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On Your Toes:
Measuring Earned Value in an Agile World

A White Paper

> About the Contributors

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Founded in 1976, CGI is one of the largest IT and business process services providers in the world, delivering high-quality business consulting, systems integration and managed services. Our innovative services and solutions and disciplined delivery approach have resulted in an industry-leading track record of on-time and within budget programs. CGI has been at the forefront of combining Agile development and EVM to provide government programs with greater flexibility and performance transparency.

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TOGETHER

Together CGI's practical experience, BDO's industry expertise and Deltek's tools offering represent the full gamut of knowledge required to implement a best-practices solution to Agile and EVM.

> Applying EVM on Government Agile Projects

Practical Applications & Evolving Best Practices

In recent years, there have been many theories proposed regarding the best way to reconcile the seemingly conflicting theories of Earned Value Management, which is based on developing a reliable baseline, and Agile development, which relies on adaptability. There is now a consolidation of ideas and a growing consensus within the community from industry groups, government committees and contractors themselves about the best way to combine the strengths of each methodology and use the data from each to its fullest value without duplication. This paper lays out the details of these evolving best practices, and discusses how to apply them in real-world scenarios. This paper is organized following these principle topics:

How can an organization enable an effective Agile development process and use EVM for project controls, without unnecessarily burdening development teams?

First, let's build a foundation for the proposed Agile and EVM approach on a common understanding of the fundamentals of Agile and EVM.

AGILE FUNDAMENTALS

Agile is a proven methodology for rapidly delivering high-value customer requirements and its use is encouraged by Government Agencies and the Department of Defense (DoD).

Agile development (Agile) came into prominence for government software development projects following the U.S. CIO's *25 Point IT Implementation Plan to Reform Federal Information Technology Management (2010)*[i] and the *National Defense Authorization Act 2010,*[ii] which promoted the use of iterative, rapid development methodologies to deliver high-priority user functionality — early and often. Agile uses cross-functional teams to develop working software in an iterative manner. Agile relies on adaptability and the ability to reprioritize scope based on stakeholder requirements as the software develops.

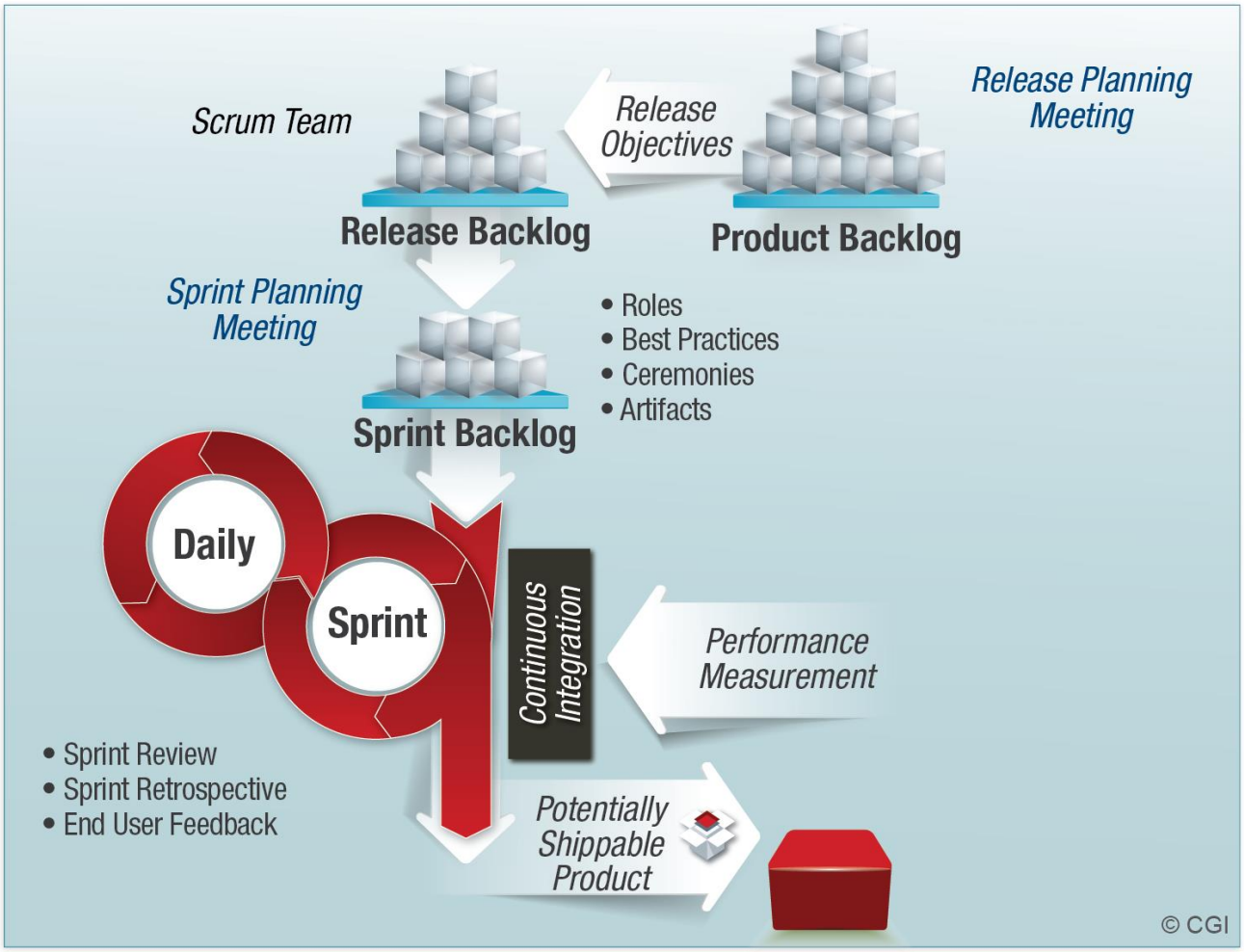


Figure 1. An Iterative Agile Process. *In an Agile environment, features, as part of a product backlog, move through the release planning process to development during a sprint, ending as a component of a potentially shippable product.*

Agile methodology has its roots in incremental software development practices from the late 1950's and also borrows from lean manufacturing. Lean is a set of principles for achieving quality, speed and customer alignment. The objective is to eliminate anything that isn't adding value. In 2001, a group of developers published the *Manifesto for Agile Software Development.*[iii] Individuals and interactions were valued over processes and tools, working software over comprehensive documentation, customer collaboration over contract negotiation, and responding to change over following a plan.

For Agile the project scope is flexible but the schedule is fixed; for Waterfall the scope is fixed and the schedule is flexible.

However, one of the common misperceptions regarding Agile is that there is no project planning or structure. This is far from the truth — within Agile, planning is a continuous and iterative process. In the Agile development process, the customer stakeholder is deeply involved in the process which starts with identifying and ranking features which provide the highest mission value. Small increments of functionality are identified, developed, and tested during sprints (sometimes referred to as iterations) which are typically 2 to 6 weeks in duration. The fully developed features are integrated into a potentially deployable release, typically not longer than 6 months in duration.

The most popular Agile development methodology is Scrum, which is a flexible methodology in which a development team works together toward a common goal. It promotes flexibility and improves alignment with stakeholders' requirements. *The Scrum Alliance*[iv] defines the process through the following steps:

- A product owner creates a prioritized wish list, known as a product backlog.
- During sprint planning, the team pulls a portion of scope from the top of the product backlog, thereby creating a sprint backlog, and decides how to implement those pieces.
- The team has a certain amount of time—a sprint (usually two to four weeks)—to complete its work, but it meets each day in a daily Scrum to assess its progress.
- Along the way, the Scrum Master keeps the team focused on its goal.
- At the end of the sprint, the work should be potentially shippable: ready to hand to a customer, put on a store shelf, or show to a stakeholder.
- The sprint ends with a sprint review and retrospective.
- As the next sprint begins, the team chooses another chunk of the product backlog and begins working again.

Another Agile methodology popular for government programs is the *Scaled Agile Framework (SAFe)*[v] for lean software and systems engineering. SAFe is an adapted Agile development methodology which is often promoted in the federal government for large-scale programs. SAFe borrows many of the iterative elements and processes from Scrum; and includes additional layers for product and portfolio management.

The primary project performance measurement technique for Agile development projects is the burndown or burnup chart which tracks how many story points have been completed in a sprint or release versus the total number of story points in the backlog. Figure 2 is a release burnup chart which measures the technical performance (story points accomplished) versus the planned technical performance (backlogged story points) by sprint.

