise of project team members
- The non-cost analysis was performed using a mix of benefit, risk, degree of difficulty, and capability using a three-point scale. In the absence of specific details of the proposed approaches, such as vendor specifications, it is impossible to offer granular analysis of the options. Instead, each option was assigned a simple assessment rating of High, Medium, or Low against the criteria in each domain based on consensus of AoA team members.
- Details of the assessments are offered beginning in Section 6.0 below.

Within this document, each category includes an assessment score legend. In every assessment metric, a high score is the more desirable option.

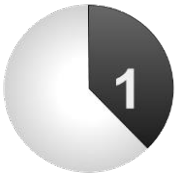
Legend: Assessment Score Metrics		
Assessment Score: Low (value = 1)  Low Alignment/Benefit, High Risk, or Low Capability	Assessment Score: Medium (value = 2)  Moderate Alignment/Benefit, Risk, Capability	Assessment Score: High (value = 3)  High Alignment/Benefit, Low Risk, or High Capability

Table 5-1: A high score  is the most desirable option.

6.0 HIT Alternative Alignment (Non-Cost Findings)

Business Requirements

This section evaluates the potential for the alternatives to be adaptable to IHS clinical and business requirements, including those currently supported in RPMS and those needs that are currently unmet and/or that may arise over time.

The table that follows is constructed from an **Alignment/Benefits** standpoint. For example, if an Option is expected to deliver the listed benefit with a high degree of confidence, the ranking will be depicted as a fully filled-in circle. A brief discussion of the reasoning that supports the assessment follows the table.

Table 6-1: A high score  **is the most desirable option.**

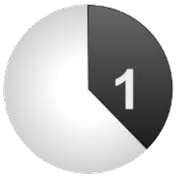
Legend: Business Requirements Assessment Score Metrics		
Assessment Score: Low (value = 1)  Low Alignment/Benefit	Assessment Score: Medium (value = 2)  Moderate Alignment/Benefit	Assessment Score: High (value = 3)  High Alignment/Benefit

Table 6-2

Evaluation Criteria	Description / Example	Option 1 – Stabilize RPMS	Option 2 – Renew RPMS	Option 3 – Selective Replacement	Option 4 – Full Replacement of RPMS
Support for Inpatient Care	• Able to deliver full range of functionality for hospital settings				
Support for Ambulatory Care	• Able to deliver full range of functionality for clinic settings				
Preservation of IHS-Specific Functionality	• Keeping existing functionality, e.g. Purchased / Referred Care				
Public / Population Health	• Population views • Dynamic registries				
Analytics	• Ability to ask questions of data in transactional systems				
Revenue cycle management	• 3rd party billing / acc'ts receivable • Pharmacy point of sale				
Interoperability	• Ease of connection to HIE				
Multi-state requirements	• Ease of connection to multiple PDMP, state IMM registries, etc.				
ONC and CMS Compliance	• ONC Certification • eCQMs				
Federal Agency-specific data/reporting	• GPRA/GPRAMA • HRSA UDS				

Support for Inpatient Care

- **Option 1** - Legacy RPMS falls short in many inpatient-related areas such as specialty functions (e.g., operating rooms) and device integrations (infusion pumps).

- **Option 2** - A renewed RPMS will facilitate integration of applications/devices but developing inpatient-specific applications is unlikely to be undertaken.

- **Option 3** - This Option will enable selective integration of 3rd party applications for areas such as inpatient or day surgery, labor and delivery, and emergency departments.
- **Option 4** - A full replacement COTS suite would be required to support all critical inpatient functions at IHS and tribal hospitals. Unique capabilities would be fulfilled through custom development and/or integration with third-party apps/components.

Support for Ambulatory Care

- **Option 1** - Legacy RPMS supports ambulatory care well, but there are numerous gaps and the technology does not support efficient enhancement, testing, and implementation.
- **Option 2** - A renewed RPMS would make it easier for IHS to perform operations and maintenance as well as new development serving ambulatory care.
- **Option 3** - This Option adds the capability to adopt best of breed products without having to develop and maintain them.
- **Option 4** - A full replacement COTS suite would be required to support all critical ambulatory functions at IHS, tribal, and urban clinics.

Preservation of IHS-Specific Functionality

- **Options 1, 2 and 3** all preserve existing functionality, but maintenance and enhancement are more difficult in the legacy architecture of Option 1.
- **Options 2 and 3** offer new ways to enhance legacy functions.
- **Option 4 -** It is unlikely that COTS solutions will cover the full range of RPMS clinical, business and population health functions (such as iCare and PRC), and these would need to be redeveloped in the new platform.

Public/Population Health

- **Option 1** - These capabilities exist in legacy RPMS but require additional development to optimize.
- **Options 2 and 3** offer facilitated ways to enhance population health functions.
- **Option 3** offers the additional possibility of integrating commercial public and population health tools.
- **Option 4** - While COTS suite vendors provide some public and population health, they have not traditionally focused on these areas. Preserving or adding these functions could require new development or costs to create/integrate these capabilities into the proprietary suite.

Analytics

In the context of this report, *analytics* is defined as the ability for any users of the EHR and related transactional applications to create and generate pre-configured or *ad hoc* queries and reports in support of their day-to-day work. The broader context of enterprise-level analytics that occurs within an entity such as the National Data Warehouse is specifically out of scope for this Project. However, the ability for options considered in this analysis to contribute data to such systems is covered under Interoperability criterion.

- **Option 1** - Data access and reporting at the individual patient or population level has been one of the strengths of RPMS since its inception. However, knowledge of and utilization of these capabilities has waned considerably for a number of reasons ranging from training to perceived complexity. The fundamental capabilities are in place and the increase in staffing and training associated with Option 1 will improve the value of these capabilities to the users.
- **Option 2** - Enhancing the native transactional analytics capabilities of RPMS by exposing more data through APIs and creating new, more usable interfaces will substantially simplify data access and improve the user experience. In addition,

this approach will support extension of analytic functions through third party integrations, and also enable administrative units such as Area Offices to perform meaningful queries across multiple databases within their jurisdiction. This option has the greatest potential to restore the "Really Powerful at Measuring Stuff" reputation of RPMS.

- **Option 3** - Although framed with industry-standard interoperability as a requirement, this approach may not be optimal for real-time queries and reports that could potentially touch several connected systems. These systems are likely to focus on transactional processes such as results reporting and may not be well suited for queries. Accessing data in ways for which these systems are not designed may create proprietary barriers.

- **Option 4** - While COTS EHR systems are typically delivered with a standard offering of out-of-the-box reports, the ability to do ad-hoc and custom analytics will be generally vendor-controlled. Commercial vendor products are not known for their ability to do user-defined queries and reports on the transactional system. Instead they tend to offer new reports at substantial added cost; most analytics in these systems occurs in a separate database, also at added cost.

Revenue Cycle Management

- **Option 1** - Current revenue cycle management functions in legacy RPMS are inadequate and require additional development.
- **Option 2** - Enhancing these functions would be much easier in a technologically renewed RPMS.
- **Options 3 and 4** - Both Selective and Full replacement Options should bring in highly capable COTS revenue cycle solutions.

Interoperability

- **Option 1** - The interoperability features of legacy RPMS are inadequate.

- **Options 2 and 3** - Both Options 2 and 3 are predicated on improving interoperability, both for health information exchange and for integrating new applications that would be of interest to IHS.
- **Option 4** - A COTS suite selected to meet IHS requirements would be expected to offer health information exchange and patient portal products.

Multi-State Requirements

- **Option 1** - Current RPMS has connections to state systems, but it challenging for IHS to address the multiplicity of requirements across the 37 states where ITUs are located.
- **Options 2 and 3** - Interoperability will be easier to achieve, including with state systems.
- **Option 4** - the COTS vendor would be required to support those connections.

ONC and CMS Compliance

- **Option 1** - The development burden to keep up with ONC and CMS requirements is particularly problematic in legacy RPMS.
- **Option 2** - This development would be easier in a renewed RPMS, but the onus would still be on IHS to do the development.
- **Options 3 and 4** offer IHS the opportunity to offload these complex and frequently-changing compliance issues to COTS vendors.

Federal-Agency Specific Data Reporting

- **Option 1** - Current RPMS meets existing requirements for some reporting, but as in other areas, development to address new requirements can be challenging.
- **Options 2 and 3** - The new technologies possible in these Options should facilitate IHS adapting to federal reporting requirements.
- **Option 4** - Introducing federal-specific data requirements into a COTS system will likely require creation of custom reports or change requests to the software.

Program Management

This section discusses a number of factors relating to program management including adoption and implementation for the various alternatives.

The table that follows is constructed from a **Risk** standpoint as depicted in the legend below. A brief discussion of the reasoning that supports the assessment follows the table.

Legend: Program Management Assessment Score Metrics		
Assessment Score: Low (value = 1)  Low Alignment/Benefit	Assessment Score: Medium (value = 2)  Moderate Alignment/Benefit	Assessment Score: High (value = 3)  High Alignment/Benefit

Table 6-3: A high score  is the most desirable option.

