



# CDC UNIFIED PROCESS PRACTICES GUIDE



## EARNED VALUE MANAGEMENT

### Purpose

The purpose of this document is to provide guidance on the practice of **Earned Value Management** and to describe the practice overview, requirements, best practices, activities, and key terms related to this requirement. In addition, templates relevant to this practice are provided at the end of this guide.

### Practice Overview

Earned value (EV) is a project management technique that answers the question what did we get for the money we spent? EV is one method that can be used to measure project performance. Some other measures of project performance may include analysis of:

- Cost vs. benefit
- Percent complete
- Predictions for total cost
- On-time delivery

The Project Management Institute's (PMI) Project Management Body of Knowledge (PMBOK) defines EV as the budgeted amount of work scheduled that was actually completed during a given period of time. EV compares the amount of work planned with the actual work completed during a given period of time to determine if cost and schedule performance is inline with planned expectations. EV measures how much of the budget and time scheduled to complete a set amount of work has been spent regardless of the actual amount of work completed.

EV provides a measurement that allows the project team to readily compare how much work has actually been completed against the amount of work that was planned to be accomplished. The practice of monitoring, reviewing, and reacting to fluctuations in EV is known as Earned Value Management (EVM).

EVM is an evaluation technique that integrates technical performance requirements, resource planning, and schedules, while taking risk into consideration. EVM integrates these factors into a single practice approach that provides an objective measurement of project performance and progress. Performance is then measured by comparing the earned value to the planned value to determine the budgeted cost of work performed. That is then compared to the actual cost of work performed to determine project performance.

The Office of Management and Budget (OMB) memorandum 5-23 requires EVM be used to “monitor and manage IT project performance”. If implemented correctly and applied diligently throughout the life of a project, EVM can provide a wealth of information to project teams and even provide an early warning of potential project budget, schedule, and overall performance issues. To accomplish this, EV assumes that all project activities “earn” value as work is completed. For EV to work a common measure must be applied. Thus, work progress, schedule, and cost performance are all measured in dollars. These values are then compared with actual and planned costs to determine project performance and predict future trends. How EV is applied at the CDC is further explained on the HHS Policy website at <http://www.hhs.gov/ocio/policy/> and on the CDC Capital Planning Investment Control (CPIC) website at <http://intranet.cdc.gov/cpic/EarnedValue.htm>

EVM uses the cost and schedule baseline contained within the project management plan to assess project progress and any variations from that baseline throughout the life of the project. The basics of EV involve understanding three key values:

1. **Budget At Complete (BAC)** – The budget values established for the work to be performed. How much should the work cost when done?
2. **Actual Cost of Work Performed (ACWP)** – The total costs actually incurred in accomplishing the work performed during a given time period. How much did the completed work actually cost?



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- Percent Complete (% Complete)** – An estimate, expressed as a percentage, of the amount of work that has been completed.

Once these three measures have been identified, the following calculations can be performed:

- **Earned Value (EV)** – EV is the budgeted cost of work performed (BCWP) during a given period of time ( $BAC \times \% \text{ Complete}$ ). How much work is actually done?
- **Planned Value (PV)** – PV is the budgeted cost of work scheduled (BCWS) to be completed up to a given point in time. How much work should be done?

Once EV and PV have been determined they can then be used to determine schedule and cost variances and to calculate overall project performance using the following formulas.

- **Schedule Variance (SV)** – SV is an efficiency indicator that reflects the schedule performance of the project. It measures the difference between what was planned to be completed and what has actually been accomplished. SV will ultimately equal zero when the project is completed because all of the planned values will have been earned ( $EV - PV = SV$ ).
- **Cost Variance (CV)** – CV is an efficiency indicator that reflects the cost performance of the project. It measures the difference between the budget and the actual amount spent for the work completed ( $CV = EV - ACWP$ ).
- **Schedule Performance Index (SPI)** – The SPI is used, in addition to schedule status, to predict the project's completion date and is sometimes used in conjunction with the CPI to forecast the project's estimate at completion. SPI is simply the ratio of the EV to the PV. An SPI below 1.0 indicates the project is behind schedule. An SPI above 1.0 indicates the project is ahead of schedule ( $SPI = EV/PV$ ).
- **Cost Performance Index (CPI)** – The CPI is used to monitor project cost and to predict cost overruns. The CPI is a commonly used cost-efficiency indicator and is simply the ratio of the EV to AC. A CPI below 1.0 indicates the project's cost is over the planned cost for the work performed. A CPI above 1.0 indicates the project's cost is under planned cost for the work performed ( $CPI = EV/AC$ ).
- **Estimate to Complete (ETC)** – ETC is the expected cost needed to complete the remaining planned work.
- **Estimate at Completion (EAC)** – EAC is the expected total cost of the planned work at completion of that work.  $EAC = ACWP + ETC$

