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Executive Summary

This root cause analysis of the Global Combat Support System-Marine Corps (GCSS-MC) was sponsored by the Director, 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. The Institute for Defense Analyses studied GCSS-MC and the Air Force's Expeditionary Combat Support System (ECSS), while the RAND Corporation studied Navy ERP.

Increment 1 of GCSS-MC, also known as GCSS-MC/LCM (Logistics Chain Management), is an information technology system that is intended to modernize Marine Corps logistics and replace four 1970s-era legacy supply and maintenance Information Technology (IT) systems. GCSS-MC/LCM will provide Marine Air-Ground Task Forces (MAGTFs) with integrated, web-based software that is expected to increase supply chain effectiveness and provide timely combat support information.

Full GCSS-MC is eventually intended to deliver integrated functionality across supply, maintenance, transportation, finance, engineering, health, and manpower systems as well as provide a common base for integrated logistics chain management.[1] In addition to this immediate charter, it will become the platform to support future logistics functions and upgrades. GCSS-MC will become the computer system that undergirds all Marine Corps logistics.

The Marine Corps received a successful Milestone (MS) A decision for GCSS-MC Block 1 in July 2004. A favorable MS B decision was achieved in June 2007. However, in their Major Automated Information Systems Quarterly Report of September 2008, the program announced that it would breach the MS B Acquisition Program Baseline (APB) critical cost and schedule thresholds (over 25 percent growth in lifecycle costs and greater than five years from MS A to Initial Operational Capability (IOC), respectively).

Because of this breach, a Critical Change Team (CCT) comprehensive review was conducted in late 2008.[2] This led to a more realistic assessment of GCSS-MC cost and schedule, and resulted in the program being partitioned into two parts. The first part,

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1 September 1997 Joint GCSS Mission Needs Statement (MNS) No. 97072DA-E04Y.

2 A *critical change* is a formal process for reviewing MAIS programs that is automatically triggered by certain conditions relating to cost or schedule. A critical change leads to a formal review and typically leads to changes in how the program is executed.

called the Enterprise Release 1.1, is focused on providing an ERP capability at the garrison (e.g., Marine Expeditionary Force, or MEF) level. Release 1.1 was scheduled for completion by July 2012. The more technically challenging capability, which will enable GCSS-MC to be used in a detached mode by a deployed MAGTF, is called the Deployed Access Release 1.2 and is scheduled for late 2013. The term Increment 1 replaced Block 1 as the name for the logistics chain management portion of GCSS-MC. No schedule or specifics for later increments have been established.

After the CCT review, the program achieved a measure of equilibrium. Enterprise Release 1.1 passed MS C in May 2010 and claimed IOC as of June 2010. However, the official schedule still called for a Full Deployment Decision (FDD) for Release 1.2 in July 2012 followed by Full Deployment (FD) in July 2013. By all current indications, FD will not be achieved by this target date.[3]

As of the time of this study the two most difficult technical challenges required for deployed access had not been solved: (1) the use by detached (deployed) users with low bandwidth and subsets of the database, and (2) the ability to shield any classified data from unclassified equipment or networks (the "cross domain solution").[4]

To put the apparent size growth of GCSS-MC in perspective, one should realize that the original scope of tactical logistics arose from the need to enable detached deployments to order supplies more efficiently. In addition to efficiency, it was hoped that a modernized supply system would remove the tendency for MAGTFs to order more supplies than were actually needed, a common workaround used to overcome limitations in the existing process. A modernized logistics ERP would also allow inventory assessment to ensure that MEFs would reorder supplies in time to fill orders expected from the field. The original vision appeared viable to the Marine Corps since it was intended to implement only a subset of full ERP functionality and this functionality was thought to be largely available using commercial off-the-shelf (COTS) software. Further, because GCSS-MC was not intended to be a primarily financial system, the Marine Corps goals were not aligned with any other ERP effort in the Department of Defense (DoD). This was identified as one of the reasons to procure a custom implementation to solve the supply logistics problem and not, for example, to rely upon Navy ERP.

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[3] This study was completed in early 2011. Since then, a subsequent MDA decision, contained in an Under Secretary of Defense for Acquisition, Technology & Logistics (USD(AT&L)) memorandum dated October 18, 2011, authorizes deployment of Release 1.1 to I MEF and II MEF. The memorandum also authorizes a limited fielding of Release 1.2 to begin Follow-on Operational Test and Evaluation (FOT&E) after Integrated Developmental Test (IDT). The IDT began in late 2011 but was never completed.

[4] Following the terminated IDT in late 2011, a subsequent Capabilities Production Document (CPD) deleted entirely the requirement for the Cross-Domain Solution (CDS) by eliminating the need for operation at the Secret level.

Therefore, the Marine Corps saw GCSS-MC/LCM as an ERP system of limited scope that could replace unsatisfactory existing procedures and legacy systems with fundamentally COTS products. At the time, DoD policy required that COTS software and the system integration services for implementing it be acquired through the DoD Enterprise Software Initiative (ESI) contract vehicle.[5] This constrained the field of available contractors to five or six vendors with business-world experience but not necessarily with expertise in non-financial supply logistics, the operating domain of GCSS-MC/LCM.

The incongruity of procuring a custom logistics ERP system through the ESI contract vehicle became evident to the Marine Corps within weeks after the job of building GCSS-MC was awarded to Accenture in April 2005. After award, Accenture explained that the Request for Proposal (RFP) implied a more complex and novel approach than was initially thought, meaning the original funding request based on COTS products was grossly inadequate. Not only were COTS ERP products more oriented to finance-centric problems, they were not at all suitable for detached access. The available COTS products assumed users would have continuous high-bandwidth access to an ERP database, which is not possible for deployed MAGTF users. Further, even the Enterprise (garrison) Release 1.1 turned out to require much more development of reports, interfaces, conversions, and extensions (or enhancements) (RICE)[6] objects to achieve the required functions than Accenture had budgeted in its proposal.

Just two months after contract award, Accenture proposed a complete solution at a considerably higher cost than it was under contract to expend. Instead of accepting the higher cost, however, the Marine Corps decided to modify the contract with Accenture so that it ended in mid-2006 upon delivery of intermediate work products and subsequently turned to Oracle Corporation in December 2006 to be the primary systems integrator for GCSS-MC. Oracle had been identified as the COTS ERP software vendor eight months before Accenture was awarded the system integration job.

Underscoring the fact that GCSS-MC was underfunded from the start, the program office told us that during the RFP phase in 2004, three of the six ESI bidders did not submit bids, possibly because the lack of appropriate COTS products meant the work could not conceivably be completed within the budget available. According to the program office and other knowledgeable program participants, one of the other bidders offered to complete the job at a price similar to Accenture's, while the third (also unsuccessful) bidder submitted a proposal that cited a considerably higher price.

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5 ESI stopped offering this type of contract in 2009.

6 RICE objects are units of software that are developed by the user or implementer that add to the existing functions of a database system.

In addition to the unrealistic constraint to use COTS software with little or no additional budget for modification, the firm fixed-price (FFP) contract required by the ESI vehicle was inappropriate for the unprecedented development needed to implement GCSS-MC. Several aspects of the program meant that a considerable amount of new development was required, including deployed access to ERP functionality, and thus a cost-plus contract would probably have been a better choice. The knowledge required to understand the full cost of an ERP implementation can only be gained after understanding the current and desired future business processes and choosing a transition strategy to move the organization to those new processes. Only then can the match between COTS function and desired processes be measured, and the required amount of new development estimated.

Following a software-first process, the Marine Corps chose the Oracle 11i e-Business Suite as the ERP product for implementation of GCSS-MC in August 2004, eight months before the Accenture award. When Accenture estimated a higher cost to provide the complete package described by the Marine Corps, Oracle offered to replace Accenture and to work on a time and materials (T&M) basis to deliver the needed system.[7] Since a key capability needed by GCSS-MC—the ability to "snap off" a portion of the supply database and operate in the field without high bandwidth to the MEF—was not off-the-shelf, Accenture would have either needed Oracle's assistance or considerable time to develop this unprecedented functionality. Presumably, Oracle convinced the Marine Corps to allow it, and not Accenture, to lead the development. According to our research, since hiring the ERP vendor to also be the system integrator (SI) raised some concerns, this was considered a temporary solution that would last only through the development of Release 1.1, and the SI contract was to be rebid for Release 1.2; however, we did not find any information about selecting a new SI to replace Oracle. At the time of the transition from Accenture to Oracle, $93 million—about three-fourths of the MS A cost estimate—had been spent on GCSS-MC for very little, if any, earned value.

This paper provides additional detail about the history and status of the ongoing GCSS-MC/LCM development and concludes:

- Because it was conceived with a limited scope to solve a specific problem, the original advocates of GCSS-MC apparently believed it would be much less difficult than a conventional ERP implementation.
- Planning, budgeting, and managing for what later became a much larger project wasted considerable time and money.

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[7] Oracle was not willing to operate as a cost-plus contractor as Accenture had done, an arrangement that would have meant sharing their proprietary overhead and cost data with the government, and was hired instead on a T&M basis.