Evaluation Criteria	Description / Example	Option 1 – Stabilize RPMS	Option 2 – Renew RPMS	Option 3 – Selective Replacement	Option 4 – Full Replacement
Delivery *Schedule*	• Time to deliver business value to Initial Operational Capability and Full Operational Capability • Schedule estimation • implementation complexity				
Procurement Model	• Creation and implementation of effective procurement process • Timeframe from solicitation request to procurement				
Business Process Change	• Impact to current users and business operations during all • phases Impact on delivery of patient care				
Human Resources, Technical Expertise	• Availability of skilled resources				
Operations & Maintenance	• Operations and maintenance for full suite				

Table 6-4

Delivery Schedule

- **Option 1**- Lowest time to delivery, because no major changes are planned. This does **not** mean Option 1 promises a rapid path to full optimization, which may take years, but the process can begin immediately (upon funding) and incremental results realized rapidly.
- **Option 2** - Delivery of results by renewal of RPMS will be dependent on technical complexity of the approach, with dependence on procurement of the necessary skill and execution of full development life cycle for each prioritized project. Because of the uncertainty of the complexity of the renewal approach at this time, this option cannot be rated as more efficient/timely than Options 3 and 4.
- **Option 3** - This option requires acquisition of the technologies that create the basis for interoperability among selected replacement systems, acquisition of these systems,

routine as well as integration testing, training, and deployment. The time to achieve the desired future configuration will be comparable to a full system replacement.

- Option 4 - In addition to selection and procurement of the target system, significant workflow analysis, implementation planning, training, and more will need to take place before go-live at any sites; this process will be repeated numerous times across the country.

Procurement Model

- Option 1 - Procurement for Option 1 will be largely limited to personnel increases, both permanent and contracted, to shore up capacity at the site and Area levels for training and support, and at the Headquarters level for development, support, and program management.
- Option 2 - This option will add a new paradigm to the existing RPMS design, development and deployment model, necessitating acquisition of the necessary skill sets.
- Option 3 - This option will introduce significant procurement needs, including a messaging layer in addition to the various selected best of breed applications; integration testing, training, and overall program management will add complexity to the procurement landscape.
- Option 4 - Selection of a single vendor for system replacement will likely simplify the procurement approach in comparison to Option 3. Additional program management, training, and support acquisitions will be needed as well.

Business Process Change

- **Option 1 -** Business process change will be part of the design as best practices for RPMS optimization are socialized.
- **Options 2, 3, and 4** - All of these Options will create increasing levels of business process change and disruption as new capabilities are planned, trained, and launched.
- **Option 3** - Business process changes may be less sweeping / intense if COTS applications are introduced incrementally, but the changes could be extended over time.
- **Option 4** - Disruption in a full system replacement can be expected to be most significant as an entire suite is replaced, but the duration is likely to be less than in Option 3. It is expected that the level of disruption from a rip and replace exercise will have significant impact on business process.

Human/Technical Resources

- **All Options** will require a substantial investment in human resources for training, support, and management of systems.
- **Option 1** - The uniqueness, complexity, and variability of RPMS across the country makes it very difficult to hire, train, and retain skilled staff for both development and support.
- **Option 2** - Renewal of RPMS with new development technologies and user interfaces, along with better standardization, should make this Option somewhat easier to support with skilled resources.

- **Option 3** - Will be easier to find skilled staff to train and support COTS modules, but working with multiple vendors will increase complexity of securing and training these resources.

  Option 4 - Any full replacement solution should enable standardization, centralized or regionalized support, and comprehensive training opportunities for users as well as technical staff.

Operations & Maintenance

- **Options 1 & 2** are high risk in the area of ongoing operations and maintenance; IHS will be responsible for the full suite of legacy or renewed RPMS applications. This will include ongoing development to remain current with certification and other regulatory requirements. In addition, the IHS will need to manage all of VistA-derived applications, adding to the maintenance burden.
- **Option 3** - The IHS will need to maintain any parts of RPMS that it contributes to the integrated suite, as well as maintaining and supporting (or outsourcing support for) the interoperability layer and its connections.
- **Option 4** minimizes operations and maintenance responsibility for IHS, offloading it to the COTS provider.

Technical

This section discusses factors relating to technical capabilities offered by the four Options under consideration.

The table that follows is constructed from a **Capabilities** standpoint, as depicted in the legend below. A brief discussion of the reasoning that supports the assessment follows the table.

Legend: Technical Assessment Score Metrics		
Assessment Score: Low (value = 1)  Low Alignment/Benefit	Assessment Score: Medium (value = 2)  Moderate Alignment/Benefit	Assessment Score: High (value = 3)  High Alignment/Benefit

Table 6-5: A high score  is the most desirable option.

Evaluation Criteria	Description	Option 1 – Stabilize RPMS	Option 2 – Renew RPMS	Option 3 – Selective Replacement	Option 4 – Full Replacement
Data Portability	• Ability to move, copy, transfer, and convert data between systems (data cleansing, normalization, standardization, etc.)				
Maintainability	• Ease of system operation and maintenance • Support for continuous improvement and system evolution				
Consolidation	• Ability to interoperate as a cohesive, unified electronic health record system				
Extensibility	• Ability to integrate with external systems via connectors, adapters, and APIs				
Security	• Support for industry-standard IT security and privacy requirements as well as Federal-specific IT security regulations				
Performance= NOT SCORED	• Ability to meet responsiveness, throughput, and efficiency goals • System performance maintained under increased loads				

Table 6-6 Data Portability

While data portability is theoretically associated with modern IT systems, currently it is incompletely supported in the health IT space.

- **Option 1** - This approach will not change the underlying RPMS architecture and will not result in improvement of current data portability capabilities.
- **Option 2** and **Option 3** - These options include service-enablement of the existing database which should facilitate data portability.
- **Option 3** - The addition of a new interoperability platform should deliver a more flexible, performant data architecture, and improve data portability.

- **Option 4** - This alternative includes data migration from the MUMPS/Caché database to an alternative database platform yet to be determined. Requirements for any COTS replacement should include an expectation that the system would meet the strategic goal of significantly improving data portability.

Maintainability

- **Option 1** - This alternative will not result in significant enhancements to RPMS design and architecture. As such, this approach offers little improvement in system maintainability.
- **Option 2** and **Option 3** - Both options include service-enablement of the existing database, and, in the case of Option 3, the introduction of a new interoperability platform. These modifications, coupled with common capabilities such as services, will improve system maintainability through APIs. The legacy codebase and business rules will operate in the background.

- **Option 4** - The rigorous process for identifying, evaluating, and selecting from among candidate electronic health record COTS platforms will ensure that the selected platform, and any custom components developed to meet the unique healthcare needs of the AI/AN community, would be highly maintainable, enhancing the system's adaptability to change, support for continuous improvement and system evolution, and ability to perform O&M activities with minimal operational impact.

Consolidation, Deployment and Upgrades, Infrastructure

- **Option 1** - This option offers little improvement in technology consolidation, reengineering of IT operations, or infrastructure enhancements.
- **Option 2** - RPMS renewal may promote consolidation through code refactoring and centralization of existing functionality into common services that are implemented using modern technologies. This technology consolidation should also drive required improvements in IT operations and internal processes to enable and support their deployment and support.

- **Option 3** and **Option 4** - Both alternatives entail migration to COTS platforms yet to be determined. Any such modern platform features a set of bundled technologies and integrated components that interoperate as a cohesive, unified electronic health record system. This integrated architecture and design promotes extensibility, maintainability, and scalability.

Extensibility

Extensibility is a measure of a system's ability to accommodate future needs through system enhancements.

- **Option 1** - RPMS has proven extensibility through frameworks such as VueCentric and Moonwalk, but the absence of fundamental enhancements to design and architecture of RPMS in Option 1 will result in little improvement in the extensibility of the system.
- **Option 2** - The scope of an RPMS renewal effort should improve system extensibility. However, these threshold updates may only provide a modicum of extensibility based largely on the scope of the renewal effort; extensibility may be improved through added ability to integrate with external systems via connectors, adapters, and APIs.
- **Option 3** and **Option 4** - Both alternatives entail migration to a COTS platform as well as development and integration of custom software components that will provide the specialized capabilities required to meet IHS-specific requirements.
- **Option 4** - An extensible design that supports third-party "add-ins" would be a primary criterion for selection of the COTS suite; however, any COTS solution that permits integration based only on limited proprietary methods, as opposed to standards-based, should be evaluated with caution.

Security

- **Option 1** - Stabilization of RPMS may not include the requisite design and architectural modifications for substantial improvements in system and data security cited in the Legacy Assessment Report. As such, any improvements in security may be marginal given the likely scope of a stabilization effort.

- **Option 2** - RPMS renewal should include service-enablement of the existing database and encapsulation of common capabilities as services that may moderately increase system and data security through the use of data encryption, secure APIs, open standards authentication and authorization protocols, and API gateways.
- **Option 3** and **Option 4** - Both alternatives comprise migration to a COTS platform yet to be determined. Selection requirements would include intrinsic design, architecture, and technology choices that promote system and data security utilizing data encryption, secure APIs, open standards authentication and authorization protocols, API gateways, and other messaging infrastructure. COTS electronic health record platforms that are cloud-deployable may tap into the added benefit of utilizing cloud-based security resources such as secure virtual private networks and virtual private clouds.

