



The Solaris to Linux Migration Project Was Delayed and Needs Improved Governance

December 6, 2018

Reference Number: 2019-20-008

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HIGHLIGHTS

THE SOLARIS TO LINUX MIGRATION PROJECT WAS DELAYED AND NEEDS IMPROVED GOVERNANCE

Highlights

**Final Report issued on
December 6, 2018**

Highlights of Reference Number: 2019-20-008 to the Commissioner of Internal Revenue.

IMPACT ON TAXPAYERS

The IRS hosts approximately 1,400 databases and 190 applications designed to operate on the Solaris Sun Sparc architecture with the Solaris operating system. The Solaris Sun Sparc architecture runs on vendor (Oracle) proprietary hardware along with the Solaris operating system. The ability to implement Linux across the IRS information technology environment without paying additional licensing fees could yield significant cost savings over the long term. Due to potential cost saving benefits, the IRS made a decision to consolidate platforms and migrate applications to Linux-based operating systems.

WHY TIGTA DID THE AUDIT

This audit was initiated to review the IRS's migration from Oracle Solaris to IBM's zLinux operating system and the procurement of hardware and technical support to facilitate the migration.

WHAT TIGTA FOUND

The Linux Migration Project operated without governance that was specific to its operations. The inadequate governance contributed to the project delays. For example, the business case did not include key factors such as the time required to train employees on how to set up and support a Linux environment. Prior to implementation, the IRS did not develop an initial project plan, or conduct upfront assessments and technical analysis on the applications and databases that were to be migrated. Original project plans estimated that

the Linux Migration Project would be complete in 2016.

The migration team did not initially follow standard software development practices when it established the Linux environment for a pilot project. As a result, the pilot project took 22 months to complete. The migration team eventually revised the pilot project to include the development of repeatable processes for future migrations.

Only eight of the 141 applications in the Linux Migration Project inventory in February 2018 have completed migration. In addition, the zLinux hardware and support purchased in September 2016 for \$6.8 million has been underutilized. For example, the Linux Migration Project has activated only 56 of the 262 available central processing units on the purchased zLinux hardware.

In January 2017, the Enterprise Demand Management process started requiring all projects to use the Linux Cross Functional Playbook and complete the required steps in order to migrate and deploy a system to Linux. This process has improved migration efforts. However, the Linux Migration Project has not implemented its planned disaster recovery or business continuity strategy.

WHAT TIGTA RECOMMENDED

TIGTA recommended that the Chief Information Officer ensure that the Linux Migration Project operates under a governance board that aligns with the organization's governance model and that the procurement of hardware, service, and support includes a well-developed plan, process for utilization, and reasonable timelines. In addition, the Chief Information Officer should ensure that the Linux Migration Project implements its planned disaster recovery and business continuity strategy utilizing alternate site processing.

The IRS agreed with all three recommendations. The IRS plans to assign Linux projects to the appropriate governance board and to submit acquisition plans for any purchases greater than \$250,000. Alternate Site Processing was implemented as of August 15, 2018.



TREASURY INSPECTOR GENERAL
FOR TAX ADMINISTRATION

DEPARTMENT OF THE TREASURY
WASHINGTON, D.C. 20220

December 6, 2018

MEMORANDUM FOR COMMISSIONER OF INTERNAL REVENUE

FROM: Michael E. McKenney
Deputy Inspector General for Audit

SUBJECT: Final Audit Report – The Solaris to Linux Migration Project Was Delayed and Needs Improved Governance (Audit # 201720033)

This report presents the results of our review of the Internal Revenue Service's (IRS) migration from Oracle Solaris to IBM's zLinux operating system and the procurement of hardware and technical support to facilitate the migration. This review is included in our Fiscal Year 2019 Annual Audit Plan and addresses the major management challenge of Achieving Program Efficiencies and Cost Savings.

Management's complete response to the draft report is included as Appendix V.

Copies of this report are also being sent to the IRS managers affected by the report recommendations. If you have any questions, please contact me or Danny R. Verneuille, Assistant Inspector General for Audit (Security and Information Technology Services).