- The FFP ESI contract vehicle of the time was appropriate for procuring COTS software but not for an ERP implementation; the amount of discovery and development required for an ERP makes a cost-plus type of contract more appropriate.
- Two key functions needed for GCSS-MC are not part of any COTS ERP package or toolset and these remain unsolved as of January 2012. The distraction of trying to solve the detached access problem contributed to the delayed development of basic garrison supply functionality.
- Where deployed, the now partially functional GCSS-MC/LCM is an improvement over the processes it replaces, although at considerable total cost when compared to the cost of maintaining the legacy systems.
- Finally, an overarching observation about ERP implementations is that they are inevitably more difficult than vendors claim they will be. They are not simply a matter of purchasing off-the-shelf software products and hiring experts to instantiate them. ERP conversions require deep organic support and broad institutional buy-in. Because they are expensive, they must be deemed more important than other efforts with which they compete for funding, or they will languish without the resources required to bring them to fruition.

Contents

1. Background

This root cause analysis of the Global Combat Support System-Marine Corps (GCSS-MC) was sponsored by the Director, 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. The Institute for Defense Analyses (IDA) studied GCSS-MC and the Air Force Expeditionary Combat Support System (ECSS), while the RAND Corporation studied Navy ERP.

GCSS-MC is an information technology system that is intended to modernize Marine Corps logistics and replace four 1970s-era legacy supply and maintenance IT systems: Asset Tracking and Supply Systems, Material Forecast Management Plan, Marine Corps Integrated Maintenance Management System, and Supported Activities Supply System. GCSS-MC will provide Marine Air-Ground Task Forces (MAGTFs) with integrated, web-based software to optimize supply chain effectiveness and provide timely combat support information. The system was originally known as MC LCM COTS (Marine Corps Logistics Chain Management Commercial Off-The-Shelf).[1]

In addition to optimizing supply chain processes, GCSS-MC is also intended to deliver integrated functionality across maintenance, transportation, finance, engineering, health, and manpower systems, and provide a common base for all logistics chain management. The intent is that it will become the platform to support future logistics functions and upgrades. As such, GCSS-MC will become the computer system that undergirds all Marine Corps logistics.

A. Chronology

July 23, 2004 (MS A): GCSS-MC was granted Milestone (MS) A approval from the Milestone Decision Authority (MDA), the Assistant Secretary of Defense, Networks and Information Integration (ASD(NII)). The program specified a software-first strategy to develop MC LCM COTS, which became known as GCSS-MC as of this date. The estimated development budget was $126 million, according to the Analysis of Alternatives (AoA) dated May 2004.

[1] Department of the Navy memo dated 7 July 2004 describing legacy system migration, available at https://www.dla.mil/j-6/dlmso/eLibrary/Restricted/MigrationPlans/USMCMigration.pdf.

August 2004: Software contract awarded to Oracle for licenses, consulting services, and training under ESI FFP contract vehicle.

April 2005: System Integrator (SI) contract awarded to Accenture under the DoD Enterprise Software Initiative (ESI) FFP contract vehicle. Interviews with current and former program participants revealed that only three of the six eligible contractors chose to bid on the Request for Proposal (RFP). Two bidders attempted to justify the government's expectations of unrealistically low cost but one bidder estimated a much higher cost based on project description. The government accepted the lowest bid, which was from Accenture.

Mid-2005: Accenture informs government that cost of GCSS-MC was likely to double. Negotiations ensue that allow Accenture to complete performance of contract in return for work accomplished.

December 22, 2005: Joint Requirements Oversight Council (JROC) approves the first GCSS-MC Capability Development Document (CDD).

January 2006: Accenture and Marine Corps part ways.

December 2006: Oracle awarded sole-source SI contract for GCSS-MC.

June 8, 2007 (MS B): As the Milestone Decision Authority (MDA), the Under Secretary of Defense for Acquisition, Technology and Logistics (USD(AT&L)) granted GCSS-MC Milestone B approval for Block 1. The cost estimate for acquisition of full operational capability (FOC) was revised to $186 million. As of this date, the program had spent $93 million, nearly 75 percent of the MS A estimate of $126 million and 50 percent of the new MS B estimate. This MS B estimate is the baseline figure against which the IDA study measured GCSS-MC cost growth.

February 2008: System Design Review completed.

March 2008: Increment 1 build phase begins. Within one month, project leadership realizes the true scope and complexity of the problem.

April 2008: GCSS-MC program manager (PM) is promoted to deputy program executive officer enterprise information systems (Deputy PEO-EIS); new PM takes over.

September 2008: The Major Automated Information Systems (MAIS) Quarterly Report (MQR) notifies the government of an inevitable cost breach (greater than a 25 percent increase in lifecycle cost) and schedule breach (greater than five years between MS A approval and Initial Operational Capability (IOC)). The program had exhausted 80 percent of its MS B budget.

January 2009: Critical Change Team (CCT) report concludes project should be split in order to reduce risk caused by delays related to detached access. A Plan of Action and Milestones (POA&M) is developed and approved by project management that

describes splitting Increment 1 into two releases. Enterprise Release 1.1 is to address garrison logistics only. Release 1.2 (Deployed Access) will address detached users.

March 2010: Program authorized to proceed with field user evaluation.

May 28, 2010: MS C approved for all of Increment 1.

May–August 2010: Release 1.1 Initial Operational Test and Evaluation (IOT&E) conducted. Initial garrison logistics functionality begins phase-in at III MEF in Okinawa, Japan.

June 2011: III MEF reports complete conversion to GCSS-MC Release 1.1.[2]

June 2011: The first forward environment use of partial capabilities occurred at 1st Marine Aircraft Wing in Atsugi, Japan to assist with earthquake and tsunami relief efforts.

November 2011: Integrated Developmental Test (IDT) for Release 1.2 (Deployed Access) was attempted but not completed. The Marine Corps Operational Test and Evaluation Activity (MCOTEA) cited issues in its summary report, entitled "GCSS-MC Developmental Test Observation Report."

December 2011: Marine Requirements Oversight Council (MROC) memorandum cites a $69 million shortfall and declares no additional funding will be provided without MROC approval. It also indefinitely defers the requirement to run on Secure Internet Protocol Router (SIPR) servers, the requirement for enterprise disaster recovery, and the requirement for a MEF-level server/shelter configuration. The MEF and field users will now use the same system configuration.[3]

B. Insights

Project leaders posed several conjectures and hypotheses in hindsight during our interviews that help to shed light on the situation leading up to the current state of GCSS-MC. Now that it has become clear that the cost of GCSS-MC is much higher than was originally assumed, the current program manager wondered whether the rejected proposal that cited a much higher cost might have pointed the project in the correct direction much earlier. A related thought was whether the ESI vendors who did not bid might have chosen to enter the discussions if a more realistic budget had been available from the beginning. Finally, there was the admission that the required use of a contract

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[2] The principal study period for this report ended in early 2011. Major events between the end of the study and 2012 are shown here for completeness.

[3] Information about the evolution of GCSS-MC after the formal study period was obtained from Charles (Larry) Gordon of IDA.

vehicle designed for the installation of COTS software was an additional blunder that cost the program considerable time and money.

There was also speculation about whether Accenture knew before contract award that the job was unrealistically funded but nevertheless hoped to negotiate a realistic price for a more appropriate solution after the initial contract for a system integrator was awarded. A competing theory is that Accenture only learned through subsequent discussions with the Marine Corps that the RFP inadequately described the problem. We did not examine the RFP, but other factors, including receiving one higher cost bid and not receiving any bid from half the vendors, seemed to point to the likelihood that the RFP described a program that was incompatible with the available budget at MS A.

Program office personnel from 2004 reported that Oracle claimed, while it was being evaluated as the COTS vendor, that the detached user capability was either already available or would be imminently available to fulfill that requirement of the planned system. Accenture reportedly worked with Oracle during the early weeks of their contract to build or at least verify this capability. Some project leaders expressed their expectation that Accenture would hire Oracle as a subcontractor to expedite this technical exchange process, however this relationship never materialized. We were told that a sizeable amount of effort expended during Accenture's performance on their contract revolved around supplying this (what would become Release 1.2) functionality, but also that Accenture attempted to have the program defer the field requirement and focus on garrison functionality. Additionally, Accenture identified a large number of Report, Interface, Conversion, and Extension (RICE) objects that would be required to bridge the gap between the COTS products and GCSS-MC enterprise requirements (Release 1.1). Reportedly, the Marine Corps, Accenture, and Oracle engaged in spirited, sometimes contentious, meetings during 2005 as they attempted to specify the gap between GCSS-MC requirements and Oracle's COTS software.

