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About This Publication

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Executive Summary

This root cause analysis of the cost and schedule overruns of the Expeditionary Combat Support System (ECSS) was sponsored by the Director of Performance Assessment and Root Cause Analysis (D,PARCA) within the Office of the Secretary of Defense (OSD). This analysis is one of three performed for D,PARCA at the request of senior officials within OSD to understand the DoD's large Enterprise Resource Planning (ERP) programs. IDA has examined ECSS and Global Combat Support System Marine Corps (GCSS-MC), while the RAND Corporation studied Navy ERP.

ECSS is an ERP that the Air Force is acquiring to transform logistics. The 31 October 2010 Major Automated Information System (MAIS) Quarterly Report (MQR) determined that the ECSS program had incurred a "critical change"[1] because:

> 10 U.S.C. Ch 144A as amended by the FY2010 National Defense Authorization Act (NDAA) requires Major Automated Information System (MAIS) programs to achieve a Full Deployment Decision (FDD) within five years after funds were first obligated for the program. Funds first obligated for Increment 1 of the ECSS program occurred on 31 Aug 05 when the Milestone Decision Authority (MDA) approved Milestone A. As of 31 Aug 10, the MDA had not approved an Increment 1 FDD thereby meeting the definition of a critical change.

This report looks at the root causes of the problems in the ECSS program and is not restricted to the critical change. While the program does not have an Approved Program Baseline (APB), and therefore has no official estimate of cost growth, the Government Accountability Office (GAO) reported that its estimated cost grew from $3.0 billion in 2008 to $5.2 billion as of their report in October 2010.[2] Of similar importance, the initial plan called for FDD by 2010; it now appears that the final FDD (the original plan only had one) will not occur until at least 2016. Therefore, a six-year schedule slip has occurred.

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[1] A critical change on a MAIS program is automatically triggered by certain conditions relating to cost or schedule. A critical change leads to a formal review, which then typically leads to changes in how the program is executed.

[2] Government Accountability Office, Report No. GAO-11-53 (October 2010).

Methodology

We visited with ECSS' sponsor at the Air Staff, the program manager (PM), his staff, and the contractor's staff to understand their positions. At our meeting with him, the PM gave us large briefing books that contain a great deal of information about the program that we found nowhere else. We also studied all publicly available data, including quarterly reports to the Congress and the Air Force budget justification books. Lastly, we read ERP literature and consulted with ERP experts, both inside and outside the government. This report is a synthesis of what we learned from those sources.

Cost Growth and Schedule Slip

The GAO asserts that the costs grew 75 percent from Milestone (MS) A to today (not yet MS B), while the program manager counters that 34 percent is the proper number because the MS A estimate and the latest estimate assume different levels of risk. We have nothing with which to compare either number, to be able to determine whether or not the number is large. The standard Nunn-McCurdy thresholds do not apply in this case because they only refer to an APB, which the MS A service cost position (SCP) is not.

The PM claimed that the largest portion of the growth in the cost estimates, $918 million, was risk that was not accounted for at MS A. We do not know precisely what he meant by "risk" in this context. In addition, he listed four categories of cost growth: data readiness ($544 million), deliberate delivery ($345 million), requirements gaps ($271 million), and schedule delays ($166 million).

The Air Force's 2007 budget listed only one FDD for this program in 2010, while as of January 2011 the final of four FDDs now specified for the program is not planned to occur until at least 2016, a slip of six years. Using the program office's (PO) assertions about the financial benefits of using ECSS, we estimate that this accounts for about $8 billion in lost benefits, though this number may be high.

Root Cause

None of the root causes of the cost growth in the ECSS program came from unpredictable exogenous events since MS A. The deepest root cause of cost growth and schedule delay in ECSS came about because the people who began this program had insufficient expertise in what they were buying. As the scope of ECSS is so big, it is possible that nobody in the world really knew how long it would take or what it would cost to acquire this system. It may also be that it is impossible to know how much a large ERP will cost until the blueprinting—a significant portion of the cost—is done.

Of the standard categories for cost growth that the Weapons System Acquisition Reform Act of 2009 lays out, this program clearly suffered from one "unanticipated design, engineering, manufacturing, or technology integration issue[s] arising during

program performance" (the data importation issues). There is also evidence that "government or contractor personnel responsible for program management" did not fully report shortfalls in program accomplishments. Lastly, the program was launched with an insufficient understanding of the problems involved and, consequently, had an unrealistically low cost estimate.

Contents

1. Background

This root cause analysis of the cost and schedule overruns by the Expeditionary Combat Support System (ECSS) was sponsored by the Director of Performance Assessment and Root Cause Analysis (D,PARCA) within the Office of the Secretary of Defense (OSD). This analysis is one of three performed for D,PARCA at the request of senior officials within OSD to understand the Department of Defense's (DoD) large Enterprise Resource Planning (ERP) programs. IDA has examined ECSS and Global Combat Support System Marine Corps (GCSS-MC), while the RAND Corporation studied Navy ERP.

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A. ERPs

An ERP is an Information Technology (IT) system used to run parts of the business operations of an enterprise. An ERP is typically composed of a set of subsystems, each handling a set of key processes, which could include an organization's human resources management, financial management, logistics, or administrative services. An organization could select to implement only one subsystem or a combination of subsystems depending on business need. The ERP is designed to optimize an organization's business processes by creating a central repository for all business data to flow through. The goal of the ERP is to supply employees with the most recent and relevant information, whether it be personnel-related data, the availability of a part in inventory, the location of a part in transit, or the payment for said part, among many other types of data.

1. Purpose of an ERP

ERP advocates explain that the primary advantages of having an ERP are visibility and efficiency. An ERP has at its core a single relational database that tracks everything within its purview. Visibility means that this database allows users to see the enterprise as a whole, which can be useful for both managers at the top who want to see what their enterprise is doing and those in the trenches who need information to do their jobs.

Efficiency comes through the use of common best practices across the enterprise. If an ERP is implemented across the Air Force for the processes of maintaining trucks, mechanics at Eglin Air Force Base (AFB) in Florida will use the same processes as mechanics at Elmendorf AFB in Alaska; if these processes are well designed, the enterprise as a whole will benefit. While the trucks at both bases may have been identical when they were new, the problems they develop over their lives are likely to be different. For example, road salt may cause certain parts to corrode quickly in Alaska, while those parts may last much longer in Florida. Designing processes that are optimal in both circumstances is difficult.

2. Commercial ERP Software

There are two large commercial suppliers of ERP software: Oracle and SAP. The ERP software they license is considered a commercial-off-the-shelf (COTS) item. The COTS software is essentially a toolkit for creating an ERP; any ERP implementation requires a significant amount of configuration and customization of the software. Business processes either need to be modified to conform to the constraints of the COTS software or the software needs to be modified to match the processes by adding reports, interfaces, conversions, or extensions (collectively called RICE objects).

3. Implementing an ERP

The process of installing an ERP is often referred to as implementing it and is carried out by specialists called system integrators (SI). In many cases, organizations that want to implement an ERP hire a firm that specializes in ERP implementation to do the work. This is what DoD has done in both of the cases we studied.

The process of implementing an ERP requires several steps. First, the SI team blueprints the ERP. This means that they look at what the enterprise does and what the client wants the ERP to do. For example, the Air Force maintains C-17 cargo aircraft and plans where they will go. ECSS will handle all maintenance of the C-17s, but it will not schedule where they fly. Handling C-17 maintenance means that the ERP will need to track all of the parts and supplies used to maintain the aircraft and know the processes used. In the blueprinting stage, the SI will record what these supplies and processes are and how they tie to other processes. The C-17 maintainers will need tires, so it is at this stage that the SI team will look at the processes involved in storing and installing tires, as well as ordering new tires and disposing of old ones.

After blueprinting, the SI must perform a "fit-gap analysis." This analysis maps the processes that the client currently uses into the ERP and identifies any gaps. The SI team meets with the client's practitioners to learn about their processes and how well they match with processes built into the ERP. Some organizations may take this opportunity to streamline and optimize their business processes to ensure consistency and efficiency. Both groups need to come to a conclusion as to how the processes will be handled once the ERP is complete. For example, the COTS software would have a process, possibly with multiple options, for receiving goods at a warehouse. If this process is the same as the one that the client has been using, it will be implemented as is. However, if the process does not match current practice, either the practitioners must change their process to match the COTS software or the SI team will have to create RICE objects to accommodate the client's requirements. This process is often long and sometimes contentious. The "fit" is where the COTS software matches organizational need and the "gaps" are where RICE objects will be needed.

Another phase of ERP implementation is populating the database. That is typically performed towards the end; however, it must be considered and planned for from the beginning in order to be successful. This can involve performing physical inventories of what the enterprise has as well as converting data and importing it from legacy IT systems. Data conversion is often labor intensive, especially when there are many legacy IT systems that store data in different ways. Legacy data must first be mapped to the new ERP and then cleansed to ensure data compatibility. Once data conversion is complete, data validation must be performed by knowledgeable staff to ensure accuracy and completeness. If an ERP is going to be used for forecasting, as ECSS is expecting in its second release, then in addition to populating the database with the current status of the

enterprise, the client will need to load historical data. Converting historical data is often more challenging than working with current data.

Although we present these steps as though they are a procedure, they are generally all part of an iterative process. ERPs are usually brought online gradually and are works in progress for some time. Often in the early stages, there are pilots in which one part of the enterprise will test out a part of the ERP, followed by the addition of more processes and more users until a full release across the enterprise becomes feasible. Releases are also often rolled out by location before the entire enterprise is involved. For example, the Air Force does not expect that Release 1 (R1) of ECSS will begin running everywhere simultaneously. The Air Force will introduce it at a few locations at a time so that the SI team can train users in one location and then move on to train new people in other locations. As that goes on they will likely be making small changes as well, either to improve performance or comply with exogenous changes in the environment.

B. ECSS

The sponsor for ECSS is Mr. Grover Dunn, the Director of Transformation, Deputy Chief of Staff for Logistics, Installations and Mission Support, Headquarters U.S. Air Force. He told us that his goal is to transform the way logistics is done in the Air Force, and he sees ECSS as an enabling tool. Today, there are more than 200 IT systems being used around the globe by Air Force personnel to conduct logistics. Transforming so many systems individually is a virtual impossibility; instead, ECSS is intended to replace them all.

In July 2009, there was some restructuring of the program office (PO). Kenneth Moran was promoted to brigadier general and named both program manager (PM) of ECSS and program executive officer (PEO) over more than one hundred Air Force logistics IT systems, including ECSS. His goal is to have ECSS replace all of the other systems in his portfolio while making Air Force logistics more capable. This management structure was created so that the head of ECSS would have the necessary control to force the changes required to make the ERP implementation succeed.

Currently, the Milestone Decision Authority (MDA) for ECSS is the Under Secretary of Defense for Acquisition, Technology and Logistics (USD(AT&L)).