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Was Delayed and Needs Improved Governance*

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Abbreviations

EDM	Enterprise Demand Management
FY	Fiscal Year
IRS	Internal Revenue Service



The Solaris to Linux Migration Project Was Delayed and Needs Improved Governance

Background

The Internal Revenue Service (IRS) hosts approximately 1,400 databases¹ and 190 applications designed to operate in the Solaris Sun Sparc architecture with the Solaris operating system. The Solaris Sun Sparc architecture is required to run on vendor (Oracle) proprietary hardware along with the Solaris operating system. In August 2013, the IRS began to analyze which existing projects and legacy systems running Solaris could be migrated to other operating systems. Studies have shown that the Linux operating system is a less expensive platform to deploy and operate than a typical distributed systems environment. Although some initial costs were higher, the ability to implement the product across the information technology environment without paying additional licensing fees could yield significant cost savings over the long term.² The IRS performed an internal total cost of ownership comparison for one of its large applications, the Modernized E-file system, to determine the potential cost savings of migrating it from Solaris to Linux. ZLinux is an IBM system that uses virtualization capabilities to allow a single mainframe to run multiple virtual Linux servers concurrently. This comparison showed that over five years, the IRS could save more than \$12 million by running the Modernized E-file system on Linux rather than Solaris. The Information Technology organization's Strategy and Planning office developed a proposal to utilize IBM zLinux mainframes rather than:

- Continue to use Solaris platforms currently running legacy systems.
- Migrate legacy systems using Solaris platforms to x86 servers running Linux.

In March 2014, the former IRS Chief Technology Officer agreed with this proposal and mandated that Solaris-based applications and databases be migrated to the Linux operating system on IBM mainframes. This decision was intended to reduce hardware costs, software costs, and the number of skill sets needed by the Information Technology organization staff. Unlike Solaris, Linux operating systems are open-source, meaning the IRS could install it on an unlimited number of computers and systems without paying for software or licensing. Prior to implementation, most IRS technical experts agreed with the plan to migrate from Solaris to Linux because, in theory, it would reduce hardware, software, and maintenance costs.

The IRS began to implement processes to migrate existing applications and databases to run on Linux and developed a roadmap with targeted goals for each fiscal year. In the Roadmap of the

¹ See Appendix IV for a glossary of terms.

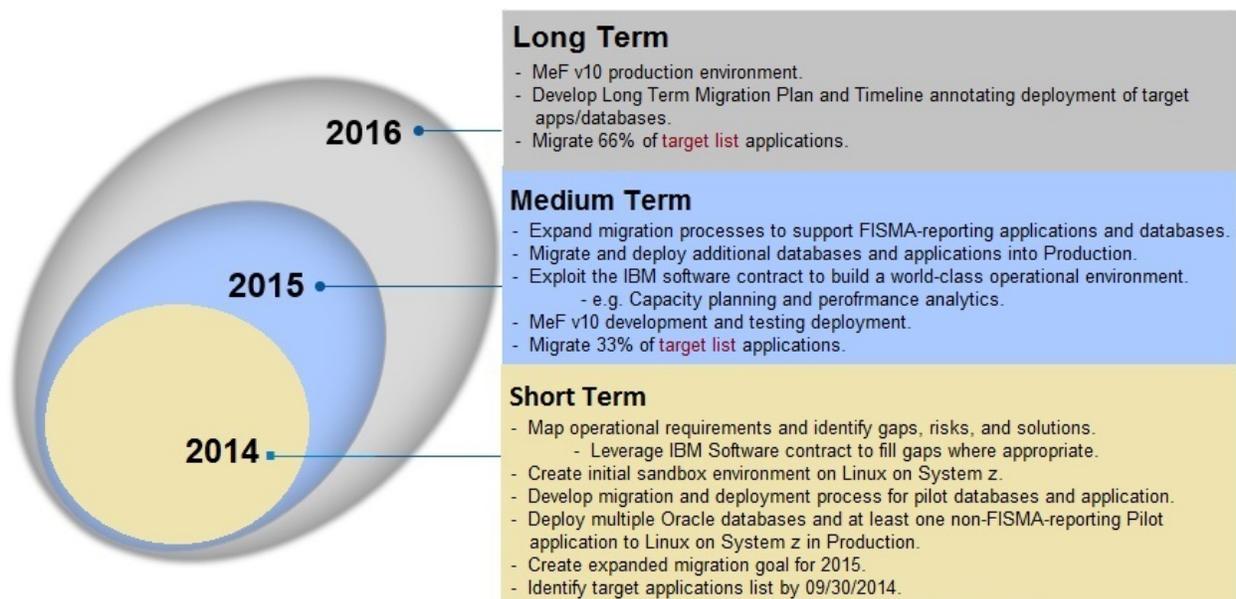
² Robert Frances Group, *Total Cost of Ownership for Linux in the Enterprise* (Sept. 2002). Alinean, *The Total Cost of Ownership (TCO) of Migrating to SUSE Linux Enterprise Server for System Z* (July 2010). Red Hat Blog, *How Red Hat Enterprise Linux Trims Total Cost of Ownership (TCO) in Comparison to Windows Server*, <https://www.redhat.com/fr/blog/how-red-hat-enterprise-linux-trims-total-cost-of-ownership-in-comparison-to-windows-server> (last visited on July 24, 2018).



