Project Management Institute

Innovation on R&D Earned Value IOC/C21 WatchKeeper System

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Abstract

The challenge addressed in this article is that of using earned value in an IT project of less than US$20 million with multiple solution partners, fixed cost contracts, no labor cost data, and an 18-month deadline. The discussion presents an example of an innovative use of a research and development (R&D)–based earned value technique. The software project overview is presented, traditional earned value reviewed, the derivation of the R&D approach is discussed, and the article closes with a look at the organizational benefit of the technique.

Background – Exploring New Approaches to Earned Value in a Project Environment

The Interagency Operations Centers/Command 21 (IOC/C21) project is a major systems acquisition project to modernize Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) capabilities in the US Coast Guard. As a result, it falls under Coast Guard acquisition policy requiring use of earned value management (EVM) techniques and principles. The acquisition project manager therefore is responsible for ensuring that the lead system integrator, Command and Control Engineering Center (C2CEN), uses these methods for tracking progress in the development and deployment of the capabilities articulated in the preliminary Operational Requirements Document (pORD). Supporting the project manager in monitoring and assessing the performance of C2CEN including EVM is an Information Management Integrated Product Team (IM IPT). The IOC/C21 project results from the Congressional Safety and Accountability for Every Port (SAFE Port) Act of 2006, which mandates establishment of IOCs in all high-priority ports within three years from the date of the enactment of the legislation.

The purpose of IOC/C21 is to improve tactical *decision-making*, *situational awareness*, *operations monitoring, rules-based processing*, and *joint planning* in a coordinated interagency environment. The initial funding was unanticipated and the team had 18 months from the project charter to deliver a completed product. As a result, the near term focus is on introducing initial capability, called Segment 1, by the end of FY09 that provides the coast guard watch standers with the ability to see a maritime tactical picture using the Automatic Identification System data, understand the planned incoming large vessel traffic, and share tactical information with local law enforcement and port partners in case of an emergency.

The new C4ISR system will be integrated and developed using spiral methodology. The process closely resembles Agile

software development in that the scope of the system over its life cycle is not well defined (Cabris & Griffiths, 2006). This aspect also resembles Phase III of an R&D project, where the scale-up and optimization risks have huge potential for impact on schedule (Lambert, 2006). At key times during the project, a demonstration for each spiral was scheduled to evaluate technical milestone deliveries, demonstrate user interfaces, and provide an opportunity for use and feedback.

The circumstances present in the WK1 project are an atypical earned value environment that presented significant obstacles. The dynamic scope, short project length, fixed cost level-of-effort contractor-funded development, dearth of available cost data, and mixed organizational solution providers created a challenging environment for using traditional earned value or developing an appropriate EVM plan that is responsive for project management.

> "An EVM is a management methodology for integrating scope, schedule and resources, and for objectively measuring project performance and progress."

The Challenge – Using Earned Value in a Small Coast Guard IT Project

Traditional Earned Value

An EVM plan was required for WatchKeeper Segment 1 by the Assistant Commandant for Command, Control, Communications, Computers, and IT. An EVM is "a management methodology for integrating scope, schedule and resources, and for objectively measuring project performance and progress. Performance is measured by determining the budgeted cost of work performed (i.e., earned value) and comparing it to the actual cost of work performed (i.e., actual cost). Progress is measured by comparing the earned value to the planned value" (Project Management Institute [PMI], 2004, p. 374) EVM is an effective tool for identifying variances from established cost and schedule baselines and telling the customer the value of the products delivered based on a time-phased budget. The acquisition staff, program sponsor, and the WK1 IM IPT can use the earned value (EV) reports to identify cost, performance, and schedule problems early on in the development process. Consequently, the leadership stakeholders can use EVM to make informed course corrections.

Typical EV is "the value of work performed expressed in terms of the approved budget assigned to that work for a schedule activity or work breakdown structure component" (PMI, 2004, p. 359). The key to accurate data is linking 40-hour work packages to resources associated with labor cost data and subsequently documenting the actual resource use and product deliverables against the schedule. EVM systems require that work progress be documented at the work package level.

The earned value report identifies variances from the plans. "Comparison of Planned Value (PV) versus Earned Value (EV) is made to obtain Schedule Variance (SV), and comparison of EV to Actual Cost (AC) is made to obtain Cost Variance (CV)" (Lambert & Lambert, 2000, p. 130).