1. Contractors

The first major contractor hired by the ECSS PO was Oracle. The PO selected Oracle to be the provider for the COTS software in their ERP. This decision was protested by SAP, but was upheld five months later by the GAO, and the PO has been licensing Oracle's software ever since.

The other major contractor hired was Computer Services Corporation (CSC). CSC was one of five firms that were allowed to compete for SI contracts under the Enterprise Software Initiative (ESI) that had been established within OSD. Since the end of a six-month contract protest by IBM—another one of the five ESI-approved contractors—CSC has been working with the PO to create ECSS.

2. Timeline

Figure 1 shows the ECSS timeline as presented by the PM in January 2011. ECSS had problems almost from the start. The following events in the timeline are worth noting:

- In November 2005, three months after MS A, SAP protested the contract award to Oracle. Then, in September 2006, IBM protested the SI award to CSC. Though both protests were overruled, they caused a combined downtime for the program of 11 months.[3]
- In May 2009, ECSS decided to switch to an all-Oracle product suite. Oracle's bid for the contract in 2005 stated that ECSS would integrate three software packages from different companies to create their ERP: Oracle, Click Commerce, and IFS. This was deemed necessary because Oracle's software did not have sufficient tools to run a heavy maintenance facility or for long term planning. Integrating those functions was more complicated, and consequently more expensive, than the PO originally expected. By 2009, the Oracle software had progressed enough that the program office decided not to use Click or IFS, but instead to build the ERP entirely from Oracle software.[4] (The PM noted in December 2010 that an Oracle-based ERP has been used as the sole IT system at an aircraft heavy maintenance facility in Europe.)
- The last thing to note from the timeline is that MS B does not appear. It has been pushed back by the MDA several times and still has not occurred for any portion of ECSS.[5]

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[3] The GAO decisions took five months and six months, respectively, according to the published reports. Figure 1 is from the PM's briefing to the MDA on 5 January 2011, which asserted that the two combined protests cost 18 months.

[4] ECSS is not in fact an all-Oracle solution; the plan calls for using another product called Ventureforth for remote access.

[5] The oldest ECSS schedule with MS B on it that we found was in the FY 2008/2009 Air Force RDT&E budget book, volume III. It showed MS B scheduled for the fourth quarter of FY 2008.

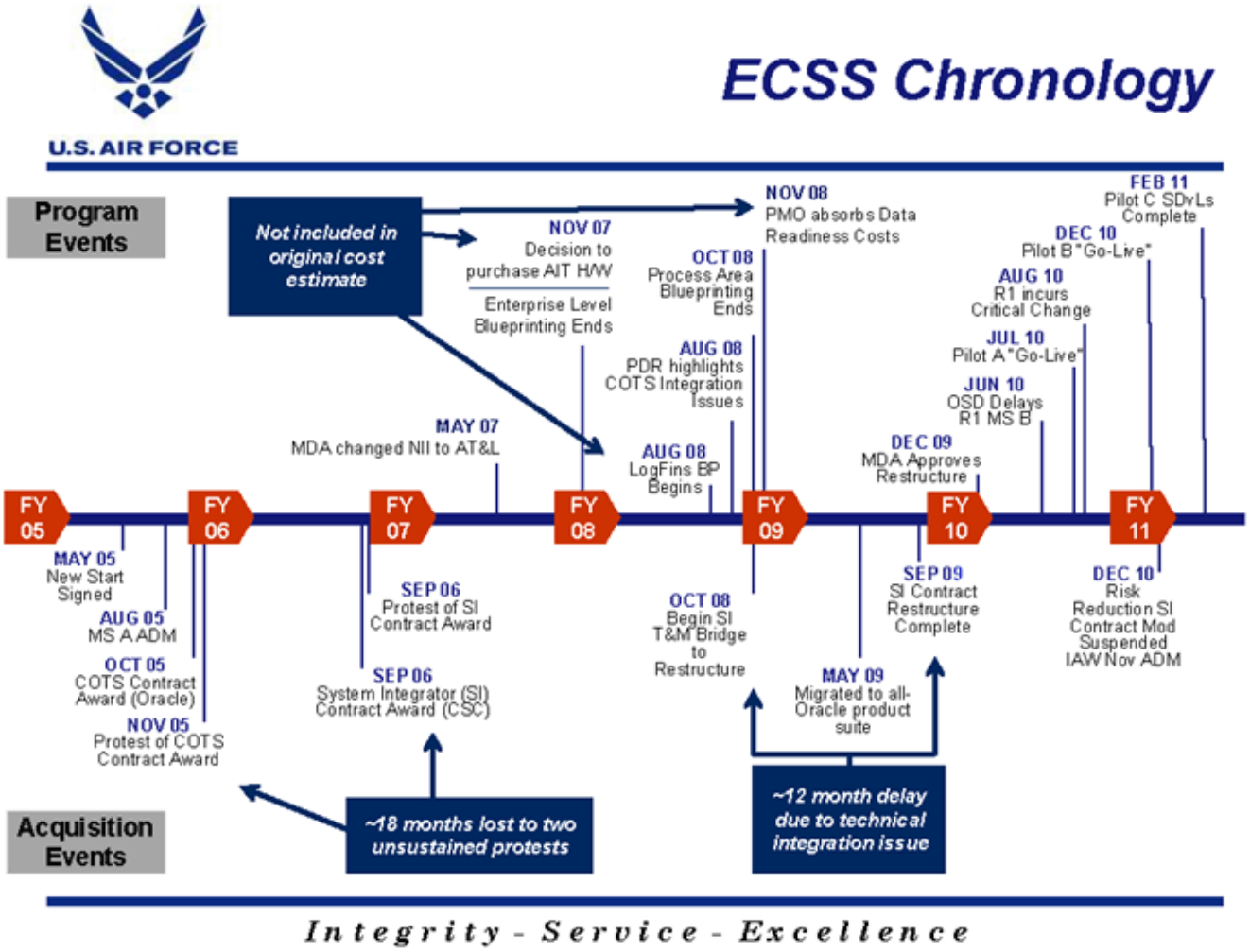

Figure 1. ECSS Chronology

3. Release Structure

As of a 2009 Acquisition Decision Memorandum (ADM), ECSS is supposed to have four releases with each release as a separate acquisition program. All cost estimates given to PARCA are for all four releases combined. While MS A was for the whole of ECSS, current funding and the first MS B is only for R1. Figure 2 shows the schedule and plans for all of the releases. R1 and R4 are supposed to be released broadly across the Air Force, while R2 and R3 are only going to be used at a small number of locations. R2 will implement planning and management functions at seven headquarters locations and R3 will be fielded at six heavy maintenance facilities.

The pilots on the chart are instances in which some subset of the release in question is fielded at a limited number of locations. These pilots help find bugs and improve performance before the system is deployed everywhere.

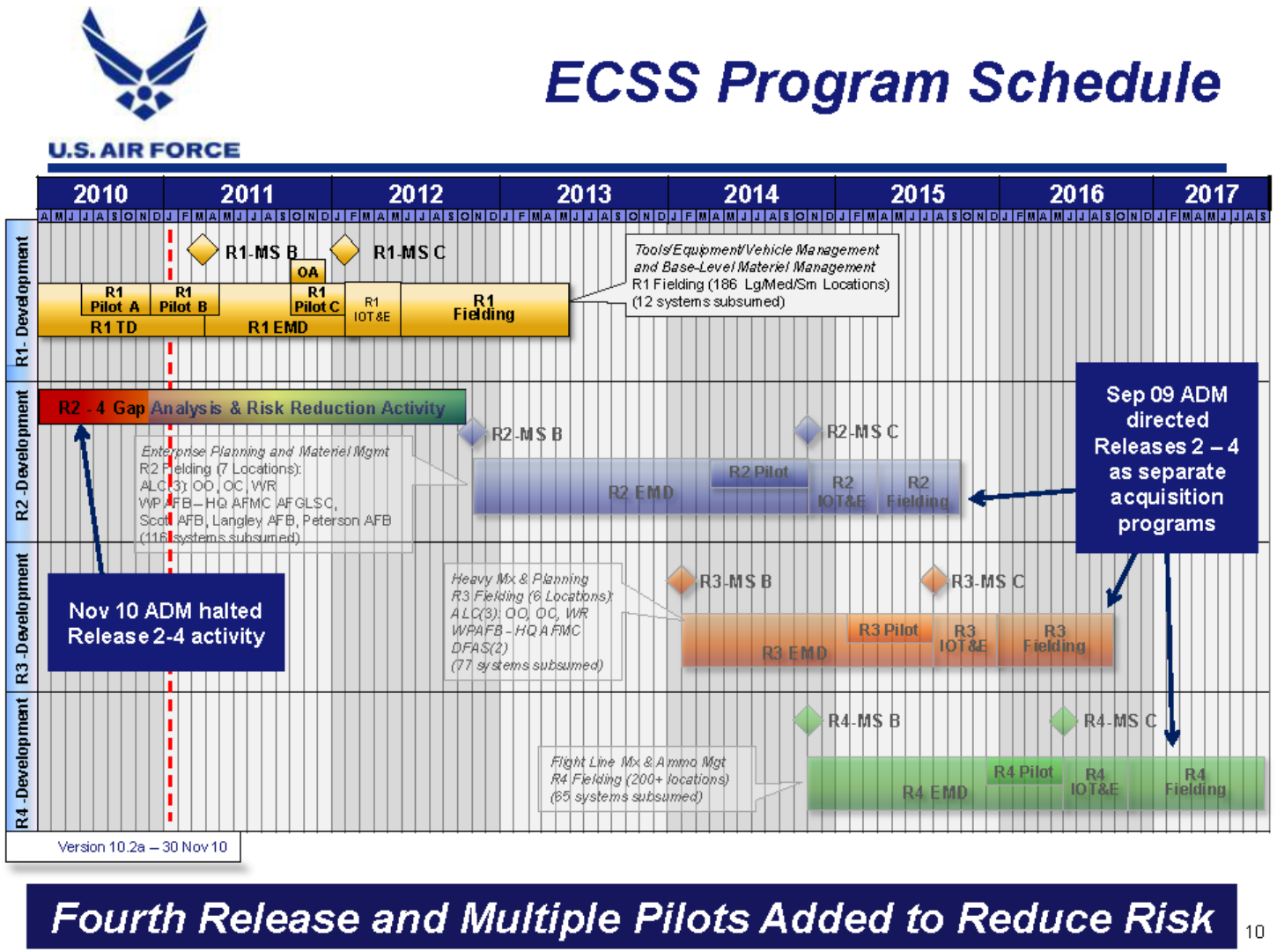

Figure 2. ECSS Program Schedule from BG Moran's 5 January 2011 Briefing

4. Regulations and Reporting

Over its history, ECSS has qualified as both a MAIS program and a Major Defense Acquisition Program (MDAP). The process for acquiring each has undergone some changes, though the MDAP process has been the more stable of the two recently. ECSS has at times been regulated like an MDAP and at other times like a MAIS program—today it is considered an MDAP. As an MDAP, the MDA is the USD(AT&L); when it was treated as a MAIS program, the MDA was the Deputy Chief Management Officer (DCMO).

