OFFICE of INSPECTOR GENERAL
NATIONAL ARCHIVES

August 16, 2017

TO: David S. Ferriero
Archivist of the United States

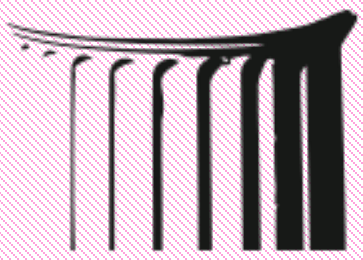
FROM: James Springs
Inspector General

SUBJECT: *NARA's Electronic Records Archives 2.0 Project*

Attached is our final report, *NARA's Electronic Records Archives 2.0 Project (OIG Audit Report No. 17-AUD-15).* Based on your August 14, 2017 response to the draft report, we are pleased our observations and analysis will help you improve the effectiveness of the ERA 2.0 development efforts.

Consistent with our responsibility under the *Inspector General Act, as amended*, we are required to publicly post the report on our website. We also may provide copies of our report to congressional committees with oversight responsibility over the National Archives and Records Administration.

Please call me with any questions, or your staff may contact Jewel Butler, Assistant Inspector General of Audits, at (301) 837-3000.



OFFICE of INSPECTOR GENERAL
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NARA's Electronic Records Archives 2.0 Project

August 16, 2017

OIG Audit Report No. 17-AUD-15

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Executive Summary

Audit of NARA's Electronic Records Archives 2.0 Project

OIG Audit Report No. 17-AUD-15 August 16, 2017

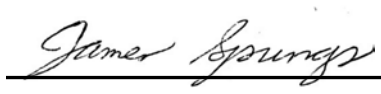
Why Did We Conduct This Audit?

Under the Federal Records Act, the National Archives and Records Administration (NARA) is given general oversight responsibilities for records management. NARA built the Electronic Records Archives (ERA) to fulfill its mission in the digital age: to safeguard and preserve the records of our government, and ensure that people can discover, use, and learn from this documentary heritage. However, the ERA Base System has proven to be limited in meeting NARA's needs. Given the limitations of the system in managing the transfer, processing, and storage of large transfers of digital materials, NARA has determined it is essential to evolve the current ERA Base System for Federal electronic records. NARA's vision for the newly improved version of ERA (i.e., ERA 2.0) consists of the incremental development of three primary modules using an agile approach. We performed this audit to assess the current status of the ERA 2.0 development effort.

What Did We Find?

We found NARA has spent over $24 million and 3.5 years developing solutions to correct deficiencies in the ERA Base System, however, the ERA 2.0 project continues to experience a number of challenges to include funding and aligning the project to NARA's System Development Life Cycle (SDLC) policy. This is an on-going development effort with initial implementation of two modules (Digital Processing Environment and Digital Object Repository) currently planned for April/May 2018. As of April 7, 2017, 53 percent of the user stories/requirements were completed, while the majority of the remaining ones were deemed low priority. The ERA 2.0 Project Plan also includes the subsuming of legacy systems over fiscal years (FY) 2018 – 2020 and deploying a classified ERA 2.0 in FY 2020. Until the ERA 2.0 functionality is tested and implemented into the production system, longstanding deficiencies may continue to impact the ERA Base System.

In addition, NARA's SDLC Methodology is used to manage projects that are intended to develop, deploy, and operate information systems and information technology infrastructure capabilities in accordance with business needs. Although the SDLC methodology addresses performing multiple iterations of the SDLC activities for agile projects, it does not articulate how to do this effectively in order to meet one of the primary agile goals which is getting functionality to the users quickly. If NARA decides to use the agile development methodology for future information technology development projects, we suggest modifying NARA's SDLC methodology to align it better for agile projects.



James Springs
Inspector General

Background

Under the Federal Records Act, the National Archives and Records Administration (NARA) is given general oversight responsibilities for records management as well as general responsibilities for archiving. This includes the preservation of permanent records documenting the activities of the government. NARA oversees agency management of temporary and permanent records used in everyday operations and ultimately takes control of permanent agency records judged to be of historic value. The law requires each Federal agency to make and preserve records that: (1) document the organization, functions, policies, decisions, procedures, and essential transactions of the agency; and (2) provide the information necessary to protect the legal and financial rights of the government and of persons directly affected by the agency's activities. Effective management of these records is critical for ensuring that sufficient documentation is created; that agencies can efficiently locate and retrieve records needed in the daily performance of their missions; and that records of historical significance are identified, preserved, and made available to the public. Without effective records management, the records needed to document citizens' rights, actions for which federal officials are responsible, and the historical experience of the nation will be at risk of loss, deterioration, or destruction.