Several of the key criteria for establishing an EVM system are the scope, schedule, and cost baselines. These baselines establish the performance measurement baseline (PMB). The PMB is the time-phased budget plan against which performance is measured. The cost and schedule planned budgets are measured against a scope baseline to help track the progress of the project.

An integrated baseline review (IBR) is a formal review led by the government program manager and technical support staff. An IBR is conducted jointly with the government and their contractor counterparts. With typical earned value reporting, an IBR is conducted within 6 months after contract award and monthly reports typically have a data latency of 1 to 2 months. The purpose of an IBR is to verify the technical content of the PMB, assess the accuracy of the related resources (budgets) and schedules, and identify potential risks. The aggressive timeline for the IOC/C21 of about 18 months' effort effectively precludes the use of an IBR and places the development team in circumstances requiring them to be very nimble.

IOC/C21 EVM System Goals

An EVM method is a project management tool that facilitates improved planning, cost control, schedule control, and scope control. However, there are a number of practical challenges

and barriers to implementing a standard by-the-book earned value reporting for the WatchKeeper system development. These are:

- **Project scope.** The project scope was not well defined at the outset. Three spirals were initially planned, and later expanded to four, with the intent to re-evaluate requirements and scope in a manner similar to an Agile project.
- **Project cost.** The relatively small total dollar value at less than US$15M.
- **18-month project length.** The relatively short time period for WK1 is insufficient to establish and implement a PMB or EVM system using a traditional IBR.
- **Solution partners.** There is a diverse blend of solution providers, Coast Guard centers of excellence and commercial developers, contributing to the final WatchKeeper Segment 1 system.
- **Cost sharing.** Mixing project funding and operations and maintenance funding among Coast Guard developers was also a factor, since organic funding was available at these sites to fund system enhancements for the enterprise products being integrated into a service-oriented architecture (SOA) environment.
- **Labor cost data.** Establishing a common integrated master schedule was not as hard as establishing costs for meaningful work packages, then collecting and consolidating work package–level progress from the diverse solution partners to support a standard EVM process. Dollar cost data for typical earned value calculations were not available.
- **Fixed cost funding.** The work packages are discrete efforts on the project schedule; however, fixed-price level-of-effort funding of contract support staff means that PV will always be EV. The mix of discrete work packages with fixed cost level-of-effort funding dilutes the value of EVM reporting.

The project was required to use EVM, yet the development environment was complicated by a unique set of circumstances that dictated the use of an alternative to typical EV.

Agile Project Management

One alternative to traditional EVM from the Agile project management arena employs a burn chart. As Cabri and Griffith (2006) point out, this approach is "conceptually equivalent to Earned Value accumulated at a specific date." A burn-up chart compares planned and increasing amounts of delivered features as a function of time. A burn-down chart displays features remaining by iteration and is useful for illustrating scope changes by spiral. Cabri and Griffith discuss using the Agile tracking techniques with cost data. The attractive aspect of these methods is that the IOC/C21 development resembles an Agile approach, although it does not formally adopt those methods. The aspect of illustrating the accomplished work over time is also appealing. Given that no accurate labor cost data are available for IOC/C21, burn charts are not well suited for reporting earned value. Also, these methods lack indications of technical difficulty and risk among participating solution partners' work efforts.

Research and Development

The lack of accurate labor cost data, a congressionally mandated aggressive timeline, fixed cost contracting, and several contributing solution partners create an environment with little time margin, abundant technical challenges, and high risk. Even though the Coast Guard will be integrating separate enterprise applications into one, they will launch an enterprise service bus and a service-oriented architecture in the process. Tracking costs in a project that uses innovative and unplanned technologies and integration approaches makes cost estimation difficult and dynamic. A better alternative is using a method for R&D projects that documents the technical difficulties of work packages, assigns the risk for each, and links tracking their progress to milestones in the spiral development.