The Defense Acquisition Management Information Retrieval (DAMIR) system contains very little data on ECSS. We were given six MQRs, but they do not contain much information. They do not contain any spending plans beyond 2013, and they do not report any information on dollars spent in the past. Neither the term "Oracle" nor "CSC" appears in any of the MQRs. The MQRs do make it clear that ECSS has no baseline and they have not submitted an initial estimate of the costs.

There is also no earned value or cost reporting data for any of the contracts in this program. This is discussed below in the section on COTS acquisition and cost reporting.

5. Status Today

A November 2010 ADM from the USD(AT&L) postponed MS B, which had been scheduled for early FY 2011, and halted work on everything except the immediate work on R1. Pilot A was run at Hanscom AFB and Pilot B is currently running there. Finding information about Pilot A was difficult, but we did gain access to an informal Analysis of Alternatives (AoA) planning document from OSD dated March 2011 that says:

> Initial capabilities fielded at Hanscom AFB in Release 1, Pilot A that enable vehicle maintenance, other maintainable items, and tools management processes. Lessons learned include both planned (future pilot) and unplanned (rework or future release) items: product data management processes must be enabled, an improved tools solution is required, reporting capabilities must be enabled, and financial processing must be completed. The Pilot as it stands is [n]ot viable for fielding to the enterprise.

This indicates that there is more work to do even on this limited part of the program, and suggests why MS B has continued to be pushed into the future.

Figure 3 shows the actual spending from the Air Force's budget justification books, along with the projections. The triangular data points show next year projections, the squares show current year projections, and the filled circles show budget actuals. In no year has ECSS spent more than the projected budget, so cost overruns are a result of work being added in the future, not unexpected costs that were promptly paid. During FY

2005, the Air Force asked for $212 million in FY 2007, but the FY 2009 justification book reports that ECSS only spent $135 million in FY 2007. It is possible that this funding shortfall caused some difficulty for the program, but the PM did not mention this as an issue. Note that the chart is not cumulative.

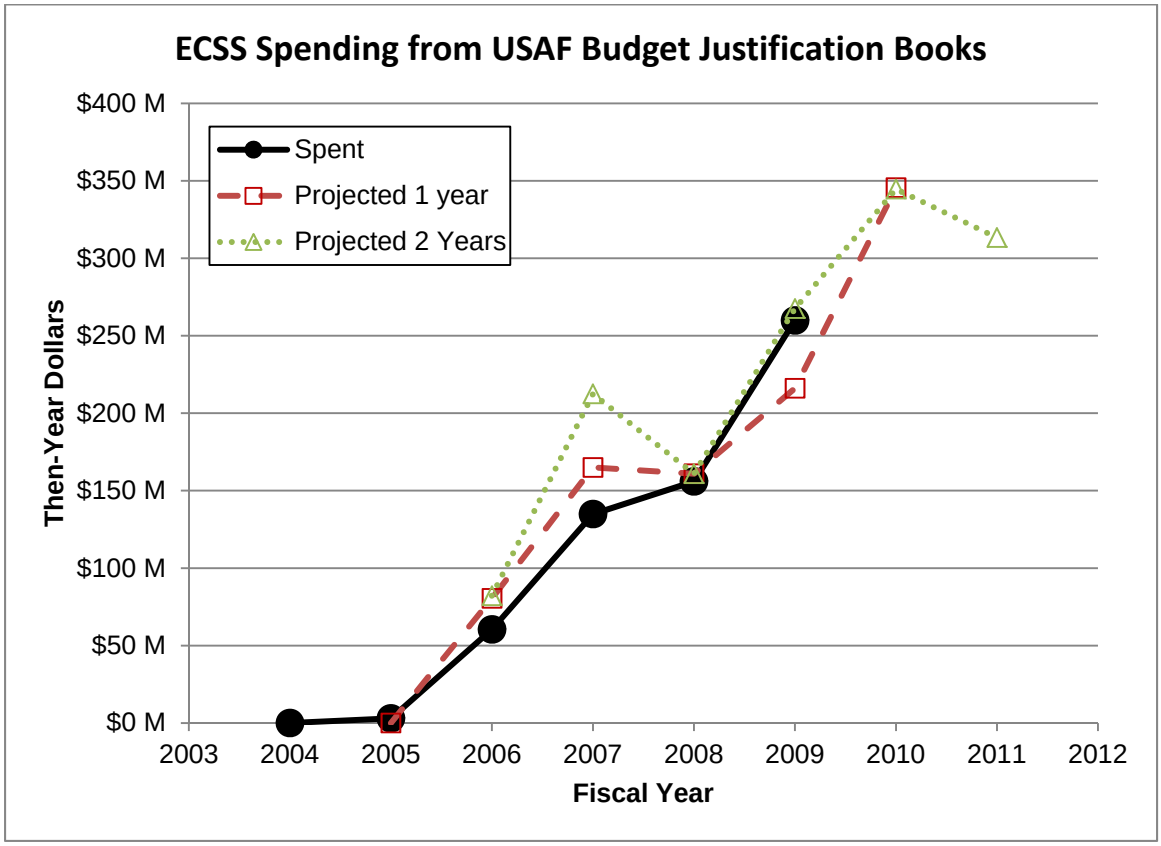

Figure 3. ECSS Spending from Air Force Budget Justification Books

2. Cost Growth and Schedule Slippage

Formally, ECSS has had a critical change because of schedule slip. The formal rules for a MAIS program call for "a Full Deployment Decision (FDD) within five years after funds are first obligated for the program," but ECSS did not achieve that.[8] The resulting critical change led to techniques designed to reduce risk, but that also increased cost.

While cost growth and schedule slippage are routinely addressed together because they are inherently linked, we have decided here to discuss them both in their own sections.

A. Cost Growth

Figure 4 shows the areas of cost growth according to the program manager. The quantities in this chart are reported in then-year (TY) dollars.[9] An explanation of the numbers follows below.

[8] Note that when the critical change was declared, this program was not being regulated as an MDAP as it is now, but rather as a MAIS program.

[9] Typically, analysis is done in base year (BY) dollars instead of TY dollars to account for inflation, but in this study all quantities are reported in TY dollars. To properly convert from TY to BY dollars requires having the funding laid out by appropriation and year by year, but this information was not provided to us. The data that split the dollars by appropriation and annual separations end with a "To Complete" entry, which contains more than 20 percent of the total dollars. We could make some educated guesses to estimate the splits, but it would introduce unnecessary complication into an analysis that already has limited precision.

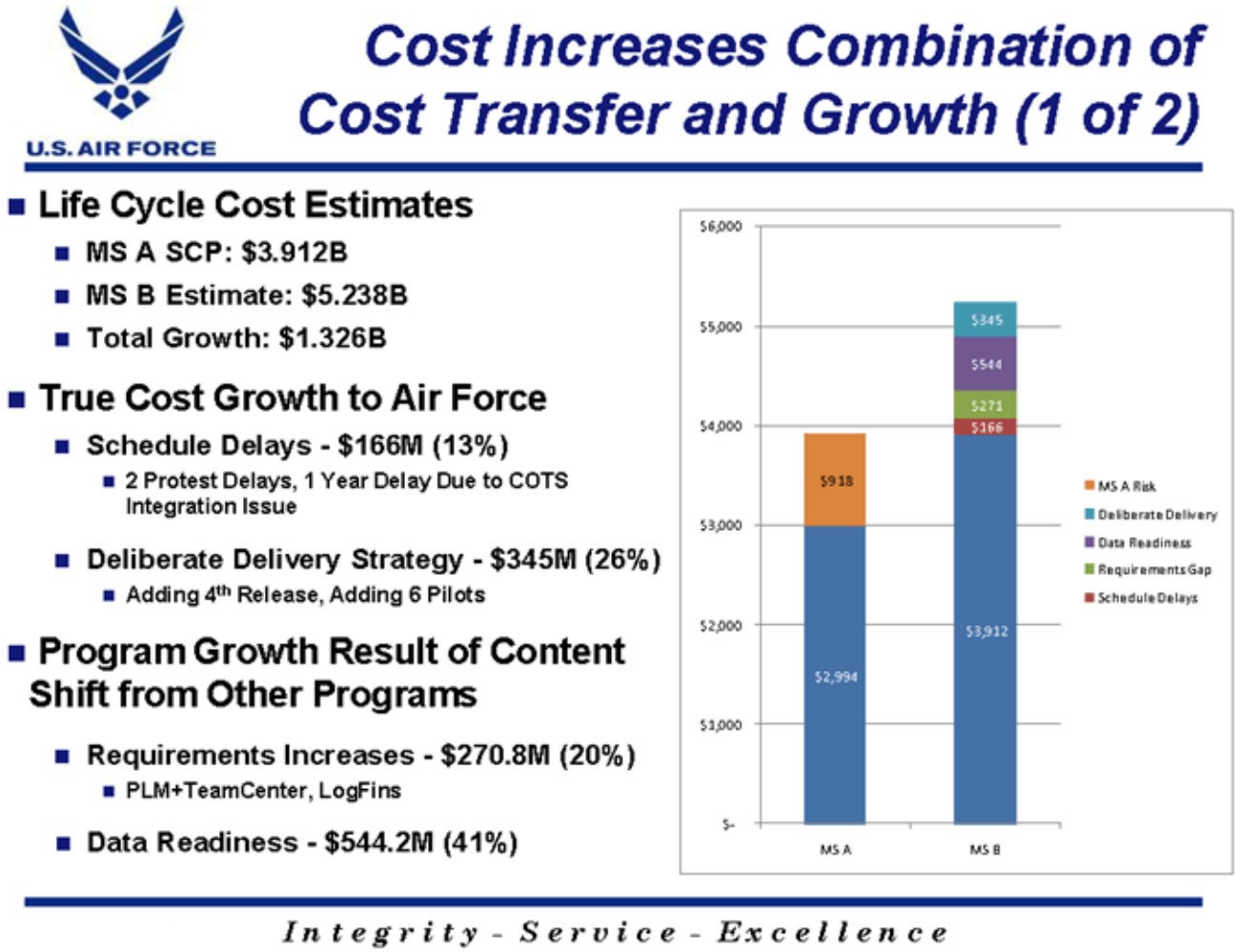

Figure 4. Cost Increases Combination of Cost Transfer and Growth (1 of 2) from BG Moran's 5 January 2011 Briefing

1. Current Estimate

The current estimate of $5.2 billion for ECSS, which is labeled "MS B" in Figure 4, is not straightforward in its presentation. The PM told us that it is the estimate for the entirety of ECSS—all four releases—and, thus, is a fair number to compare to the MS A Service Cost Position (SCP). However, the MS B authority that the program office is seeking is only for R1. OSD and the PM have disagreed on whether R1 is mature enough for MS B authority, which suggests that this portion of the cost estimate may not be very precise. Since both agree that R2, R3, and R4 are not yet ready for MS B, there is even less certainty in those portions of the cost estimate. We do not have the necessary data to identify the R1 costs alone.