NARA built the Electronic Records Archives (ERA) to fulfill its mission in the digital age: to safeguard and preserve the records of our government, ensure that the people can discover, use, and learn from this documentary heritage, and ensure continuing access to the essential documentation of the rights of American citizens and the actions of their government. NARA deployed the ERA Base System (i.e., ERA 1.0) in 2008 to allow Federal agencies to perform critical records management transactions online. Agency records management staff use the ERA Base System to draft new records retention schedules for records in any format, officially submit those schedules for approval by NARA, request the transfer of permanent records in any format to NARA for accessioning or pre-accessioning, and submit electronic records for storage in the system.

However, the ERA Base System has proven to be limited in meeting NARA's needs. The system currently has had many problems with its reliability, scalability, usability, and cost, which has prevented it from being adequate for both NARA's current and expected future workload. Given the limitations of the system in managing the transfer, processing, and storage of large transfers of digital materials, and advances in technology (particularly cloud computing), NARA has determined it is essential to evolve the current ERA Base System for Federal electronic records. This will entail the correction and re-factoring of current capabilities, as well as the adaptation and expansion of capabilities in order to fulfill the agency's mission to meet the expected demands of a rapidly growing backlog of digital and digitized materials.

NARA's vision for the newly improved version of the ERA Base System (i.e., ERA 2.0) consists of the incremental development of three primary modules using an agile approach that will refactor and enhance the existing ERA Base system. These modules are:

- Digital Processing Environment (DPE) – The DPE shall serve as a scalable and flexible environment with an expandable catalog of software tools to enable the NARA archivist to process a wide variety of digital materials, and then to prepare them for preservation in the Digital Object Repository (DOR) and/or access through NARA's National Archives Catalog (NAC).
- Digital Object Repository (DOR) – The DOR shall serve as a scalable and safe repository that provides long-term preservation and access to digital objects stored in the improved version of the ERA system.
- Business Object Management (BOM) System – The BOM shall serve as a secure, and flexible application to manage business objects governing the scheduling, transfer, and custody processes.

This newer version is designed to leverage cloud computing technology for non-classified materials to improve processing and storage capabilities with dynamic resource management and implementation of a "data-at-rest" system model. This limits the need for timely and costly transfers of data across agency and NARA networks by bringing the processing to the data, rather than the traditional model of bringing the data to the process.

Per NARA, achieving this vision of the new ERA program shall enable NARA to:

- Stabilize and reduce program costs;
- Enhance productivity and featured support;
- Improve collaboration across custodial processes and workflows for preservation and access;
- Perform safe, reliable, and secure "long-term" preservation of digital objects;
- Enhance capabilities to search, view, and retrieve preserved digital objects;
- Streamline workflows for managing transfer, acceptance/rejection, and update of legal custody;
- Address the existing limitations in ingest, storage, and retrieval of digital objects; and
- Address the growing backlog of preservation activities.

ERA 2.0 will update ERA 1.0 with an enhanced, scalable tool for scheduling, transfer, and long-term storage of permanently-valuable electronic Federal records. Improvements to the ERA platform are necessary to support the transition to fully managing electronically all permanent electronic records. Office of Management and Budget (OMB) Memorandum M-12-18, *Managing Government Records Directive* requires that by December 31, 2019, all permanent

electronic records in Federal agencies will be managed electronically to the fullest extent possible for eventual transfer and accessioning by NARA in an electronic format.

In addition, the scope of the ERA 2.0 Project also includes subsuming legacy systems and developing a classified system.

Objectives, Scope, Methodology

The objective of this audit was to evaluate and report on the current status of the ERA 2.0 development effort. The audit was conducted at the National Archives in College Park, Maryland (Archives II).

To accomplish our objective we interviewed and obtained information from representatives from Information Services – Portfolio Management Division, Project Management Branch, and the Quality Management Division; and Research Services – Still Pictures and Textual Processing Branches. We also reviewed:

- OMB Memorandum, Managing Government Records Directive (M-12-18);
- OMB Contracting Guidance to Support Modular Development;
- NARA System Development Life Cycle (SDLC) Methodology;
- NARA 801 – Capital Planning and Investment Control;
- Government Accountability Office (GAO) Report GAO-12-681, *Software Development, Effective Practices and Federal Challenges in Applying Agile Methods*;
- ERA 2.0 Concept of Operations (CONOPS);
- DPE and DOR Technical Direction Letters (TDL);
- ERA 2.0 Road Map/Project Plan; and
- DPE and DOR Statements of Work.