## How to Manage Using Earned Value

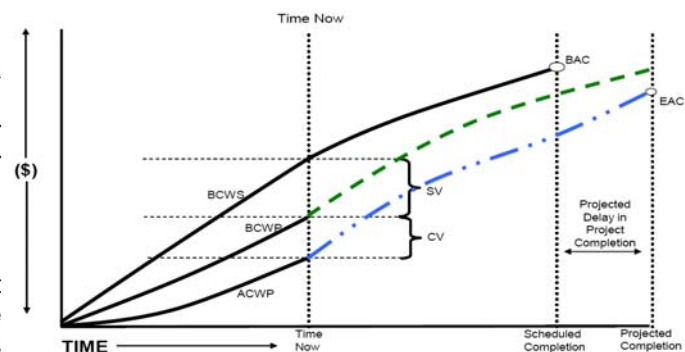
Incorporating EVM into project management practice is a three step process:

1. Define project work
2. Estimate and baseline cost and schedule
3. As work is completed regularly record progress (earned value)

The extent to which projects adopt EV determines how detailed step three will eventually become. EV analysis often reveals what is causing deviations from a project's baseline schedule and cost. Correcting these variances is easier earlier in the projects life cycle when small adjustments may still have significant impact over time.

The project manager (PM) analyzes EV data comparing performance indexes (SPI, CPI, etc). Using this information in conjunction with their understanding of the remaining work, and their experience, the PM forecasts EAC for cost and schedule for the project.

For example, the image to the right illustrates that the budgeted cost of work performed is below the budgeted cost of work scheduled. This indicates





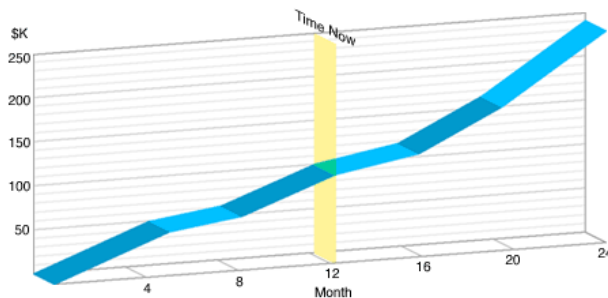
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that the project is behind schedule, by how much is calculated by the project manager (PM) as a schedule variance. The actual cost of work performed is also below the budgeted cost of work performed. This indicates that the work completed to this point of the project was done for less than planned. This project is ahead of planned budget, by how much is calculated by the PM as a cost variance. The PM would then apply project management techniques and best practices balancing cost, quality, and schedule to bring project variances back in-line with the original baseline plan.

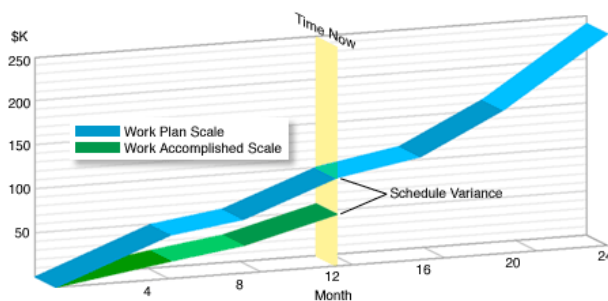
### DETAILED EXAMPLE OF EARNED VALUE ANALYSIS (SOURCE: NASA EVM)



The graph to the left illustrates how EVM can identify how a project is performing. The blue bar shows the project's baseline. It illustrates that the project has a total budget of \$240k and is expected to complete in 24-months. The "Time Now" line represents a point within the projects life that shows that \$100k of the project resources was planned to be completed at that point. Another way to look at this is that the project was planned to be 41.6% complete ( $\$100k / \$240k$ ) at this point in time.