2. MS A Estimate Disagreement

Figure 4 shows two numbers for MS A. The PM's claim is that while the MS A SCP said $3.0 billion, that estimate did not have the same risk factor as the current $5.2 billion estimate. To make the estimates equivalent, the PM added $0.9 billion to the MS A number. Whether or not we accept the PM's claim determines whether we would say this program experienced 34 percent or 75 percent cost growth since MS A. The PM never asserted what the MS A or MS B confidence levels are or were.

Whether one calls the cost growth 34 percent or 75 percent from MS A to today—not yet at MS B—we still do not have a comparable figure in order to determine whether the number is large. The standard Nunn-McCurdy thresholds do not apply in this case because they only refer to an APB, which the MS A SCP was not.

3. PM's Cost Growth Categories

The PM listed four categories of cost growth, which are discussed below. This is in addition to the largest category of growth—risk—which was discussed immediately above.

a. Data Readiness – PM Estimate: $544 Million

Data conversion is often challenging because there are many legacy IT systems, and each has its own particular database structures, data formats, and data definitions. Furthermore, the legacy systems may have inconsistencies or mistakes in them, all of which need to be painstakingly corrected by both the people who know the data and the ERP implementation experts. The PO knew from the beginning that data would need to be imported and that it would be a significant expense.

The cost growth associated with data readiness has two components: the expected effort required, and who will bear the costs. When the ERP team started looking at the

data to be imported into the ERP, they found the task to be more difficult than had been anticipated. We have no evidence that this cost is well understood today.

Furthermore, the PM reported in his 5 January 2011 briefing that, in November 2008, the program office absorbed the Data Readiness costs, which had previously been assigned to the Air Force's major commands (MAJCOMs). This second point is somewhat in contention. The program's sponsor from the Air Force staff told us in an interview that it had always been his intention for this program to be a help—not a hindrance—to the MAJCOMs, and he had decided at the outset to bear all of the costs in the program, including data-related costs.

b. Deliberate Delivery Strategy – PM Estimate: $345 Million

The PM told us that several times in ECSS' history the program has been told to reduce risk, either by the GAO, the MDA, or by parties within the Air Force. Each time, this has involved doing less in parallel and adding more steps, such as pilots. Each of these steps reduces the risk of cost growth by accepting additional cost up front. The PM said that most of these steps were helpful and more may be added in the future. However, because the early cost estimates seemed to assume ECSS would be simpler to implement than proved to be the case, these risk mitigation strategies—added later—have increased the PO's cost estimate.

The largest such mitigation strategy occurred in late 2009, when the MDA approved a restructure of the program. ECSS went from being three releases within a single acquisition program to four releases, each of which is its own separate acquisition program. Initially, R1 would have been all of the parts being spread around the entire Air Force with R2 and R3 being smaller releases used at a few facilities for planning and heavy maintenance.[10] When R4 was created, much of R1 was moved to R4, making it the largest release of all in terms of fielding locations. R4 is expected to include flight line maintenance, which is particularly challenging because it requires accessing the ERP on portable devices that personnel can use next to an aircraft outdoors. We have no particular reason to believe this pattern of spending more to alleviate risk is over; there may be more risk mitigation costing more time and money in the future if this program is granted MS B authority.

c. Requirements Increase – PM Estimate: $271 Million

The reported cost growth from increased requirements is made up of three parts: Product Lifecycle Management (PLM) for $132 million, hardware[11] for $108 million and

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[10] It is unclear if the original R1 included IFS and Click Commerce or if they were only expected to be used in R2 and R3.

[11] This entry refers to IT hardware, such as computers, cabling, and routers.

Logistics Financials (LogFins) for $31 million. For PLM, the claim is that its cost was underestimated at MS A and was not properly accounted for in the initial contract with CSC. The current cost estimate for this is based on the contract negotiations with CSC that were approved in 2009. One might argue that this is not a change in requirements but rather a flaw in the early cost estimate. The PM called it an increase in requirements because it was a change in the requirements on the CSC contract.

The hardware cost growth comes from the program agreeing to buy some hardware for the MAJCOMs to run ECSS. Many ECSS users will access the ERP using computers they already have, but some new hardware will be required to put computers in places where there were none before and perhaps to strengthen the infrastructure so it is capable of handling the increased traffic from ECSS. While these costs are not new, the PM told us that, at MS A, hardware—like data readiness—would be paid for by the MAJCOMs, but now the ECSS PO will pay for it; therefore, it is a new requirement for ECSS.

LogFins was originally going to be part of another ERP called Defense Enterprise Accounting and Management System (DEAMS). That ERP is sponsored by the Air Force's finance community, and was originally intended to track all Air Force financial transactions. In CSC's design for ECSS, a large amount of data transmission would have to occur between ECSS and DEAMS for each purchase, requiring the creation of many RICE objects. However, the COTS software from Oracle could handle all of the LogFins internally relatively easily, even in 2005. By moving LogFins into ECSS, the requirements for DEAMS decreased, while ECSS's requirements increased.[12] Because this requires less interaction between the two systems, this change should decrease the total cost to the Air Force. What this means in practice is that ECSS will handle all financial transactions for the Air Force's maintenance working capital fund, in addition to its originally planned capabilities.

d. Schedule Delays – PM Estimate: $166 Million

Schedule delays due to COTS integration and contract protest are estimated by the PM to have cost $159 million and $7 million, respectively. COTS integration refers to the original attempt to use Click Commerce and IFS software along with Oracle's software to build ECSS. The ECSS program spent time and money to integrate those packages before the non-Oracle packages were ultimately discarded in favor of an all-Oracle solution. It is our opinion that changes like this in the pre-MS B phases of a program should be expected; such exploration of alternative approaches is a typical part of the requirements analysis and design process, and cost estimates should take such possibilities into account from the start.

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[12] We have not studied DEAMS and therefore cannot say if their cost estimate shows a decrease from this decision.

The contract protests against the selections of Oracle and CSC accounted for five and six months of delays in 2006 and 2007, respectively. We do not understand why such major delays in a program with this sort of expenditure rate cost only $7 million. ECSS spent $60 million in 2006 and $135 million in 2007.

B. Schedule Slippage

When ECSS (as a single acquisition program) was given MS A authority, there was an assumption that FDD must have been scheduled no later than FY 2010, five years from program inception. The schedules provided by the PM do not say when the four FDDs will be (one for each of the releases in the current plan), but they do show an estimate for each MS C, which precedes FDD. According to Figure 2, R1 FDD will occur after January 2012, which is two years late.[13] However, since all of ECSS began at the same time, a better marker for the schedule slip would be the MS C for R4, which is projected to be in May 2016, six years late.

1. Causes of Schedule Slip

In our discussions with the PM, there were several different problems that caused the schedule to change, and they all line up with the categories for cost growth discussed in Section 2.A.2. Most elements that added cost added work to the program and caused the final delivery date to move further into the future. We do not have any data that allow us to partition the schedule changes among different categories similar to the information we received from the PM on cost growth.

2. Consequences of Schedule Slip

The primary reason for purchasing ECSS is that it will allow the Air Force to carry out its logistics function more economically than by continuing to use all of the incumbent systems, thereby providing a means of quantifying the benefits of fielding ECSS. Delays in implementing ECSS effectively mean that the Air Force will receive less benefit from buying it. The program office provided detailed estimates of the financial benefits of ECSS by year from 2011 through 2026, and it is reasonable to consider the lost benefit as being similar to extra cost.[14]

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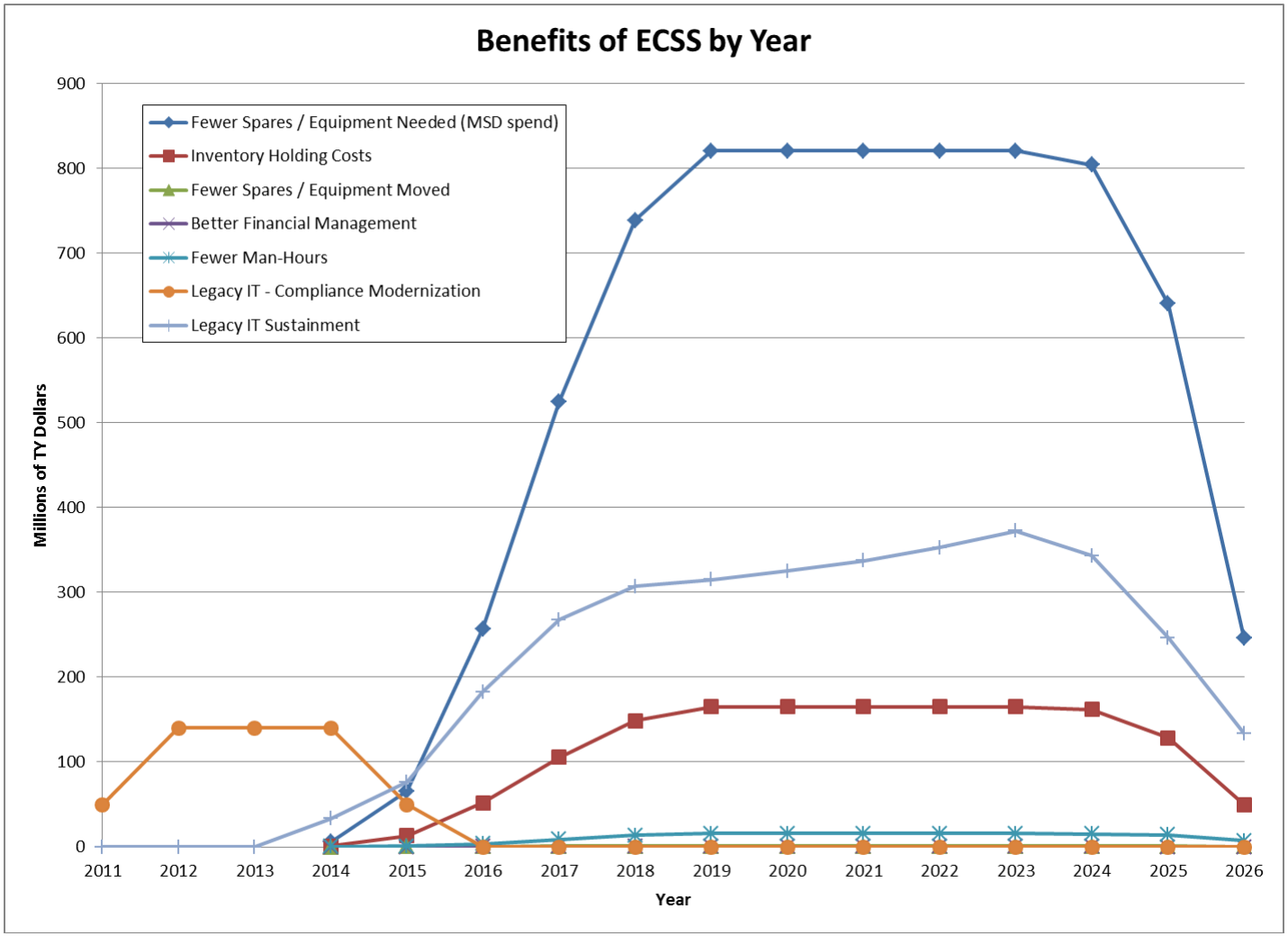
[13] We do not know the schedule for FDD that existed at MS A. If it was scheduled before the deadline, the delays are even longer than we estimate.