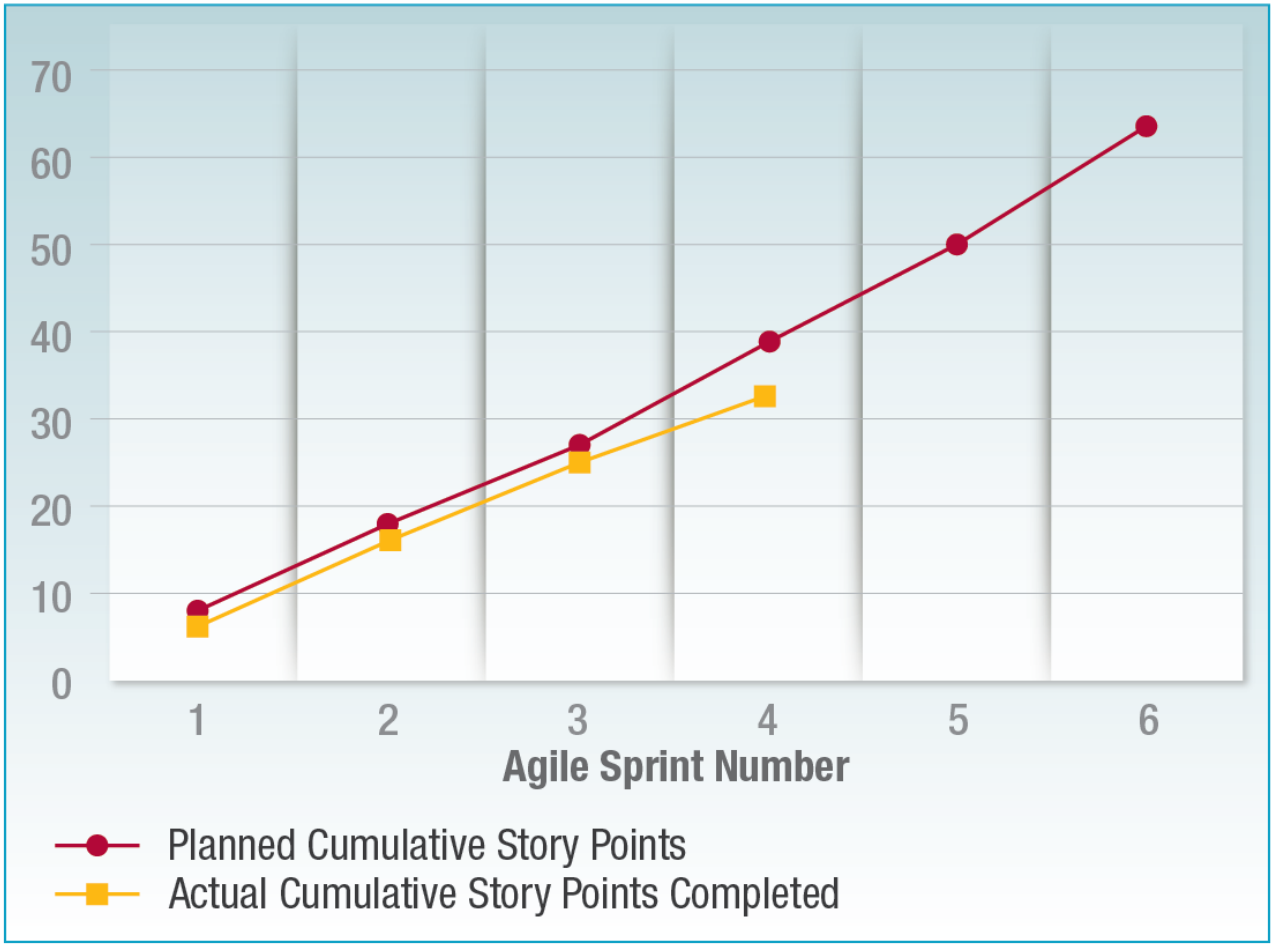


Figure 2. Release Burnup Chart. *As stories are completed, their associated story points are tracked against the overall scope backlog.*

Agile Versus Waterfall Software Development

In contrast to the iterative Agile methodology, Waterfall assumes each product development phase is performed sequentially: 1) define requirements, 2) design the product, 3) develop the features, 4) test the system, and 5) deploy the system. It's often referred to as a "Big Bang" methodology because all of the functionality is tested and delivered to the customer at the end of the project rather than in an iterative fashion.

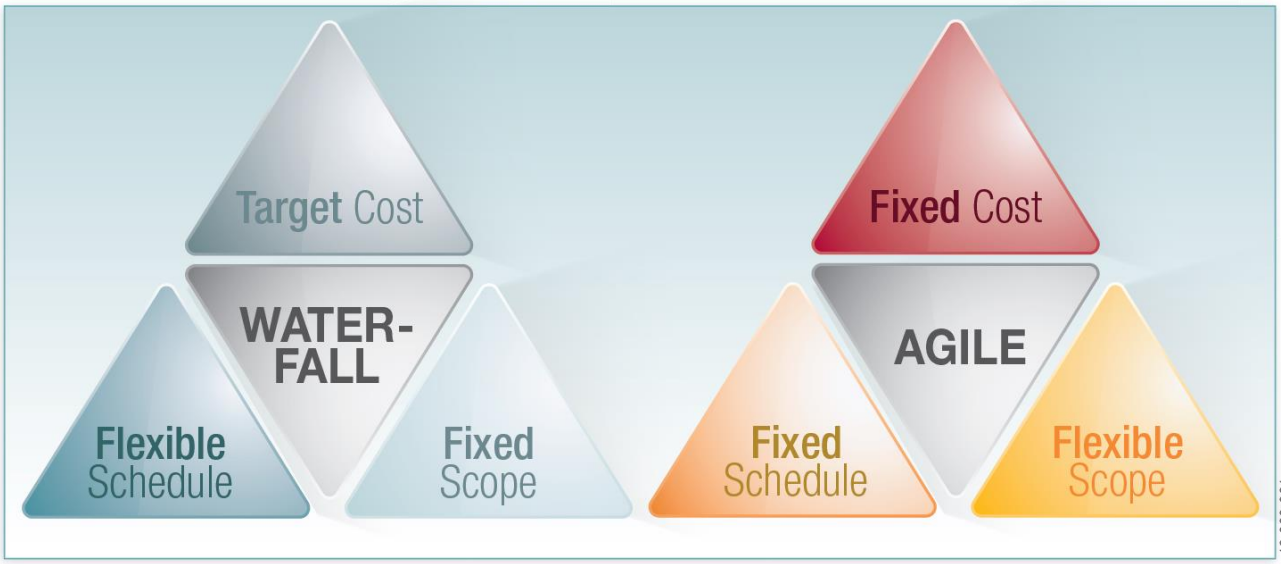


Figure 3. The Iron Triangle. *Where traditionally Waterfall has a fixed scope, Agile has a fixed schedule.*

Proponents of Agile argue that delivering higher-priority features in a functioning product to customers sooner is better than later. Some Agilists consider Waterfall to be a higher-risk development methodology because customer requirements are not typically validated and tested until all of the product development is completed.

The traditional "iron triangle" of project management balances the project scope of work with the schedule and cost. Comparing the iron triangles for Waterfall and Agile in Figure 3, we can see that, for Agile, the project scope is flexible, but the schedule is fixed and the cost is fixed; for Waterfall, the scope is fixed and the schedule is flexible. Both methodologies have a target cost, but they will apply resources, as required, within reason, to complete the scope.

EVM Fundamentals

Earned Value Management (EVM) as a performance management methodology on government projects originated within the Defense community in the early 1970's and its use for project controls has expanded across the entire federal government. EVM is usually applied to projects that use a Waterfall project management approach. It is a proven project management methodology with the goal of objectively measuring project performance based on the actual amount of work accomplished during a given period as compared to the cost and schedule plan. In 2005, the Office of Management and Budget (OMB) required federal agencies to use EVM for major IT investment programs undertaking development, modernization, and/or enhancement. This was implemented with the issuance of *Capital Programing Guide, OMB Circular A-11 part 7.*[vi] In addition, *Federal Acquisition Regulations*[vii] (FAR) and *Defense Federal Acquisition Regulations Supplement*[viii] *(DFARS)* require that government contractors establish, maintain, and use an EVM System (EVMS) that is compliant with the 32 guidelines of the *EIA-748 EVMS standard* on all major capital asset acquisitions.

Earned Value Management (EVM) as a performance management methodology on government projects originated within the Defense community in the early 1970's and its use for project controls has expanded across the entire federal government.

Projects that don't use EVM for project controls typically apply subjective measures of performance. Usually the amount of budget consumed or the amount of time elapsed, along with the project manager's knowledge of the project, is used to subjectively estimate the amount of work completed. This subjective measure of performance and productivity is then used to estimate the final cost and completion date.