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Solaris to Linux Migration Plan, 33 percent of the targeted applications were to be migrated in Fiscal Year (FY) 2015 and 66 percent in FY 2016. Figure 1 provides more detail on the project's roadmap.

Figure 1: Roadmap of the Solaris to Linux Migration Plan



Source: IRS Linux on System z Strategic Migration Plan (Mar. 2014). MeF = Modernized E-file. FISMA = Federal Information Security Modernization Act.

This review was performed at the Information Technology organization's Enterprise Program Management office; Enterprise Operations, Enterprise Services, and Applications Development functions; and the Office of Procurement in Lanham, Maryland, during the period December 2017 through June 2018. We conducted this performance audit in accordance with generally accepted government auditing standards. Those standards require that 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 objective. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objective. Detailed information on our audit objective, scope, and methodology is presented in Appendix I. Major contributors to the report are listed in Appendix II.



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Results of Review

Inadequate Governance of the Solaris to Linux Migration Project Contributed to Poor Planning, Insufficient Technical Skills, Significant Delays, and Funds Prematurely Spent on Hardware and Support

Internal Revenue Manual 2.16.1.8³ defines governance as a process of putting structure around how the Information Technology organization's strategy aligns with the IRS's business strategy, ensuring that it stays on track to achieve its goals, as well as implementing good ways to measure the Information Technology organization's performance. The primary objective of IRS Governance is to ensure that assigned investment, program, and project objectives are met; risks are managed appropriately; and enterprise expenditures are fiscally sound. IRS Governance is granted control for all investments, programs, and projects within its assigned portfolio. IRS governance boards provide direction on the information technology scope and schedule baseline based on established funding and targeted business results.

According to Internal Revenue Manual 2.5.1, *Systems Development*,⁴ the IRS is required to establish reasonable plans for managing development projects and engineering tasks. According to *IBM's Solaris to Linux Migration: A Guide For System Administrators*,⁵ whether in a data center or on client workstations, migrations involve considerations beyond simple operating system operation. In many cases, the move to a new platform involves organizational and strategic changes as well. Also, according to IBM's guide, the most important steps involved in planning a migration to a Linux platform include:

- Assembling the stakeholders.
- Setting objectives and defining scope.
- Assessing workload and environment.
- Assessing skill requirements.
- Building a plan.

IBM's guide states that a main key success factor for a Linux Migration is a well-built plan. The migration team needs to understand the objectives and include performance metrics. These objectives and metrics should include stakeholder involvement and agreement to provide a good

³ Internal Revenue Manual 2.16.1, *Enterprise Life Cycle Guidance* (Dec. 22, 2015).

⁴ Internal Revenue Manual 2.5.1, *Systems Development* (Sept. 1, 2015).

⁵ Dated February 2006.



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base from which to build a plan. All key requirements, such as timing, resource needs, business commitments, and service level agreements, should be included in the plan. All related aspects of the migration, such as new workloads, infrastructure, and consolidation should also be included. The following key factors should be included when building a migration plan:

- Resources, including hardware and software.
- Education, including staff training for a Linux skillset.
- Service level agreements.
- Any other related aspects to the project.

In August 2013, prior to the start of the Linux Migration project, the former Chief Technology Officer required the Solaris software running applications and databases be updated and ready for migration in four months. According to migration status documentation, the updates caused serious performance and security issues that affected the functional speed and response of the applications and databases. IRS security scans also identified vulnerabilities on the new software. The four-month target was not possible for many applications and databases due to the time needed to address the identified issues.

During the migration, the Linux Migration Project operated without governance that was specific to its operations. The project was under an Executive Steering Committee that received quarterly reports on the migration progress and investment. The project also reported to a Technical Advisory Group that provided technical communication, support, and guidance. These levels of governance provided broad oversight to the project, but could not provide in-depth authorizations and recommendations.

The Linux Migration Project is a cross-functional and collaborative partnership between members of the Enterprise Operations, Enterprise Services, Applications Development, and Cybersecurity functions. The Linux Migration Project drafted a governance board charter and identified personnel to perform in these positions. As of February 2018, the charter was still unsigned and the board was not established. Without sanctioned governance, the Linux Migration Project did not start with proper controls or authorization of its process and procedures.