[14] We note that to keep this analysis consistent, all money is presented as non-discounted TY dollars. If we did discount these dollars, the cost from deploying ECSS late would look even higher because the lost savings come early in the program's life. However, we would also need to discount the costs to stay consistent and we have not done so because we do not have that split out by year, as noted above.

It is notable that benefits taper off after 2023; that occurs because each release of ECSS is assumed to have a limited lifespan, so as each one phases out, the benefits also end. We consider that this is an artifact of the assumptions about program duration and not real. To estimate the annual benefits that have been lost from six years of schedule slippage, we take the values of the typical years, 2018 through 2023, average them, and then multiply that figure by six. This comes to about $1.3 billion per year for six years, or a total of $8 billion.

Figure 5 shows benefits as reported by the PM. Appendix C has complete data.



Source: Data from ECSS PM, chart by IDA.

Figure 5. Benefits of ECSS by Year

3. Root Causes for Cost Growth

In Section 2, we detailed the specific items that the PM believes were responsible for the cost growth in ECSS to date. While we generally accept the PM's claims, we think there are root causes that go deeper.

A. DoD ERPs Are Not COTS Acquisitions

The Oracle and SAP software packages that are used to build ERPs are COTS items that can be licensed and used as is. However, just using the software does not mean that the enterprise has an ERP; the software allows an ERP to be built and run. The full ERP has a populated database and has mapped the enterprise's procedures to the software. Customizing and configuring the ERP is not a COTS purchase.[15] This relates to the perceived change in risk and the deliberate delivery strategy.

1. Modifications to the COTS Software

In the world of ERP implementations, it is so common for the COTS software to be insufficient for the user that there is a name for the fixes: RICE objects. It is neither surprising nor a reason for concern that ECSS includes some of these—the current estimate is 250 in R1.[16] However, ECSS requires modifications to the COTS software that go beyond RICE objects, and this has been a hallmark of other DoD ERPs as well.[17]

ECSS has at least three requirements that go beyond what Oracle's software could do at MS A: mobile connectivity, heavy maintenance, and planning. For the mobile connectivity, ECSS will use a product from Ventureforth, Inc. that has been used in the past with Oracle with a high enough success rate that Ventureforth has been designated

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[15] Some services that are purchased, like home moving, might be considered "customizable COTS." This means that while each home is unique, it is made up of standard parts, and moving companies know how to estimate the cost and schedule for any typical move. ERP implementation in some instances may be like this, although the large DoD ERPs like ECSS are not.

[16] The count of 250 RICE objects in R1 is a dramatic decrease from earlier estimates. However, it is unclear how much of that reduction in number is because they have been moved to other releases, especially R4, as opposed to a reduction in the number of RICE objects needed to be generated in total for ECSS.

[17] Both ECSS and the Marine Corps' Global Combat Support System (GCSS-MC) required modifications to the Oracle COTS software. In both cases, Oracle has created the new functionality and offered it for sale to commercial customers.

an "Oracle Certified Partner."[18] For the other two problems, Oracle now has code that is in their standard software suite.

Oracle has agreed to make changes to its software to accommodate ECSS without charging extra for the work.

2. Non-COTS Portion of Any ERP Implementation

Even the simplest ERP is more complicated than typical COTS software—which is why an SI is generally hired to create the solution. Common examples of COTS software are Microsoft Office and Mathematica; the software is provided on disks or downloaded to the user and then installed on a computer. Once the installation is completed, the software is ready for use. At most, there are a few questions during installation regarding such things as optional functions or the desired installation location on your hard drive or network. The purchaser of an ERP must decide what processes will be handled by the ERP and how to map them into the COTS software package. For an ERP to be useful, it must be set up for use on numerous machines. Old data must be imported from across the enterprise. If the ERP is going to be used for forecasting, it must have historical data in addition to the current status of the enterprise. For these reasons every ERP—if not the software used to make it—is unique, not COTS, by the time it is actually implemented and used.

Another reason ERPs are not COTS is that they involve changing the way people do their jobs. For example, in ECSS, the process for troubleshooting a check engine light on a truck will be standardized across the enterprise. A mechanic may not be able to order a replacement fan belt until he has checked the oil level, because the checklist puts that first. In an organization like the Air Force, there may be many different methods of working that all need to be modified to match the software. Furthermore, the procedures that will be used by the ERP need to be selected so that everyone can use them—the goal being to improve average productivity. These processes must work, and ideally be optimal, in the Alaska winter, the Florida summer, and a small base in the Afghan mountains (recall that the "E" in ECSS stands for "Expeditionary").[19]

Lastly, ERPs are so large and affect so many different people and processes that it is exceedingly difficult to know from the outset precisely how much work will be required. For example, the requirements for a new helicopter may not be difficult to explain: fly at a certain speed, carry a specific weight load, have a designated sensor system, and so forth. Yet the documents for these straightforward requirements are generally a few

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[18] http://www.ventureforth.com/mobile_i2k.asp, accessed 1 April 2011.

[19] In a discussion with an ERP expert we asked if it were possible for the checklists to be designed so that they differ by season or location. The answer is in theory yes, but doing so would rapidly expand the complexity of the ERP.

hundred pages. For an ERP, someone needs to determine all of the processes that the enterprise does and figure out how to have the ERP interface with them. This is a big part of the SI's work, and specifying the requirements, unless it is done at a very high level, is difficult from the outset. Only after blueprinting is it clear which processes need to be designed and mapped to the software; even then, which will prove difficult and which easy may not be known. This process is a lot more like research and development than COTS acquisition. It may be possible to do a cost analysis from a very high level with cost-estimating relationships before the blueprinting is done, but to our knowledge that type of analysis has not been done for any DoD ERP system.

3. Consequences of Treating an ERP as COTS

a. Fixed Price Contracting

In the late 1990s, DoD established the ESI. Its mission is to lower the costs of COTS software for DoD, the Coast Guard, and the intelligence community, which it does by negotiating deals with COTS providers. In 2005, when ECSS went through MS A, ESI was offering a fixed price contract vehicle for SI services that could be competed among five companies: Accenture, Bearing Point, CSC, Deloitte, and IBM.[20] Many of the ERPs whose problems were written about by the GAO in October 2010 (Report No. GAO-11-53) were started in this era.

The theory was that SI services could be thought of as COTS, so the contracts were fixed price based upon the specific request for proposal (RFP) generated by the program. An assumption of fixed price contracts is that cost is fairly precisely known. Not only is this assumption incorrect, cost growth was the rule—not the exception—in ERP SI contracts. As the ECSS program went on, the PO realized that requirements needed to be added or changed to make ECSS useful, because the RFP was insufficiently precise. Each change resulted in a negotiation. Based on this experience, it is not clear that anybody could write an RFP with sufficient precision to execute with no changes before the blueprinting is complete. In cost reimbursement contracts, such changes do not involve much negotiation; there might be a cost estimate, but, ultimately, the government would order the work and the contractor would do it and bill the cost. In fixed price contracts, however, each change must have a negotiated price. ECSS also has used some time and materials arrangements that have negotiated rates instead of price.

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[20] According to ESI's webpage (http://www.esi.mil/contentview.aspx?id=133&type=1, accessed 1 April 2011), these SI contracts were ended as of 13 July 2009. The webpage reports they will be replaced, but so far there is nothing new. We do not think this contract will come back, because SI services are not COTS.

It is generally accepted that fixed price and time and materials contracts are not well suited to research and development; while ERP implementation is not exactly research, it is similar enough that this contract vehicle has caused problems. The PM of ECSS said the contract with CSC was not an ideal vehicle, but he was working with it. In some other programs the contract was changed or replaced. One problem for cost analysts is that because ERPs have been bought with fixed price contracts, there is no cost reporting to improve cost estimates.

b. COTS Acquisition and Cost Reporting

In studying DoD programs, it is common for analysts to use contract performance reports (CPRs) and contractor cost data reports (CCDRs) to track the cost of work. For ECSS, these do not exist. The ECSS PM and some other ERP experts argued that for an ERP it does not make sense to track progress relative to a work breakdown structure, as these reports require. Although we do not have a position with regard to that statement, the fact remains that there is currently almost no cost reporting in DoD ERP acquisitions, and there probably will not be any cost reporting unless the regulations governing these acquisitions are overhauled. The repercussions of such rule changes may be significant and should be analyzed before they are adopted.

Major defense contractors are accustomed to working with the government and reporting their costs. When these firms sign cost reimbursement type contracts with the government, they already have accountants and systems that are fully prepared to report their costs in a way that satisfies the government customer and brings in profit. They understand reimbursable costs and how to structure their business.

CSC, Oracle, and most firms in the ERP field do not use cost-type contracts. In their commercial work, most SIs use a combination of fixed price and time & materials type contracts, while COTS suppliers charge licensing fees. They are not set up to share their cost data as major defense contractors are. If cost reporting were required, some companies might build the expertise to do it, but other suppliers might decide that federal government contracts are not worth the trouble, and exit the market. Cost reporting expertise is also expensive, so the COTS suppliers would have higher costs. Some of them might instead team up with traditional defense contractors so they could work as subcontractors instead of primes. This, too, could increase the cost of the programs.

B. CSC's Performance

The CSC employees who are working on ECSS are located near the PO government staff and they share information informally. Without standard cost reporting and CPRs, this informal communication may be the PM's best insight into CSC's performance. We also obtained a number of monthly and weekly briefings—called program monthly reports (PMR) and program interim reports (PIR)—that are generated by CSC. Although

these reports do not have any consistent cost numbers in them, they do sometimes track contract line items.

Each PMR from 14 April 2010 through 14 December 2010 contained two lists of tasks related to each pilot of R1: tasks to complete in the next month and tasks completed in the previous month. Using these lists, we tracked whether CSC was accomplishing what it had set out to accomplish in the previous month. Table 1 shows what we found.

Table 1. Analysis of Tasks Reported in CSC's PMRs

Work Area	Tasks Completed As Planned	Tasks Completed Late	Tasks With Inconclusive Status
Release 1 Pilot A (R1PA)	16 (52%)	2 (6%)	13 (42%)
R1PB	23 (52%)	7 (16%)	14 (32%)
R1PC	23 (37%)	5 (8%)	35 (56%)
Total	**62 (45%)**	**14 (10%)**	**62 (45%)**

Forty-five percent of all tasks with specific end dates were reported as completed on time. Ten percent of tasks were reported to be completed a month or more after they were due. Forty-five percent of tasks were never reported as completed. We do not know if the tasks in this last group were completed on time, completed late, still ongoing, or discarded as no longer necessary.