This performance audit was conducted in accordance with generally accepted government auditing standards between August 2016 and May 2017. The generally accepted government auditing standards require we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our conclusions based on our audit objective.

This audit was conducted by Ed Densmore, Senior IT Auditor.

Audit Results

ERA 2.0 Status

We found NARA has spent over $24 million and 3.5 years developing solutions to correct deficiencies in the ERA Base System, however, the ERA 2.0 project continues to experience a number of challenges to include funding and aligning the project to NARA's SDLC policy. This is an on-going development effort with initial implementation of two modules (DPE and DOR) currently planned for April/May 2018. As of April 7, 2017, 53 percent of the user stories/requirements were completed, while the majority of the remaining ones were deemed low priority. The ERA 2.0 Project Plan also includes the subsuming of legacy systems over fiscal years (FY) 2018 – 2020 and deploying a classified ERA 2.0 in FY 2020. Until the ERA 2.0 functionality is tested and implemented into the production system, longstanding deficiencies may continue to impact functionality of the ERA Base System.

Limitations of the ERA Base System

Limitations of the ERA Base System have been addressed in a number of Office of Inspector General (OIG) reports over the years. For example, Advisory Report No. 11-16, *Implementation Status of the Electronic Records Archives System Requirements* dated July 15, 2011, identified 58 percent of the original requirements were no longer planned to be included in the system by the end of the development phase on September 30, 2011. Many of those requirements represented significant system components such as record descriptions, access restrictions, and redaction of assets. OIG Advisory Report No. 12-08, *The National Archives and Records Administration's Reliance on Legacy Systems to Meet Electronic Records Mission Needs*, dated March 30, 2012 found that by not implementing many of the original requirements, the ERA System lacked much of the functionality originally envisioned, which resulted in NARA spending almost $7 million a year to operate and maintain eight older, outdated, legacy systems that were supposed to be retired and/or subsumed with the implementation of the ERA System. In addition, OIG Audit Report No. 13-11, *Audit of the Base ERA System's Ability to Ingest Records*, dated September 19, 2013 reported system performance issues when ingesting large amounts of data. Many of these problems were tied to design limitations of the system.

Further, NARA's Digital Processing Environment System Requirements Specification document dated May 19, 2014 stated "The need for a new concept for meeting the business needs of ingesting, processing, preserving and processing for access to digital materials was identified based upon the limitations of the current NARA systems, including the following:

- Producers (e.g., a Federal Agency) are limited in the volume of digital materials that they can disseminate to NARA.
- NARA is unable to efficiently ingest and preserve large transfers of digital materials.
- Digital materials that are not accessioned Federal Records with a corresponding records schedule disposition authority cannot be ingested or preserved by NARA.
- It is extremely difficult for NARA staff to search and access digital materials after they are preserved.
- The internal NARA network topology is insufficient to meet the business need to share digital materials between NARA organizations, forcing the inefficient hand-delivery of digital materials on physical media.
- The capacity of the available working storage is inadequate to meet the business needs given the volume of digital materials which are being received.
- The tools necessary to prepare digital materials for permanent preservation and access or to respond to a reference request are not available or are not generally available (i.e., are not available to all of the NARA staff who need them).
- The volume of digital materials that will require permanent preservation in the near future is expected to increase greatly."

The ERA 2.0 CONOPS dated September 9, 2016 also reiterated some of these limitations by stating the challenges as:

- Current digital accession volume exceeds ingest capability;
- Projected accessioning grows exponentially;
- Slow records processing further stagnates preservation; and
- Insufficient records preservation limits public access and hinders request responses to researchers and Freedom of Information Act requests.

ERA 2.0 Scope

NARA's ongoing efforts to address the limitations of the ERA System have evolved and been subject to various changes in scope and milestones over the years. Originally identified as the Optimized Ingest Framework (OIF), its goal was to define an operational concept, and develop business and system requirements, preliminary designs and pilots to support the eventual development of a set of flexible capabilities to support the transfer, ingest, processing, and safe archival management of significant volumes and varieties of digital materials and electronic records.

The major concepts and key components of the OIF included:

- Modular Approach – Move away from one monolithic enterprise system that manages the ingest, processing, storage, and preservation of electronic records with rigid workflows

that limit the flexibility of users to deal with the wide variety of scenarios they encounter with transfers.