In addition, EVM analysis enables identification of lower-level variances from the original baseline plan in order to identify the root causes of potential project issues before the overall project is impacted. EVM has three major elements which must be in place in order to objectively measure performance.

Seek to maintain a lean development environment, while providing adequate performance transparency

1. Planned Value (PV, also referred to as Budgeted Cost of Work Scheduled): EVM requires that all activities are fully planned to completion in terms of cost and schedule. However, it is also acceptable to use a rolling wave approach by fully planning all activities for a shorter period of the project and storing remaining scope and related budget in a future planning package. The future planning package will be fully planned down to the activity level before beginning this period of the project. A key element of the planned value, or performance measurement baseline (PMB), is the control account plan (CAP). The PMB is the baseline for which all future performance will be measured against and the CAPs are the building blocks for the PMB which describe the technical scope, cost, and schedule for a specific block of project work which is managed by a control account manager (CAM).

2. Earned Value (EV, or Budgeted Cost of Work Performed): EVM requires a method for objectively measuring performance, or earned value, on projects. As each period of performance is completed, the project team will apply an objective measurement of the actual work completed. Discrete methods are utilized which are based on identifying the completion of planned project milestones and deliverables. The status of deliverables which are planned to be completed within a shorter period of time, say 30 days, may be determined based on whether they are done or not. If the milestone is complete, or the deliverable is done based on previously identified standards of performance and quality, then the project earns the budgeted value for that milestone or deliverable. It's important to note that measuring the budget consumed or time elapsed (level of effort methodology) as a measure of performance is discouraged because it doesn't provide an accurate picture of the actual work accomplished. However, it may be used on some relatively minor project activities which don't lend themselves to discrete measurement; usually program management is provided as an example.

3. Actual Costs (AC, or Actual Cost of Work Performed): EVM requires that the organization collect actual direct and indirect costs from their financial system for the prior performance period by resource or element of cost. Project costs should be able to be reported on and applied in the EVMS at the work package (WP) or control account (CA) level.

These three performance measurement elements come together in **Figure 4** which compares the Planned Value, versus the Earned Value, and the Actual Costs. The chart shows the performance of an Agile development project using Earned Value and expressed in dollars over six reporting periods, typically a month. These three building blocks provide the fundamental EVM variance measurements.

- **Schedule Variance:** a measure of efficiency executing the plan = Earned Value – Planned Value.
- **Cost Variance:** a measure of the project's efficiency using resources = Earned Value – Actual Costs.

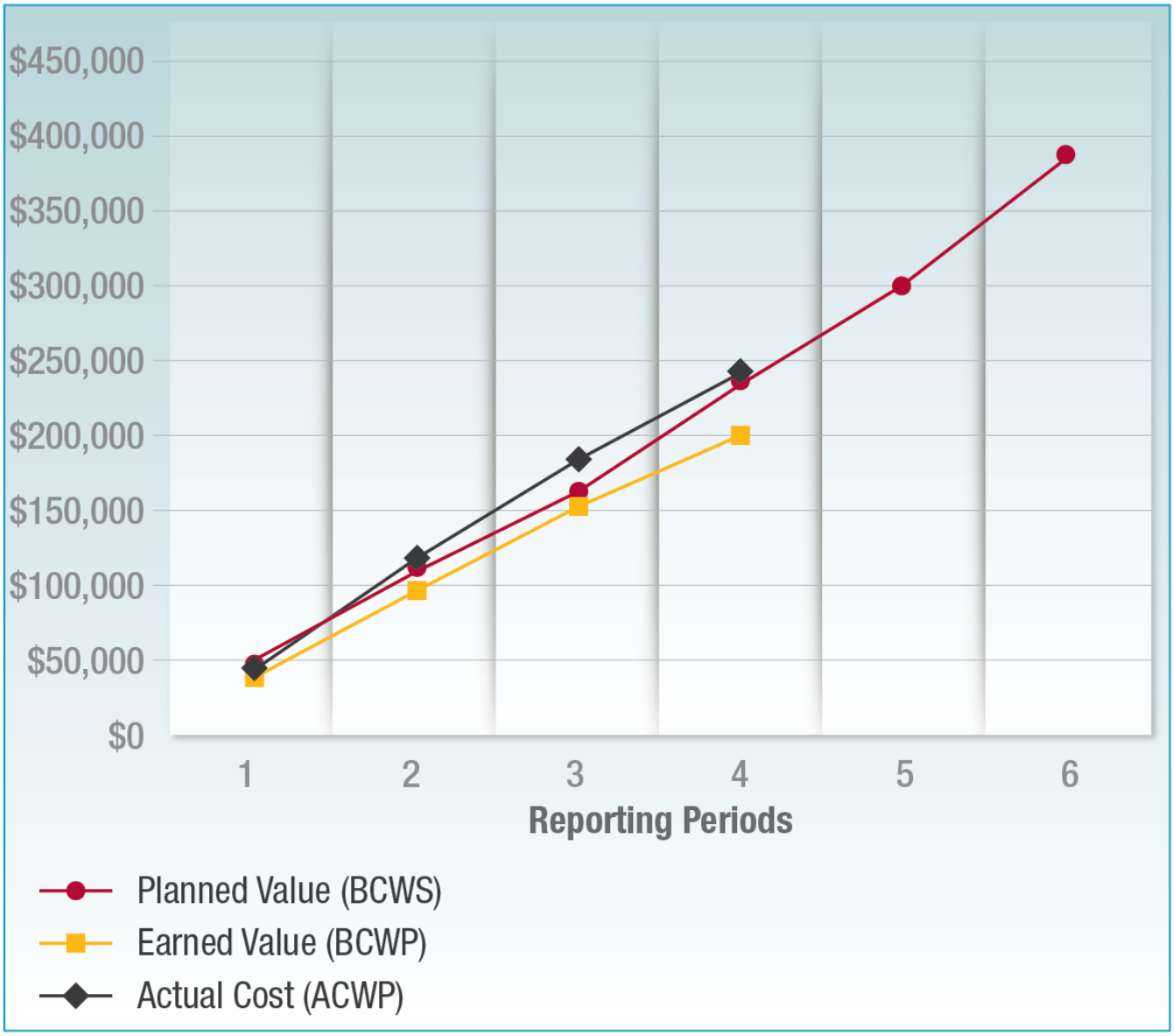


Figure 4. Earned Value Management Chart. *Using the cost and schedule variance formulas above, this chart shows a project that is behind schedule and over cost.*

The differences between Agile and Waterfall methodologies, and the application of EVM on Agile projects, present a conundrum. How do we balance the desire to enable flexible project scope with the traditional fully planned and fixed project scope usually associated with EVM? Let's first consider why Agile and EVM should be used together.

The Benefits of Combining Agile Development Methodology and EVM

…programs should deliver early and often and aim to promote a culture of speed and responsiveness by deploying capabilities every 12 to 18 months.

Federal agencies' and the Department of Defense's (DoD's) experience implementing large-scale IT development projects has not always been positive. The *25 Point Plan to Reform IT Management* states that, "many current IT projects are scheduled to produce the first deliverables years after work begins, in some cases up to six years later. In six years, technology will change, project sponsors will change, and, most importantly, program needs will change. Programs designed to deliver initial functionality after several years of planning are inevitably doomed."

The OMB proposed the use of a modular development approach and stated that federal IT programs must be structured to deploy working business functionality in release cycles, ideally shorter than 6 months, and no longer than 12 months, with initial deployment to end users no later than 18 months after the program begins. Additionally, guidance was provided in a 2012 paper called *Contracting Guidance to Support Modular Development.*[ix] The DoD promoted the use of Agile in the *National Defense Authorization Act 2010 Section 804* which stated that programs should deliver early and often, and aimed to promote a culture of speed and responsiveness by deploying capabilities every 12 to 18 months.

Beyond compliance with federal policies and regulations, how can EVM as a project management tool be used to address some inherent limitations of Agile?

1. Federal programs need to answer several questions on a regular basis. How much has been spent relative to funding? What is the current estimated cost to complete the program? What is the estimated completion date? Agile performance measures help assess the team's technical performance, whereas EVM expresses performance in terms of costs. As an even greater benefit, project costs in the EVMS can be analyzed many different ways: by resource, by element of cost, by period and more.

2. Agile forecasts depend on accurate measures of each teams' velocity (based on the teams' historical technical performance, which is expressed in terms of the average number of story points completed per sprint). However, velocity is a volatile metric because it is dependent on having a stable team without a lot of turnover or reassignment of personnel: a condition which rarely occurs on government programs. EVM by contrast allows for forecast to be calculated statistically using a variety of formulas and can provide a good counterpoint to validate the realism of the CAMs forecast.