We used only PMRs to find tasks to be completed, but both PMRs and PIRs were used to verify task completion. The last PMR from December 2010 was only used to check on the completion of previous tasks, while all other PMRs were also used to see what tasks were scheduled.

Because we do not know the size or importance of any particular task, it is not fair to assume that all tasks are equally important to the success of ECSS; it may be that the most important tasks are in the 45 percent that were completed on time. This makes us unsure as to whether CSC is doing a good job with regard to such measures as cost, schedule, test discrepancy reports, etc. If they are not, it could contribute to any part of the cost growth.

C. ECSS Is Big

The size of ECSS is relevant. The only DoD ERPs that come close to ECSS in size are Global Combat Support System Army (GCSS-Army) and Navy ERP. Several metrics for the size of these ERPs are presented in Table 2. Finding comparable data for the size of commercial ERPs is not easy, but there are few companies with as many employees as ECSS is projected to have users, and the Air Force logistics enterprise is more complicated and diverse than most companies. Cynthia Rettig wrote a paper critical of

ERPs in the Fall 2007 *MIT Sloan Management Review*[21] that claims that the average installation cost of an ERP is $15 million, but large organizations often spend hundreds of millions of dollars. Even the smallest of the DoD ERPs written about in the 2010 GAO report were expected to cost over $100 million at MS A, and DoD's largest, including ECSS, are an order of magnitude larger than that.

Table 2. ERP Size Metrics from GAO-11-53 for the Three Most Expensive ERPs

	Current Life Cycle Cost Estimate	Legacy Systems Replaced	Number of System Interfaces	Number of Users	Number of Locations
ECSS	$5.2B	240	830	250,000	186
GCSS-Army	$3.9B	7	106	169,880	379
Navy ERP	$2.4B	98	51	66,000	53

Source: All Data is from GAO-11-53 and was current on 31 December 2009.

Note that as of today, ECSS R1 is expected to have 40k users and 157 system interfaces; the numbers in the table are for all of ECSS.

According to GAO-11-53, ECSS is the biggest in all metrics except for number of locations, where it is second. The life cycle cost estimate of $5.2 billion is the most expensive in DoD. The large scope of ECSS makes the research-like portion of the program more complicated. Even if cost does scale linearly with regard to legacy systems replaced and with the number of system interfaces, there are likely to be interaction terms that make the costs more difficult to project. In other words, the cost of adding one more system to replace—holding everything else constant—may be straightforward to calculate, but when one system is added *and* one more interface is added the cost goes up even more than the sum of the system and the interface because the newly configured system must interact with all the old interfaces plus the new one.

The large size of ECSS made it more difficult to estimate the cost. This would have contributed to the risk estimate as well as the cost growth in every other category.

D. The "Fourth Estate"

DoD Components are expected or required to use a wide variety of IT systems, and this makes them more complicated than commercial ERPs. For example, the Defense Contract Management Agency has a system called Wide Area Workflow (WAWF) to handle electronic invoicing. The Oracle COTS software has an intrinsic capability to do invoicing, but it cannot be used; the ERP must work with the existing system instead. Since the Air Force cannot control how WAWF works, it has to generate RICE objects to

[21] Cynthia Rettig, "The Trouble with Enterprise Software," *MIT Sloan Management Review* 49, No. 1 (Fall 2007).

work with it. In a sense, this breaks the continuity of the ERP, because ECSS does not control a process from end-to-end as the COTS developer intended. This makes its operation more complicated even though it is doing less. Also, if WAWF changes its interface, which is outside the control of the ECSS program, then ECSS must spend its own money to adapt to it.

Figure 6 shows ECSS's content in a chart from the PO. Each of the purple boxes on the top represents an organization outside of the Air Force with which ECSS needs to interact. Many of these organizations have multiple systems that must communicate with ECSS.

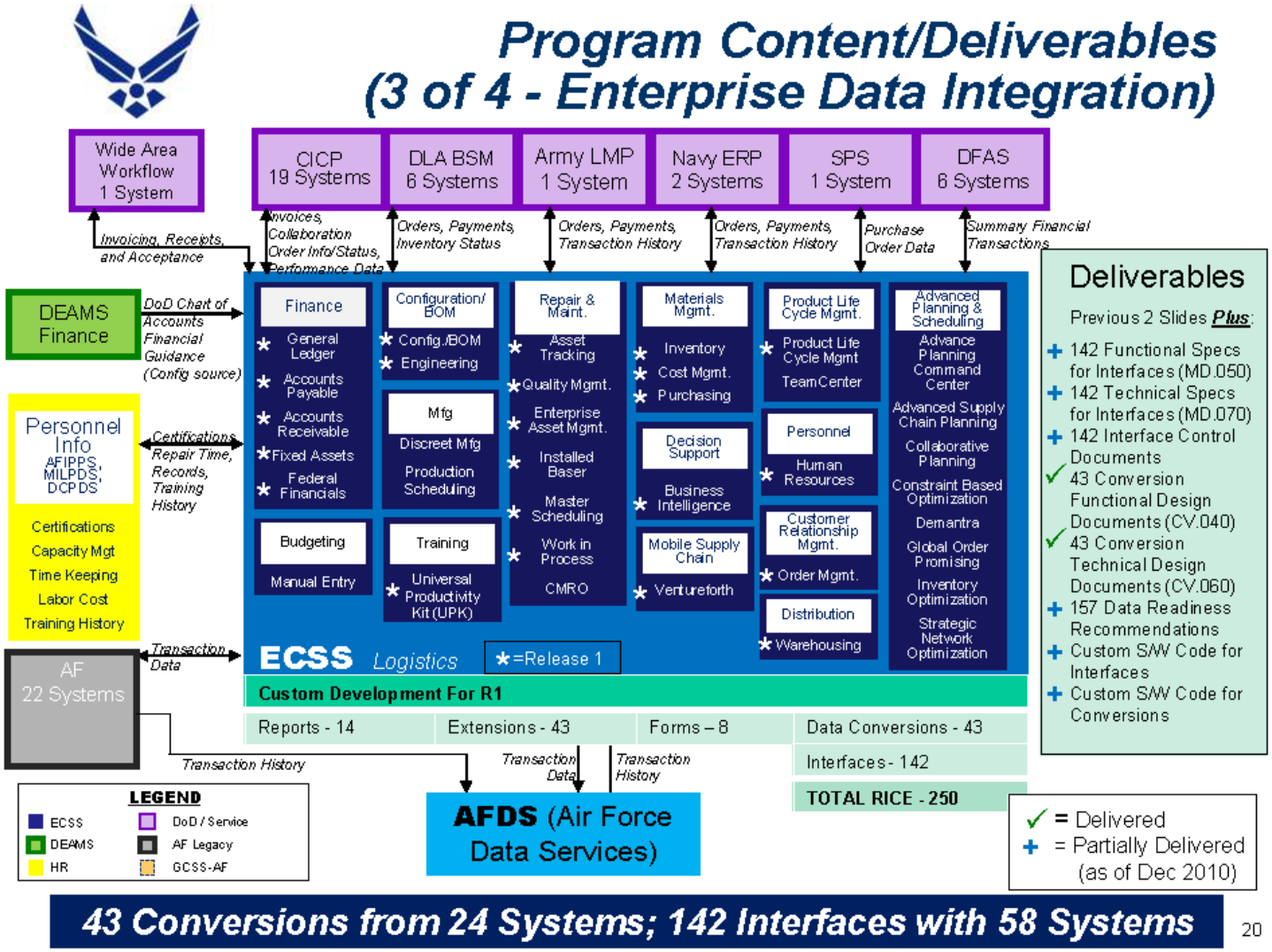

Figure 6. Program Content/Deliverables from ECSS PM 5 January 2011 Briefing

It is probably the case that one such system would not present a terrible hurdle for an ERP, but there are many DoD systems that control aspects of what an ERP would normally do. This problem is sometimes called the "fourth estate" problem by ERP experts in and around DoD, including within the ECSS PO and the Business Transformation Agency (BTA). It is called the fourth estate because it is a collection of outside forces that shape the way the ERP works, but are not part of it.

BTA personnel told us that in the commercial world, an ERP typically would replace most of the other systems with which DoD ERPs need to communicate. An ERP with fewer external processes is easier to implement because it needs fewer RICE objects and has more continuity in the data. This is a general difficulty of all DoD ERPs, and, according to BTA, it is a serious one.

If the fourth estate—which existed from the start—had been well understood from the beginning, it would have increased the proposed cost of ECSS, but would not have created cost growth during the program's execution. The only category of growth from the PM's list that this would have contributed to is risk.

E. Management Authority and Decision Velocity

According to Rettig and other ERP literature, a commonly reported problem in ERP implementation is lack of authority at the top. In order for an ERP implementation to succeed, it must be adopted by many people throughout the enterprise. The ERP must conform to their needs, but people also need to change the way they work to take advantage of the ERP. If the leader of the ERP effort has insufficient authority over the users, there will be problems.

While working on the fit-gap analysis, disagreements will occur over how the ERP should be configured. In the simplest case, the people who currently run a process will send a representative to meet with the SI personnel to discuss how a process should be standardized. The SI will present the COTS processes, and the practitioner may contend that none are suitable as is. Coming to agreement is often difficult and the rate at which decisions are made is referred to as "decision velocity." This problem can get significantly worse if there are multiple groups that currently do the same process—for example, at different bases or from different communities—in different ways, because all must be satisfied with the final decision. These meetings are a significant portion of the cost of configuring an ERP. Once a conclusion is reached and the ERP is implemented, there is still the difficulty of getting the various users to adapt to the new ways of doing business.

Umble, Haft, and Umble wrote in the European Journal of Operation Research that a successful ERP implementation requires "strong leadership commitment and

participation by top management."[22] The company's president needs to be associated with the project to succeed because this sort of program goes far beyond IT. If the top person pushing for ECSS were the Air Force Chief of Staff, issues would be easier to resolve and decision velocity would be higher.[23] On the other hand, if the top person were a field grade officer, the experts from around the Air Force would feel no compulsion to yield to the SI—the result being either an ERP with a great deal of RICE objects increasing the cost to build and maintain it and minimal uniformity from one group to another, or exceedingly slow decision velocity. The situation at ECSS is between these two. Part of the reason a brigadier general was selected to run ECSS and be the PEO for all logistics IT systems was to provide the authority required to push development forward.

If insufficient management authority has caused cost growth in this program, it would be part of the risk, schedule delay, and deliberate delivery strategy categories previously discussed.

F. ERPs in Business Today

Another root cause may be that ERPs are, in general, not good investments. It is our impression from the literature, like Rettig and Gosain,[24] that ERPs have a reputation for trouble that includes cost overruns and schedule slips in the implementation phase and disappointment with the systems once they are running.