Derivation: R&D Earned Value with Performance Index

In the R&D earned value method, three variables are used that consider critical path, technical difficulty, and risk (Lambert, 2006, p. 466). The planned value is assigned to the work packages using this formula: F1(F2+F3) = PV, where

F1 = Value determined by proximity to the project critical path

F2 = Value determined by project type and the assessed level of technical difficulty

F3 = Value determined by accessing each work package to evaluate any risk factors that could impact the project

Details on how to determine each of these values can be found in the referenced documentation. The WK1 project schedule is event-driven and is maintained to show the progress of completion by percentage complete. At each Spiral deadline, the master plan is updated to reflect the

progress of each work package. This percentage of the work accomplished is used to establish the earned value of the work performed, where EV = PV * work package percent complete. A "planned value" is assigned to each work package using formula F1(F2+F3) = PV. The roll-up of each spiral's work package provides an earned value score that can be used to assess the schedule base variances from the plan. No planned budgets are a part of this approach, so there will be no cost variance analysis.

R&D Earned Value Derivation

What was lacking was a performance index. Since timely and accurate labor cost data linked to work packages were not available, a decision was made to use a derivation on the traditional approach. Knowing how useful the schedule performance index and cost performance index are, what was needed was some way to indicate how the lead system integrator, C2CEN, performed against the planned Spiral milestones. Of the scope, time, cost, and quality constraints, tracking costs was not an option. Scope and quality would be addressed somewhat by the Agile software approach and by the IM IPT engagement and feedback. A performance index was needed to show how the lead integrator used time as a Spiral performance metric, as well as establishing data points for trend analysis.

Many years ago as a young Coast Guard storekeeper on an isolated duty in Sitkinak Island, Alaska, I used to create urgent electronics equipment replacement orders that were transmitted on the teletype. The most pressing operational supply order, of course, was for power amplification (PA) tubes. In those days, the PA tube was one critical component for transmitting the Long Range Aid to Navigation (LORAN) C signal. One data field on those military orders, each essentially representing an 80-column data card, was the date from the Julian calendar that established the order's required delivery date. In a quirk of fate, one of the Coast Guard electronics technicians who worked installing those PA tubes at LORAN Station Sitkinak, was Charles Schue. Now, years later, I am employed by UrsaNav, whose CEO is that very same former third-class petty officer electronics technician! Measuring time performance was the key, and the often-used phrase "time is money" came to mind from those days in Alaska using the Julian calendar. A time performance indicator may prove invaluable to the IM IPT, given the congressional mandate to deliver and the aggressive project timeline.

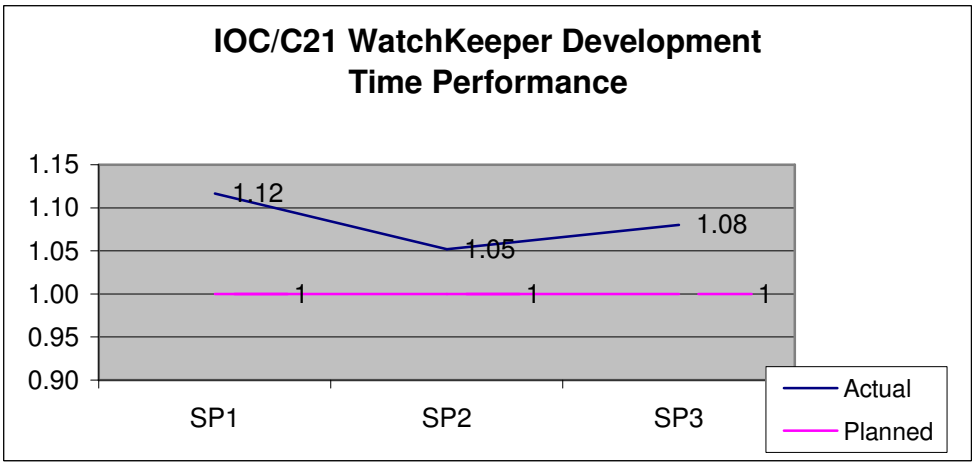
The Julian calendar is a consecutive numbering system for the days in a year. Numbering from 001 to 356 where January 01 is the first day and December 31st is the last day. Using this simple approach, the project start date of March 1, 2008 on the Julian calendar was 60 and Spiral 1's November 18, 2008 delivery date was 322, so the difference of 257 days was the planned Spiral 1 length. A performance index using elapsed time emerged. The planned days for WK1 Spiral 1 was 257 days, but actual time used was on December 18 which resulted in 287 days' length, so the calculation of actual time over planned time provided an 1.1167 performance index (Table 1). Approximately 12% more time was used than planned.