Performance

While overall system performance is a critical attribute to be evaluated in product selection, it cannot be evaluated meaningfully in the absence of an understanding of the technical architecture of the target system. For example, cloud-enabled systems may be unbeatable when deployed in enterprises supported by a robust network infrastructure, but may have completely unacceptable performance in locations with unreliable connectivity. This factor remains among those that must be included in subsequent analysis, but for the purposes of this document, it cannot be scored.

Modernization of the Environment

This section evaluates the potential for the alternatives to operate within the variable operating context of the modern I/T/U site. The perspective is current and future state environments and the anticipated changes that I/T/U environments will undergo over time.

The table below is constructed from a **Capability/Risk** standpoint. For example, if an Option is expected to deliver the listed benefit with a high degree of confidence, the ranking will be depicted as a fully-darkened circle.

Legend: Modernization of the Environment Assessment Score Metrics		
Assessment Score: Low (value = 1)  Low Alignment/Benefit	Assessment Score: Medium (value = 2)  Moderate Alignment/Benefit	Assessment Score: High (value = 3)  High Alignment/Benefit

Table 6-7: A high score  is the most desirable option.

Evaluation Criteria	Analysis	Option 1 – Stabilize RPMS	Option 2 – Renew RPMS	Option 3 – Selective Replacement	Option 4 – Full Replacement of RPMS
Potential for Modernization	• Clear vision for software evolution • Ability to keep pace with market demands, trends, and innovations • Defined product roadmap				
Architecture requirements	• Interoperable with data-dependent systems • Systems are maintainable with market standard skill sets • Broad spectrum of device supportability				
Network	• Relative bandwidth requirement at main site and satellite facilities • Cloud-deployable design and architecture				

Scalability	• Ability of the solution to scale to the Indian Health Service enterprise • Able to scale down to clinical needs.				
Data sovereignty	• Patient data location and portability adheres to sovereign treaties				
Data severability	• System supports movement of data from system to system				

Table 6-8 Potential for Modernization

- **Option 1** - This approach will be the least disruptive to sites in terms of change management; clearly the approach includes user training but not to the same degree required for the other alternatives. RPMS has historically struggled to keep up with regulatory requirements, medical device integration, and growing patient/provider expectations for access to timely, accurate data.

  At some point IHS will need to assume responsibility for VA-sourced applications, or contract for continued maintenance of these applications with VistA-based companies. This approach does not address the concern about maintenance and support for hundreds of disparate databases, except through increased staffing and training.

  With little in the way of market pressure and the required focus on stabilization, RPMS development will likely lag behind market leaders, choosing to have a "me-too" approach after other solutions have proven a given feature's viability.

- **Option 2** - Option 2 requires a vision for execution. A renewal approach of RPMS brings with it two attendant risks that Option 1 faces as well. This is the assumption of the VA-sourced applications and the lack of market pressure. The risk of not receiving and responding to user/market demands is somewhat ameliorated by the steady pace of modernization that the renewal process would take, but is not eliminated. This option, too,

would likely use a "me-too" approach to keeping pace but with a shortened time signature due to its architectural design. By migrating to an architecture that supports continual renewal through the use of APIs and interfaces, Option 2 would lessen the gap that Option 1 would face comparatively.

- Option 3 - Option 3 yields the highest level of customizability through its selection of best of breed software for each domain of use. Accordingly, the change management impact of this will likely be the highest of the considered options. The granularity of change increases the level of effort from selection through to implementation and support. Each best of breed selection will have its own software evolution definitions, road-map, and be subject to market demands that may not be in alignment with other software packages that may require interoperability with the software in question. Graded at the comprehensive level, the system would not have, by design, a holistic software evolution vision or roadmap.

- Option 4 - Full Replacement, while significantly disruptive in its rip and replace approach, is reasonably expected to have a well-defined software evolution vision, road map, and to be as responsive to market demands. A deliberate selection of an appropriate COTS solution would likely meet all three requirements.

Architecture Requirements

- Option 1 - The demands on the modern electronic health records require the flow of data between interdependent systems and must be able to support a broad spectrum of devices. RPMS' ability to interoperate with systems outside of its own domain will see modest success given the VA codebase and the need to operate within its constraints, which has not prioritized system interoperability. As documented earlier in this report, RPMS struggles to integrate with many medical devices in a variety of clinical settings. The architectural decisions for RPMS are not in alignment with market standard skill sets, and will likely require specialized staff to administer and maintain the systems over time. A stabilization effort, while likely to improve on each of these architectural success factors at some point in

time, will struggle over the course of time to maintain the same level of integration and data flow it would achieve at its initial completion point.

- **Option 2** and **Option 3** - Both Renewal of RPMS and Selective Replacement approach environment modernization through the use of APIs and targeted, phased implementation that addresses both an ability to interoperate with disparate systems and supporting medical devices. They would likely fulfill the architectural requirements around interoperability and device support.

  Options 2 and 3 both incur some level of risk around skill set profile. Option 2, due to its phased approach, will require either staff that are competent in both current and new systems or will require additional staff and collaboration between the two. This would multiply effort and increase the probability of disruption from the resulting complexity. Option 3 has risk similar in depth and breadth as uniform consideration for code bases, API support, and supporting systems will not be in place.
- **Option 4** - The leading COTS solutions in the space tend to leverage current systems that are sustainable with widely spread skill sets. Sourcing stewardship of a COTS system and its attendant requirements will likely be straightforward, whether that is through system support staff or developers supporting published APIs for a certain class of cloud hosted solutions.

  Most COTS solutions have mixed to poor interoperability track records, typically working with a select few systems if at all; the implementation of interoperability focused standards like HL7/FHIR or publishing APIs for consumption is an uncommon occurrence. This is unlikely to change. Device support by the selected COTS system will likely be best in class of all the options available.

Network

There is a wide variability of network connectivity across the I/T/U service spectrum of sites. These constraints, along with uncertainty with respect to if and how those challenges will be resolved, have influenced these assessments.

- **Option 1** - The architectural demands of a system serving the spectrum of IHS sites have a number of unique requirements. One such requirement is the need to operate in an autonomous disconnected mode in order to support locations where bandwidth is low and/or connectivity is unreliable; the system should have the capability to sync the data back when in a connected state. Option 1 has a moderate level of risk associated with these requirements. RPMS has a mixed history of operating in environments of low to poor connectivity. Stabilization would likely address a number of its connectivity shortcomings related to network instability.

  RPMS does not have a cloud strategy, nor will a stabilization effort address this by definition of its scope.

- **Option 2** - Service driven architectures tend to assume network stability and that may present implementation challenges for teams approaching modernization via Option 2. It is possible, but with an unknown level of probability, that Option 2 would achieve an implementation of an API driven architecture that gracefully operates in areas with frequent network service disruptions.

  Option 2 will have, by the choices inherent in its format, a cloud-friendly architecture. Systems that communicate via APIs and interfaces typically do not require significant overhaul to integrate with or migrate to the cloud.

- **Option 3 -** Option 3 carries with it similar challenges as Option 2 although the underpinnings are somewhat different. By the wide variance in the architecture format and environmental assumptions each best-in-breed solution may bring with it, there is no way to assume that each solution would be able to gracefully operate within a constrained or volatile network. There is no guarantee that a best-in-breed solution would have a cloud strategy. Therefore, Option 3 architecture cannot be assumed to be either cloud-deployable nor have an ability to operate on a poor network.

Option 4 - Operating within low-bandwidth/poor connectivity environments is typically not a design consideration of most COTS solutions. These systems tend to be geared toward sites that operate in metropolitan areas with access to modest to good levels of connectivity. Special enhancements to a COTS solution will likely need to be implemented to ameliorate this risk. It is a reasonable conclusion that an on premise COTS solution would implement modifications to address this issue. It is not a reasonable conclusion to assume that a cloud first based solution would be able to attend to this issue appropriately. Evaluated separately, an on premise solution would likely be able to operate in a low connectivity environment, where a cloud based solution would not. The blended ability to fulfill these requirements is partial depending upon the system architecture of the selected COTS. This evaluation is bifurcated as either full or partial fulfilment.

Likewise, with cloud-deploy ability, a best-in-suite COTS solution is not guaranteed to have a cloud strategy. A cloud based COTS, by definition, fits this bill; that fact does not, for the purposes of this assessment, assume the position of being best of suite.

Electronic health record COTS platforms that are cloud-deployable may leverage the on-demand elasticity of private, public, or hybrid cloud infrastructure as well as data services of public cloud infrastructure - e.g., Relational Database Services (RDS) of AWS - to achieve maximum cost-efficient performance. These assertions about the performance potential of Options 3 and 4 assume that the telecommunications infrastructure is not an impediment.

Scalability

Option 1 - RPMS' architectural design currently leverages high performance data systems. Option 1 does not seek to modify the data underlayment of the system and the system will likely remain close to its operational capacity. RPMS has experienced performance issues at scale in hospital settings around software performance. While uncommon, these limitations have been demonstrated as programmatic in nature and not related to underlying infrastructure. As many install bases for RPMS do not meet the at-scale parameters where these performance issues emerge, this issue will likely be isolated to a relatively small number of deployments.