3. Agile performance measures are focused on team performance rather than program performance. Because the basis of this performance measurement is the team's velocity, Agile doesn't provide a reliable roll up of performance for a large program with multiple teams working simultaneously with multiple release cycles. EVM provides a consistent metric which can be rolled up by Release and program. It will also provide an early warning regarding the cost and schedule impact of a delay in one team's technical performance versus plan on another work stream.

As we saw in **Figures 3** and **4**, both the release burnup chart and the EVM chart provide valuable information regarding project performance and forecast. The bottom line is that government programs are often compelled to use EVM for project controls. Over the last few years, several influential organizations have taken on the challenge of capturing best practices for Agile and applying EVM on Agile projects.

The goal is to not burden Agile teams with unnecessary program artifacts and processes that might inhibit a lean development environment, but continue to provide adequate program oversight.

What are the Best Practices for Agile and EVM for Government Programs?

The Office of Secretary of Defense Performance Assessment and Root Cause Analysis (PARCA), Government Accountability Office (GAO), and National Defense Industrial Association (NDIA) Integrated Program Management Division (IPMD), are all working toward the same objective of enabling the use of Agile with EVM for project controls. In this regard, they are also taking a fresh look at the *EIA-748 EVMS standard* and how that standard is applied to Agile projects.

One of the common themes these organizations have expressed is the desire to not burden Agile teams with unnecessary program artifacts and processes that might inhibit a lean development environment. However, there is also the desire for adequate program oversight to ensure that agencies and programs are responsible stewards of Americans' tax dollars.

PARCA and the NDIA IPMD have provided guidance for DoD programs. Both guides are closely aligned because they had common personnel working collaboratively. Below is a summary of the PARCA Desktop Guide. However, it is reasonable to expect further guidance provided in the future will be more applicable to federal civilian agencies.

Performance Assessment and Root Cause Analyses (PARCA)

The PARCA EVM division is responsible for developing and implementing policies for the use of EVM on DOD programs. The principle guide within the defense community for compliance with the *EIA-748 standard 32 guidelines*[x] is the PARCA *EVM System Interpretation Guide (EVMSIG).*[xi] After consultation in 2016 with government and industry committees, PARCA released *Agile and EVM: a Program Managers Desk Guide.*[xii] The guide states that the EVMSIG is flexible enough to allow the use of a disciplined Agile development approach, and that Agile and EVM, properly implemented, are complementary in enabling a robust program management process. The guide is organized into four sections which describe how the EVMSIG may be interpreted to ensure an Agile project's compliance.

1. Organization and the Work Breakdown Structure (WBS)

a) The DoD *Mil Std 881C WBS standard*[xiii] is a product-based structure that supports an Agile WBS with mission capabilities at the control account (CA) level and features rolling up to the CAs. The latter identifies product features at level 4 of the WBS rather than product activities/deliverables.

b) System requirements must be traceable and documented as they are broken down into capabilities and features. Each level of decomposition must have clear and documented completion acceptance criteria.

2. Planning and Scheduling

The Performance Assessment and Root Cause Analyses (PARCA) division released "Agile and EVM: a Program Managers Desk Guide" in early 2016.

a) Decomposition of scope is achieved by the hierarchical relationship between capabilities, features, and user stories which have been defined to develop features.

b) Time phasing of all work is required and more immediate releases should be time phased in terms of features. Future releases may have planning packages containing capabilities and features. A rolling-wave approach is acceptable.

c) The IMS should have the sufficient detail to provide actionable information and a critical or driving path through milestones.

d) An Agile tool may be used to manage tasks or activities required to complete milestones. Progress in the IMS may be summarized from completed work in the Agile tool.

3. Measuring Progress

a) Measurement of progress should be tied to the completion of technical scope and not the completion of time-boxed events such as sprints.

b) Agile processes which occur below the feature level in the IMS must be traceable to the Agile system.

c) The completion of technical scope must be supported by quantifiable backup data (QBD). The use of stories to measure progress in the Agile system is acceptable but must be disciplined and consistent. Story points as a measure of complexity of the user story should not change. Stories may be added or removed from QBD. The use of an earned value technique (EVT) in conjunction with stories should be documented in the EVMS description.

d) Features are expected to span multiple accounting months which are often used for EVM reporting.

e) The Agile tool should be used to support bottom-up forecasts and estimates to complete as required by the EVMSIG.

4. Baseline Maintenance

a) Product backlog changes must be documented. As the baseline is established at the feature level, any changes should be documented in accordance with processes defined in the organization's EVM System Description and the EVMSIG.

b) The guide also suggests in the interest of customer collaboration and transparency that the buyer should have access to the contractor's Agile tools.

The PARCA guide contains many additional details beyond this brief summary and is a great read for anyone interested in Agile and EVM. It's important to note that PARCA guide:

- Encompasses Agile and EVM lessons learned from top government officials and contractors.
- Represents the first official government guidance for DOD programs and it is in alignment with the processes recommended in this document.

Now that the fundamentals of EVM and Agile, and what the government and industry is advising, have let's look at the methodologies in practical terms by breaking down some of the terminology and looking at how this would play out in a real project schedule.

> Applying EVM on Agile Development

Applying EVM on Agile development projects still aligns the *EIA-748 EVMS standard's* five primary process areas: 1) Organization; 2) Planning, Scheduling, and Budgeting; 3) Accounting Considerations; 4) Analysis and Management Reporting; and 5) Revision and Data Management. Many of the processes are the same regardless of whether the project uses a Waterfall or an Agile methodology. This section will focus on primary process areas which require a different approach in order to implement EVM on Agile projects.

While scope is flexible on Agile development projects, the concept of a scope hierarchy still applies and is important for building out a Work Breakdown Structure and developing a performance measurement baseline.

ORGANIZING

The process of organizing an Agile project starts in the same way as any other project performing EVM would. The first *EIA-748 EVMS standard* guideline is to define the WBS. Likewise, in an Agile/EVM scenario, a product-focused, hierarchical breakdown of the project scope is defined. The PARCA EVM Division Agile and EVM desktop guide, summarized earlier, states that the Agile product-focused approach is consistent with *MIL-STD-881C* which is often required for DoD programs.

Work Structure/Scope Hierarchy

There is, however, no single standard for Agile work structure. SAFe uses an Epics>Capabilities>Features>Stories hierarchy. PARCA recommends a similar structure. Many other methodologies simplify the hierarchy to use Epics>Features>Stories. The Scrum Alliance replaces features with themes. Varying Agile tools use different terminology, and have different field availability, but conceptually the idea of a work hierarchy is the same. The actual terms matter less than having a clear definition of what each encompasses, its place in the hierarchy relative to other terms, and its approximate duration. Note that though Stories are included in the structure they are not typically a formal part of the project scope and can be added or deleted without compromising the end-product to the client, and without a baseline change request. Refer to **Figure 5** for the definitions and parameters used in this paper.

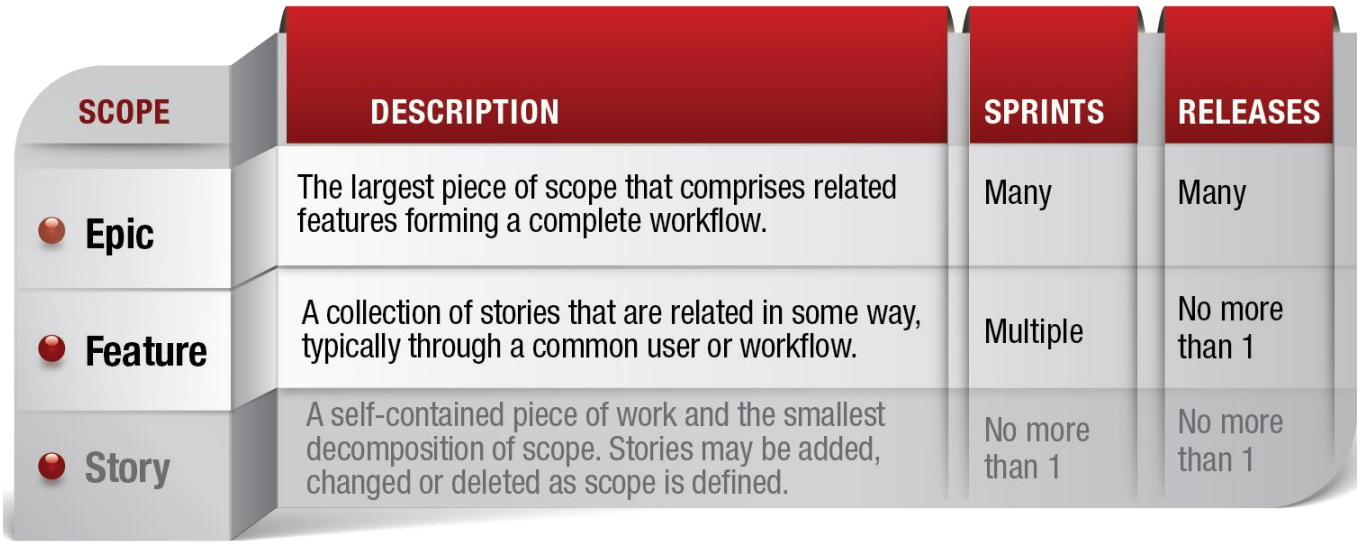


Figure 5. Scope/Work Terminology. *Common definitions used throughout this paper.*

THE GOLDILOCKS THEORY OF MEASURING PERFORMANCE

When it comes to measuring performance, the scope being measured should be neither too big nor too small. Like Goldilocks looking for the perfect chair, it should be just right.