How much work has been performed, or "earned" over the same timeframe? Comparing earned value with the planned value measures the dollar value of work accomplished versus the dollar value of work planned. Any difference is known as a schedule variance. A negative variance means less work was accomplished than was planned for the same period. Conversely, a positive variance means more work was completed than was planned.

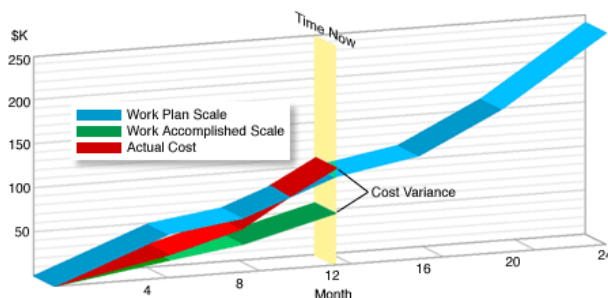
In the graph below the plan was to have accomplished \$100k worth of work in twelve months, but only \$60k was actually completed. The difference between the accomplished work (\$60k of earned value) and the value of the planned work (\$100k) to date is \$40k.



The graph shows this as a negative schedule variance. At this point in time the project is behind schedule, in dollars, by \$40k.

The value earned for the work performed compared with the actual cost incurred for that work provides a measure of cost efficiency. Any difference is called a cost variance.

A negative cost variance means more money was spent for the work accomplished than was planned. Conversely, a positive variance means less money was spent for the work accomplished than was planned to be spent.



Continuing with the example, the graph to the left now shows that the actual cost of performing the \$60k of work (earned value) was \$110k. The difference between the earned value of \$60k and the actual cost of work performed of \$110k is \$50k. The graph shows this as a negative cost variance. At this point in time the project is behind schedule by \$40k and over budget by \$50k.



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EVM is applied similarly in an iterative development environment and can provide added value for project stakeholders, product and project managers, and team members. Once a baseline is established for a set of work, progress is measured against that baseline within predefined boundaries such as a single iteration, weekly, or monthly. At each boundary EV measures are recorded and EVM techniques applied.

### Best Practices

The following best practices are recommended for the practice of **earned value**:

- **Start Early** – EVM enables a project manager to identify project variances early in the project when smaller, less costly, changes may have a greater positive project impact over time.
- **Calculate Regularly** – Regularly calculate, manage, and address variances in the project’s EV.
- **Manage** – Regularly review EV calculation so that corrective action can be taken when needed.

### Practice Activities

For projects the following practice activities are appropriate:

- Establish or adopt an earned value management system
- Decompose WBS elements into activities that can be scheduled
- Estimate work, budget, and duration and align project activities to create an approved project schedule
- Baseline the approved schedule and budgets
- As work is completed, budgets are earned (earned value)
- Regularly calculate, track, and manage EV
- Provide project status, including earned value, against project baselines
- React to variances in EV as required to complete project work on time and within budget

### Practice Attributes

This section provides a list of practice attributes to help project teams determine when and how applying **earned value** impacts a project.

<b>Practice Owner</b>	CDC UP Project Office – NCPHI
<b>Criteria</b>	All projects regardless of type or size should have some type of document that outlines how work and project performance will be measured.
<b>Estimated Level of Effort</b>	Moderate
<b>Prerequisites</b>	N/A
<b>Practice Dependencies</b>	N/A
<b>Practice Timing in Project Life Cycle</b>	EVM is an activity that is performed throughout the project life cycle with updates and refinements made throughout the project’s life, as necessary.
<b>Templates/Tools</b>	Earned Value Practices Guide, Earned Value Checklist
<b>Additional Information</b>	<a href="http://www.hhs.gov/ocio/policy/">http://www.hhs.gov/ocio/policy/</a> <a href="http://intranet.cdc.gov/cpic/EarnedValue.htm">http://intranet.cdc.gov/cpic/EarnedValue.htm</a>

### Related Templates/Tools

Below is a list of template(s) related to this practice. Follow the link below to download the document(s). <http://www2.cdc.gov/cdcup/library/matrix/default.htm>

- *CDC Earned Value Management Spreadsheet* located under the “CPIC Tools” navigation bar on the right side of this web page <http://intranet.cdc.gov/cpic/>