While many RPMS installations are smaller organizations, RPMS itself is a broad package with many hospital grade assumptions in packages and support requirements, including the hardware and software configurations required for operation. A stabilization effort would not address any scale up or down concerns and would maintain the current status-quo for these success factors.

- Option 2 - Option 2, depending upon a number of implementation choices, may be able to accommodate scaling at a near-linear scale. API-driven architectures naturally lend themselves to scaling and tend to be enterprise friendly designs.

  Service orientation does not scale down well. This is due to the fact that many service architectures require a minimum level of complexity that is difficult to fulfill in a small scale setting. Option 2 bears a level of risk that its format will preclude many current RPMS operators from continuing their systems without serious disruption.

- Option 3 - With Option 3, Selective Replacement, each component must be scalable to achieve comprehensive scalability; however should a system fail to scale efficiently, its failure to scale will only impact its domain with some possible performance impacts.

  As with the Network success factors in this assessment, the variability between formats, environmental requirements, and system design yields a resultant level of uncertainty and complexity, and therefore, risk to the comprehensive system's ability to scale up or down.

- Option 4 - Scalability for many COTS solutions, whether on premise or cloud, is a high priority design consideration. These systems tend to leverage private or public cloud capabilities that are architected to deliver near-linear scaling. Additionally, cloud systems eliminate much of the complexity of scaling away from the client, further reducing scaling limitations that may be imposed upon on premise architecture by forcing an accounting of space, power, and connectivity, all common environmental limiters to scaling at I/T/U sites.

Scaling down is a less frequent consideration but one that cloud-based COTS systems tend to be better positioned to fulfill. There is some level of risk, non-trivial but not significant, that a COTS solution would not be amenable for operation within a clinical setting.

Data Sovereignty

Data sovereignty is defined here as the ability for tribes to own and extract their data as a modular component of the information system(s) deployed

- **Option 1** - On-premise solutions such as locally deployed instances of RPMS are able to accommodate data sovereignty requirements. There is a moderate level of risk due to unaddressed issues related to the National Data Warehouse and similar movements of data throughout the IHS system, possibly without the knowledge or approval by the governing tribal body. This issue, given the scope of effort the stabilization effort, the organizational design of IHS, along with legal complexity, may not be addressed.

- **Option 2** - While the opportunity for change, in contrast to Option 1, is greater given the scope of effort in redefining RPMS' functionality through a renewal effort the same factors for consideration for stabilization impact Option 2. That is, the legal complexity, the existence of a distributed organizational architecture, and the scope of effort required to modernize RPMS puts addressing this issue at risk as well. Prioritization of this environmental constraint will be necessary to reduce this risk to an acceptable level.

- **Option 3** - Selective Replacement makes a case by case evaluation of best in breed software for each domain of operation. Data sovereignty is generally not a well understood requirement for software firms operating in the United States; it is not a reasonable conclusion that each and every system would be both best of breed and be designed to honor data sovereignty requirements. A single system that moved unapproved data outside of predefined restrictions by the tribal body could compromise the requirement of the system as a whole.

- **Option 4** - Depending upon the architecture of the deployed COTS system, data sovereignty would be honored by system design or be extremely challenged in compliance. Locally deployed systems, with localized controls over communication and interfaces, would naturally adhere to data sovereignty requirements. The risk of an on premise COTS solution complying with data sovereignty is low. Cloud deployments, by their distributed scale, would face significant challenges with compliance. Data is often, for redundancy and scalability purposes, duplicated in data centers across the country. Verification that data is not repurposed, sold, or otherwise distributed without prior authorization can only be performed by an independent third party review or via self-attestation by the COTS provider themselves. For tribal organizations seeking to ensure that member data adheres to governing body policy and treaty rights will find themselves challenged with establishing in fact those requirements are being met.

Data Severability

In this context, the term "data severability" refers to the ability for an entity, such as a tribe, to copy data from a federal system of records to its own system, particularly under the circumstance of compacting for health care services. In this case the tribe would be standing up its own health information system separately from the federal system and would need to have historical patient data. Data in the federally-managed system would not be removed or deleted, as the IHS has an obligation to retain all patient related data for 75 years after the death of the individual.

- **Option 1** - Data severability, as detailed throughout this document and the Legacy Assessment Report, is based upon systems, design philosophies, and database design that is substantially outside of current architectures throughout the marketplace. Data export from RPMS to other systems is currently an arduous process, often resulting in a significant level of manual input. Option 1 makes no effort to address these issues. This consideration, along with RPMS' struggle to interoperate with systems outside of the RPMS deployment space, places the risk of adhering data severability requirements as very high.

- **Option 2** - A natural consequence of Option 2's approach, leveraging an API-centric design, enables data portability and subsequently, data severability. Properly implemented, a renewed RPMS architecture would likely accelerate data export through mass export. API design will likely only expose a segment of the system's data; so special consideration for full export of system data will need to be included as part of the renewal process.
- **Option 3** - Selective Replacement, by selecting best of breed versus best of suite, would implement a number of disparate systems, each with their own data definitions and dictionaries. Aggregating each system and migrating them from a consolidated or a federated architecture, elevates the risk level of moving from system to system to high.
- **Option 4** - Data severability, as a design consideration, is generally a low priority design consideration for the majority of current COTS solutions; and market incentives motivate de-prioritization of data severability as a design requirement. A compensating factor for this is that most COTS solutions also engineer systems for data migration from a competing vendor to theirs as part of their competitive strategy. These data export systems typically leverage features of on premise infrastructure. Cloud systems, due to the walled garden nature of their design, do not accelerate data export. Depending upon the comparative size, maturity, and design of the COTS solutions selected, data severability in and out of the systems in question is highly variable. High variance is a significant influencer of risk and places the risk around data at high.

7.0 HIT Cost Analysis

This Analysis of Alternatives is evaluating four options for HIT modernization across the IHS enterprise:

Option 1	Option 2	Option 3	Option 4
Stabilize RPMS	Renew RPMS	Selective Replacement of RPMS Components	Full Replacement of RPMS

The following cost analysis is for directional guidance ONLY to compare Rough Order of Magnitude (ROM) estimates between Option 1 and Option 4. The numbers in the preliminary estimates are subject to change based on changes in assumptions, user population identified, and scope criteria. Due to the early stage of business planning and the lack of detailed clinical and business requirements, the best approach to cost analysis for such a large, complex, unique health care delivery model spanning both rural and urban areas is a high-level ROM estimate based on published government implementations of COTS solutions. The cost of a commercial electronic health records implementation is difficult to determine without a formal solicitation. Data on COTS implementations are very rarely published both in the commercial and government space. It is difficult to correlate these industry implementations due to variations in size, scope, complexity, and uniqueness of the IHS healthcare enterprise. In 2017, VA contracted with the consultancy group Grant Thornton to help inform the department's decision on whether to replace its homegrown VistA electronic health record system with a commercial provider solution. The Grant Thornton research paper was used as a guide to obtain industry benchmarks and average vendor ROM estimates. Any deviation from the scope covered in the Grant Thornton document could significantly affect the estimated costs.

Additionally, this ROM estimate over the lifetime of the project is subject to change based on the vendor selected, inflation estimates, assumptions made at the business planning stage, concerns raised during implementation of the project, unknown factors impacting the project timeline, unknown costs, etc. An industry-wide RFI/RFQ from several vendors and subsequent vendor proposals/contracts will validate the findings in the high-level estimate analysis for all options. Any preliminary ROM estimates are meant to serve as a directional guide only, and are subject to change.

Based on this approach, legacy system stabilization (Option 1- Non Viable) is focused on stabilization and optimization of the current technology largely through increased staffing and support, and does not require major architectural changes or software acquisitions. The estimated cost is the least in this scenario. On the other hand, it is assumed that the most

expensive option would be full replacement of the current system (Option 4). Costs for Options 2 and 3 (Renew RPMS and Selective Replacement) are assumed to fall between these two extremes. It is possible, because of the need for an integration technology (e.g., an interoperability layer) and licensing costs for multiple best of breed modules, the overall cost for Option 3 may approach that of the full replacement cost of Option 4. Once a roadmap identifies specific requirements, planning, acquisition, implementation, training, maintenance, and timing expectations, more precise costing estimates can be provided. Because of the imprecision of the costing estimates, non-cost/technical rankings should assume higher weight in the current analysis of alternatives.