There are several good criteria for defining objective performance: 1) the scope being measured should be short enough so that it is two reporting periods or less in duration, and 2) it should be well defined enough that it can be included in a baseline.

The level at which to measure performance is important to consider when defining the project WBS. As described earlier, the main goal of EVM is to remove subjectivity from performance measurement and reporting. To that end, much of the debate surrounding how to combine Agile and EVM has been around the level at which to measure performance (BCWP or EV). That is to ask, where should percent complete be calculated? There are several good criteria for defining objective performance: 1) the scope being measured should be short enough so that it is two reporting periods or less in duration, and 2) it should be well defined enough that it can be included in a baseline.

Sprints or iterations–too vague

Sprints are probably the least objective way to measure performance. Sprints are merely a passage of time. Completion of a sprint doesn't actually indicate how much scope was completed. It doesn't indicate whether the plan was achieved, it merely indicates that a certain period of time has elapsed. In an Agile environment, scope can easily move from one sprint to the next. This is not an objective performance measure.

Epics–too long

Epics tend to be long, as the name implies. Using the most typical definition of the term, epics can span more than one release, often many periods, cutting across various system components making them hard to use as a measure of performance. Since epics span so much time and encompass a diverse scope, managers often end up estimating performance. While those estimates might be based on expert opinion, it doesn't make them objective.

Stories–too volatile

In contrast to epics, stories are too small and are subject to change. Stories are typically the smallest measure of work in an Agile framework, and can be added or deleted at any point without compromising the scope that is to be delivered. They are too granular to be a good measure of performance and typically aren't defined early enough during the development process to be included in a PMB.

Features–just right

Features define a fixed piece of functionality. Once slated for development, features don't often get pushed out in the schedule and are therefore relatively stable. Features are typically short enough that they can be completed within two reporting periods, and where they have a longer duration, they can use stories as quantifiable back-up data. Features are made up of a number of stories that are weighted using story points. If a story (and its associated story points) gets deleted or added to the feature, the denominator (i.e., total story points) might change, but overall, the feature will still be delivered. Note that though the total story points for a feature may change due to added or deleted features, story points for any single user story should not change. In this way, features meet both criteria for defining objective performance measures: they are discrete enough and stable enough in scope, and the stories that roll up underneath them are short enough to be able to measure 0:100. These factors make features just right for performance measurement.

PLANNING, SCHEDULING, AND BUDGETING

Planning, scheduling, and budgeting are completed based on the WBS/Agile hierarchy your organization and program team have determined is appropriate and effective. However, as presented in **Figure 6**, this paper recommends that features which are equivalent to EVM work packages are the lowest level of the hierarchy in the IMS and EVMS.

The planning process is relatively straight forward. Begin with the core capabilities to be developed and the total funding or contract award. Break down the core capabilities into epics, plan the work, and develop a cost estimate for the resources required to develop the epics. The cost estimate should be consistent with the project's funding or the team may have to consider alternative development approaches.

Agile and EVM at work

"For many years, CGI has had healthcare clients whose system we developed and enhanced using a Waterfall methodology. Prior to 2012, the schedule for this program had 1,700 lines of code. After adopting CGI's Agile/EVM methodology, the program is now maintaining a schedule with less than 400 lines. By moving to Agile software development and taking advantage of the data already being collected in our Agile tool to report Earned Value, we were able to trim our schedule by 76%. As a result, CGI has implemented an effective and efficient Agile development process by removing redundant project management processes and reporting. The CGI Agile/EVM process removes unnecessary performance impediments so Agile teams can focus on rapidly addressing our government customers' requirements."

Janelle Voyakin, Director, Consulting Services, CGI

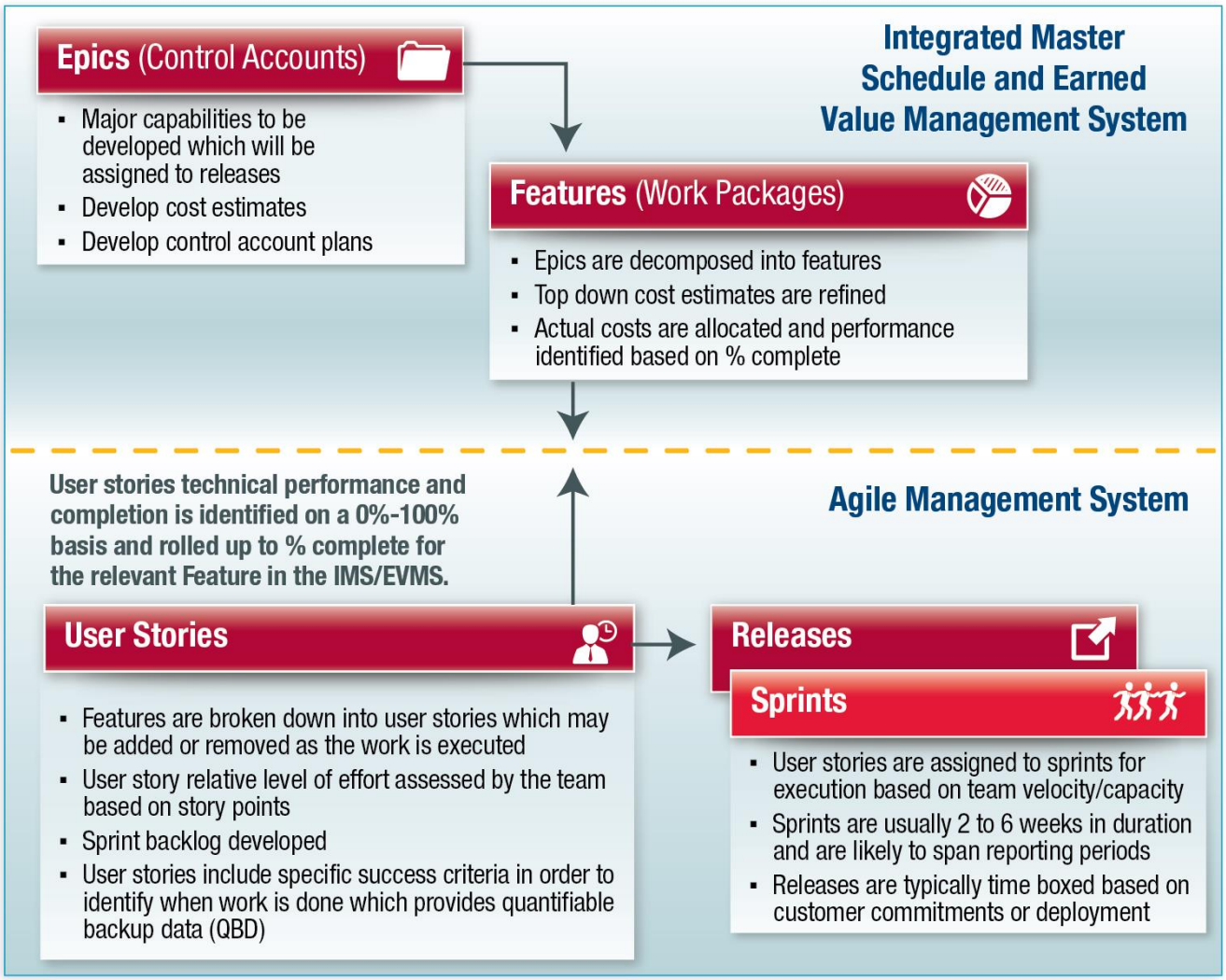


Figure 6. Information Segregation. *Keeping details below the feature limited to the Agile Management System reduces redundant data.*

The epic functionality and cost estimate is translated into a roadmap. The roadmap provides the framework for initial release planning. During planning you will also breakdown epics into features and associated budget in order to develop a product backlog for the first release. The remaining epics are summary level planning packages and will be decomposed during planning for the subsequent release. This rolling-wave planning approach is well accepted and often utilized on waterfall projects. The definition of the planning window will be outlined in the EVM system description for that program.