The IRS established the Linux Migration Project in March 2014. Inadequate governance led to several factors that contributed to project delays. For example, the business case relied upon to authorize the decision to go forward did not include key factors, such as the time required to train employees on how to set up and support a Linux environment. Specifically, the Enterprise Services function needed trained personnel with specific technical skills to perform proper capacity planning, performance analysis, and performance testing. In addition, the Applications Development function did not have staff with the required technical skills needed to determine the scope of the Linux Migration Project.



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Because the Linux Migration Project's staff did not have the technical skills required to carry out the migration, the project purchased \$814,272 worth of support services provided by the vendor. Project status briefings show that support services included technical labor for setting up the IBM mainframes with customized program coding. Due to insufficient planning, the Enterprise Operations office personnel did not schedule zLinux mainframe training until two years after the start of the Linux Migration project. However, the IRS could not provide evidence that the training was completed.

The Linux Migration Project started with goals to migrate 33 percent of its 140 target applications to Linux by December 2015, and 66 percent, including the Modernized E-file system, by December 2016. However, the IRS did not develop an initial project plan, conduct upfront assessments, or perform a complete technical analysis on the applications and databases that were to be migrated. The migration team did not effectively assess the portability of applications and databases from Solaris to Linux. The migration team's insufficient planning and analysis led to an inadequate understanding of all requirements needed for an enterprise-wide Linux migration effort.

Prior to the Linux Migration Project's kickoff, the migration team began evaluating applications to migrate to Linux. The approximately four-month long evaluation identified the Totally Automated Personnel System/Single Entry Time Reporting application as a pilot project for its Linux migration efforts. The pilot project started in March 2014, but its Linux environment had serious performance and security issues that required extra effort to stabilize the environment. For example, the pilot project exceeded its available memory capacity, but the staff did not have a process to identify and mitigate performance issues resulting in a bottleneck of processing resources. Additional security issues related to the inability to run required security scans on the application. The migration team was able to work through the issues and migrate the pilot project to Linux.

While the migration team established the Linux environment, it initially did not follow standard software development practices. The team had to restart the pilot project's migration process using standard software development practices in order to develop repeatable standards, processes, and procedures for future migrations. As a result, the entire pilot process of migrating the Totally Automated Personnel System/Single Entry Time Reporting application to the Linux environment took 22 months and was completed in September 2015.

Inadequate governance allowed for an improper approval and prioritization process across the project. For example, internal risk-tracking documents reported the Linux Migration Project did not have proper control authorization to build Linux servers. Without these controls, projects from various departments would be able to submit Unified Work Requests without approved engineering designs.



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In addition, reporting on the Linux Migration Project was not included in the Quarterly IRS Information Technology Investment Reports. The Consolidated Appropriations Act, 2016⁶ Division E, requires the IRS to submit quarterly updates on key Operations Support and Business Systems Modernization investments. The cost threshold for reporting on these major information technology investments is \$10 million a year or \$50 million over a project's lifecycle. The Linux Migration Project exceeded the \$10 million a year threshold in FY 2016 and FY 2017. The FY 2018 and FY 2019 funding requests exceed this threshold as well.

As of February 2018, only eight (about 6 percent) of the 140 applications in the Linux Migration project inventory have completed the migration. A large undertaking and a major focus of this migration, the Modernized E-file system, was listed as "in process" as of February 2018.

As of February 2018, the Linux Migration Project has 140 applications in its inventory:

- 50 applications (36 percent), including approximately 259 servers, have not been started.
- 45 applications (32 percent), including approximately 894 servers, are in process.
- 35 applications (25 percent), including approximately 140 servers, are in the planning stage.
- 8 applications (6 percent), including approximately 59 servers, have been migrated.
- 2 applications (1 percent) were determined to be out of scope.