Although only backward looking, documenting data points by milestones is helpful in predicting future performance as a trend is established over the project's life. Figure 1 is the beginning of a trend chart spanning three Spirals comparing planned versus actual delivery performance. With three to five data points, the performance index can be used for trend analysis. Also, interestingly enough, the performance index can be used to tell bad news in a good way in predicting future spiral end dates by giving the leadership advance notice of potential delays.

Table 1: EV reporting spreadsheet using representative data for demonstration purposes.

WatchKeeper Segment 1 Performance Baseline						
Capability	F1 WP Schedule Position On Critical Path: 30 <= 10 Days off CP: 25 >= 11 Days off CP: 20 >= 30 Days off CP: 10	F2 Technical difficulty (greater diff, higher value) Development: 3-5 Enhancement/ Improvement: 1-3	F3 Risk (greater mitigation, lower score) 0-5	Planned Value (PV) F1(F2+F3)	% Complete End of Spiral 1 (18 NOV 08)	Earned Value (EV) PV x % Complete
				PV		EV
Spiral 1 Solution Development						
Demonstrate MHS-OPS viewing capability	10	1	0	10.00	50.0%	5.00
Demonstrate SHP port to Red Hat, RHEL, JBOSS platform	30	4	2	180.00	80.0%	144.00
Demonstrate NAIS data display	25	3	1	100.00	0.0%	0.00
Demonstrate processing of canned NOA data	25	2	1	75.00	50.0%	37.50
				365.00		186.50
	Planned Time (3/01/08)	257.00	Actual Time (11/18/08)	287.00		
		Spiral 1 performance index (Actual / planned)		1.1167		

Figure 1: Performance index trend.



Conclusion: Organization Benefit and Results

The organizational benefit to using earned value varies. This earned value system and accompanying reports are in use by the project team and serve as a dashboard for identifying potential schedule problems. Those items that are on or close to the CP, that are high in technical difficulty, and that are greater in risk will have high planned value scores. It serves as an instrument that tells the bad news in a good way since the planned value and earned value scores point to potential problems. Commander Marc Sanders (personal interview, May 19, 2009), the IM IPT chair, stated that this approach has merit since the elements of the work package data, the critical path and percentage complete, are from the project plan and the technical difficulty and risk are provided by the integrators. In an environment of electronic engineers and information technology professionals, a scoring-based earned value method is straightforward to use, interpret, and communicate. The scorecard is a somewhat objective measure to track project progress on deliverables.

According to Commander Ken Marien (personal communication, May 20, 2009), the IOC/C21 acquisition project manager, the method presented in this article highlights work packages with high planned value scores and low earned value. The report format is useful to evaluate earned value against the percentage complete as the work progresses through the spiral. If those high-scoring work packages are not logging appropriate progress, more investigation is needed. Using this R&D approach on projects less than US$20 million allows the project team to easily identify problem areas for further analysis, and the earned value system is easy to implement and use if accurate labor cost data are not available.

Mr. Mark Powell (personal communication, April 28, 2009) addressed earned value at the enterprise management level. He acknowledged that areas for earned value improvement exist for all projects. Efforts are underway to begin prototyping an enterprisewide system to capture labor hours. In addition, moving towards a culture of project management philosophy is underway, with plans to require Project Management Professional (PMP)® certification for those managing projects. Establishing the earned value methodology used in WK1 as a first iteration enterprise standard for projects of less than US$20 million is a first step toward common project management in the Coast Guard.

The weakness of the approach lies in establishing a consistent percentage claiming technique and distilling all work packages to the same degree of granularity across all solution partners' plans. The various schedules are rolled up into an integrated master schedule. The fidelity of the critical path and reporting progress relies on consistent approaches to creating the same level of detail in the plan and the method used to claim work accomplished in a project schedule that is properly base-lined for each spiral. Including milestone deliveries mitigates using percentage complete, especially where progress reporting is not based on common granularity in the work breakdown structure.

This article has presented the use of an improvised earned value approach in a Coast Guard software development effort. The intra Coast Guard development cost sharing, the fixed cost commercial contract, the absence of labor cost data linked to work packages, and the congressionally mandated 18-month delivery date made the use of typical earned value impractical. Using a derivation on an R&D earned value system provides the project team with timely information

on problem areas, and the added performance measure establishes data points that predict variances in future on-time spiral delivery.

References

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