- Digital Processing Environment – Introduce the idea of a Digital Processing Environment separate from the current ERA Ingest and Storage capabilities, as a place to provide flexible processing capabilities for electronic records and digital surrogates. The idea is to: (1) simplify, and make more reliable and robust, the functionality of a trusted digital repository to store and manage large volumes of digital materials; and (2) leave the complexity and variations in processing to the DPE environment where a number of tools and capabilities can be rapidly implemented.
- Submission Information Package (SIP) Specification – Develop a specification for a standard SIP for electronic records and metadata that are destined for the trusted digital repository. The SIP Specification should be accompanied by a packaging tool application that assists users in the creation of compliant SIPs for the repository.
- A Trusted Digital Repository – Ingest and provide archival storage for digital materials and metadata, as well as provide the capabilities for users to search, locate, and output copies of digital materials to the DPE for such activities as preservation processing or processing for public access.

According to a NARA official the period of performance for OIF was September 2013 to May 2014 with a cost of $1.9 million. The work accomplished and completed during OIF included developing the: Concept of Operations (DPE-focused), High-level Stakeholder Requirements, System Requirements, and Preliminary Technical Design. These deliverables helped form the vision, concepts, use cases, and requirements for the major components (i.e. DPE, DOR, and BOM) of ERA 2.0. There was a significant pause in the program during the Spring and Summer of 2014 for about four months while several different acquisition approaches were being considered.

The project's name was changed to ERA 2.0 in 2015 to reflect the preferred branding by agency leadership, and to better represent the programs work and goals to evolve the ERA system. The scope of the project was also further defined to include subsuming legacy systems, as well as, developing a classified system. The development and implementation of ERA 2.0 is planned for six phases. NARA has completed phases 1-2, and is currently in phase 3.

The cost, iteration, and release information for Phases 1 thru 3 are:

Phase 1 – September 2014 to December 2015 (Iterations 1 thru 10)

- Pilot Releases 1 & 2 in July 2015 and January 2016
- $14,124,000

Phase 2 – December 2015 to October 2016 (Iterations 11 thru 20)

- Pilot Releases 3 & 4 in June and October 2016

- $8,357,000

Phase 3 – October 2016 to September 2017 (Iterations 21 thru 32)

- Pilot Releases 5 & 6 in April and September 2017 (est.)
- $6,314,000

According to a NARA official, Phases 4-6 are still notional at this point, and the true composition and costs for each of these phases have not been determined. [redacted] Since this variable was a significant unknown until just recently, the exact composition and cost for each future phase was difficult to determine. Due to the continuing resolutions of FY17, and given the likelihood of significant changes to anticipated funding for the remainder of FY17 and beyond,[1] the ERA 2.0 team will soon be reevaluating and revising the Road Map which includes the schedule and scope of the project. NARA plans to start defining notional plans for future phases based on budget expectations. [redacted] As more feedback is received from stakeholders in the remaining releases of Phase 3, the backlog of user stories (e.g., requirements, features, functionality) will be groomed to highlight those absolutely required for implementation before the Pilot application is deployed into production.

NARA plans to deploy the first production release of ERA 2.0 in 2018. Once ERA 2.0 is deployed, NARA will begin migrating unclassified functionality from legacy records processing systems. NARA expects to realize cost savings from migrating unclassified functions but; savings will be limited until NARA is able to provide similar functionality for classified records and can fully retire legacy systems. NARA is still in the earliest stages of assessing how the ERA 2.0 capability can be used to meet its mission responsibilities for classified electronic records, and needs support to develop an efficient and effective solution that will meet its needs in a secure manner. [redacted] Until the ERA 2.0 functionality is tested and implemented into the production system, longstanding deficiencies may continue to impact functionality of the ERA Base System.

According to a NARA official, in order to achieve an Authority to Operate (ATO) determination for the current functionality in the pilot, NARA needs to comply with its governance processes,

[1] NARA's FY17 budget request included an additional $6.5 million for ERA 2.0; however, due to the Continuing Resolution, NARA operated the ERA 2.0 project for most of FY17 at the lower "base" funding level provided in FY16 ($9 million). NARA requested this one-time increase to accelerate deployment of ERA 2.0 into production; NARA's FY18 request would reduce the project back to $9 million.

which includes going through a number of steps and gate reviews related to requirements, security, testing, operations, and training. This process also involves developing documentation such as new System Security Plans, Privacy Impact Assessments, Security Assessments, Test Reports, and Operational Plans. This work was not part of the scope of the current DPE and DOR TDLs related to development of the ERA 2.0 Pilot, and was always considered additional follow-on work. [redacted]