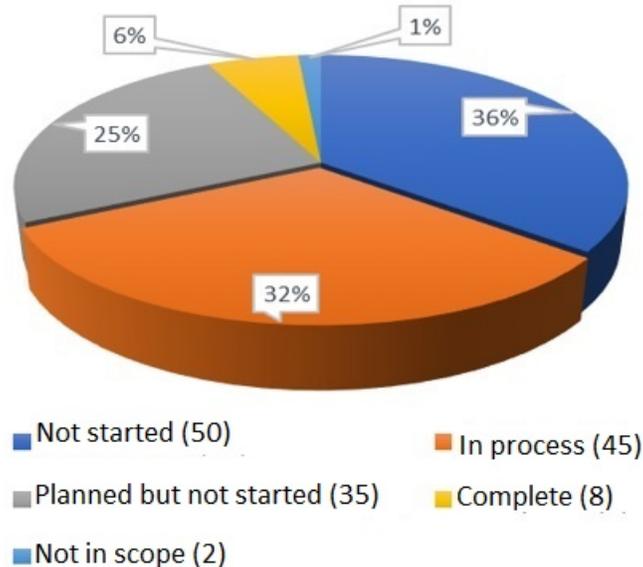
Figure 2 shows the applications status as of February 2018.

⁶ Pub. L. 114–113 (Dec. 18, 2015).



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Figure 2: Applications Status for the Solaris to Linux Migration Project



Source: IRS Linux Program Demand and Enterprise Demand Management Pipeline Overview, dated March 2018.

In September 2016, the Linux Migration Project purchased two IBM mainframes running zLinux along with service and support for \$6.8 million. As of February 2018, the production zLinux mainframe installed in Martinsburg, West Virginia, purchased for \$3.4 million, was running eight production applications along with a few other test and development environments. The IRS has been slow to use the zLinux mainframe installed in Memphis, Tennessee, at a price of \$2.6 million, designed to run backup and disaster recovery operations. As of December 2017:

- The Martinsburg, West Virginia, zLinux production mainframe has activated 50 of the 141 available central processing units.
- The Memphis, Tennessee, zLinux backup mainframe has activated only six of the 121 available central processing units.

Outside of the zLinux hardware purchase, the Linux Migration Project spent nearly \$15 million in FY 2016 and \$11.4 million in FY 2017 for the acquisition of software, hardware, and contractor services, according to a briefing status report and investment documentation. The Linux Migration Project requested an additional \$14.9 million for both FY 2018 and FY 2019 for contracting support and the migration of applications. If approved, the FY 2018 and FY 2019 funding requests bring the Linux Migration Project's total costs (excluding IBM hardware purchase) to \$56.2 million through FY 2019.

According to the IRS, in FY 2017, the hardware and software maintenance costs to continue running all IRS legacy systems on the Solaris platform that can be migrated to Linux was nearly



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\$2.4 million annually, or more than \$7 million through FY 2019. This amount does not include other potential costs savings (such as software licensing) that might affect how quickly the IRS recovers the Linux migration expenses. The IRS estimates that the migration project will be completed in FY 2020. The IRS will be unable to recover the full costs of migrating to Linux and begin realizing savings until several years after the project is completed.

Recommendations

The Chief Information Officer should:

Recommendation 1: Ensure that the Linux Migration Project operates under a governance board that aligns with the organization’s governance model and project life cycle.

Management’s Response: The IRS agreed with this recommendation. The IRS will assign Linux projects to the appropriate Governance Board in alignment with the Information Technology organization’s Governance framework and process.

Recommendation 2: Ensure that the procurement of hardware, service, and support includes a well-developed plan, process for utilization, and reasonable timelines.

Management’s Response: The IRS agreed with this recommendation. The IRS processes are maturing with consistent use of the Enterprise Demand Management tool in conjunction with the “Linux Cross-Functional Playbook” to effectively assess and execute Linux migration activities. Per IRS policy, the Information Technology organization will continue to submit acquisition plans for any purchases greater than \$250,000.

The Linux Migration Project Has Not Fully Implemented Its Planned Backup or Disaster Recovery Strategy

Internal Revenue Manual 10.8.60, *Information Technology (IT) Security, IT Service Continuity Management (ITSCM) Policy and Guidance*,⁷ provides IRS responsibilities for information systems security and availability regarding information system contingency plans and disaster recovery. The IRS is required to ensure compliance with policy, regulations, and the ability to recover critical business processes through the systems and applications that support them. All IRS systems and applications shall have sufficient disaster recovery capability to recover IRS data with appropriate system and application functionality.

The Linux Migration Project’s backup mainframe in Memphis, Tennessee, was significantly unused while the project focused on the production mainframe environment. The IRS activated

⁷ Internal Revenue Manual 10.8.60 (Sept. 4, 2015).



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one central processing unit from the date the backup mainframe was purchased in September 2016 to November 2017.