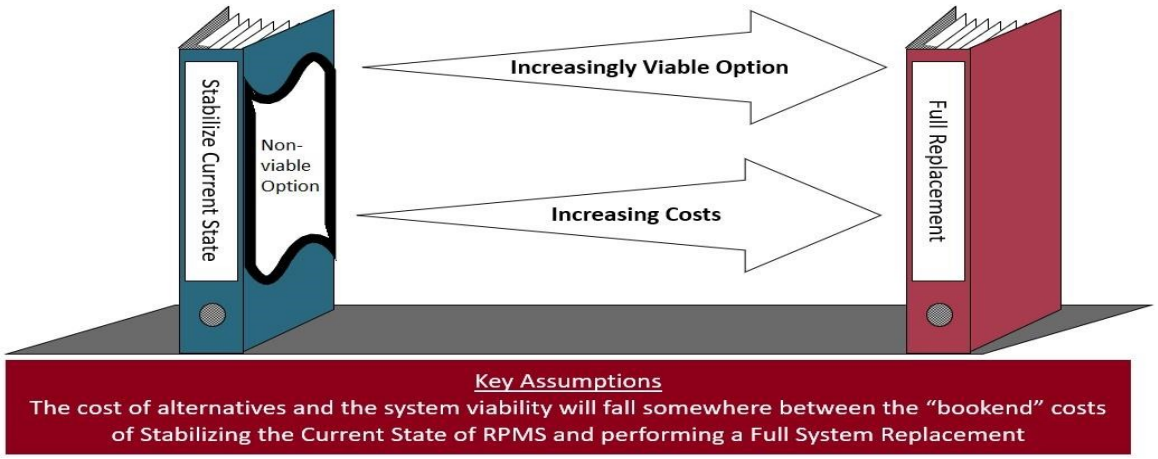


Figure 7-1

Cost Assessment Methodology

Option 1 -The AoA team reviewed the FY 2019 Business Case UII 009-000001362 dated 2019-04-05[13] (OMB 300 document), which lists the total estimated life cycle costs for the Health Information Technology Systems and Support (HITSS) investment. In addition, the team contacted the RPMS Program Management Office to obtain actual costs and is currently in the process of obtaining additional cost information from the IHS Office of Finance and Accounting. The business case estimates for legacy costs are assumed to be baseline costs for Option 1. It must be emphasized that the Option 1 estimate is based on a business case and not on the actual spending on the legacy system. The OMB 300 document cost estimate could not be validated by the project team due to time constraints. Additional FTE costs by facility were forecasted and added in inflation factor to come up with a high level ROM estimate for Option 1.

The table below displays the cost estimates for Option 1. Using current cost figures, low and high estimates were calculated for the implementation of Option 1 in the fiscal year 2021.

In reviewing this information, the Cost Analysis was performed independently of the Non-Cost Analysis described in sections 5.0 and 6.0 above. The Non-Cost Analysis concluded that Option 1 is **not** a viable modernization alternative for IHS.

The cost estimate does not include necessary infrastructure investments required to upgrade the underlying network, hardware, and facilities to support the solution nor does it include the costs to fully maintain and enhance RPMS applications that are dependent on VistA after the Department of Veterans Affairs migrates off the VistA platform.

[13] https://itdashboard.gov/drupal/summary/009/009-000001362#

(TABLE REMOVED DUE TO POTENTIAL PROCUREMENT ACTIVITY, ESTIMATES ARE NOT BEING RELEASED PUBLICALLY)

Option 4 - The cost of a commercial electronic health record implementation is difficult to determine without a formal solicitation. Data on COTS implementations are very rarely published both in the commercial and government space. It is difficult to correlate these industry implementations due to variations in size, scope, complexity, and uniqueness of the IHS healthcare enterprise. In 2017, VA contracted with the consultancy group Grant Thornton to help inform the department's decision on whether to replace its homegrown VistA electronic health record system with a commercial provider solution. The ROM estimate is based on the Grant Thornton research paper that provided industry benchmarks and average vendor ROM estimates. This report did not address the need for additional user support and training during implementation of new functionality and/or new systems.

The AoA team has used this high-level estimate as a starting point for analysis and adapted it to IHS. There are numerous differences between IHS and VA as noted in section 3.2 above. For simplicity, the approach is based on the difference in service population receiving care at IHS and VA facilities. The AoA team assumes the same implementation timeline as outlined in Grant Thornton research paper. An inflation rate of 3% to 4% was then applied to account for future rate increases in labor categories. Additional FTE costs by facility on an annual basis were estimated.

(TABLE REMOVED DUE TO POTENTIAL PROCUREMENT ACTIVITY, ESTIMATES ARE NOT BEING RELEASED PUBLICALLY)

Cost estimate areas include **vendor costs** - software, vendor team, application support, training, and other vendor costs and **service costs** – program management office, integration, and other services.

Note: This cost estimate does not include necessary infrastructure investments required to upgrade the underlying network, hardware, and facilities to support the solution.

Estimated Adoption Timeline

The length of time that an optimized RPMS will need to be supported depends on the option chosen. For purposes of this high level ROM study, the project assumes 10 years for Option 1 support. The project implementation timeline is also assumed to be 10 years starting in FY2021 for option 4 consistent with the Grant Thornton study. For Options 1, 2, and 3, the adoption timeline will vary based on overall organizational readiness, detailed project scope, roadmap, and other timeline impacting factors. In this scenario, if Option 4 is selected, the Option 4 estimated costs are additive to the cost estimates of Option 1.

Cost Assumptions

The high-level Rough Order of Magnitude (ROM) estimate analysis is based on the following assumptions:

1. The ROM estimate is based on the Grant Thornton document. Any deviation from the scope covered in the Grant Thornton document will affect the cost estimate.
2. Rough Order of Magnitude model is based on VA COTS implementation over 10 years and clinical user population of 9.1 million at VA facilities.
3. Assuming patient population to be a major cost driver, this model uses population derived metric to estimate the cost of implementing COTS solution.
   The current patient population at I/T/U healthcare facilities is 2.6 million.
4. FTE and contracting/consulting costs are increased annually by an inflation rate ranging between 3%-4% for each year of the project life.
5. Benefits for Federal employees are assumed to be 33% of total compensation.
6. Additional FTE costs at the facilities and regional level are included to address support and training gaps (see Appendix B). These increases should be considered essential to meet baseline needs. Comparable costs in supporting staffing throughout the enterprise can be assumed to be same for all four of the options under consideration.
7. Infrastructure must be updated in terms of bandwidth, network, communications, hardware, support, and training. This need is irrespective of the option chosen. Hence, infrastructure readiness costs have not been computed and are not included in this analysis.
8. Any costs at the facility level to the host health information system, including utility costs, are not accounted for.
9. Risks associated with the project cannot be quantified and as such are out of the scope for cost analysis.

10. It is assumed that IHS will follow the same implementation schedule as shown in the Grant Thornton research paper.
11. Any costs associated with supporting VistA dependent applications are not included in this estimate.
12. The RPMS Business Case from which Option 1 cost data was derived is principally focused on software operations and maintenance as well as limited development and testing; operational costs in the field are not included.
13. Any indirect costs for an enterprise level system are excluded from this high-level Estimate.
14. Any costs for implementing unique RPMS functionalities are not included in this high-level estimate as it is difficult to determine at this early stage of planning which RPMS functions will be supported by COTS vendors.
15. Any unknown costs related to systems enhancement or implementation have not been accounted for. These costs, to a large extent, should be uncovered after a full deep-dive system analysis, validation of assumptions, and completion of a project roadmap.

Preliminary Cost Analysis Results

(CONTENT REMOVED DUE TO POTENTIAL PROCUREMENT ACTIVITY, ESTIMATES ARE NOT BEING RELEASED PUBLICALLY)

8.0 Summary and Recommendations

		Weighted Scores			
Criteria Category	Category Weight (sum to 100)	Option 1 -- Stabilize RPMS	Option 2 – Renew RPMS	Option 3 – Selective Replacement	Option 4 – Full Replacement of RPMS
Business Requirements	35	56.0	94.5	101.5	91.0
Program Management	15	30.0	27.0	24.0	30.0
Technology	30	30.0	60.0	78.0	78.0
Modernization	20	23.3	46.7	26.7	36.7
TOTAL SCORE		**139.3**	**228.2**	**230.2**	**235.7**
TEN YEAR COST (in billions)		*			*

Table 8-1 ***CONTENT REMOVED DUE TO POTENTIAL PROCUREMENT ACTIVITY, ESTIMATES ARE NOT BEING RELEASED PUBLICALLY**

The AoA team used multiple knowledge streams, as well as the 2017 AoA performed for VA, to identify options and evaluation criteria for modernization. An expanded view of the non-cost scoring is provided in Appendix 1 -- Non-Cost Scoring Table. The AoA also offers a "bookend" approach to cost estimates. Although the choice of an alternative should be independent of cost, it is unrealistic to do so. Cost was placed in its own category to facilitate an elastic approach to decision-making independent of funding.

The analysis reveals that various strategic paths are viable options that can be further refined by the Agency in accordance with their evaluation of constraints and benefits.

Option 1 - **Stabilize RPMS** - is, however, **not viable** based on this review. This option can only be an alternative if appropriated funding is insufficient to permit consideration of any other approach. It would be unsustainable in the long term and would not support the mission of IHS.

All three of the other options - **Renew RPMS**, **Selective Replacement**, and **Full Replacement** - are alternatives that can be considered by HHS and IHS. The close scoring in the AoA final calculations provides IHS considerable flexibility in determining its path forward. Deciding between these options will require additional delineation of functional and technical requirements, evaluation of the infrastructure landscape, and an understanding of fiscal and human constraints both now and in the future. Note that although the results of the Data Call from the field reveal a strong desire, even enthusiasm, for changes to HIT systems, the Project did not formally assess Organizational Readiness for Change (ORC) at the enterprise (Headquarters and Area Offices) level. Steps for assessing and creating ORC will be discussed in subsequent Project deliverables.