Having identified features as the level at which to measure performance, and therefore define work packages, it makes sense that the IMS would go down to the feature level, and that budget would be defined there as well. *EIA-748 Guideline 10* must be addressed during planning. For Agile development work packages, the EVT will be percent complete based on a 0% - 100% completion of user stories which are tracked in the Agile Management System. User stories (see **Figure 6**) represent the

technical scope. The number of story points identified by the development team is used to represent the level of effort; and as weight for the calculation of the percent complete. At this point in the process, the work package has been planned and dollarized (budget assigned) based on the previously developed resource cost estimate. Dollarization at the feature level in the IMS/EVMS is supported in the *PARCA Agile and EVM Desktop Guide* reviewed above.

The section below on "Putting the Theory into Practice" describes in more detail how this process is managed using EVM and Agile management software solutions.

It's worth noting that some organizations may dollarize user stories in order to develop a bottoms-up cost estimate and budget. However, this adds unnecessary complexity due to the need to periodically reconcile the bottoms-up budget with the top-down cost estimate as user stories are developed. In addition, this practice is redundant because the product owner and team will be required to periodically develop a bottoms-up estimate to complete (ETC) for program management reporting. Any cost overruns due to an incomplete understanding of the work required to develop a feature will become apparent and will need to be addressed.

Project Execution and Performance Analysis

Having established the cost and schedule baseline, the team begins to execute the work and captures progress in the Agile tool as presented in **Figure 6**. In order to avoid creating redundant processes and data, the Agile tool is used to manage development and the IMS/EVM tools are used to manage the project and project controls.

Minimize duplication of processes and data by allowing the Agile, Scheduling, and Earned Value tools to do what they do best. Programs and organizations should aim to minimize duplication and thereby create programmatic efficiencies while maintaining traceability.

Using the Agile tool, stories are added, deleted and completed over time. At the end of the reporting period, the completed story points (SP) are measured as a ratio of the total number of SP, which becomes the status and gets transferred to the IMS/EVMS. While it might seem more objective to measure against the originally planned SP, it is typically not the best choice. Let's take an example of a feature which is planned to take 100 SP. If that value is used to calculate the percent complete and post-baseline, it becomes clear that the work can be completed in 75 SP. The WP would forever be stuck at 75% complete. Alternately if it is known that it's now going to take 125 SP, the WP would be marked as 100% complete, despite the fact there is still another 25 SP left and it's really only 80% complete.

Measuring performance against the currently forecasted SP, rather than the original SP, means that there is the ability to more accurately align performance and actual cost. Note that measuring against the currently forecasted SP means that if there is a significant decrease in the total number of SP (greater than the number completed in that period), the earned value may go down. This is not a common scenario but is possible.

In this way, the Agile tool is traceable to the IMS/EVMS and is used to provide QBD supporting the EVM reports. The team will also be required to periodically develop bottoms-up ETC's in support of the Estimate at Completion (EAC forecast) and program management reporting. The forecast appears in Agile as SP remaining/uncompleted, and gets translated into the IMS as remaining work, and into the EVM tool as an ETC.

> Putting the Theory into Practice

Now that features have been defined as "what" to track, the questions must be answered, "how" and "where" will they be tracked in practice?

Agile tools manage the product backlog and provide the basis for earned value calculation. During sprint planning and execution, the Agile tool is the backbone of organization for Agile teams.

Much of the recent discussion around Agile in an Earned Value environment has been related to the appropriate touch points of data and systems. Given that the feature is the appropriate level at which to tie the Agile and Earned Value data together, it is important to define how it is done in practice. It's easy to get confused about what to do where and how not to duplicate data and effort. Scheduling, Earned Value and Agile tools abound, each with robust functionality designed for their unique purposes. The following provides a simple, practical, and proven approach to data integration between Agile, schedule and cost management applications.

AGILE PROCESSES

Applications such as Atlassian® JIRA®, Rally (CA Agile Central)[xiv], and Microsoft Visual Studio Team Foundation Server[xv] are best suited to manage Agile teams and associated work. These tools provide functionality specific to supporting the Agile methodology and approach to projects such as defining user stories and acceptance criteria, managing the product backlog, and reporting Agile metrics such as sprint burndown and team velocity. User stories and their related story points provide the linkage between the Agile tool, IMS and Earned Value engine.

Each feature should be broken down to user stories in the Agile tool for execution by the respective Scrum teams. Each story is then given an SP metric which reflects the relative effort to complete a story. This weighting provides a good basis for determining the cumulative completeness of a feature. For example, assume "Feature A" has 10 stories which represent total effort of 80 SP. As stories are completed, the related SP can be used to assess progress. Let's assume three stories representing 50 SP have been completed for "Feature A." The overall feature is then 62.5% complete (50/80=0.625). In this way, SP planned and completed in Agile tools can be used to calculate the progress of features within the schedule and subsequently flowed to the cost tool for Earned Value analysis and reporting.

Figure 7 is an example of an epic burndown chart produced by Agile tools. It tracks the SP for all features within an epic and how they are added and completed. It also projects the future burndown of the backlog by using velocity. In the example below, the team has completed an average of 140 SP in the first two sprints. Based on the remaining 521 SP, it will require four additional sprints to complete all features within the epic. It is important to note that stories can be added and deleted during sprints so the total SP may change, which could impact the number of sprints required to complete a feature and epic.

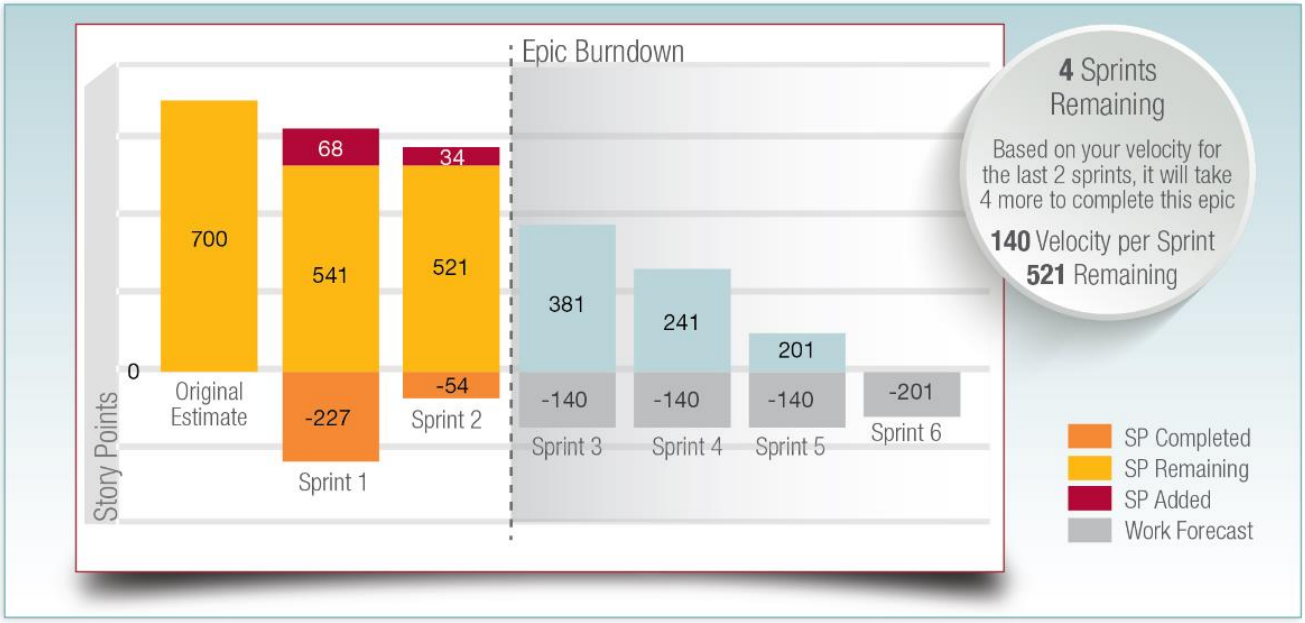


Figure 7. Epic Burndown Chart.