As of February 2018, the recovery process involved activating the backup mainframe and using data replication and tape backups to restore applications. This strategy meets the recovery goal of 36 hours. While the Linux Migration Project has a disaster recovery strategy in place, it is working to implement an improved disaster recovery and business continuity strategy that should reduce the expected recovery time.

As of March 2018, the zLinux mainframe environment in Memphis, Tennessee, was being setup to run the IRS backup and disaster recovery strategy for the production applications in Martinsburg, West Virginia. The team plans to improve backup and disaster recovery functionality by utilizing alternate site processing as its disaster recovery strategy. However, some of the reasons for the delay in deploying alternate site processing include the need for:

- Network cabling for the backup mainframe.
- Direct-access storage device replication.
- zLinux virtual machine tape backup strategy implementation.
- Alternate site processing testing.

Due to the Linux Migration Project running behind schedule, the migration team focused on migrating projects to zLinux and on setting up the production mainframe environment. The delays in migrating critical tax processing applications, such as the Modernized E-file system, to the zLinux mainframe environment result in the financial resources invested in the newer mainframes acquired to support the improved disaster recovery strategy remaining significantly underutilized.

Recommendation

The Chief Information Officer should:

Recommendation 3: Implement the Linux Migration Project's planned disaster recovery and business continuity strategy utilizing alternate site processing.

Management's Response: The IRS agreed with this recommendation. Alternate Site Processing was implemented as of August 15, 2018. In addition, Disaster Recovery has been successfully tested annually for the last two years.



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The Enterprise Demand Management Process Has Improved the Migration Efforts

For the Solaris to Linux Migration Project, the IRS designed and developed the Enterprise Demand Management (EDM) process in Calendar Years 2015 and 2016. Once the IRS successfully deployed the Totally Automated Personnel System/Single Entry Time Reporting pilot to show that a migration to Linux was possible, the EDM team began developing the goals, objectives, and requirements for any IRS system to be migrated to Linux. In January 2017, the EDM process officially started requiring all projects to use the Linux Cross Functional Playbook the EDM team created and complete the required steps in order to migrate and deploy a system to Linux.

The EDM team uses a software tool from Hewlett-Packard called Project and Portfolio Management Center as its system of record to help with forecasting migration hardware needs. No single system at the IRS contains all of the data the EDM team needs. This tool collects data from SharePoint surveys, Excel spreadsheets, and Access databases in order to forecast future migration needs. The Project and Portfolio Management Center acts as a work request system. For each Linux Migration project, the project or system owner has to complete forms that provide detail on the size and computing power required for its migration. The EDM team prioritizes each project request for hardware resources. Once the EDM team identifies the projects, solution engineers review these requests for migration feasibility. The solution engineers determine if the requestors actually need the requested amount of space and computing power.

The Linux Cross Functional Playbook is a standard solution that provides guidance and outlines the specific steps for any project migrating from Solaris to Linux. All projects and applications specifically performing a Solaris to Linux Migration must complete all the steps in the Linux Cross Functional Playbook and each project and application must update its checklist. The EDM team refined the Linux Cross Functional Playbook as the process matured. Initial estimates for the time required to complete a project migration were from 99-148 weeks. As of October 2017, more recent estimates indicate the project migrations will take between 83-113 weeks. Projects can be migrated concurrently so more than one application and database are migrated at a time. This allows for approximately 70 Solaris database migrations per month. The updated estimate includes joint planning time with the various stakeholders involved in the migration, environment setup, development work, and deployment activities. This process ends with a lessons learned phase in order to develop ways to improve the EDM process.



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Appendix I

Detailed Objective, Scope, and Methodology

Our overall objective was to review the IRS's migration¹ from Oracle Solaris to IBM's zLinux operating system and the procurement of hardware and technical support to facilitate the migration. To accomplish our objective, we:

- I. Determined whether the IRS effectively and efficiently planned the migration from Solaris to Linux.
 - A. Obtained and reviewed planning documentation developed by the IRS on the migration of applications and databases to determine if proper migration processes were followed.
 - B. Determined whether the IRS performed up front technical assessments to identify skills needed to ensure the successful migration and determined if IRS personnel possessed these necessary skills.
 - C. Determined what training was provided to IRS personnel to ensure that they possessed the technical skills necessary for the migration.
 - D. Obtained and reviewed any cost/benefit analysis developed by the IRS and used in the decisionmaking process to support the migration.
 - E. Determined if the IRS completed the necessary analysis and followed procurement procedures for the purchase of hardware and technical support to facilitate the migration.
- II. Determined the effectiveness and efficiency of the IRS's efforts to migrate applications and databases from Solaris to Linux.
 - A. Obtained and reviewed migration status report documentation, including program updates to steering committees and/or governance boards.
 - B. Determined the original number of applications and databases planned for migration.
 - C. Determined the current number of applications and databases migrated.
 - D. Interviewed program management to determine why applications/database migrations were delayed or not completed.