When the Marine Corps learned that Accenture could not perform within the contracted amount, they decided not to increase Accenture's budget. Instead, they terminated Accenture's contract for work performed, giving Oracle the opportunity to step into the system integrator (SI) role. One project leader stated, and others agreed, that, "Oracle desperately wanted to get into this problem space." The customary ERP procurement model is for a software vendor to supply COTS ERP products, consulting, and internal customizations, while a systems integrator (SI) that specializes in adapting ERP products to specific customer requirements acts as the prime contractor. Because of the complexity associated with adapting COTS products to specific customer requirements, it is often the SI and not the ERP vendor who receives the bulk of the work and funding during the implementation of an ERP system. The apparent advantage to the government for using Oracle as both tool vendor and SI was that Oracle agreed to fund development of the detached user functionality internally. We were not able to

reconstruct the decision process or shed any further light on any misinformation or misconceptions.

C. Additional Observations

A key failure during the early execution of GCSS-MC was the lack of visibility into earned value. Before its departure, Accenture identified numerous RICE objects as well as the novel detached user functionality as necessary steps to implementing a solution. Even if the program office did not previously understand the amount of work implied to field GCSS-MC prior to contract award, Accenture's revelations should have been an indication of the program's true scope. Yet, even after Oracle took over the role of SI, we did not see any indication that expenditures were tied to measureable amounts of product development. There did not appear to be any fundamental changes in contract oversight or progress reporting until the original budget was essentially spent.

Some have said that the distraction of trying to solve the detached user problem required for tactical logistics diverted resources from deploying the garrison logistics solution. However, others said there were also numerous problems reconciling the Oracle COTS products with Marine Corps requirements at the garrison, and pointed to the numerous RICE objects identified by Accenture as a measure of the gap that needed to be bridged.

The program is now envisioned to consist of three blocks. Block 1, now known as Release 1, is the focus of this study and involves two (sub)releases. The first, Release 1.1, is currently performing garrison supply logistics at III MEF, Okinawa. Release 1.2, which is to add deployed access, failed to complete its first IDT and the program is currently re-evaluating the schedule.

2. ERP Systems in the DoD

A. What Is An ERP?

Enterprise resource planning is an extension of manufacturing resource planning (MRP) employed in the 1980s and 1990s to support the manufacturing process. MRP systems are credited with the streamlining of supply chain management for major manufacturers (e.g., of automobiles) that minimized parts inventories without restricting production. Suppliers could be notified of the dates that inventory would be required in order to meet the production requirement (just-in-time delivery). Optimizations could be performed on costs and schedule using the insights afforded by an MRP system.

ERP systems evolved next, and typically consist of a suite of software programs that address the management of an entire enterprise, including financials, inventory, assets, orders, personnel, training, resource scheduling, and often even individual tasking and workflow. An ERP system can also perform reporting and analysis to provide visibility and to enable enterprise optimizations. ERP systems revolve around a centralized database and typically utilize a common computing platform to consolidate all business operations in order to avoid any replication of data. For example, an employee name would not have to be entered in a training record as well as in a task assignment, or a supplier would not be separately entered in a requisition record as well as in an accounts payable file. A fundamental rule of ERP systems is that every data item has a current value that is managed and maintained by an identifiable unit of software, and that every other use of that data item is a copy of, or reference to, that definitive value. Because simultaneous operations can occur that affect the value of a data item (e.g., the quantity of a certain part in inventory), ERP systems must establish locks and critical sections that serialize otherwise simultaneous updates in order to prevent errors (e.g., such as could occur if two processes attempted to remove the same item from inventory). This serializing of changes to data is exactly what became a stumbling block for detached access users, since it is impossible to know until the remote operations are reconciled with the master database whether the changes were feasible (e.g., that the items requested could in fact be supplied and were not removed from inventory during detached operation).[4]

[4] A common example with which many people have experience is online seat selection for airline flights. Each user is given a brief period to select seats online, or a subset of available seats is shown to simultaneous users, in order to prevent assigning the same seat to more than one passenger. This

Since the late 1990s, all ERP vendors have extended their original products by offering web-enabled products that can further interconnect suppliers, manufacturers, banks, and customers by allowing systems from one enterprise to interoperate with systems of another enterprise over the Internet.

B. Why Are ERP Implementations So Difficult?

Because of their inherent complexity, as well as the difficulty converting an organization from disparate, and often home-grown, IT solutions to a comprehensive and integrated solution, ERP implementations have a reputation for being budget-busters and are frequently abandoned short of completion. ERP systems are complex and difficult to verify. Converting an organization to the use of one implies verification of its correct function, but that might not be simply a matter of comparing the ERP system output with legacy systems. Since the proper approach to adopting ERP includes clean-sheet replacement of the supported business process, there may be no way to ensure correct functioning without manual verification. But even after a new system is running correctly, some of the old systems may still have to be supported because they perform other functions that the ERP system has not yet subsumed. For this reason, the information systems of an organization in transition will grow before they can be consolidated by the ERP conversion, and this often protracted spike in cost can overwhelm budgets before the eventual goal of efficiency and cost savings comes within reach. A rough order method for estimating the cost of system integration is not based on the cost of the procured COTS products, but rather on the entire IT budget of the organization undergoing ERP conversion. IDA reported in a 2011 study that an organization can expect a 15 percent increase in its entire IT budget during the first 18 to 24 months of an ERP integration.[5]

In addition to the implementation effort involved, ERP conversions require multiple phases that can stretch over several years, covering such tasks as:

- Identification and unification of an enterprise's data,
- Identification of the functions that the new ERP system will assume and the schedule for that transition,
- Configuration of the COTS products to perform those functions,
- Verification of the new system's operation, and
- Eventual decommissioning of legacy systems.

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process can only reliably occur if users are connected to the seat assignment database with relatively brief response times.

5 Paul K. Ketrick, John W. Bailey, and Gilbert J. Watson III, "Relative Cost Modeling for the U.S. Army Corps of Engineers: Five IT 'Courses of Action'," IDA Document D-4418, Draft Final (Alexandria, VA: Institute for Defense Analyses, August 2011).

All this must take place even as legacy systems are maintained, new software releases and upgrades are being introduced into both the old and new solutions, and stakeholders come and go at all levels of the organization.

Because of the diverse capabilities of ERP systems, it is generally not possible for an organization to procure a package of ERP software and simply install it with in-house expertise. Most organizations know they will need outside help but there is no single recipe for how to plan for a conversion, pick the software required, configure that software to perform the needed functions, and transition from current processes to the new set of processes. Such a broad range of knowledge, experience, and resources are needed to conduct an ERP conversion that the software industry has generally partitioned into two complementary fields: vendors of ERP products and system integrators to adapt those products for users. Currently, the largest COTS ERP software product vendors are Oracle and SAP, with Microsoft, Infor/Lawson (geared to mid-sized companies) and Sage (geared to smaller companies) also having sizeable market shares. The list of system integrators contains several well-known companies, including IBM, Accenture, CSC, Deloitte, BearingPoint and EDS as major players, although more recently Tata and Wipro in India have captured sizeable market shares. Even Oracle and SAP are now considered players in this area (more on this below).

The division of responsibility between ERP vendors, who provide the underlying software products and the SIs, who configure specific user functionality using those products, has certain advantages for customers. Among the advantages is the ability for an independent SI to examine the needs of an organization and recommend an ERP solution that involves a particular suite of software products from an outside vendor. That SI becomes responsible for the configuration and optimization of those products to support the business processes of the client organization. In theory, this allows the ERP software vendors to build general-purpose solutions that are applicable to the broadest array of customers, while specialists in the installation of those products choose the software tools and handle the individual customization and transition required to ensure a customer's success.

A basic tenet for integrating functions across an organization is that no piece of information should need to be entered in more than one place. This means there should be no confusion over where a "datum of record" resides, even if it is used in multiple places. This often turns out to be difficult in practice, particularly when an ERP system is expected to replace multiple legacy systems, which is almost always the case. Organizations grow, and they generally acquire computer systems and programs as necessary to handle specific needs. When the decision is made to replace legacy systems with an integrated solution, a lot of groundwork is required to identify all the participating data items (a data model), the business rules or processes that act on each data item (a process model), and the appropriate states of the data (database integrity).

Only then can a database model be realized by a database management system, and the ERP modules process an organization's business rules by operating on that data.

Stakeholder involvement, including both management and system users, is crucial though difficult to ensure. Even in the military, with its culture to follow high-level direction, users must be directly involved in order to ensure that their tasks can be performed at least as well after the conversion. The time required from all levels of the organization to map out all the effects of a conversion on an organization, and to design (and train) new procedures where necessary, is almost always underestimated.

Often, there is no single authority over all data and processes in an organization, and therefore multiple, sometimes conflicting, agendas must be reconciled. Since each data item must always have a single authoritative source, most of the users of that data element will not be able to change it. This can be frustrating for an office that is used to having its own "stovepiped" system but that must now learn to operate on enterprise data and provide results that are potentially visible, and therefore comprehensible, across the organization. Thus, ERP conversions can require a considerable amount of cultural change in order to overcome the inevitable inertia of existing processes and systems.

C. Commercial ERP Adoption

ERP systems are designed to satisfy business requirements in the commercial world. They can manage inventories, orders, manufacturing flows, maintenance procedures, personnel records, accounting, payroll, depreciation, and diverse reporting, while simultaneously tracking the cost, value, and progress of the processes within an organization. Further, ERP systems are frequently made to interoperate with the systems of other companies in order to optimize the purchasing of supplies, the shipment of products, and the issuing and payment of invoices.