ERA 2.0 Pilot

ERA 2.0 is currently being developed as a functional Pilot, using an agile methodology that allows for frequent releases of new capabilities for testing and feedback from key stakeholders. The ERA 2.0 Pilot is currently focused on two major components, the DPE and the DOR. The DPE component will support the capability to upload digital materials of all types, provide a variety of software tools for verification and processing, provide the ability to create and edit metadata, and allow users to submit packages of processed digital materials to the DOR component for preservation. The DOR component will support the capability to ingest processed digital materials from the DPE, to provide for safe archival storage, deliver advanced search and discovery capabilities, and the ability to provide digital materials back to the DPE for further processing for preservation and public access through the NAC. As of April 7, 2017, 53 percent of the user stories/requirements are completed, while the majority of the remaining ones are deemed low priority.

Description of Agile Methodology

As stated previously, ERA 2.0 is being developed using an agile methodology. Agile is a method of developing software solutions that focuses on delivering high-quality working software frequently and consistently, while minimizing project overhead and increasing business value. A description of the most common steps in an agile software development approach are in Appendix A. Agile software development supports the practice of shorter software delivery times. Specifically, agile calls for the delivery of software in small, short increments rather than in the typically long, sequential phases of a traditional waterfall approach.[2] Appendix B provides a description of the differences between the agile and waterfall methodologies. Agile emphasizes this early and continuous software delivery, as well as using collaborative teams, and measuring progress with working software. The agile approach was first articulated in a 2001

[2] Waterfall is a sequential model where software development activities are divided into phases and the output of one phase becomes the input for the next phase.

document called the Agile Manifesto. The manifesto has four values: (1) individuals and interactions over processes and tools; (2) working software over comprehensive documentation; (3) customer collaboration over contract negotiation; and (4) responding to change over following a plan. Appendix C provides additional information on the Agile Manifesto and its related principles. By practicing agile according to its values and principles, unnecessary activities are removed, and benefits are delivered early. In agile, working software constantly being delivered to customers is integral and among the primary focuses of agile.

Additionally, OMB cites in its *Contracting Guidance to Support Modular Development* the benefits of a modular approach. The guidance states that modular approaches involve dividing investments into smaller parts in order to reduce investment risk, deliver capabilities more rapidly, and permit easier adoption of newer and emerging technologies.

This guidance states that by following a modular approach, agencies can recognize the following benefits:

- Delivery of usable capabilities that provide value to customers more rapidly as agency missions and priorities mature and evolve;
- Increased flexibility to adopt emerging technologies incrementally, reducing the risk of technological obsolescence;
- Decreased overall investment risk as agencies plan for smaller projects and increments versus "grand design" (each project has a greater overall likelihood of achieving cost, schedule, and performance goals than a larger, all-inclusive development effort);
- Greater visibility into contractor performance. Tying award of contracts for subsequent Task Orders to the acceptable delivery of prior projects provides agencies better visibility into contractor performance and allows a greater opportunity to implement corrective actions without sacrificing an entire investment; and
- An investment can be terminated with fewer sunk costs, capping the risk exposure to the agency when priorities change, a technology decision does not work or the contractor's performance does not deliver results.

ERA 2.0 Challenges

As noted by OMB, there are many benefits that can be derived from agile and the pilot users we interviewed cited the level of user involvement as very positive. The users like the functionality being released in the pilot, but would like to have it in the current production environment more timely. A NARA official stated that deploying new functionality to users on a frequent basis in the pilot environment has been instrumental in getting early, periodic, and valuable feedback in order to guide the development and enhancement of functionality that meets their needs. Having stakeholders see early versions of functionality has resulted in a process with common points of

reference that allows them to better articulate their requirements, and provide features and functions more responsive to those needs.

According to a NARA official, part of the current issue of deploying the functionality developed thus far in the DPE and the DOR to users in a production environment is that NARA decided to develop a functional ERA 2.0 Pilot, and therefore structured the TDLs to do that. [redacted]

[redacted]

NARA's Current SDLC Policy

If NARA decides to use the agile development methodology for future information technology development projects, we suggest modifying NARA's SDLC methodology to align it better for agile projects. NARA's SDLC Methodology dated November 27, 2013 is used to manage projects that are intended to develop, deploy, and operate information systems and information technology infrastructure capabilities in accordance with business needs.