¹ See Appendix IV for a glossary of terms.



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- E. Obtained the utilization reports for the mainframes involved in the migration from Solaris to zLinux and determined the utilization rates for the mainframes.
- F. Determined whether assets involved in the migration efforts were efficiently identified and utilized.

Internal controls methodology

Internal controls relate to management's plans, methods, and procedures used to meet their mission, goals, and objectives. Internal controls include the processes and procedures for planning, organizing, directing, and controlling program operations. They include the systems for measuring, reporting, and monitoring program performance. We determined that the following internal controls were relevant to our audit objective: IRS policies, procedures, and processes for asset management, information technology governance, and systems development. We also used the industry best practice *IBM's Solaris to Linux Guide*. We evaluated these controls by interviewing officials and reviewing documents that included monthly project status briefings, hardware and support services purchase orders, internal planning documentation, and the Linux Migration Playbook for the EDM process in the Enterprise Operations, Office of Procurement, Cybersecurity, Strategy and Planning, and Enterprise Services functions.



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Appendix II

Major Contributors to This Report

Danny R. Verneuille, Assistant Inspector General for Audit (Security and Information
Technology Services)
John Ledford, Director
Myron Gulley, Audit Manager
Corey Brown, Lead Auditor
Kasey Koontz, Senior Auditor



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Appendix III

Report Distribution List

Deputy Commissioner for Operations Support
Deputy Chief Information Officer for Operations
Associate Chief Information Officer, Applications Development
Associate Chief Information Officer, Cybersecurity
Associate Chief Information Officer, Enterprise Operations
Associate Chief Information Officer, Enterprise-Program Management Office
Associate Chief Information Officer, Enterprise Services
Associate Chief Information Officer, Strategy and Planning
Director, Business Planning and Risk Management
Director, Security Risk Management
Director, Office of Audit Coordination



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Appendix IV

Glossary of Terms

Term	Definition
Alternate Site Processing	Involves moving production processing from one Enterprise Computing Center to the other Enterprise Computing Center using replication and gridding (virtual tape) technologies.
Application	A software program hosted by an information system.
Central Processing Unit	An internal component of the computer that performs arithmetic and logical operations, extracts instructions from memory, decodes instructions, and executes instructions.
Cybersecurity Function	Responsible for ensuring IRS compliance with Federal statutory, legislative, and regulatory requirements governing confidentiality, integrity, and availability of IRS electronic systems, services, and data.
Database	A computer system with a means of storing information in such a way that information can be retrieved.
Disaster Recovery	The ability of an organization to respond to a disaster or an interruption in services by implementing a disaster recovery plan to stabilize and restore the organization's critical functions.
Distributed System	A distributed system is one in which both data and transaction processing are divided between one or more computers connected by a network, each computer playing a specific role in the system.
Enterprise Operations Function	Responsible for providing server and mainframe computing services for all IRS business entities and taxpayers.



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Term	Definition
Enterprise-Program Management Office	Responsible for the delivery of integrated solutions for several of the IRS's large-scale programs. It plays a key role in establishing configuration management and release plans and implementing new information system functional capabilities.
Enterprise Services Function	Responsible for designing and testing enterprise solutions. It includes the Enterprise Systems Testing Division responsible for the Final Integration Test.
Linux	Enterprise-wide operating system designed to meet various performance, reliability, and scalability demands on a broad range of hardware, including mainframes, servers, workstations, and personal computers.
Mainframe	A powerful, multiuser computer capable of supporting many hundreds of thousands of users simultaneously.
Migration	The process of translating data from one format to another. Data migration or conversion is necessary when an organization decides to use a new computing or database management system that is incompatible with the current system. Also, it is defined as the process of moving data from one storage device to another.
Modernized E-file	An IRS program that receives and processes tax returns in an Internet environment.
Operating System	The software that serves as the user interface and communicates with computer hardware to allocate memory, process tasks, and access disks and peripherals.
Solaris	The UNIX based operating system of Sun Microsystem.
Strategy and Planning Function	Responsible for facilitating the alignment of information technology and business through strategic planning and financial management practices that offer transparency and overall information technology demand, supply, and the value of information technology investments.