Up to some point in the life of a company, it is feasible and customary to provide each of these functions through stand-alone systems, such as by using an accounting system for payroll, a personnel database for employee tracking, a travel system for employee travel, and so on. However, at some point, the advantages of merging all the functions via a common database become apparent. For example, it should be possible for payroll, travel, training, and career functions to all share the same employee records as well as the business rules within the company that describe different job categories, career paths, compensation packages, etc.

To handle the diverse business functions that can be assisted by data processing solutions, an ERP system consists of a suite of interoperating modules of software, each addressing a particular aspect of an organization's business while communicating with other modules and the outside world via an underlying database. Thus, the state of an

organization at any moment in time is represented by the state of the database, and that state is being continually queried and updated by the ERP modules that depend upon it.

In the commercial world, personnel and payroll modules are some of the most commonly needed solutions, so much so that they are often the only general purpose business software required by many small- to medium-sized organizations, particularly at service firms or other non-manufacturing businesses. The capabilities of these fundamental modules can vary depending on the needs and size of the business. Beyond basic contact and attendance information, personnel modules can schedule training and track employee experience, record performance evaluations, manage job assignments, monitor career advancement, handle multiple sites and travel between them, or automate other job functions. The computations provided by payroll modules automate tax and benefit deductions, track leave and vacation, compute pay by job assignment, reconcile advances, file withholding reports, manage union dues and charitable elections, and may either transmit the data as required or directly manage the printing of checks and statements. Retirement plans, benefit choices, travel management, and reimbursable expense accounting, or other related functions, are often handled by additional ERP modules that share data with personnel and pay modules.

Businesses that are engaged in repetitive activities, such as manufacturing or sales, investment and asset management, leasing, or logistics (such as shipping companies), or that deal with large volumes of customer data (such as airlines) can take advantage of additional modules that may be available to assist in these activities. An order-processing module, for example, might take in a customer's name, address, requested items or services, and method of payment. A separate module may be responsible for fulfilling the order, either by locating and reserving inventory, submitting requests for a purchasing module to acquire materials, assigning human tasks, or other necessary steps. Invoicing and shipping modules may be invoked to compute bills and print packing slips that may involve processing taxes, shipping costs, partial delivery, backorder advice, warranty registration, and various other details.

These are examples of typical commercial ERP functions. SAP offers about 50 modules in 10 categories (with names like asset management, human resources, financial accounting, production planning, quality management, etc.) and Oracle offers over 100 modules in 12 categories or product lines in its E-Business Suite. However, none of these off-the-shelf modules can perform their functions without first being provided with the business rules about the specifics of each task. For personnel and pay modules, for example, business rules specify employee categories, how vacation hours accrue, and retirement contribution policies. For order-processing modules, business rules explain the product catalog and pricelist, any shipping charges, and allow the calculation of fulfillment time. Configuring a suite of ERP modules to conduct business in the manner desired by each customer is the job of a system integrator. It is this task that can be

difficult to budget since it depends on whether the off-the-shelf ERP software is sufficient to automate an organization's requirements with only minimal information, such as employee names, addresses, and social security numbers, or whether the software must be extended to handle unique requirements such as semi-monthly pay for employees in some locations and bi-weekly pay for others. One solution to lowering the cost of an ERP implementation is to simplify the business rules first. Unusual mixes of business rules are common after company acquisitions, or even across the departments of a large company, and executive decisions are frequently required that inflict some organizational pain up front in order to reduce ERP transition costs and achieve simpler operation in the future. The ability to reach and enforce these kinds of compromises is critical to the success of an ERP conversion.

D. Military vs. Commercial ERP Implementations

Although ERP systems were initially devised to address the needs of manufacturing, the diversity of functions that came to be offered by ERP solution vendors became so broad that they are now potentially applicable to nearly any complex human-led activity. Since the 1990s, when ERP systems first began to appear as extensions to MRP systems, DoD has spent considerable resources trying to replace a multitude of individual computer systems with comprehensive new systems based on COTS solutions.

However, stakeholders and implementers must agree where COTS solutions are appropriate and where they are not. As each requirement is analyzed, if the fit of the COTS software to satisfy that requirement is poor, that gap must be filled with additional custom software. This process is often referred to as a "fit/gap analysis." After many experiences in DoD, where organizations attempted to replace existing processes with ERP systems that were intended for the business world, it has become apparent that the fit using COTS ERP solutions is often less than ideal. Unfortunately, the many gaps that are usually identified when commercial software is applied to military processes lead to considerable effort to create unique RICE objects that become the responsibility of the implementing organization to develop and maintain for the life of the system. This in turn leads to a difficult decision. Either military processes must change to be compliant with those in the commercial world or an organization must bear the cost of developing and maintaining custom solutions for their unique but essential processes.

For example, some of the earliest efforts by DoD to use ERP systems targeted personnel and payroll operations, functions in the military that seem sufficiently analogous to their commercial world equivalents to offer hope. However, the sheer scale of the DoD payroll, including active duty, reservists, and retirees, and involving families and dependent data, meant that personnel records numbered in the millions, instead of in the thousands as in the largest commercial world implementations. Beyond this unprecedented scale, DoD organizations currently use many existing systems with

different business rules; those rules must either be subsumed by the new system or modified by the individual organizations. So, even using COTS products for military functions that seem reasonably analogous to those in the commercial world is not straightforward. The DIMHRS program (Defense Integrated Military Human Resources System) spent over $800 million between 1995 and 2010 attempting to unify personnel and pay functions within DoD before it was cancelled. Now, each Service has been tasked with building its own personnel and pay systems—a divide-and-conquer solution. This is more likely to work not only because the Services already have command structures to make unifying, organizational-wide decisions, but also because the scale of an individual Service is closer to the scale of the largest commercial concerns.

Beyond the seemingly similar business processes of payroll and personnel functions, however, most fundamental military processes are very different from those in the commercial world. Procurements follow entirely different procedures and rules, items procured often have no precedent, and the motivations and goals of a military organization are entirely different from those of a business entity. ERP vendors typically have departments that specialize in federal customers, since those are already sufficiently different from the commercial world to require different functions and solutions. But the military world is yet one further step away from standard business processes than is a civilian federal entity, such as a cabinet department or agency.

The result of this analysis is bleak. Organizations adopt commercial ERP products because they implement routine business processes efficiently using standard solutions that are more cost-effective to purchase than to develop from scratch. Yet, even in the commercial world, the failure rate of ERP implementations has been reported to be over 50 percent.[6] DoD, with its unique mission and non-conforming processes, has an even more uncertain outlook. A military organization is faced with either building a custom system to implement ERP-like functions suitable to its domain or abandoning all legacy procedures and data and adopting commercial analogs in their place. This latter option has been the preference of the Congress and every military ERP conversion attempt since commercial products became available. However, a middle ground between a home-grown solution and a COTS product is inevitably adopted because of the nonconforming business practices followed in the military, where there is essentially no auditable tax-based accounting, no inventory valuation or depreciation, no profit motive, and so on. Ironically, this middle ground, where commercial solutions are modified and extended to accomplish ERP in the military problem domain, is probably the worst possible approach. It leads to an organization paying for the development of unique ERP functionality while also licensing the basic products. But, because of the constraints of those underlying

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[6] A 2001 Robbins Gioia survey (www.robbinsgioia.com) of 232 respondents accessed in 2012 reported that 51 percent viewed their ERP implementations as unsuccessful.

solutions, this approach is almost certainly destined to lead to disruptive compromise solutions that still do not conform to the full needs of an organization.[7] Thus, a military organization converting to a commercial ERP solution risks replacing an older set of unique, arcane IT systems with a newer, more expensive, unique, arcane IT system. The bottom line is that a military organization can either relinquish all hope of maintaining its legacy procedures and data or it can relinquish all hope of using a COTS ERP solution.

E. ERP Success Indicators on GCSS-MC

IDA compiled eight conditions for a successful ERP implementation in a 2011 paper on ERP programs for the OSD Comptroller and the Deputy Chief Management Officer.[8] By our analysis, the GCSS-MC program met none of the conditions during its early years but has recently demonstrated success in three or four. Others are still lacking or only partially fulfilled. Table 1 lists the conditions and includes our assessment of whether GCSS-MC currently satisfies each.

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7 Paul K. Ketrick et al., "Assessment of DoD Enterprise Resource Planning Business System," IDA Paper P-4691 (Alexandria, VA: Institute for Defense Analyses, February 2011).