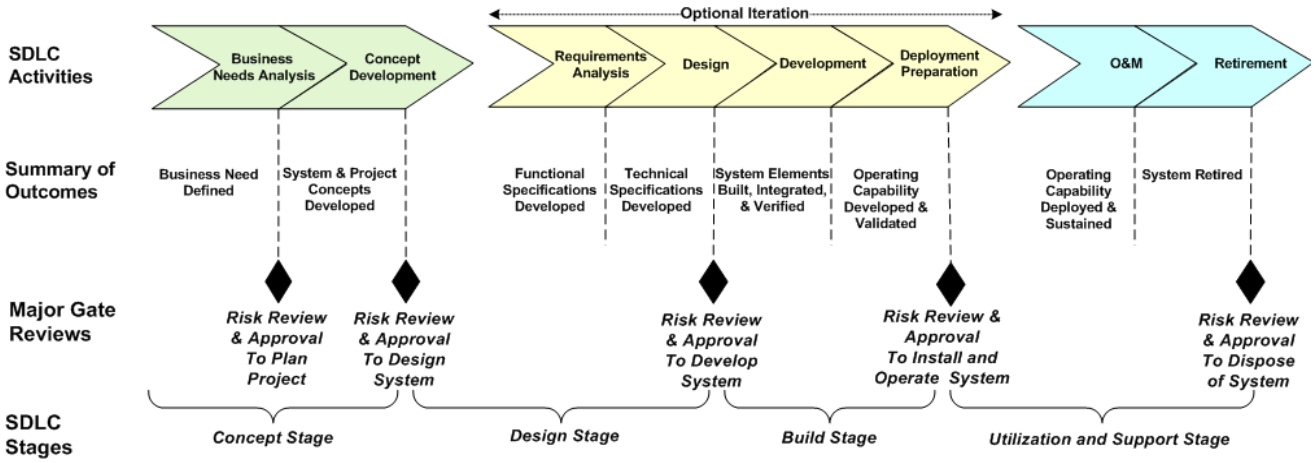
NARA's SDLC process is predicated upon four basic concepts (See Table No. 1): (1) SDLC Stages; (2) SDLC Gate Reviews; (3) SDLC Activities; and (4) SDLC Tailoring.

- SDLC Stages represent the level of maturity of a system as it moves through the life cycle from the analysis of business needs and the development of a system concept at the onset, through the design of a system solution, to the development and deployment of the solution, and finally to the ongoing operation and maintenance of the system and its eventual retirement. All systems will progress through these general stages of maturity, regardless of their size and complexity.
- SDLC Gate Reviews are prescribed governance checkpoints within the system life cycle that are used to assess the maturity of a system and the readiness of a project to move to

the next stage of implementation. Gate reviews also determine if the system, at each stage of maturity, meets requirements, and can still deliver the expected benefits when needed in accordance with the cost and schedule estimates established by the business case.

- SDLC Activities are broad categories of systems engineering tasks that are performed to implement a system. SDLC activities include: (a) business needs analysis; (b) concept development; (c) requirements analysis; (d) design, (e) development; (f) deployment preparation; (g) operations and maintenance; and (h) retirement.
- SDLC Tailoring is a planning activity whereby the project manager and lead systems engineer assess the nature of the system being developed and the overall complexity of the project. Based on this assessment, an appropriate SDLC tailoring plan is developed that defines the tasks and work products that are appropriate to and necessary for successful project performance and system implementation.

Table No. 1: Overview of NARA's SDLC Process



Source NARA SDLC Methodology

NARA's SDLC establishes four stages of system implementation: (1) Concept; (2) Design; (3) Build; and (4) Utilization and Support. Each of the project gate reviews have exit criteria that must be satisfied to demonstrate that the project has successfully completed the current SDLC stage and the system is mature enough to proceed to the next stage. For larger, more complex projects; or for projects that will perform multiple iterations of SDLC activities (e.g., projects using agile or iterative development approaches) it may be necessary to incorporate additional gate reviews into the project schedule. The purpose of a gate review is to have the appropriate governance board review the status of the project against the exit criteria for the applicable SDLC stage. Based upon the outcome of the gate review, the governance board determines whether or not the project has satisfied the exit criteria and can proceed to the next SDLC stage.

Although the current SDLC methodology addresses performing multiple iterations of the SDLC activities for agile projects, it does not articulate how to do this effectively in order to meet one of the primary agile goals which is getting functionality to the users quickly. For example, with agile the user stories/requirements are subject to constant changes and revisions throughout the SDLC, however it is not discussed if the exit criteria for this aspect of the gate review could be modified or if it should be deferred until all iterations are completed. Based on lessons learned from the ERA 2.0 Project, we suggest modifying NARA's SDLC methodology to align it better for agile projects. This could be done by developing a separate track for agile projects or identifying the specific tailoring needed for the current stage gate reviews and the accompanying exit criteria.