Based on data received from multiple sources across the Project, certain components are foundational to success and must be included.

- **Governance** - An enterprise governance structure supported by the active engagement of informed, experienced programmatic and technical leaders is a *sine qua non* for a modern enterprise health information system. The organization must provide leadership and standardization around technical issues such as IT security policy, access controls, and database management. It must establish and guide best practices in configuring and using HIT systems.
- **Technical Infrastructure** - Any 21st century modernization approach will have a significant infrastructure component to facilitate centralized support, cloud hosting, health information exchange, telehealth services, or all of the above. The geographic realities of AI/A communities pose stark challenges in this regard, and if not proactively addressed will create significant limitations on IHS' modernization options.

- **Human Resources** - Whether the choice is to renew RPMS or replace it with a commercial system, the human resources necessary to optimize, configure, train, and support the system on a national level must be in place. These are not just technical resources, but domain-specific, ranging from the front office to the pharmacy, and must include a cadre of clinical informaticians. The choice of the modernization solution may impact the distribution of these resources, whether central, regional or local, but the need will be there nonetheless.
- **Funding** - None of these options are realistic unless supported with recurring funding. Health information technology modernization is not a project or an event. It is an ongoing organizational process that requires consistent support. Although IHS has been able to take advantage of nonrecurring appropriations in the past to make significant advances in RPMS capabilities, this model is unsustainable and cannot support the critical mission of the agency.

HIT Modernization is of critical importance to the Indian Health Service and AI/AN communities. The Analysis of Alternatives makes no specific recommendation on the future choices for IHS; however, the AoA team recommends the following interim near term steps:

- Establish a Program Management Office to further evaluate the alternatives, roadmap(s), and results from technical readiness, and develop an implementation strategy, IT acquisition strategy, and lead program execution;
- Develop and implement appropriate governance that ensures that decisions are made jointly with clinical and technical input;
- Complete an in-depth assessment and roadmap addressing technical and infrastructure needs;
- Develop an organizational readiness framework and roadmap that includes such things as increased training and support as well as expansion of capabilities in clinical informatics.

IHS is not constrained to a single approach for modernization of its HIT systems; the Agency can choose from multiple paths forward with an expectation of success. In summary, an appropriate and effective HIT system is essential to supporting care delivery to the AI/AN community.

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Appendix A – Non-Cost Scoring Table

Summary Numeric Analysis – Page One					
Legend: Assessed Score High: 3 Medium: 2 Low: 1		Option 1 - Stabilize RPMS	Option 2 - Renew RPMS	Option 3 - Selective Replacement	Option 4 - Full Replacement
Criteria/Category	Evaluation Criteria	Assessed Score	Assessed Score	Assessed Score	Assessed Score
Business Requirements Multiplier (weight); 35	Support for Inpatient Care	1	2	3	3
	Support for Ambulatory Care	2	3	3	3
	Preservation of Functionality	2	3	3	2
	Public/Population Health	2	3	3	2
	Analytics	2	3	2	2
	Revenue Cycle Management	1	2	3	3
	Interoperability	1	3	3	3
	Multi-state Requirements	2	3	3	3
	ONC and CMS Compliance	1	2	3	3
	Federal Agency Specific Data Reporting	2	3	3	2
	Category Subtotal	**16**	**27**	**29**	**26**
	Subtotal Mean	**1.60**	**2.70**	**2.90**	**2.60**
	Weighted Subtotal	**56.0**	**94.5**	**101.5**	**91.0**
Program Management	Delivery Schedule	2	1	1	1

	Procurement model	3	2	1	2
Multiplier (weight): 15	Business Process Change	3	3	2	1
	Human Resources/Tech. Expertise	1	2	2	3
	Operation & Maintenance	1	1	2	3
	Category Subtotal	10	9	8	10
	Subtotal Mean	2.0	1.8	1.6	2.0
	Weighted Subtotal	30.0	27.0	24.0	30.0

Summary Numeric Analysis – Page Two					
Legend: Assessed Score High: 3 Medium: 2 Low: 1		Option 1 – Stabilize RPMS	Option 2 – Renew RPMS	Option 3 – Selective Replacement	Option 4 – Full Replacement
Criteria/ Category	Evaluation Criteria	Assessed Score	Assessed Score	Assessed Score	Assessed Score
Technical Multiplier (weight): 30	Data Portability	1	2	2	2
	Maintainability	1	2	2	3
	Consolidation	1	2	3	3
	Extensibility	1	2	3	2
	Security	1	2	3	3
	Performance	-	-	-	-

	Category Subtotal	5	10	13	13
	Subtotal Mean	1.00	2.00	2.60	2.60
	Weighted Subtotal	30.0	60.0	78.0	78.0
Modernization of the Environment Multiplier (weight): 20	Potential for Modernization	1	2	2	3
	Architecture Requirements	1	2	2	2
	Network	1	2	1	1
	Scalability	1	2	1	2
	Data Sovereignty	2	3	1	2
	Data Severability	1	3	1	1
	Category Subtotal	7	14	8	11
	Subtotal Mean	1.17	2.33	1.33	1.83
	Weighted Subtotal	23.3	46.7	26.7	36.7
Weighted Totals		139.3	228.2	230.2	235.7

Each Criterion is scored individually, and the mean score for each Category is calculated. Mean scores are multiplied by the weight assigned for that Category (weights add to 100). Weighted totals are summed at the bottom of the table. Maximum possible score is 300.

Appendix B – Additional Full Time Employee (FTE) Calculations

These new FTE should not be assumed to be limited to IT Specialists (2210 Series), but would also include personnel categories with domain expertise across the full range of services - nursing and pharmacy informatics, business office, etc. While the ultimate distribution of these personnel - site level, Area Office, or Headquarters - may vary depending on the HIT modernization solution, the research of this Project as well as information available from VA and the broader industry indicates that adequate staffing for implementation, training, and ongoing support is essential for success.

Type of Facility	IHS Facilities	Tribal Facilities	Total Facilities	Assumed FTE's per Facility	Assumed GS Level	Total Resourcs	Base Annual Salary	Annual Benefits@ 33% of Total Comp	Annual Sal + Benefits	Total Additional Annual Labor Costs
Hospital	24	22	46	4	11	184	74,926	36,904	111,830	20,576,693
Health Center	50	285	335	2	11	670	74,926	36,904	111,830	74,926,000
Health Station	24	54	78	1	9	39	61,924	30,500	92,424	3,604,531
Alaska Village Clinic	-	127	127	-	-	-		-	-	-
School Health Center	11	5	16	2	11	32	74,926	36,904	111,830	3,578,555
Youth Regional Treatment Centers	7	5	12	4	11	48	74,926	36,904	111,830	5,367,833
Headquarters			1	10	13	10	106,785	52,596	159,381	1,593,806
Headquarters			1	10	14	10	126,191	62,154	188,345	1,883,448
Area Office			12	4	13	48	106,785	52,596	159,381	7,650,269
	116	**498**	**627**			**1,041**				**119,181,134**

Note:-
1 Federal Pay salaries are average of all steps for all areas in US.
2 Benefits are assumed to be 33% of total compensation

Appendix C – RPMS Dependencies on VistA

The following table lists application packages from the VA VistA system that are incorporated into the RPMS suite. The notes on modified routines are based on research conducted in 2010.

VA VistA Packages used in RPMS with Substantial Modification	
Computerized Patient Record System	Delphi code componentized in RPMS EHR
Outpatient Pharmacy	111 of 430 routines modified
Laboratory	819 of 1132 routines modified
Scheduling	106 of 403 routines modified
Text Integration Utilities	78 of 367 routines modified
Adverse Reaction Tracking	19 of 116 routines modified
VA VistA Packages Used in RPMS with Little or No Modification	
Inpatient Pharmacy	6 of 218 routines modified
Radiology	28 of 344 routines modified
Consult Tracking	1 of 153 routines modified
Bar Code Medication Administration	IHS uses an outdated version of BCMA
National Drug File	Updated annually by VA for IHS
VA Lexicon	
VistA Imaging	
VistA RAD	
Order Entry / Results Reporting	
Clinical Reminders	
Patient Record Flags	
Consolidated Mail Order Pharmacy	
Controlled Substances	
Pharmacy Data Management	
VA Vitals	RPMS also has a separate vitals package
Admit/Discharge/Transfer	
FileMan	
MailMan	

Kernel	
HL7 Optimized	IHS uses other interfacing packages as well
VA VistA Packages Only Installed as Prerequisites for RPMS EHR	
Case Management	Nursing
Dietetics	Pharmacy Benefits Management
Foundations	Problem List
Intake and Output	Surgery
Medicine	VistALink

Appendix D – Applications and Functions Unique to RPMS

Following is a subset of applications and/or functions that are believed to be unique to RPMS and would be difficult to find or reproduce in COTS solutions. This may not be a complete list.

- **iCare Population Management application**
  - There is no comparable package in industry or VA. There are ways to get population views and do population-based analytics in other systems using their data warehouses, but nothing that allows providers and case managers to quickly create patient panels using a variety of demographic and clinical parameters, and track these patients as a panel across numerous performance indicators.