8 Ibid.

Table 1. ERP Success Indicators

#	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.	Improving
2	Leadership willingness and ability to make hard decisions relative to proceeding or not proceeding with an implementation based on program performance.	Recently Demonstrated
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.	Poor
4	An organizational operating model (structure and process) aligned to the design of the ERP with minimal requirements to cross-organizational boundaries to execute components of a process outside of the ERP, thus breaking the inherent integration of the ERP.	Fail
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.	Presume Fail
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).	Partial; Improving
7	Defined metrics for operational improvement to be gained, supported by a baseline describing existing business performance.	No Evidence Observed
8	Accurate, consistent, and authoritative data.	At Least Partial

Indicator 1, sustained involvement of relevant leadership, was marginal at the beginning of GCSS-MC development but improved after the program implemented the recommendations of the CCT in 2009. However, because of the uncertainties of critical functions, there still appears to be an exploratory approach to how the evolving system will integrate with existing systems and what processes will change or be replaced.

Performance-based go/no-go decisions (Indicator 2) have only recently been demonstrated when the IDT for Release 1.2 was terminated before completion. The December 2011 MROC memorandum required MROC approval for any additional funding and removed two requirements, including SIPR server operation. However, during the primary study period, the policy was to require the program manager to continually apply for small increments of money based on incremental progress. This consumed a lot of program and oversight resources, yet was not a viable substitute for effective earned value measurement or meaningful functional milestones.

Success on Indicator 3 (stakeholder representation and rapid, measureable decision-making) is questionable. Difficult decisions appear to be delayed pending incontrovertible evidence that a change is necessary. The SIPR execution requirement has

finally been deleted, but no solution appears to exist yet for remote operation. Our observations of both successful and unsuccessful ERP conversions confirm that each modification of a standard ERP package adds risk to the ultimate success of the implementation. At some point, modifications can swamp the project and it will never converge on a viable solution. If decision makers do not routinely resist the temptation to adapt an ERP package to existing processes instead of adapting the existing processes to the software, an implementation will almost certainly fail. This is confusing to many in the world of software development, since the whole point of software is that it is flexible and can accomplish diverse functions. However, ERP systems involve some of the business world's most complex software and, like any software system, once it is modified, it must be forever maintained as a separate entity. Software reuse is an entirely different undertaking than software development, and decisions must be made in favor of preserving the integrity of the ERP packages even at the cost of not receiving the functionally perfect solution.

Compliance of the problem space to COTS ERP functionality, the essence of Indicator 4, has always been a problem for GCSS-MC. Among these eight indicators, this one is probably the main reason that program costs have exceeded expectation and that only garrison functionality has been delivered after more than seven years. To be fair, this is the indicator with which most ERP implementations struggle. ERP vendors and system integrators are frequently unrealistic about the effort required to convert an organization from existing business processes to an integrated, but often unfamiliar, collection of new procedures.

Organizational adoption of an ERP system is at best a two-fold challenge, and, often, the more predictable of the two is converting the data and ensuring that the software is performing properly. A second, more subtle, and frequently unexpected challenge is co-opting functional users who may feel that the new business processes are more laborious than the familiar methods. This goes beyond simply training users in the new system; since a corporate culture must be engendered at the same time, that gives a meaningful context for the evolution. Like all software, an ERP solution can only be as good as the data its users provide, so users must be motivated to overcome the inertia of using status quo approaches.

The good news in a military setting is that users are committed to the organizational mission and are acclimatized to following procedures. However, because military missions have few analogs in the public sphere, and possibly also because they have often developed organically over a considerable time, military procedures are often fraught with interactions, side effects, multiple options, and arcane steps. Replacing only a subset of existing procedures can have unintended consequences on other processes, and a user who must deal with both existing and new methods for different parts of the mission may not feel any benefit from the transition.

There must be a net benefit of an ERP transition across the organization as a whole even if certain steps for some users may actually take more time and effort. A new repair procedure might require certain diagnostics in order to track the condition of a piece of equipment over time. A technician who is familiar with the failure modes of that piece, however, may have enough experience to shortcut the process, but this would eliminate the longer-term benefit of collecting data over the lifetime of the equipment. Functional savings and benefits in one area can lead to additional costs in other areas: for example, if users need to supply additional information or perform additional steps as they do their jobs.

A further complexity is deciding how to partition an ERP implementation that by necessity needs to be rolled out over several phases. How much functionality must a first deployment provide to replace existing processes? Is the chosen design a good point of departure to augment with additional features and efficiencies in a later upgrade? The cost (and schedule) of implementing an automated capture or lookup of information at a given step may seem to exceed the cost of having human users supply that information, but what is the cost of correcting subsequent data errors? Determining an appropriate balance between many agendas is an inexact science; many would say it is more of an art. Further, as with art, the worthiness of an ERP implementation often depends upon an individual's point of view.

We did not see evidence that Indicator 5 (addressing the root of the problem, not the symptoms) was given more than qualitative consideration in the early stages of GCSS-MC. While it is certainly true that the Marines envisioned GCSS-MC as the solution to managing supply logistics from deployed locations, there was only cursory analysis done to determine whether this would be a COTS capability or a significant area for research and development. It quickly became the latter, and no one can say today whether the project would have been undertaken in the first place given the knowledge that was gained after the first year or so of discovery. Further, quantifying the goals for a military ERP implementation is not the same as doing so for a commercial concern that has a clear fiduciary responsibility to its shareholders. In the commercial world, the value of an ERP to accomplish certain tasks, save a projected amount of money, and improve competitiveness and time to market, can be monetized and compared with the cost. In the military world, however, a delay in obtaining spare parts in a battle zone can cost lives and jeopardize a mission. Nevertheless, if it had been seriously considered, this indicator may have dissuaded the Marines from taking the approach used at the beginning of the project, and might well have led to a period of closer analysis of the issues and available solutions. Alternative approaches may have emerged, such as one that solved the most pressing problems first with a specific, scaled-down tactical system, but deferred other desired organizational improvements for later consideration or even compatibility with Navy ERP. The fact that, of the original three blocks, only Block 1 survived as a

budgeted program after the 2008 breach suggests that the original scope was entirely out of scale with what was realistically achievable. Even the partition of requirements into the blocks was peculiar, since two of the main commodities needed by a deployed unit, fuel and ammunition, are not part of the Block 1 requirements. In other words, a deployed unit was expected to use legacy systems to order fuel and ammunition even as it used GCSS-MC to obtain other parts, equipment, and supplies.

Indicator 6 (requisite skillset) may have been partially fulfilled on the contractor side, but the story we received was that the government stakeholders did not have the experience in the ERP domain to make appropriate decisions about direction or otherwise conduct effective oversight. The CCT identified this deficiency in skill and manpower, and, after their report, the government program office was staffed at a much higher level. Even at the contractor level, however, this indicator was not fully satisfied. The fact that Accenture either needed a much larger budget or assistance from Oracle, or both, to implement deployed ERP access is an example of the lack of required expertise to perform on this particular, nonstandard implementation.

Indicator 7 (metrics that define success for an ERP implementation) is similar to Indicator 5 in that it is more directly applicable to the commercial world where time and money are measureable and can even be traded off. In the military, mission success is almost entirely about timing. In a deployment, speed and accuracy are the main criteria for accomplishing a mission. Congressional appropriations are never on the critical path to success. Yet, we saw no evidence of exactly how the envisioned system would improve Marine success, either by accelerating the accomplishment of a mission or saving lives. For example, we heard that a deployed unit might order more replacement parts than were actually needed in order to ensure that enough arrived. We did not hear, however, how much it actually cost to use this workaround. Perhaps it was an appropriate solution when compared with the cost and effort to implement and conduct a more exact process. If a quantitative analysis existed of the potential improvements the proposed new system would provide, we did not hear about it. No measureable goals were revealed to us as the motivation for investing in the ERP conversion. Only qualitative improvements were described.

Finally, before an ERP can assume control of the data of an organization, that data must be cleansed of errors and inconsistencies, and mapped into the new system and processes. Indicator 8 (reliable data) is always difficult to fulfill, but an organization must accomplish it in order to succeed with an ERP conversion. Because the initial release of GCSS-MC is now deployed at the garrison level, at least the data involved in that deployment was mapped and ported from the existing processes. However, data conversion will be an ongoing effort as the ERP implementation involves more of the organization and, particularly, as the systems previously used to support the logistics processes are decommissioned.

3. GCSS-MC History and Status

A. Cost Growth

IDA only studied GCSS-MC Block 1 cost growth since the MS B estimates; later blocks have not been included in any estimating or planning since MS A. The MS B development cost estimate from the June 2007 APB was $186 million, and the MS B total lifecycle cost estimate was $415 million. FOC was to have been three years later, in 2010. However, three years later, in the April 2010 APB, the development cost estimate grew to $471 million and the lifecycle estimate grew to $935 million. FOC was slipped to 2013, again three years out. These and other cost figures reported here from the IDA study are in base year (BY) 2007 dollars.