SCHEDULING TOOL

The IMS reflects the overall execution plan and critical path of the project. It is an important piece of the Agile/Earned Value puzzle. The IMS should include features planned out for all in-process and near-term work, as well as planning packages for work outside the rolling-wave window. This schedule reflects the plan to complete contractual deliverables. It is the foundation of Earned Value Management. Tools such as Deltek Open Plan and Microsoft Project are best suited for this task.

The IMS is the foundation of EVM and should be used to tie the Agile progress to Earned Value calculation and reporting.

In **Figure 8**, features are scheduled below their respective epic. There may be other approaches to setting up the hierarchy within the scheduling tool, but the overall goal should be the ability to directly link Agile features to the contractual WBS used for earned value reporting while minimizing duplication of data from the Agile tool.

Custom numeric fields in the scheduling tool can be used to display total SP for each feature based on the detailed stories in the Agile tool as well as SP completed. Adding these columns means that there is no need to have the detailed user stories in the scheduling tool. Total SP associated with a feature provide a practical basis for progressing work. Again, keep in mind that stories are added and deleted in the Agile tool as needed, and therefore the total SP in the scheduling tool should also be updated each time the schedule is statused.

WBS	Epic/Feature	Name	SP Total	SP Complete	% SP Complet	Physical % Complete
2.5.2	**Epic**	**Epic 1**	**30**	**30**	**100**	0%
2.5.3	**Epic**	**Epic 2**	**10**	**2**	**20**	0%
3.1.1	**Epic**	**Service Finder**	**802**	**281**	**35.04**	**0%**
3.1.1.01	Feature	Search and Return a List of Results	194	92	47.42	47%
3.1.1.02	Feature	Setting up Proof of Concept	262	109	41.6	42%
3.1.1.03	Feature	Data Display (Quality Measures)	86	26	30.23	30%
3.1.1.04	Feature	Interact with Data on a map	32	26	81.25	81%
3.1.1.05	Feature	Compare Results	52	28	53.85	54%
3.1.1.06	Feature	Filter Results	26	0	0	0%
3.1.1.07	Feature	Information Content	64	0	0	0%
3.1.1.08	Feature	View location on a map	40	0	0	0%
3.1.1.09	Feature	Navigation Controls	24	0	0	0%
3.1.1.10	Feature	Print Information	22	0	0	0%

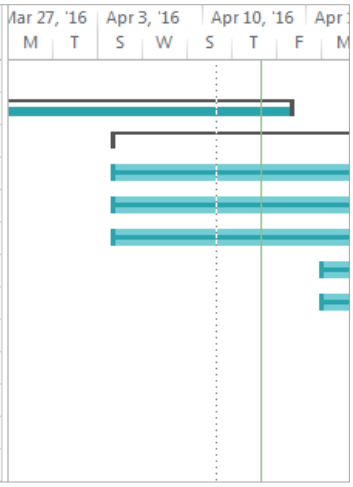


Figure 8. Integrated Master Schedule (IMS). *Features are resource loaded and roll up to epics in the schedule.*

As stories are completed, the total SP completed is entered in a second custom numeric field in the scheduling tool. It is recommended to use numeric fields when using Microsoft Project so the values roll-up to the summary task/feature. A third field calculates the percent of SP completed using the formula: *SP Complete/SP Total* = % SP Complete.

Earned Value engines such as Deltek Cobra integrate with the IMS and use the Agile data to provide robust earned value reporting.

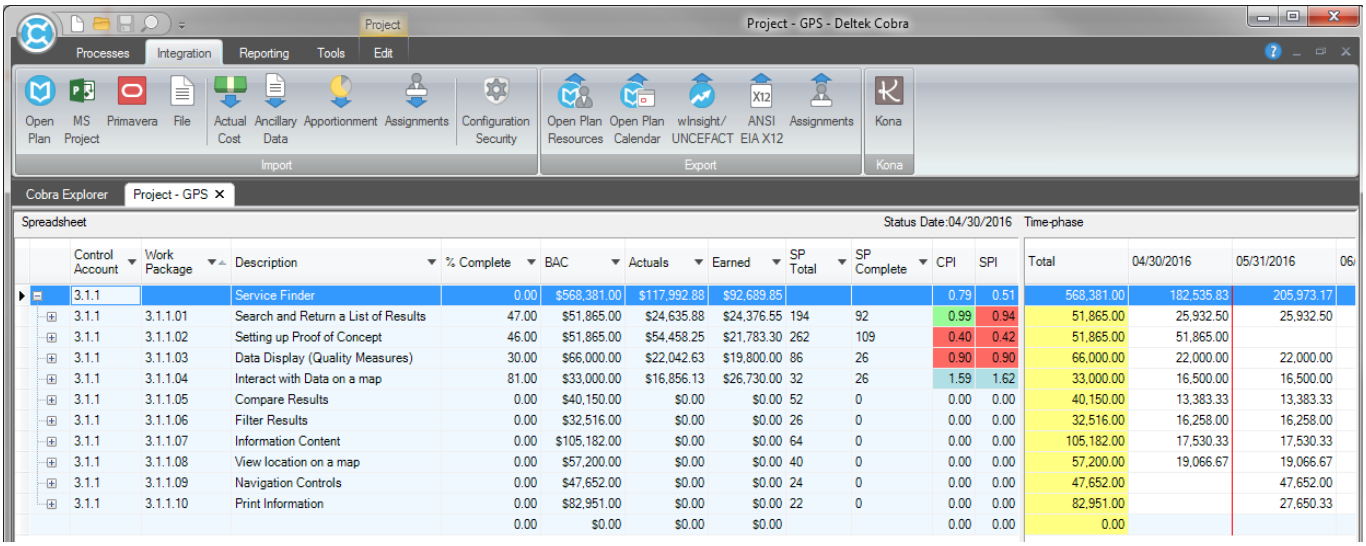
The % SP Complete is the physical % complete of the feature. In practice, the value can be copied to the Physical % Complete field in the scheduling tool and subsequently used to calculate Earned Value. Keep in mind that in some scheduling tools, such as Microsoft Project, Physical % Complete does not allow decimal places and therefore the value will be rounded to the nearest whole percentage.

Note that this approach uses an EVT of Percent Complete at the work package level but is effectively using an EVT of 0:100 at the story level, which is the lowest level that scope is decomposed. Once a story is complete, the total SP for that story is claimed. This approach works within the premise that stories fit into a single sprint which is less than four weeks long and more often one to two weeks. Another approach would be to bring the stories into the IMS and subsequently into the earned value tool as milestones or QBDs on the work package. However, the overhead associated with doing so may likely outweigh the benefits. There is certainly an added maintenance to keeping the stories updated as they are frequently added and deleted.

In addition, it duplicates data rather than allowing it to reside solely in its source system. In situations where sprints are longer than four weeks, it may be desirable to see the detail within the IMS and earned value tools in order to quickly asses what is driving variances.

EARNED VALUE COST ENGINE

EVM is designed to objectively measure project performance against the planned schedule and actual costs. Like Agile, Earned Value has specific data, metrics, and reports including strict compliance requirements for government contractors. Best-in-class applications, such as Deltek Cobra, provide all the necessary functionality to successfully manage and report earned value on projects. EVM, however, is reliant on good data, especially accurate progress of work. It is critical that the Earned Value on a project accurately reflects the planned work completed to date, in order to successfully analyze historical performance and future efficiency.



Control Account	Work Package	Description	% Complete	BAC	Actuals	Earned	SP Total	SP Complete	CPI	SPI	Total	04/30/2016	05/31/2016
3.1.1		Service Finder	0.00	$568,381.00	$117,992.88	$92,689.85			0.79	0.51	568,381.00	182,535.83	205,973.17
3.1.1	3.1.1.01	Search and Return a List of Results	47.00	$51,865.00	$24,635.88	$24,376.55	194	92	0.99	0.94	51,865.00	25,932.50	25,932.50
3.1.1	3.1.1.02	Setting up Proof of Concept	46.00	$51,865.00	$54,458.25	$21,783.30	262	109	0.40	0.42	51,865.00	51,865.00	
3.1.1	3.1.1.03	Data Display (Quality Measures)	30.00	$66,000.00	$22,042.63	$19,800.00	86	26	0.90	0.90	66,000.00	22,000.00	22,000.00
3.1.1	3.1.1.04	Interact with Data on a map	81.00	$33,000.00	$16,856.13	$26,730.00	32	26	1.59	1.62	33,000.00	16,500.00	16,500.00
3.1.1	3.1.1.05	Compare Results	0.00	$40,150.00	$0.00	$0.00	52	0	0.00	0.00	40,150.00	13,383.33	13,383.33
3.1.1	3.1.1.06	Filter Results	0.00	$32,516.00	$0.00	$0.00	26	0	0.00	0.00	32,516.00	16,258.00	16,258.00
3.1.1	3.1.1.07	Information Content	0.00	$105,182.00	$0.00	$0.00	64	0	0.00	0.00	105,182.00	17,530.33	17,530.33
3.1.1	3.1.1.08	View location on a map	0.00	$57,200.00	$0.00	$0.00	40	0	0.00	0.00	57,200.00	19,066.67	19,066.67
3.1.1	3.1.1.09	Navigation Controls	0.00	$47,652.00	$0.00	$0.00	24	0	0.00	0.00	47,652.00		47,652.00
3.1.1	3.1.1.10	Print Information	0.00	$82,951.00	$0.00	$0.00	22	0	0.00	0.00	82,951.00		27,650.33
			0.00	$0.00	$0.00	$0.00			0.00	0.00	0.00		

Figure 9. Cobra Project View. *Features and epics from the IMS are seen as Work Packages and Control Accounts.*

Tight integration between the cost and scheduling tools ensures traceability and reduces duplication of effort. Control Accounts can represent epics, and features become work packages or some similar grouping of work scope such as capability. Releases can be used if the release represents a discrete chunk of work scope and is not merely a time-boxed activity. For example, if a release go-live date is not going to move and the release will wrap up after a fixed number of sprints, regardless of completion of the underlying features, then it would not be appropriate to use as a control account.