The October 2010 GAO report makes it clear that ERPs are difficult to implement in DoD. There is also literature that says implementing commercial ERPs is difficult. In 2007, Rettig wrote about the difficulties of ERPs and cited the attention-grabbing statistic that 75 percent of ERP implementations were considered failures.[25]

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[22] Elizabeth J. Umble, Ronald R. Haft, and M. Michael Umble, "Enterprise Resource Planning: Implementation Procedures and Critical Success Factors," *European Journal of Operational Research* 146 (2003): 241–257.

[23] Even the Air Force Chief of Staff may not have sufficient pull to make the Air Force adopt an ERP like ECSS as quickly as some might like, but nobody else could do it faster.

[24] Sanjay Gosain, "Enterprise Information Systems as Objects and Carriers of Institutional Forces: The New Iron Cage?" *Journal of the Association for Information Systems* 5, No 4, Article 6 (2004).

[25] Tracking down this statistic to its source showed that it came from a survey-based analysis in which 34 of 50 surveyed companies responded. There are reasons to think that the survey might have been biased toward successful ERPs, as the 50 were selected by ERP COTS software vendors. For a full discussion, see K. K. Hong and Y. G. Kim, "The Critical Success Factors for ERP Implementation: An Organizational Fit Perspective," *Information & Management* 40, No. 1 (October 2002): 25.

G. Root Cause Summary

One question asked in every root cause analysis for D,PARCA is whether this problem was caused before the program's inception or after. Since "birth" is generally defined as MS B, this program has not yet been born. It is conceivable that ECSS R1 will receive MS B authority sometime soon, with a baseline it can stick to, and never suffer a cost breach.

None of the root causes of the cost growth in the ECSS program came from unpredictable exogenous events since MS A. The deepest root cause of cost growth and schedule delay in ECSS came about because the people who began this program had an insufficient understanding of what it entailed—its size, its scope, and the nature of the problems presented. As the scope of ECSS is so big, it is possible that nobody in the world really knew how long it would take or what it would cost to acquire this system. It may also be that it is impossible to know how much a large ERP will cost until the blueprinting is done, which is a significant portion of the cost.

Because ECSS is still pre-MS B, it is possible that the cost growth and schedule delay to date can be dismissed as growing pains and this program will settle down into a good performer for the Air Force. We are skeptical, though, because the data about CSC's performance problems are from early FY 2011 and the PM wants his R1 APB soon.

Of the standard categories for cost growth that the Weapons System Acquisition Reform Act of 2009 lays out, this program clearly suffered from one "unanticipated design, engineering, manufacturing, or technology integration issue[s] arising during program performance" (the data importation issues). There is also evidence that can be interpreted as "poor performance by government or contractor personnel responsible for program management" in that they did not fully report shortfalls in program accomplishments. Lastly, the program was launched with a grossly insufficient understanding of the problems involved and, consequently, had an unrealistically low cost estimate.

Appendix A.
Hidden Costs Typically Overlooked

There are several components to every successful ERP implementation that are often overlooked because they are external to the primary effort of bringing the new system online. These additional tasks can add unexpected costs and effort to the process, yet an ERP implementation will fail without them. Some of this work must be conducted within the organization, while other work requires outside vendors to go beyond their basic ERP development tasks. We call them out here because, while they are mentioned above, they do not contribute to the official costs of the program that are recorded in budget requests or PO reporting. Rather they will come out of the activities of other commands generally in the form of overtime hours worked or reduced productivity.

First, the organization must engage personnel at every level from the onset. Users of the system and of its reports must meet to work through the suitability of the planned automation and its constraints. Leadership must consider the results of these meetings to decide if ERP is appropriate for the organization as well as the depth and breadth of its implementation.

Second, the business processes must be documented and examined for suitability of automation. Some procedures may have to be modified, some replaced, and some left external to the automation (e.g., improvement analysis). Many organizations choose to streamline their processes prior to selecting an ERP product or vendor while others prefer to select the software first (perhaps for compatibility across a larger organization) and later fit their processes to the constraints of the software. The optimum approach may be a combination of high-level re-engineering to accommodate known deficiencies or inconsistencies in current business processes followed by a fit-gap analysis to select the software that can best accommodate the organization's needs. After software is selected and its limitations are known, progress can be made at a more granular level to adapt process details as needed, as well as to consider customizations to the software. An ERP vendor or SI is typically hired to assist with these steps.

Finally, personnel who will use the ERP or its reports must be trained, not only in the re-engineered processes but also in the use of the software itself. While the cost of training may be included in vendor estimates, the hours spent by personnel to attend training, in addition to the loss in productivity during the conversion period when new and old processes often overlap, are frequently external to the cost estimates for standing up the new system.

Appendix B.
ECSS and IDA's Conditions for Successful ERP Implementations

In 2011, IDA produced a paper on ERP programs for the OSD Comptroller and the Deputy Chief Management Officer, which was required by the House Armed Services Committee.[1] The IDA analysis resulted in a list of eight necessary conditions for a successful ERP implementation, meaning that "benefits and operational improvements are realized to the planned extent." The idea behind these conditions is that if they are not all present, the attempt will either exceed the expected costs or fall short on benefits. By our analysis, the Air Force ECSS program currently meets only one of these necessary conditions and is actively working towards meeting another, although they are not there yet. We cannot judge the status of two others. This appendix contains our assessment of ECSS relative to each condition.

#	Condition	Assessment
1	Sustained involvement of senior leadership with authority over and accountability for the definition and execution of all end-to-end processes impacted by the ERP.	Fail

The Air Force has come to understand this problem and is attempting to address it; however, there is a long way to go before this condition is met. The PM has a great deal of control within the Air Force and it may be enough, but he has no control over other DoD systems that are vitally important to ECSS functioning.

The Air Force addressed the internal issues in July 2009 by appointing a brigadier general to the role of program manager for ECSS as well as PEO for all logistics systems that ultimately will be replaced by ECSS. The PEO/PM does have control over much of the Air Force's logistics-related IT systems.

Neither the PEO nor the Air Force controls how other parts of DoD operate and handle data. This "fourth estate" has caused problems for other ERPs and will cause problems for ECSS. Reducing the fourth estate's impact would require granting the

[1] Paul K. Ketrick, John W. Bailey, Marilee O. Cunningham, Laura A. Odell, Graeme R. Douglas, Dawn M. Floyd, and Anthony Insolia, "Assessment of DoD Enterprise Resource Planning Business Systems," IDA Paper P-4691 (Draft Final), Institute for Defense Analyses, February 2011.

enterprises that are implementing ERPs more autonomy in their business practices than currently exists.

#	Condition	Assessment
2	Leadership willingness and ability to make hard decisions relative to proceeding or not proceeding with an implementation based on program performance.	Unclear

This program has a program manager, a sponsor, and a milestone decision authority. In addition, higher level personnel, such as the Secretary of the Air Force, the Secretary of Defense, and even some officials in the White House, are aware of this program. It is unclear who would have the authority to cancel it if they thought it was warranted.

#	Condition	Assessment
3	Strong integrated governance that includes representation of and participation by all impacted stakeholders. The representatives must have the authority to make decisions that are binding on the communities they represent. Decisions must be made rapidly and the effectiveness of the governance must be actively measured and reported.	Fail

As with condition #1, the PEO has sufficient authority within the Air Force, but ECSS has many ties outside the Service over which the PEO and his superiors have little or no control. To improve this condition, the Air Force logistics enterprise would need more autonomy over its business practices than it currently has, although granting that authority to the Air Force would create new issues for study.

#	Condition	Assessment
4	An organizational operating model (structure and process) aligned to the design of the ERP with minimal requirements to cross-organizational boundaries and which execute components of a process outside of the ERP, thus breaking the inherent integration of the ERP.	Pass

The PM's team is adamant about fighting vested interests within the Air Force to get them to change their processes to work with the Oracle software as much as possible.

#	Condition	Assessment
5	A strategy and approach that address the root cause (not just the symptoms) of the problems being solved and the measurable operational improvement to be gained by solving them.	Unclear

This condition is bigger than ECSS. An ERP cannot be successful by itself because it is merely a tool. This condition asks if the ERP is part of a broader strategy that will improve the enterprise. This broader strategy comes from the Air Staff and, in particular, the sponsor's office. It is called Expeditionary Logistics for the 21st Century or eLog21. It was beyond the scope of this study to determine whether or not this plan attacks the deepest issues in Air Force logistics.

#	Condition	Assessment
6	Personnel with the requisite skill set and experience necessary to define and execute an ERP implementation (e.g., source selection, contracting, vendor management, change management, technical oversight).	Fail – probably improving

In the early days of this program, the plan was to buy Oracle's ERP software and integrate it with two other software packages: IFS for maintenance and Click Commerce for supply planning. Nobody had experience integrating these products because it had never been done, although the Air Force treated this as a COTS acquisition. This anecdote, along with other evidence discussed in the main body of this paper, suggests that the Air Force did not fully understand what they were buying. The Air Force has since decided that Oracle's latest products can give them the capability they need. However, the Air Force has not demonstrated that it has acquired more expertise on the implementation of ERPs. We marked this condition as "probably improving" because the ECSS PO does contain numerous highly capable people who have been working with CSC for several years.

#	Condition	Assessment
7	Defined metrics for operational improvement to be gained, supported by a baseline describing existing business performance.	Fail

The Air Force created a 105-page Capability Document and a 66-page TEMP, both of which came into their current form in Spring 2010. The TEMP has 63 MOEs and Measures of Suitability (MOSs) that R1 is supposed to meet. Nine of these relate to the performance of the Air Force. Thirty-nine describe the capabilities of the program—measures that should help to improve the Air Force, but are not direct measures of how well the Air Force is doing. Thirteen are about the capability of the computer system, which should make the program better, and a better program, in turn,

should make the Air Force better—although that is not guaranteed. The last two relate to satisfaction of guidance and standards, which may be wise but are not measures of improvements to the Air Force.

Of the nine MOEs that relate to the Air Force, five of them have criteria listed as "TBD," so the requirement has not yet been set. The other four are shown in Table B-1.

Table B-1. Requirements in the ECSS TEMP for Air Force Performance

Test Descriptor	Requirement	Measure	Criteria
Operations and sustainment cost savings	ECSS shall be less expensive to operate and sustain (O&S) than the subsumed systems in constant FY 2005 dollars	(Key System Attribute) MOS 3.19: Operations and sustainment cost savings	Programmed ECSS, release 1, O&S dollars: ≤99% of FY 2005 dollars expended for planned subsumed systems
Percent auditable transactions	ECSS shall enable auditable transactions involving vehicles, equipment, mobility gear, and tools	MOE 2.5: Percent of auditable transactions	≥ 98%
Percent of successful on-time deliveries	(Key Performance Parameter (KPP)) ECSS shall enable on-time delivery	(KPP) MOE 1.2: Delivery Rate. Not a measure exclusive to ECSS	≥ 75%
Percent of orders filled	(KPP) ECSS shall enable full order	(KPP) MOE 1.3: Fill Rate. Not a measure exclusive to ECSS	≥ 95%

These four requirements seem fairly powerful, but only MOS 3.19 really focuses on the capability of the Air Force—by spending less money on logistics, there should be more money available elsewhere. The Air Force would like to have more orders filled and delivered on time, but if, for example, the system only increases on-time delivery by lengthening schedules and maintenance happens at the same speed, even that is not a significant improvement, and it may even make the Air Force worse off. It is possible that all of these metrics could be satisfied—possibly going well above the baseline—and the Air Force would still be less well off for having implemented ECSS. Suppose, for example, that ECSS meets all four requirements above but the availability rate for some aircraft types falls because the system forces mechanics for those types to work less efficiently than they had before. What is needed are MOEs saying that the sortie rates or availability rates of all aircraft in the inventory must not decrease—possibly with a normalization for aircraft aging.