Appendix A – Steps In Agile Software Development

The most common steps in an Agile software development approach are:

1. **Discovery**

Agile software development projects start with a series of discovery sessions and research to understand the user's goals, challenges, and business environment. These sessions include key members of the project team including the users, project manager, designer, developer, and product owner to ensure a shared understanding across the entire team.

2. **The Product Backlog**

During discovery, the team works together to create a high-level product backlog**,** a wish list of all the features that would be useful to the users. The product owner works with the users to prioritize these features, determining the order in which the features are elaborated, developed, tested, and delivered. By allowing the users to determine priority, the team stays focused on delivering the highest value features before moving on to lower value features.

3. **Iterations**

After ensuring the team understands the user's vision and has created a high level backlog of features, the team delivers features through a series of time-boxed iterations called sprints. These are fixed durations of 1-4 weeks (depending on the project size and duration), each delivering a subset of the overall product backlog.

4. **Continuing the Cycle**

Additional sprints are conducted as needed to deliver additional features and incorporate feedback from previous iterations, reviews, and user beta testing. Each successive sprint is both iterative, providing improvements to work completed in previous sprints; and incremental, adding new features to the system.

Appendix B – Differences Between Agile and Waterfall Methodologies

The agile approach differs in several ways from traditional waterfall software development which produces a software product at the end of a sequence of phases. For example, the two approaches differ in: (1) the timing and scope of software development and delivery; (2) the timing and scope of project planning; (3) project status evaluation; and (4) collaboration.

Timing and scope of software development and delivery

In an agile project, working software is produced in iterations of typically one to eight weeks in duration, each of which provides a segment of functionality. To allow completion within the short time frame, each iteration is relatively small in scope. Iterations combine into releases, with the number of iterations dependent on the scope of the multistep process. To meet the goal of delivering working software, teams perform each of the steps of traditional software development for each iteration. Specifically, for each iteration, the teams identify requirements, design, and develop software to meet those requirements, and test the resulting software to determine if it meets the stated requirements. In contrast, waterfall development proceeds in sequential phases of no consistent, fixed duration to produce a complete system. Such full system development efforts can take several years. Waterfall phases typically address a single step in the development cycle. For example, in one phase, customer requirements for the complete product are documented, reviewed, and handed to technical staff. One or more phases follow, in which the technical staff develop software to meet those requirements. In the final phase, the software is tested and reviewed for compliance with the identified requirements.

Timing and scope of project planning

In agile, initial planning regarding cost, scope, and timing is conducted at a high level. However, these initial plans are supplemented by more specific plans for each iteration and the overall plans can be revised to reflect experience from completed iterations. For example, desired project outcomes might initially be captured in a broad vision statement that provides the basis for developing specific outcomes for an iteration. Once an iteration has been completed, the overall plans can be revised to reflect the completed work and any knowledge gained during the iteration. For example, initial cost and schedule estimates can be revised to reflect the actual cost and timing of the completed work. In contrast, in traditional waterfall project management, this analysis is documented in detail at the beginning of the project for the entire scope of work. For example, significant effort may be devoted to documenting strategies, project plans, cost and schedule estimates, and requirements for a full system.