Two Government Accountability Office (GAO) studies have covered aspects of GCSS-MC cost growth. In its July 2008 study, the GAO reported the 2004 Analysis of Alternatives (AoA) MS A cost estimate of $126 million had increased to $249 million just one year later, and had further increased in 2007 to $442 million. FOC was expected three years after the date of estimate in each case.[9] All estimates were intended to cover development and several years of ownership (a lifecycle cost); however, unlike the MS A estimate, the 2005 and 2007 estimates were only for Block 1 of the three blocks envisioned in the MS A description. In their October 2010 report, the GAO studied several DoD business systems, most of which were cited for overruns. In this report, the GAO reported that GCSS-MC Block 1 deployment will slip from FY 2010 to FY 2013, that the development cost estimate was now $489 million, and that the lifecycle cost estimate was $934 million, according to the December 2009 PMO.[10] At the time of the study, $245 million was reported as expended, which was over 50 percent of the development estimate at the time.

Because GCSS-MC was considered a MAIS, it was required to submit quarterly reports that documented any revisions in estimated costs. IDA found four MQRs that were submitted by the program between the June 2007 Development APB and the April 2010 APB. In their MQR of June 2008, one year after the Development APB, the

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9 Government Accountability Office (GAO). "DoD Business Systems Modernization: Key Marine Corps System Acquisition Needs to Be Better Justified, Defined, and Managed," GAO-08-822 (Washington, DC: GAO, July 2008). https://www.gao.gov/assets/280/278733.pdf.

10 GAO. "DoD Business Transformation: Improved Management Oversight of Business System Modernization Efforts Needed," GAO-11-53 (Washington, DC: GAO, October 2010), https://www.gao.gov/new.items/d1153.pdf.

estimated development cost had risen slightly to $206 million, a 10 percent increase. However, the September 2008 MQR revealed a 37.5 percent increase from the MS B baseline, $256 million in BY 2007 dollars. Further, the MQR estimated IOC would not be available until October 2009, more than five years after MS A approval. Either of these revised estimates in cost or schedule constituted a Critical Change (the MAIS equivalent of a Nunn-McCurdy breach)[11] in program growth. These Critical Changes led to the CCT investigation.

The CCT determined that the full costs to reach FOC for Block 1 were $529 million in BY 2007 dollars, a figure that was reported in the December 2008 MQR. The only other MQR IDA found that was filed prior to the Production APB was in March 2010, in which the estimated development cost dropped to $471 million. The two subsequent MQRs, for June and September of 2010, reported the same $471 million development cost figure.

As an Acquisition Category (ACAT) IA[12] program, GCSS-MC was also required to submit Defense Acquisition Executive Summary (DAES) reports to the Defense Acquisition Management Information Retrieval (DAMIR)[13] system. Curiously, the DAES report from December 2009, filed a year after the CCT, reported an estimated total development cost of $592 million, and the DAES report from June 2010 reported a further increase to $661 million, even as the MQR for the same month reported its $471 million estimate. As before, all figures are normalized to BY 2007 dollars. We were not able to discover what definitions, if any, differed between the costs reported in the MQR reports and those in the DAES reports. The sequence of cost estimates, including a breakout of development (Research, Development, Test, and Evaluation, or RDT&E) funds, procurement funds, and acquisition operations and maintenance funds required to reach FOC for Block 1 is shown in Figure 1.

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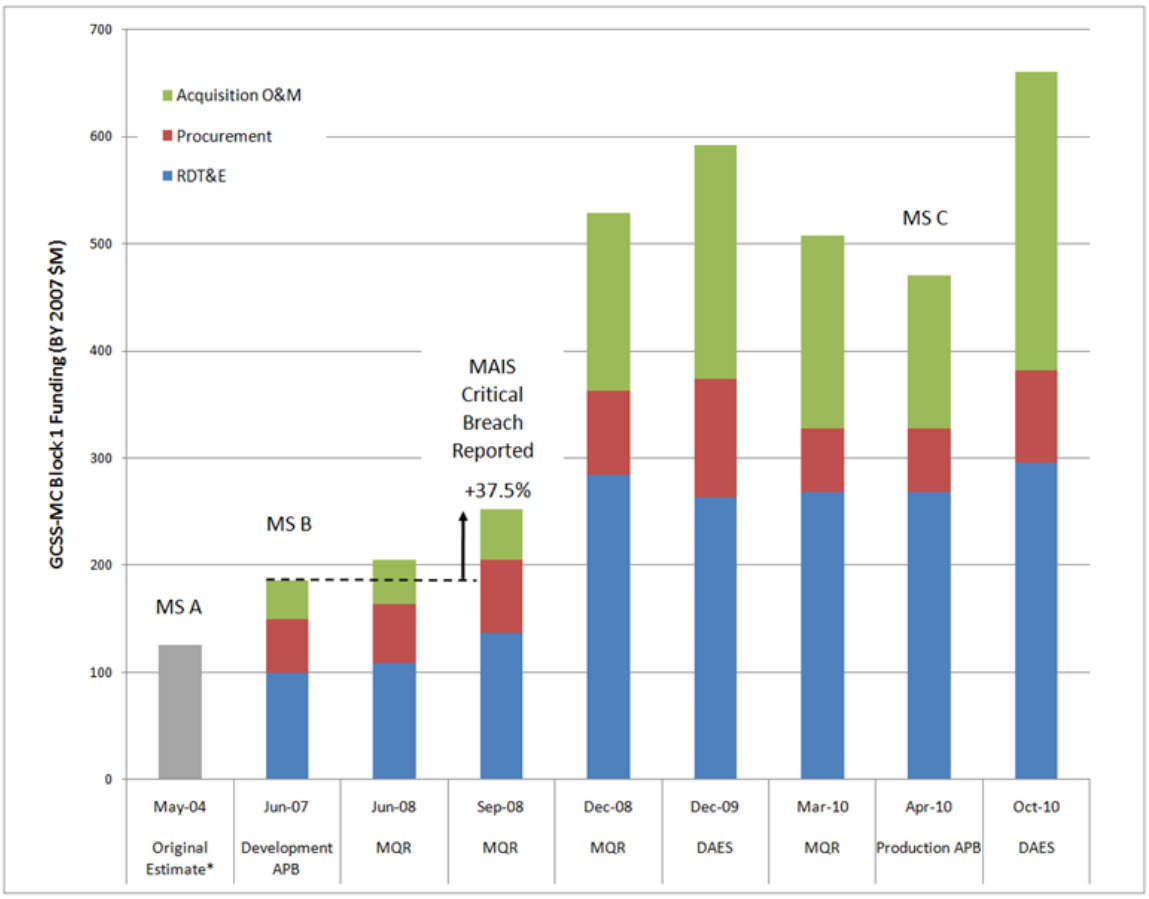
[11] The Nunn-McCurdy Act was part of the 1982 DoD Authorization Act. It requires the DoD to report to the Congress whenever a major defense acquisition program experiences a cost overrun of 25 percent over the current baseline, or 50 percent over the original baseline estimate. The Act was later amended to also define a breach as failure to achieve a full deployment decision within five years of when funds for a program were first obligated. These thresholds were further codified in statute by U.S. Code title 10, Subtitle A, Part IV, Chapter 144A Major Automated Information System (MAIS) Programs.

[12] The term Acquisition Category, or ACAT, is used to classify defense programs by total acquisition and lifecycle cost, as well as cost incurred in a single fiscal year. ACAT I programs are the largest, exceeding $365 million in a fiscal year or $2.19 billion for procurement. A program is classified as ACAT IA if it is expected to incur more than $32 million in a single year, $126 million for its procurement, or $378 million over its useful life.

[13] DAMIR is an internet-based DoD resource that receives and makes available acquisition program information to authorized users.



*Not in BY 2007 $ and breakout not provided
Source: GAO Report "DoD Business Transformation: Improved Management Oversight of Business Modernization Efforts Needed"

Figure 1. Estimates of GCSS-MC Funding Requirements from May 2004 through September 2010

Until the considerable increase in estimated cost to complete GCSS-MC was reported in late 2008, the actual expenditures incurred by the program rose to significant percentages of each then-current cost estimate. For example, by the time of the MS B estimate of $186 million, $89 million had been spent, a figure that is fully 70 percent of the MS A estimate. Even with the increased estimate of $186 million, it means the program had spent 48 percent of its total expected development budget between MS A and MS B. Figure 2 shows the amount expended (or budgeted), according to the December 2009 DAES, using BY 2007 dollars.