Also, it is not clear that 98 percent of auditable transactions is good enough to get the Air Force the "clean audit" that the Congress requires.

Finally, there does not seem to be any document containing baselines. This may be in part because there are as many different baselines as there are many different ways tasks are performed throughout the Air Force.

#	Condition	Assessment
8	Accurate, consistent, and authoritative data.	Fail – but being worked on

Air Force logistics data is stored on many different systems in different ways all across the Air Force. This problem is understood, and a significant portion of what the ECSS program is doing is trying to fix the various datasets to make them accurate, consistent, and authoritative. Currently that work is ongoing.

Appendix C.
Benefits by Year and Benefits by Release

Table C-1. Benefits by Years FY 2011–FY 2019 (millions of TY dollars)

Benefit Title	2011	2012	2013	2014	2015	2016	2017	2018	2019
Fewer Spares / Equipment Needed (MSD spend)				5.47	65.66	257.17	525.30	738.73	820.83
Inventory Holding Costs				1.10	13.20	51.70	105.59	148.50	165.00
Fewer Spares / Equipment Moved				0.01	0.09	0.34	0.69	0.96	1.07
Better Financial Management				0.00	0.02	0.04	0.06	0.07	0.07
Less Man-Hours				0.26	0.79	3.67	8.65	13.44	15.86
Supply Chain Sub Total	**0.00**	**0.00**	**0.00**	**6.84**	**79.76**	**312.92**	**640.29**	**901.70**	**1002.83**
Legacy IT - Compliance Modernization	50.00	140.00	140.00	140.00	50.00	0.00	0.00	0.00	0.00
Legacy IT Sustainment	0.00	0.00	0.00	33.52	76.35	182.93	267.59	307.12	315.08
Legacy IT Sub Total	**50.00**	**140.00**	**140.00**	**173.52**	**126.35**	**182.93**	**267.59**	**307.12**	**315.08**
Total	**50.00**	**140.00**	**140.00**	**180.36**	**206.11**	**495.85**	**907.88**	**1208.82**	**1317.91**
Cumulative Total	**50.00**	**190.00**	**330.00**	**510.36**	**716.47**	**1212.32**	**2120.20**	**3329.02**	**4646.93**

Table C-2. Benefits by Years FY 2020–FY 2026 (millions of TY dollars)

Benefit Title	2020	2021	2022	2023	2024	2025	2026	Total
Fewer Spares / Equipment Needed (MSD spend)	820.83	820.83	820.83	820.83	804.42	640.25	246.25	7387.40
Inventory Holding Costs	165.00	165.00	165.00	165.00	161.70	128.70	49.50	1484.99
Fewer Spares / Equipment Moved	1.07	1.07	1.07	1.07	1.05	0.81	0.32	9.62
Better Financial Management	0.07	0.07	0.07	0.07	0.06	0.01	0.00	0.61
Less Man-Hours	15.86	15.86	15.86	15.86	15.07	14.28	7.14	142.60
Supply Chain Sub Total	**1002.83**	**1002.83**	**1002.83**	**1002.83**	**982.30**	**784.05**	**303.21**	**9025.22**
Legacy IT - Compliance Modernization	0.00	0.00	0.00	0.00	0.00	0.00	0.00	520.00
Legacy IT Sustainment	325.04	337.50	353.06	372.51	343.21	246.23	134.01	3294.15
Legacy IT Sub Total	**325.04**	**337.50**	**353.06**	**372.51**	**343.21**	**246.23**	**134.01**	**3814.15**
Total	**1327.87**	**1340.33**	**1355.89**	**1375.34**	**1325.51**	**1030.28**	**437.22**	**12839.37**
Cumulative Total	**5974.80**	**7315.13**	**8671.02**	**10046.36**	**11371.87**	**12402.15**	**12839.37**	

Table C-3. Benefits by Release (millions of TY dollars)

O&M Benefit	R1			R2		
	Low	**Likely**	**High**	**Low**	**Likely**	**High**
Fewer Spares / Equipment Needed (MSD spend)	84.43	147.75	168.86	844.28	1477.48	1688.55
Inventory Holding Costs	17.82	29.70	59.40	178.20	297.00	593.99
Fewer Spares / Equipment Moved	0.14	0.19	0.29	1.49	2.12	3.14
Better Financial Management	0.03	0.03	0.29	0.38	0.45	0.76
Less Man-Hours	4.75	7.13	14.26	4.75	7.13	14.26
Supply Chain Sub Total	**107.17**	**184.80**	**243.10**	**1029.10**	**1784.18**	**2300.70**
Legacy IT - Compliance Modernization	72.91	72.91	72.91	149.03	149.03	149.03
Legacy IT Sustainment	419.41	419.41	419.41	906.64	906.64	906.64
Legacy IT Sub Total	**492.32**	**492.32**	**492.32**	**1055.67**	**1055.67**	**1055.67**
Total	**599.49**	**677.12**	**735.42**	**2084.77**	**2839.85**	**3356.37**

Table C-4. Benefits by Release (millions of TY dollars)

	R3			R4			Total		
O&M Benefit	**Low**	**Likely**	**High**	**Low**	**Likely**	**High**	**Low**	**Likely**	**High**
Fewer Spares / Equipment Needed (MSD spend)	2026.25	3545.96	4052.53	1266.42	2216.23	2532.83	4221.38	7387.42	8442.77
Inventory Holding Costs	427.68	712.79	1425.58	267.30	445.50	890.99	891.00	1484.99	2969.96
Fewer Spares / Equipment Moved	3.12	4.43	6.57	2.03	2.89	4.28	6.78	9.63	14.28
Better Financial Management	0.08	0.09	0.15	0.03	0.03	0.05	0.52	0.60	1.25
Less Man-Hours	42.79	64.18	128.36	42.79	64.18	128.36	95.08	142.62	285.24
Supply Chain Sub Total	**2499.92**	**4327.45**	**5613.19**	**1578.57**	**2728.83**	**3556.51**	**5214.76**	**9025.26**	**11713.50**
Legacy IT - Compliance Modernization	149.03	149.03	149.03	149.03	149.03	149.03	520.00	520.00	520.00
Legacy IT Sustainment	956.83	956.83	956.83	1011.28	1011.28	1011.28	3294.16	3294.16	3294.16
Legacy IT Sub Total	**1105.86**	**1105.86**	**1105.86**	**1160.31**	**1160.31**	**1160.31**	**3814.16**	**3814.16**	**3814.16**
Total	**3605.78**	**5433.31**	**6719.05**	**2738.88**	**3889.14**	**4716.82**	**9028.92**	**12839.42**	**15527.66**

Illustrations

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Abbreviations

ADM	Acquisition Decision Memorandum
AFB	Air Force Base
AFWCF	Air Force Working Capital Fund
AIT	Automated Information Technology
AoA	Analysis of Alternatives
APB	Approved Program Baseline
AT&L	Acquisition, Technology, and Logistics
BG	Brigadier General
BSM	Business Systems Modernization
BTA	Business Transformation Agency
BY	Base Year
CCDR	Contractor Cost Data Report
CFO	Chief Financial Officer
COTS	Commercial-off-the-shelf
CPR	Contract Performance Report
CSAG	Consolidated Sustainment Activity Group
CSC	Copmuter Sciences Corporation
D,PARCA	Director of Performance Assessment and Root Cause Analysis
DAMIR	Defense Acquisition Management Information Retrieval
DCMO	Deputy Chief Management Officer
DEAMS	Defense Enterprise Accounting and Management System
DLA	Defense Logistics Agency
DLR	Depot-Level Reparable
DMAG	Depot Maintenance Activity Group
DoD	Department of Defense
DWWCF	Defense-Wide Working Capital Fund
ECSS	Expeditionary Combat Support System
eLog21	Expeditionary Logistics for the 21st Century
ERP	Enterprise Resource Planning
ESI	Enterprise Software Initiative
FDD	Full Deployment Decision

GAAP	Generally Accepted Accounting Principles
GAO	Government Accountability Office
GCSS	Global Combat Support System
HASC	House Armed Services Committee
ICE	Independent Cost Estimate
IDA	Institute for Defense Analyses
IT	Information Technology
KPP	Key Performance Parameter
KSA	Key System Attribute
LogFins	Logistic Financials
MAIS	Major Automated Information System
MAJCOM	Major Command
MC	Marine Corps
MDA	Milestone Decision Authority
MDAP	Major Defense Acquisition Program
MOE	Measure of Effectiveness
MOS	Measure of Suitablility
MQR	Major Automated Information System Quarterly Report
MS	milestone
NDAA	National Defense Authorization Act
OSD	Office of the Secretary of Defense
PARCA	Performance Assessment and Root Cause Analysis
PEO	Program Executive Officer
PIC	Positive Inventory Control
PIR	Program Interim Report
PLM	Product Lifecycle Management
PM	Program Manager
PMR	Program Monthly Report
PO	Program Office
RCA	Root Cause Analysis
RFP	Request for Proposal
RICE	Reports, Interfaces, Conversions, and Extensions
SBR	Statement of Budgetary Resources
SCP	Service Cost Position
SI	System Integrator
SMAG	Supply Management Activity Group

TAV	Total Asset Visibility
TEMP	Test and Evaluation Master Plan
TY	Then Year
USD	Under Secretary of Defense
WAWF	Wide Area Work Flow

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14. ABSTRACT

We performed a root cause analysis on the Air Force's Expeditionary Combat Support System (ECSS) program, an Enterprise Resource Planning (ERP) program that has undergone a critical change due to schedule slippage. Our purpose was to find the root cause of both that schedule slip and the program's reported cost growth—although to date there is no approved baseline for this program. We visited with the sponsor at the Air Staff, the program manager, his staff, and the contractor's staff to hear their positions. We also studied all publicly available data, including quarterly reports to the Congress and the Air Force budget justification books. We found that the primary problem in this program has been a lack of government expertise on ERPs—not enough people understood what they were trying to acquire. The result of this was an acquisition that was not well suited to buying an ERP or estimating its schedule or cost.

15. SUBJECT TERMS

Root Cause Analysis, RCA, Expeditionary Combat Support System, ECSS, Enterprise Resource Planning, ERP, Major Automated Information System, Oracle, MAIS, Computer Sciences Corporation, CSC

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