The key to success is up front planning, a strong understanding of both Agile and EVM methodologies, and clearly defined success criteria.

Time-phased scheduled resources are priced to obtain budget dollars by feature and Physical % Complete, calculated in the scheduling tool using story points, is used to calculate earned value. In the above example, SP Total and SP Complete columns are populated during integration of the IMS to the earned value engine strictly for visibility. Again, duplication of data should be minimized when not adding value.

A Closer Look at Integration

All this information can be seamlessly integrated from scheduling tools to a cost tool like

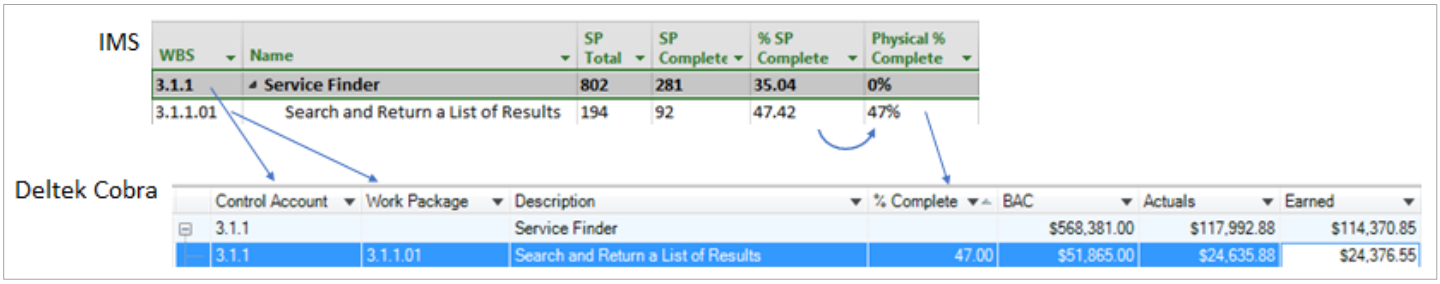


Figure 10. Data Traceability. *Data is integrated from the schedule tool into the Earned Value tool.*

> Practices to Encourage and Avoid

Practices to Encourage

A common understanding of project artifacts and terminology by all team members is critical to successful implementation of this approach.

- Encourage projects to develop a their own detailed definition of key Agile terms:
  - What does an epic look like? What makes up a feature?
- Encourage projects to really understand their SP methodology:
  - Some projects use 1, 2, 4, 8, and 16 to size their stories. Others' use Fibonacci's sequence; 1, 2, 3, 5, 8, 13, 21. Still others use a scale of 1 to 10. The numbers don't matter so much as having team consensus about the size of the story each number represents.
  - SPs should be a reflection of the relative effort required to complete the story. While factors such as complexity, risk, and uncertainty influence the effort required to complete a story, it is ultimately the effort itself that should be used to size the story.
- Encourage projects to take full advantage of the functionality inherent in their chosen Agile tool.
  - Use reports and exports to roll up performance data to the feature level.
- Encourage projects to have clear exit criteria for features and stories:
  - To clearly show the link between technical performance and the value earned, projects need to be able to articulate what "done" looks like.

Practices to Avoid

- Avoid data redundancy
  - Keep Agile and EVM processes lean by allowing each tool to do what it was designed to do. Also, don't burden Agile teams with unnecessary processes such as updating status in the IMS. Capture performance in their normal daily stand ups and status in the Agile Management system
- Avoid measuring performance against the number of original SPs.
  - As the feature continues to be elaborated upon, the total number of SPs may increase or decrease. Always assess performance based on the current stories.
- Avoid having features with too few stories/too few SPs.
  - Given that performance is measured only when a story is complete, it is important to have enough stories to accurately assess overall feature performance at the end of each reporting period.

> Conclusion

Agile and EVM each provide unique benefits to project managers, teams, and stakeholders. Agile provides an iterative and collaborative approach to managing project scope and delivery on a day-to-day basis, ensures work is prioritized appropriately, and enables early and continual evaluation of requirements and solutions. EVM provides a methodology to assess past and future project performance based on planned scope and objective measures of work completed. If implemented correctly, both approaches can coexist. When used together, they can add a level of value and visibility not found with each alone.

The key to successfully taking advantage of what both methods have to offer is to allow each to do what they do well, and not encumber one with the other. This is accomplished by defining the appropriate touch points between the respective processes and data, as well as the tools employed to manage them. Using the approach outlined in this paper, the strengths of each methodology can be combined to improve overall project execution, measurement, and reporting while minimizing duplication of effort and data.

Agile and Earned Value Management Together

Combining Agile and Earned Value Management can lead to project success: cost savings, schedule security, risk reduction, and customer satisfaction.

> Source Documents

[i] OMB 25 Point Implementation Plan to Reform Federal IT Management - https://www.whitehouse.gov/sites/default/files/omb/assets/egov_docs/25-point-implementation-plan-to-reform-federal-it.pdf

[ii] National Defense Authorization Act 2010 Section 804 - https://www.gpo.gov/fdsys/pkg/PLAW-111publ84/html/PLAW-111publ84.htm

[iii] Agile Manifesto - https://www.agilealliance.org/agile101/the-agile-manifesto/

[iv] The Scrum Alliance - www.scumalliance.org

[v] Scaled Agile Framework (SAFe) for Lean Software and Systems Engineering - Scaled Agile, Inc. - http://www.scaledagileframework.com/

[vi] The Capital Programming Guide and OMB Circular A–11, Part 7 - https://www.whitehouse.gov/omb/circulars_a11_current_year_a11_toc/

[vii] Federal Acquisition Regulations - https://www.acquisition.gov/?q=browsefar

[viii] Defense Federal Acquisition Regulations Supplement - http://www.dcaa.mil/dfars.html

[ix] Contracting Guidance to Support Modular Development - https://www.whitehouse.gov/sites/default/files/omb/procurement/guidance/modular-approaches-for-information-technology.pdf

[x] EIA-748-C EVMS Standard, TechAmerica - http://webstore.ansi.org/RecordDetail.aspx?sku=SAE+EIA+748C-2013+(SAE+EIA748C-2013)

[xi] DOD EVM System Interpretation Guide - http://www.acq.osd.mil/evm/docs/DoD%20EVMSIG.pdf

[xii] Agile and EVM: A Program Manager's Desk Guide, PARCA - http://www.acq.osd.mil/evm/NewsList.shtml

[xiii] Work Breakdown Structure (WBS) MIL-STD-881C - https://acc.dau.mil/adl/en-US/482538/file/61223/MIL-STD%20881C%203%20Oct%2011.pdf

[xiv] Rally / CA Agile Central is either a registered trademark or trademark of CA Technologies in the United States and/or other countries.

[xv] Microsoft, Microsoft Visual Studio and Microsoft Project are either registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries.

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Dave has more than 25 years of experience with both government and commercial customers in the implementation of systems and methodologies to improve management processes. He has extensive experience designing, implementing, and supporting compliant IPM/EVM Systems for both the U.S. government and government contractors. In addition, he has provided EVMS assurance services supporting government contractors EVMS compliance with the *EIA 748 standard*. He provides a unique perspective gained through his experience directly supporting Agency and Department of Defense (DoD) programs surveillance of contractors EVM reporting and EVM Systems. He has a B.B.A in Finance from Loyola Marymount University. dmscott@bdo.com 973.349.2561