- **iCare also offers related capabilities including:**
  - HIV Management System (HMS) - such systems are no doubt available as COTS specialty systems, but may not be integrated with primary care EHRs
  - Care Management Event Tracking (CMET) - the ability to track key phases/steps in screening activities from beginning to end, so that patients are not lost to follow-up.

- **Purchased/Referred Care (PRC, formerly CHS)**. This includes both the ability to refer patients out with appropriate documentation, receive reports and invoices from providers, and pay invoices through a Fiscal Intermediary. It also includes the ability to capture denials, either because the patient has an alternate payer (e.g.Medicaid),

the patient does not reside in the catchment area, or the referral is not for a priority condition. Facilities have to be able to report all this information, including denials, to IHS to inform the PRC budget requests.

- **GPRA/GPRAMA measure calculation, Improving Patient Care and other internal IHS performance measures**
    - COTS packages will have the CMS measures but not GPRA or others, so these would have to be developed at a cost, assuming the product includes the necessary data to support GPRA measure logic.
- **UDS - Uniform Data Set**. This is the system used by Federally-Qualified Health Centers (FQHC), of which there are many in Indian country, to do mandatory reporting to the Health Resources and Services Administration (HRSA) to remain compliant with their grant requirements. Among the HRSA requirements are a number of performance measures relating to clinical care, and IHS maintains and updates these measures in RPMS on an annual basis. Sites leaving RPMS have reported the absence of UDS in COTS systems to be a significant impediment to success.

- **Ability to reconcile revenue cycle applications with federal accounting systems (UFMS).** This gap only applies to federally-managed facilities, but is a potential barrier for transition to COTS. Interfacing COTS solutions to UFMS would have to take place before deployment on the federal side, and would have to be maintained and updated on a regular basis.

- **PCC Management Reports**
    - Numerous management reports have been developed specifically for use at I/T/U facilities, drawing heavily on data in Registration, PCC, and other packages. These reports in many cases inform mandatory reporting from facilities to Areas and Headquarters. Examples include:
        - Provider Practice Description report
        - Diabetes Audit report
        - In addition to PCC Management Reports, many other packages have internally-generated reports as well
        - See the User Manual Table of Contents at https://www.ihs.gov/RPMS/PackageDocs/BJPC/bjpc0200.11u_apcl.pdf

- **Q-Man and other ad hoc query tools (PGEN/VGEN).** These are included in the PCC Management Reports but called out separately here because of their uniqueness and value, not just to look up information not readily available in other reports but to use

as templates for panel definitions in iCare. The ability to do rapid, *ad hoc* queries in real time on the transactional database is a powerful capability that would be missed unless it were reproduced in a highly accessible and usable business analytics platform.

- **Diabetes Management System and Diabetes Audit.** These systems were developed in the 1980s to track and manage the epidemic of diabetes and its complications in Indian country, and are still used today. The significant reduction in a number of complications of diabetes in Indian country is attributable in part to data afforded by these applications.

- **Community Health Representative (CHR) package.** The CHR program is a unique and critically important extension of services into reservation communities by local staff hired and trained to make home visits, deliver medications, check on status, provide rides to clinic, etc. Both CHR workload and clinical observation data on patients (such as weights and blood pressures) could be entered into the CHR package. The RPMS CHR package has not been updated in years, and the security requirements for tribal employees (which CHRs typically are) to enter data into a federal system have become prohibitive. The CHRs will continue to be an important part of the healthcare ecosystem in Indian country and functionality to allow them to record their activities and patient observations, communicate with clinicians through HIT, and for clinicians to access data entered by CHRs will be needed going forward.

- **Clinical Reporting System (CRS).** CRS was a game-changing (and award-winning) development for IHS. CRS offers a diverse range of over 300 clinical performance measures, representing 70 clinical topics. CRS eliminates the need for manual chart audits for evaluating and reporting clinical measures derived from RPMS data. Reports from CRS are used in numerous ways to evaluate performance at all levels of the organization; these results inform reports made by IHS to HHS, OMB and Congress.

- **Behavioral Health System.** Clearly there are numerous electronic record systems used in behavioral health settings. The important issue for IHS is the integrated care model that allows for team-based care and sharing of clinical data, including notes as appropriate, between physical and behavioral health care providers.

- **Electronic Dental Record Interface.** Few if any commercial systems natively support the co-location of medical and dental services, including the sharing of patient demographic, clinical, coding and billing information. The Dentrix-RPMS interface, while incomplete at present, supports this arm of the IHS integrated care model.

- **RPMS Electronic Health Record.** While any COTS solution chosen will have an EHR by definition, the RPMS EHR includes components that in COTS alternatives may require acquisition of add-on capabilities or an entirely separate application. Examples include:
  - Well Child Module
  - Prenatal Care Module
  - Eye Care (Optometry) Module
  - Patient Education Module

Appendix E – Crosswalk to Other Project Knowledge Streams

Crosswalk 1: Site Visit Knowledge Stream Crosswalk

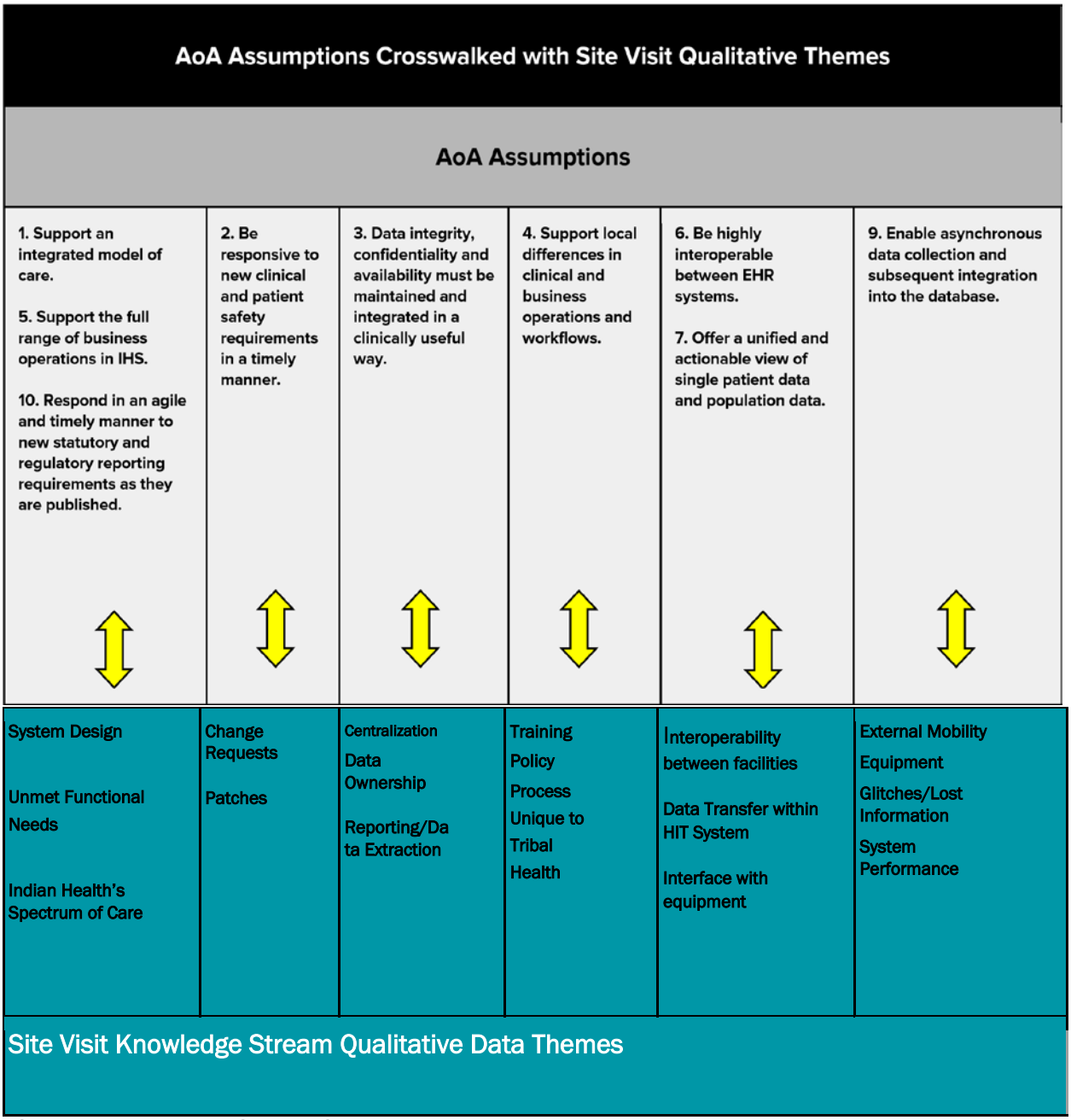
Site Visit Data Sources:

- Site Visit listening sessions
- Emails sent to IHS HIT Modernization project email address
- Listening sessions at the Oklahoma City Tribal Self-Governance Conference

Findings:

Site Visit Knowledge Stream Qualitative Data Themes cross walked with the AoA Assumptions (see section 4.6).

The table below provides a crosswalk between the assumptions of the AoA and the Site Visit Knowledge Stream qualitative data themes.



Site Visit Knowledge Stream Qualitative Data Themes cross walked with the AoA Evaluation Categories (see section 4.5).