Project status evaluation

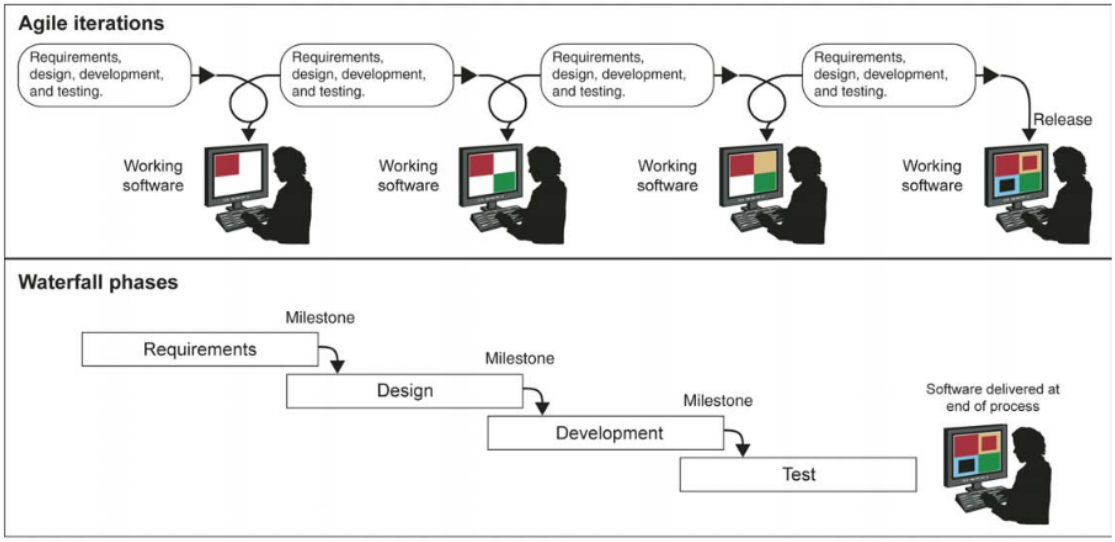
In agile, project status is primarily evaluated based on software demonstrations. For example, iterations typically end with a demonstration for customers and stakeholders of the working software produced during that iteration. The demonstration can reveal requirements that were not fully addressed during the iteration or the discovery of new requirements. These incomplete or newly-identified requirements are queued for possible inclusion in later iterations. In contrast, in traditional project management, progress is assessed based on a review of data and documents at predetermined milestones and checkpoints. Milestones and checkpoints can occur at the end of a phase, such as the end of requirements definition, or at scheduled intervals, such as monthly. The reviews typically include status reports on work done to date and a comparison of the project's actual cost and schedule to baseline projections.

Collaboration

Agile development emphasizes collaboration more than traditional approaches do. For example, to coordinate the many disciplines of an iteration, such as design and testing, customers work frequently and closely with technical staff. Furthermore, teams are often self-directed, meaning tasks and due dates are done within the team and coordinated with project sponsors and stakeholders as needed to complete the tasks. In contrast, with traditional project management, customer and technical staff typically work separately, and project tasks are prescribed and monitored by a project manager, who reports to entities such as a program management office. See the GAO Figure 1 below for a depiction of agile development compared to waterfall development.[3]

[3] Source: GAO Report GAO-12-681, *Software Development, Effective Practices and Federal Challenges in Applying Agile Methods.*

Figure 1: Comparison of Agile and Waterfall Development



Source: GAO.

Appendix C – The Agile Manifesto and Principles

Agile development encompasses concepts that were previously used in software development. These concepts were documented as agile themes and principles by 17 practitioners, who called themselves the Agile Alliance. In February 2001 the Alliance released "The Agile Manifesto," in which they declared: "We are uncovering better ways of developing software by doing it and helping others do it. Through this work we have come to value:

- individuals and interactions over processes and tools
- working software over comprehensive documentation
- customer collaboration over contract negotiation
- responding to change over following a plan."

The Alliance added that while they recognized the value in the second part of each statement (i.e., "processes and tools"), they saw more value in the first part ("individuals and interactions"). The Alliance further delineated their vision with twelve principles.

The 12 Agile Principles behind the Manifesto are:

1. Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.

2. Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.

3. Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.

4. Business people and developers must work together daily throughout the project.

5. Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.

6. The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.

7. Working software is the primary measure of progress.

8. Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.

9. Continuous attention to technical excellence and good design enhances agility.

10. Simplicity, the art of maximizing the amount of work not done, is essential.

11. The best architectures, requirements, and designs emerge from self-organizing teams.

12. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.

Appendix D – Acronyms

ATO	Authority to Operate
BOM	Business Object Management
CONOPS	Concept of Operations
DOR	Digital Object Repository
DPE	Digital Processing Environment
ERA	Electronic Records Archives
FY	Fiscal Year
GAO	Government Accountability Office
NAC	National Archives Catalog
NARA	National Archives and Records Administration
OIG	Office of Inspector General
OMB	Office of Management and Budget
OIF	Optimized Ingest Framework
SIP	Submission Information Package
SDLC	System Development Life Cycle
TDL	Technical Direction Letters

Appendix E – Management Response

NATIONAL ARCHIVES

Date: AUG 1 4 2017

To: James Springs, Inspector General

From: David S. Ferriero, Archivist of the United States

Subject: Management's Response to OIG Audit Report 17-AUD-15, *NARA's Electronic Records Archives 2.0 Project*

Thank you for the opportunity to provide comments on this final report. We appreciate your willingness to meet and clarify language in the report.

The observations and analysis included in your report will help us to improve the effectiveness of ERA 2.0 development efforts. Please contact Kimm Richards if you have any questions at Kimm.Richards@nara.gov or by phone at (301) 837-1668.

DAVID S. FERRIERO
Archivist of the United States

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