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Term	Definition
System Z	IBM software that can run Linux distributions. This system uses virtualization capabilities to allow a single mainframe to run up to thousands of virtual Linux servers concurrently.
Virtual Machine	A simulated environment created by virtualization, also described as a tightly isolated software container that can run its own operating systems and applications as if it were a physical computer.



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Appendix V

Management's Response to the Draft Report

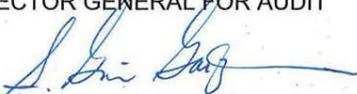


CHIEF INFORMATION OFFICER

DEPARTMENT OF THE TREASURY
INTERNAL REVENUE SERVICE
WASHINGTON, D.C. 20224

NOV 01 2018

MEMORANDUM FOR MICHAEL E. MCKENNEY
DEPUTY INSPECTOR GENERAL FOR AUDIT

FROM: S. Gina Garza 
Chief Information Officer

SUBJECT: Response to Draft Report – The Solaris to Linux Migration
Project was Delayed and Needs Improved Governance
(Audit # 201720033)

Thank you for the opportunity to review and comment on the above subject draft report. The IRS Information Technology (IT) organization is committed to continuously improving governance and implementing sound internal controls required for achieving goals and driving strategic portfolio investment solutions. The IRS agrees with all three of TIGTA's recommendations and has taken steps toward fully addressing the concerns noted in the report.

We appreciate your recognition of the extensive efforts IRS has devoted over the years to implementing an IT Governance Process, as well as creating cost savings and operational efficiencies within its IT operating systems. The Linux program is currently governed by the Infrastructure Enterprise Steering Committee. The Linux projects will be assigned to the appropriate IT Governance Board as indicated in our corrective action plan. The Linux Migration Project operates under the appropriate IT Governance Board that aligns with the organization's IT Governance framework and Project Life Cycle.

Our processes are also maturing with consistent use of the Enterprise Demand Management tool in conjunction with our "Linux Cross-Functional Playbook", to effectively assess and execute Linux migration activities. To address concerns identified in the report, IT will continue to submit acquisition plans for any purchases greater than \$250K, per IRS policy.

Effective August 15, 2018, all software and infrastructure components have been installed and Alternate Site Processing (ASP) is now available for Linux servers. The next project due for migration in 2019 is Modernized e-File (MeF) which will be implemented under the ASP model. IT leadership has built the Linux solution with high



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Was Delayed and Needs Improved Governance*

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service availability and resiliency in mind. Specifically, the current disaster recovery (DR) solution approved for Linux supports a 36-hour recovery time objective (RTO) and 24-hour recovery point objective (RPO). Every project migrated to Linux is required to have a DR/Backup recovery process documented via an Information System Contingency Plan (ISCP). All projects migrated to Linux have executed and completed a DR test successfully prior to project migration, and current Linux projects have successfully completed DR recovery tests post-migration.

Attached is the corrective action plan to address the TIGTA recommendations. Please contact me directly at 202-317-5000 or Carmelita White, Senior Manager, IT Program Oversight Coordination at 240-613-2191, should you have any questions. We thank you again for the opportunity to comment on the draft report.

Attachment



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Recommendation #1: Ensure that the Linux Migration Project operates under a governance board that aligns with the organization's governance model and project life cycle.

Corrective Action #1: IRS agrees with this recommendation. IRS will assign Linux projects to the appropriate IT Governance Board in alignment with the IT Governance framework and process.

Implementation Date: June 15, 2019

Responsible Official: Associate Chief Information Officer, Strategy & Planning

Recommendation #2: Ensure that the procurement of hardware, service, and support includes a well-developed plan, process for utilization and reasonable timeliness.

Corrective Action #2: IRS agrees with this recommendation. Our processes are maturing with consistent use of the Enterprise Demand Management tool in conjunction with our "Linux Cross-Functional Playbook", to effectively assess and execute Linux migration activities. Per IRS policy, IT will continue to submit acquisition plans for any purchases greater than \$250K.

Implementation Date: March 15, 2021

Responsible Official: Associate Chief Information Officer, Applications Development

Recommendation #3: Implement the Linux Migration Project's planned disaster recovery and business continuity strategy utilizing alternate site processing.

Corrective Action #3: The IRS agrees with this recommendation. The Alternate Site Processing (ASP) was implemented as of August 15, 2018, ahead of schedule. In addition, Disaster Recovery has been successfully tested annually for the last two years.

Implementation Date: August 15, 2018

Responsible Official: Associate Chief Information Officer, Enterprise Operations