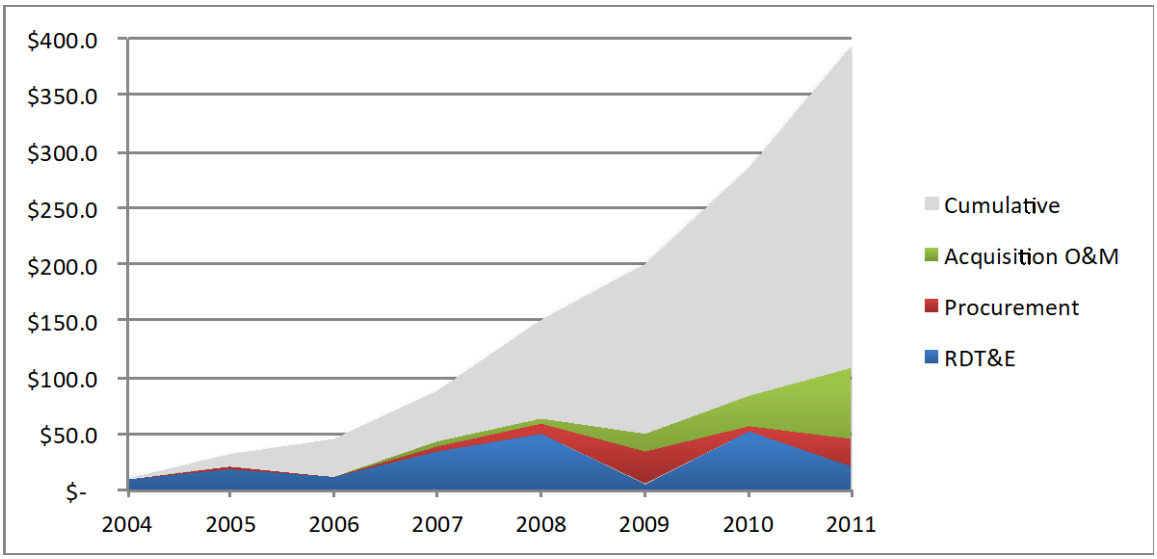


Figure 2. Annual Spending Incurred by GCSS-MC 2004–2009 and Budgeted 2010–2011, according to December 2009 DAES ($M in BY 2007 Dollars)

These two pictures are shown superimposed in Figure 3, showing how close actual spending came to each authorized limit, before the CCT results scoped the true size of the problem.

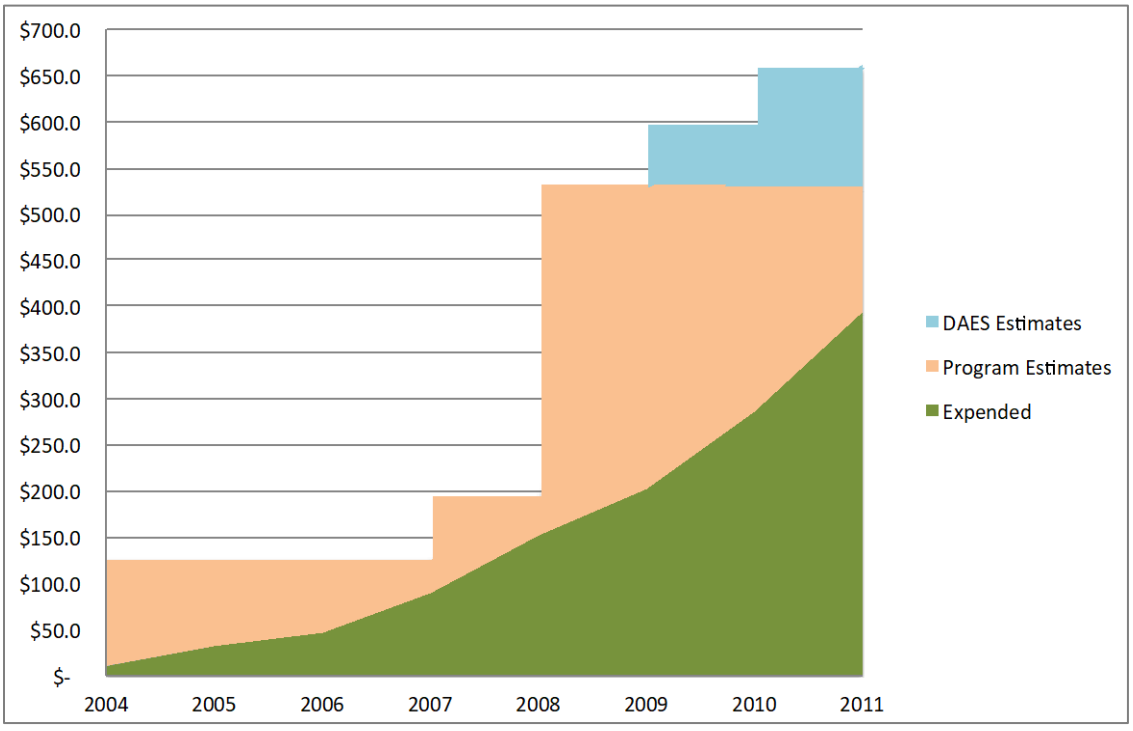


Figure 3. GCSS-MC Annual Spending, with Background Showing Authorized MS A, MS B, and CCT Total Procurement Estimates ($M in BY 2007 Dollars)

B. Direct Causes of Cost Growth and Schedule Slip

1. Background

In the simplest terms, the development of GCSS-MC was always a hard problem, but one that was originally sold to decision makers as tractable and as having an off-the-shelf solution. The project was undertaken before the government had enough understanding of its true scope to budget and staff it appropriately. Time and money was wasted attempting to solve the problem with suboptimal contracts and limited expertise. IDA felt after the study period that enough was finally understood about the problem to bring an initial subset of capabilities online. However, based on the latest test experiences at the time of this report, GCSS-MC budget growth is probably not over yet.

The Operational Requirements Document (ORD) from September 11, 2003 contained the following description of universal access to GCSS-MC:

> GCSS-MC is global in scope. It shall be enabled to be deployed under any circumstances, during peace or war, independent of geographical location. GCSS applications shall be designed to readily adapt to changes in mission scenario. The precept expressed in the phrase, "Any box (within security parameters), any authorized user, one net, one picture," underscores the requirement to provide sustained, integrated, responsive, and relevant information to the operating forces regardless of the tactical situation. This is a fundamental Critical Operational Issue of GCSS-MC and is required for the operational effectiveness of GCSS-MC applications to meet mission needs.[14]

In addition to this goal of providing a consistent picture of assets for all users, the ORD goes on to describe requirements for detached, expeditionary MAGTF operations, as follows:

> In a deployed environment, GCSS-MC will have a stand alone or mobile capability in the event of network connectivity not being available. All or a portion of the GCSS-MC database, consistent with the operational situation, must be capable of being replicated or loaded onto a hardware platform, along with software supporting at a minimum the Request Management, Order Management, Inventory Management, and Capacity Management functions of GCSS-MC. The hardware platform will enable mobile units to accomplish the above-mentioned functions while disconnected from a network and must be capable of being synchronized with the governing instance of GCSS-MC when network connectivity becomes available again.[15]

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[14] *Operational Requirements Document Global Combat Support System – Marine Corps (GCSS-MC)*, September 11, 2003, 18.

[15] Ibid., 21–22.

The above description may have seemed logical to the Marine Corps; indeed, it was exactly what the leadership envisioned to automate detached logistics and supply. The first hint of trouble may have been the failure to obtain bids from a few of the available vendors on the ESI contract vehicle, plus the fact that one of the three vendors who did offer to deliver an ERP system that satisfied this detached access requirement quoted a price that was far greater than the baseline budget of $126 million.

2. Detached Access

In general, ERPs are designed to work from fixed locations with good network connections, but GCSS-MC is required to work for deployed Marines in austere environments over a tactical network that is slower and less stable than those over which COTS ERPs are designed to operate. Connectivity is important because ERPs typically store all of their data in a single database, and users both send and retrieve considerable amounts of data while the system is operating.

A Marine operating from a base can expect a solid, fast connection so that it would be possible to host GCSS-MC centrally and use it from any Marine base, e.g., even from Okinawa. However, in a deployed, austere environment, a fast connection to the central server may not be available, so a local server must be populated with the necessary portion of the database that has been *snapped off* for detached use. However, opportunistically refreshing both the remote data and the central database with changes that have occurred on each is not trivial and requires a technical solution that Oracle only recently created and is still testing. This basic solution was described in an Oracle white paper,[16] but it was evidently not scalable to multiple simultaneous users until at least 2009, according to our information about GCSS-MC.

The following is an example of why this is a complicated problem. Assume two detached companies (A and B) request the only available High Mobility Multipurpose Wheeled Vehicle engine turbocharger, and Company B has a higher priority because of its current assignment. Company A connects first, uploads its request in the form of a database update, receives a confirmation, and thinks they are getting the turbocharger. They then go offline. Company B connects and uploads its request, which bumps Company A down in the queue because Company B has higher priority. Company A needs to be notified, but will not know of the change until the next connection. This could all be occurring while other directly connected users are also accessing, and potentially updating, the parts inventory.

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[16] Maria Pratt, "Oracle 9i Replication: An Oracle White Paper" (Redwood Shores, CA: Oracle Corporation, June 2001), accessed December 2012, http://www.oracle.com/technetwork/database/oracle-adv-replication-twp-132415.pdf.

With multiple users and resources that interact, the requirement for synchronization becomes complex. It can even mean that a detached user makes the wrong decision due to the inability to see a complete picture (e.g., “If we can’t get the turbo by Friday, we will request a new engine now, but if that’s not available by next Monday, we will order a new vehicle now.”).