Alternatives identified in the AoA were evaluated using four domain categories that reflect the proposed strategic evaluation framework. Within each category, selection criteria were assessed

in accordance with their likelihood to deliver benefits, mitigate risk, limit the degree of difficulty, and enhance the system capability. Cost is an independent variable that is evaluated separately.

The four domains are weighted in accordance with their proposed relative importance to the overall HIT modernization strategy.

Evaluation Category	Weight Multiplier (sum to 100)
Business Requirements	35
Program Management	15
Technical Considerations	30
Modernization of the Environment	20

AoA Evaluation Categories with Site Visit Qualitative Themes			
AoA Evaluation Categories			
Business Requirements	**Program Management**	**Technical**	**Modernization of the Environment**
• Support for Inpatient Care • Support for Ambulatory Care • Preservation of Functionality • Public / Population Health • Revenue cycle management • Interoperability • Multi-state requirements • ONC and CMS Compliance	• Delivery Schedule • Procurement Model • Business Process Change • Human Resources, Technical Expertise • Operation &	• Delivery Schedule • Procurement Model • Business Process Change • Human Resources, Technical Expertise • Operation &	• Potential for Modernization • Architecture requirements • Network • Scalability • Data sovereignty
• Federal Agency specific data reporting ↕	Maintenance ↕	Maintenance ↕	• Data severability ↕
• Interoperability • UI/UX • Reporting/Data Extraction • Functional Needs	• Staffing • Support Structure • Training	• Equipment • Internal Mobility and WiFi • External Mobility and VPN • System Performance	• Data Ownership
Site Visit Knowledge Stream Qualitative Data Themes			

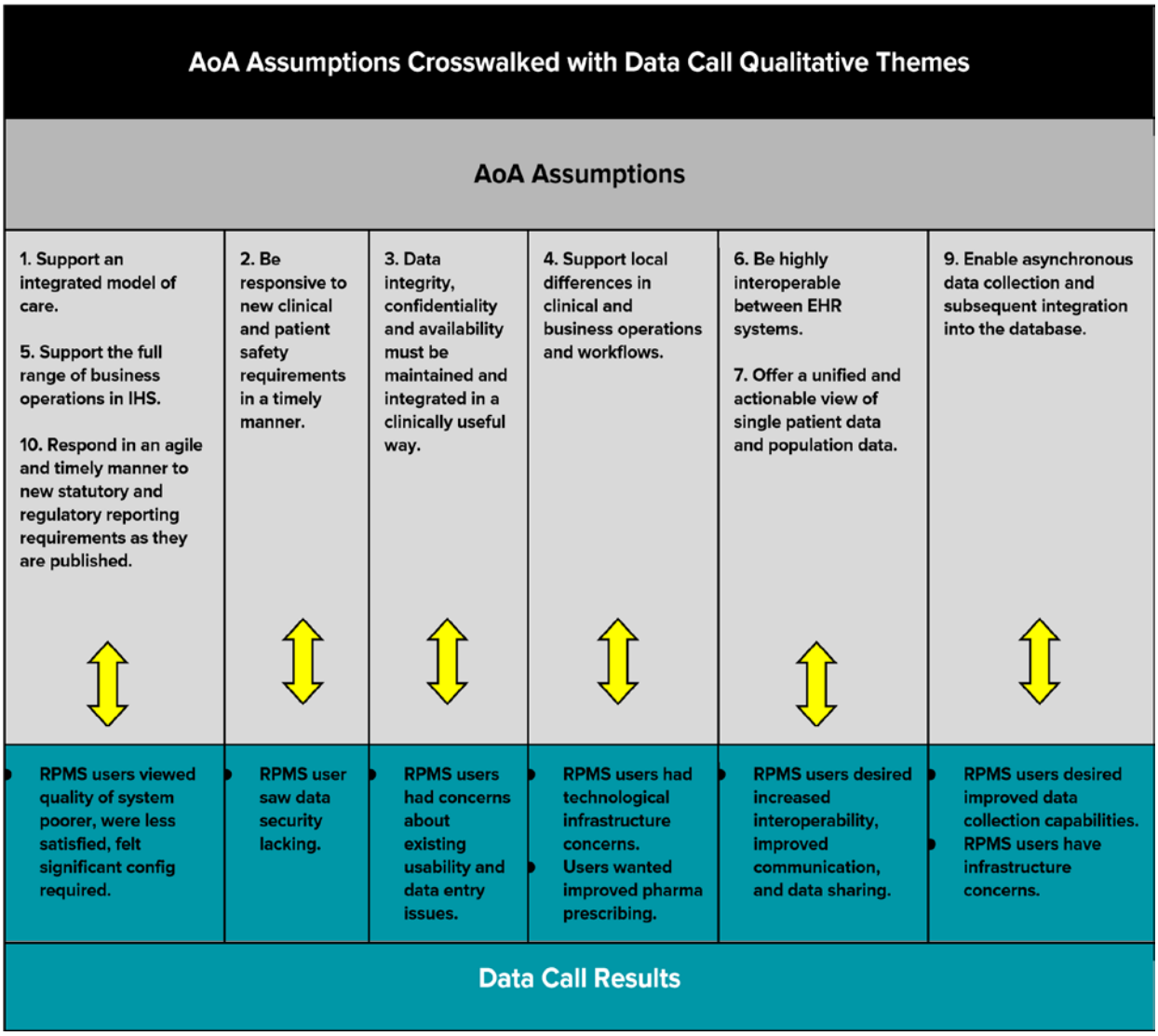
Crosswalk 2: Data Call Knowledge Stream Crosswalk

Data Call Data Sources:

- Data call survey sent broadly to the I/T/U via Area Offices, listservs, and various other communication channels
- 1,381 individuals responded with 1,037 fully completed surveys
- Domains included satisfaction, functionality performance, functionality needs, and perceived organizational readiness.

Findings:

Data Call Knowledge Stream Qualitative Data Themes cross walked with the AoA Assumptions.
The table below provides a crosswalk between AoA's assumptions and the Data Call quantitative data themes.


AoA Assumptions Crosswalked with Data Call Qualitative Themes
AoA Assumptions
1. Support an integrated model of care.
5. Support the full range of business operations in IHS.
10. Respond in an agile and timely manner to new statutory and regulatory reporting requirements as they are published.
2. Be responsive to new clinical and patient safety requirements in a timely manner.
3. Data integrity, confidentiality and availability must be maintained and integrated in a clinically useful way.
4. Support local differences in clinical and business operations and workflows.
6. Be highly interoperable between EHR systems.
7. Offer a unified and actionable view of single patient data and population data.
9. Enable asynchronous data collection and subsequent integration into the database.
RPMS users viewed quality of system poorer, were less satisfied, felt significant config required.
RPMS user saw data security lacking.
RPMS users had concerns about existing usability and data entry issues.
RPMS users had technological infrastructure concerns.
Users wanted improved pharma prescribing.
RPMS users desired increased interoperability, improved communication, and data sharing.
RPMS users desired improved data collection capabilities.
RPMS users have infrastructure concerns.
Data Call Results

Data Call Knowledge Stream Qualitative Data Themes cross walked with the AoA Evaluation Categories

AoA Evaluation Categories with Data Call Qualitative Themes			
AoA Evaluation Categories			
Business Requirements	**Program Management**	**Technical**	**Modernization of the Environment**
• Support for Inpatient Care • Support for Ambulatory Care • Preservation of Functionality • Public / Population Health • Revenue cycle management • Interoperability • Multi-state requirements • ONC and CMS Compliance • Federal Agency specific data reporting	• Delivery Schedule • Procurement Model • Business Process Change • Human Resources, Technical Expertise • Operation & Maintenance	• Delivery Schedule • Procurement Model • Business Process Change • Human Resources, Technical Expertise • Operation & Maintenance	• Potential for Modernization • Architecture requirements • Network • Scalability • Data sovereignty • Data severability
Want increased Interoperability Want improved functionality Want the ability to respond more efficiently to state and federal reporting requirements	Have concerns about facilities' IT capabilities	Have concerns with security Dissatisfied with system usability and data entry	Ready for modernization See themselves lacking in hardware, network, and Wi-Fi capabilities
Data Call Knowledge Stream Results			

Appendix F – Glossary of Acronyms

AI/AN	American Indian/Alaska Native
CMS	Centers for Medicare and Medicaid Services
COTS	Commercial-off-the-Shelf
EHR	Electronic Health Record
GPRA	Government Performance and Results Act
GPRAMA	GPRA Modernization Act
HHS	Department of Health and Human Services
HIE	Health Information Exchange
HIT	Health Information Technology
HITECH	Health Information Technology for Economic and Clinical Health
HL7	Health Level Seven International
HRSA	Health Resources and Services Administration
IHS	Indian Health Service
IT	Information Technology
I/T/U	IHS/Tribal/Urban
OCTO	Office of the Chief Technology Officer
OIT	Office of Information Technology
ONC	Office of the National Coordinator for Health Information Technology
PCC	Patient Care Component
QPP	Quality Payment Programs
RPMS	Resource and Patient Management System
VA	Department of Veterans Affairs
VistA	Veterans Health Information Systems and Technology Architecture