3. Dual Classification Level

Military departments frequently operate both classified and unclassified computer networks, and military ERP systems are often envisioned to operate across both. This has obvious benefits since supply quantities, schedules, equipment status, and so on, can be reconciled across users of either classified or unclassified networks. However, such a dual-level solution makes the protection of classified information difficult. Because the first network installed at a forward deployment is typically the classified network, but because many users would eventually need unclassified access to the system, GCSS-MC was originally required to run on both unclassified and classified networks. However, the difficulties in moving data between the two networks while making sure that no SECRET data could be reconstructed from access to only the unclassified network made this requirement infeasible. The current solution is to only run GCSS-MC on unclassified networks.

The requirement for dual-level operation was dropped after the study period but before this paper was completed. So, although effort had reportedly been applied to satisfy this requirement, it is no longer an issue for the project. We could not estimate the amount of money that was spent addressing this individual requirement, but we suspected it was considerable, since it was mentioned as a cause for concern by nearly everyone we interviewed.

4. Summary

The IDA team compiled a list of observations based on the above summary of budget and spending research and on insights into the program.

- DoD acquisition and contracting procedures at the time contributed to early mistakes; e.g., the FFP ESI contract vehicle for ERP acquisitions was probably inappropriate, and the required documentation and processes were not oriented toward the necessary discovery processes.
- The OSD did not have the visibility into the development portion of the contract through EVM reports, which are customary for cost-type development contracts, because they are not required on FFP contracts.
- Unrealistic performance expectations (a prescribed root cause) arose from early underestimation.
- The GCSS-MC program did not develop its own MS B cost estimate; it was computed by the Naval Center for Cost Analysis and the Office of the Secretary of Defense, Program Analysis and Evaluation. This deprived the program of a potentially valuable bottoms-up cost estimate and the requirements review that goes along with it.
- The estimated cost of GCSS-MC doubled within six months of source selection.
- The program was not justified on economic grounds. The Marine Corps desired a functional solution but the cost effectiveness of procuring and implementing that solution was not evaluated.
- The government did not do its own due diligence in researching the true complexity of the problem and appeared willing to accept the lowest cost proposal.
- ASD(NII) and Overarching Integrated Product Team (OIPT) did not exercise proper oversight as the true complexity of the problem and the likely cost of the solution became evident.
- The Independent Review Board (IRB) accepted a low MS A estimate, and misconceptions about the program cost continued for five years.
- The earliest Integrated Master Schedule (IMS) for the program that we could find was dated 2008, after significant problems had surfaced and considerable money had been spent. We suspect that no IMS existed prior to that date.

- Corrected estimates of the true cost of the problem were viewed as cost growth and blamed on the subsequent execution of the program rather than on the initial scoping and estimation. This misunderstanding resulted in micro-management that required the program manager to justify each month's budget.
- True requirements changes accounted for only a small portion of the additional funds required for GCSS-MC. The most significant change was in the procurement quantity, as the number of users grew from 4,000 to 30,000. However, the study team learned that the cost of accommodating this change was about $6 million, or one percent of the total program budget.
- An estimate of $150 million for a customized military ERP of this scale was unrealistic even without the unprecedented nature of the detached access and multi-level security requirements.

These factors contributed to the following significant impacts on program costs:

- There was insufficient government staffing to manage the discovery process. The government PM office was originally staffed by nine individuals. This was increased to 40 full-time equivalents when the program was restructured and resized after the CCT.
- Contractor staffing was initially insufficient both in terms of size and the unique skill set required for this unprecedented work.
- Considerable time and money was spent on a premature solution that was ultimately wasted effort when the program was restructured.

The wasted effort between MS A and MS B, coupled with the realization of the true size of the problem and the required solution, resulted in a MAIS statutory breach of cost and a breach of the five-year deadline to deploy an MAIS development.

Of the categories for cost growth laid out by the Weapon Systems Acquisition Reform Act of 2009, this program suffered primarily from the following two: (1) "unanticipated design, engineering, manufacturing, or technology integration issues arising during program performance" and (2) "poor performance by government or contractor personnel responsible for program management." Of the two, the greater appears to be **Poor performance of government personnel**. At inception, the Marine Corps did not understand the true scope of the envisioned ERP, and this led to a series of poor decisions, including use of the wrong contract type, selection of a contractor that did not have the proper skill set, acceptance of an unrealistic cost estimate, and inadequately staffing the program office. During execution, ASD(NII) and the Overarching Integrated Product Team (OIPT) did not exercise proper oversight, even as the true complexity of the problem and the likely cost of the solution became evident.

Illustrations

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Abbreviations

ACAT	Acquisition Category
ADM	Acquisition Decision Memorandum
AIT	Automated Information Technology
AoA	Analysis of Alternatives
APB	Acquisition Program Baseline
ASD(NII)	Assistant Secretary of Defense (Networks and Information Integration)
AT&L	Acquisition, Technology, and Logistics
ATLASS	Asset Tracking Logistics and Supply System
BTA	Business Transformation Agency
BY	Base Year
CCT	Critical Change Team
CDD	Capability Development Document
CDS	Cross-Domain Solution
COTS	Commercial off-the-Shelf
CPD	Capabilities Production Document
CSC	Computer Sciences Corporation
D,PARCA	Director, Performance Assessment and Root Cause Analysis
DAES	Defense Acquisition Executive Summary
DAMIR	Defense Acquisition Management Information Retrieval
DEAMS	Defense Enterprise Accounting and Management System
DIMHRS	Defense Integrated Military Human Resources System
DoD	Department of Defense
ECSS	Expeditionary Combat Support System
EIS	Enterprise Information System
ERP	Enterprise Resource Planning
ESI	Enterprise Software Initiative
EVMS	Earned Value Management System
FD	Full Deployment
FDD	Full Deployment Decision

FFP	Firm Fixed-Price
FOC	Full Operational Capability
FOT&E	Follow-on Operational Test and Evaluation
GAO	Government Accountability Office
GCSS-MC	Global Combat Support System–Marine Corps
HASC	House Armed Services Committee
ICE	Independent Cost Estimate
IDA	Institute for Defense Analyses
IDT	Integrated Developmental Test
IMS	Integrated Master Schedule
IOC	Initial Operational Capability
IOT&E	Initial Operational Test and Evaluation
IRB	Independent Review Board
IT	Information Technology
JROC	Joint Requirements Oversight Council
LCM	Logistics Chain Management
LogFins	Logistic Financials
M	Million
MAGTF	Marine Air-Ground Task Force
MAIS	Major Automated Information System
MAJCOM	Major Command
MCOTEA	Marine Corps Operational Test and Evaluation Activity
MDA	Milestone Decision Authority
MDAP	Major Defense Acquisition Program
MEF	Marine Expeditionary Force
MQR	Major Automated Information System Quarterly Report
MROC	Marine Requirements Oversight Council
MRP	Manufacturing Resource Planning
MS	Milestone
NDAA	National Defense Authorization Act
NII	Networks and Integration
OIPT	Overarching Integrated Product Team
ORD	Operational Requirements Document
OSD	Office of the Secretary of Defense

PA&E	Program Analysis and Evaluation
PARCA	Performance Assessment and Root Cause Analysis
PEO	Program Executive Officer
PM	Program Manager
PMR	Program Monthly Report
PO	Program Office
POA&M	Plan of Action and Milestones
RCA	Root Cause Analysis
RDT&E	Research, Development, Test and Evaluation
RFP	Request for Proposal
RICE	Reports, Interfaces, Conversions, and Extensions
SASSY	Supported Activities Supply System
SCP	Service Cost Position
SI	System Integrator
SIPR	Secure Internet Procotol Router
T&M	Time and Materials
TEMP	Test and Evaluation Master Plan
TY	Then Year
US	United States
USD(AT&L)	Under Secretary of Defense (Acquisition, Technology & Logistics)

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14. ABSTRACT

The Institute for Defense Analyses performed a root cause analysis of the critical cost overrun and schedule slippage experienced by Increment 1 of the Marine Corp's Global Combat Support System (GCSS-MC) program, an Enterprise Resource Planning (ERP) software system that will provide logistics support for Marine Corps combat operations. We visited the program office and met with contractors concerning the past and current status of GCSS MC. We also researched Operational Requirements Documents, Major Automated Information System Quarterly Reports, Approved Program Baselines, Initial Operational Test and Evaluation reports, Defense Acquisition Executive Summary reports, Government Accountability Office reports, and US Navy and US Marine Corps websites. Our primary findings were that (1) the program was initially significantly underfunded either because available funds were deemed sufficient by necessity or because the original planners did not understand the true scope and cost of the required ERP implementation, and (2) the original program scope was unrealistically narrow and thus lacked a sufficiently high-level mandate to ensure that the necessary business process changes would be adopted. Therefore, some of the cost growth can be attributed to unrealistic initial cost estimates and the balance can be attributed to inefficiencies caused by failed development and organizational change approaches that were not suited to the true size of the problem.

The primary sources of unexpected cost and complexity were two technical requirements that proved to be particularly difficult and expensive. The first was the requirement to deploy ERP clients on detached, tactical networks, and the second was the requirement to provide users with access through both classified and unclassified systems and networks. Neither of these capabilities was available in off-the-shelf ERP products and both are unsolved as of the time of this report.

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