Ready for what's next.

# Emerging Earned Value Management Technique

## *Earned Schedule*

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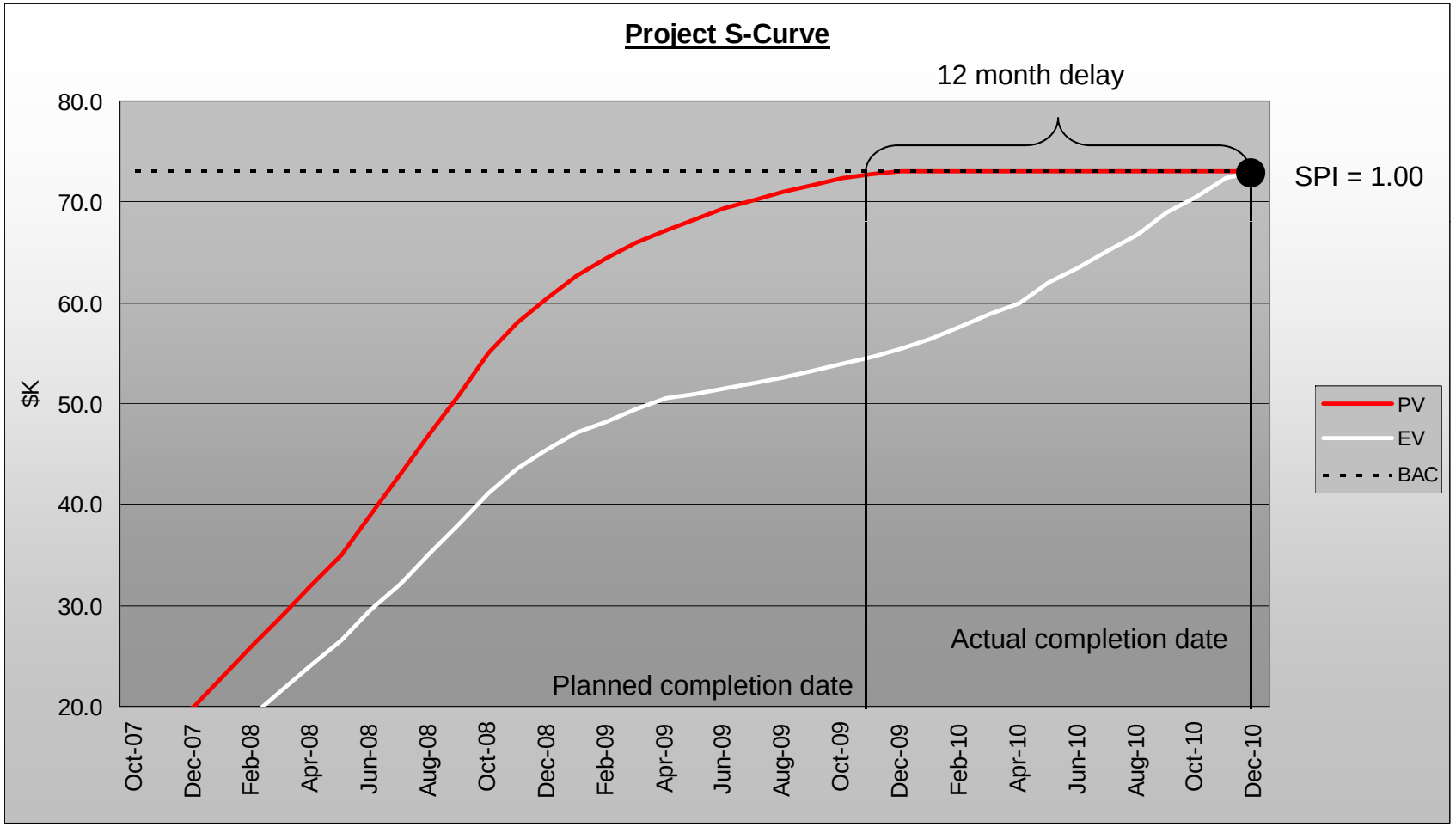
## Introduction to Speakers

- **Our EVM Experience:**
  - PMO-level EVM Support for Projects at EPA, GSA
  - Program-level EVM Analysis at US Coast Guard
  - CIO-level EVM Analysis for USAID
  - Generate EVM data and reports for Booz Allen Projects

# What is Earned Schedule?

- **A New Metric**
  - Lipke devised a new metric to combat SV and SPI limitations and created *Earned Schedule*
    - A measure of work completed in a designated increment of time
- **Added Value without extra data collection**
  - Additional calculation based on data collected for ANSI-748 Compliant Earned Value Management System
    - Inputs: Start date (plus last day of first month), finish date (plus last day of previous month), PV, EV and BAC
    - Outputs: Earned Schedule, forecasted completion date
- **A technique to compensate for the downfall of traditional Earned Value and SPI calculations**
  - No matter the project, the delay, or early delivery, SPI and SV will always track back to unity at then end of every PoP showing perfect schedule adherence at complete
- **Basis for Intuitive Schedule Forecasts**
  - Provides scheduled forecast in dates based on current schedule performance metrics applied to the duration of work remaining

# Weakness of traditional EVM: a project that finishes late has an SPI = 1.00 once all planned work is complete

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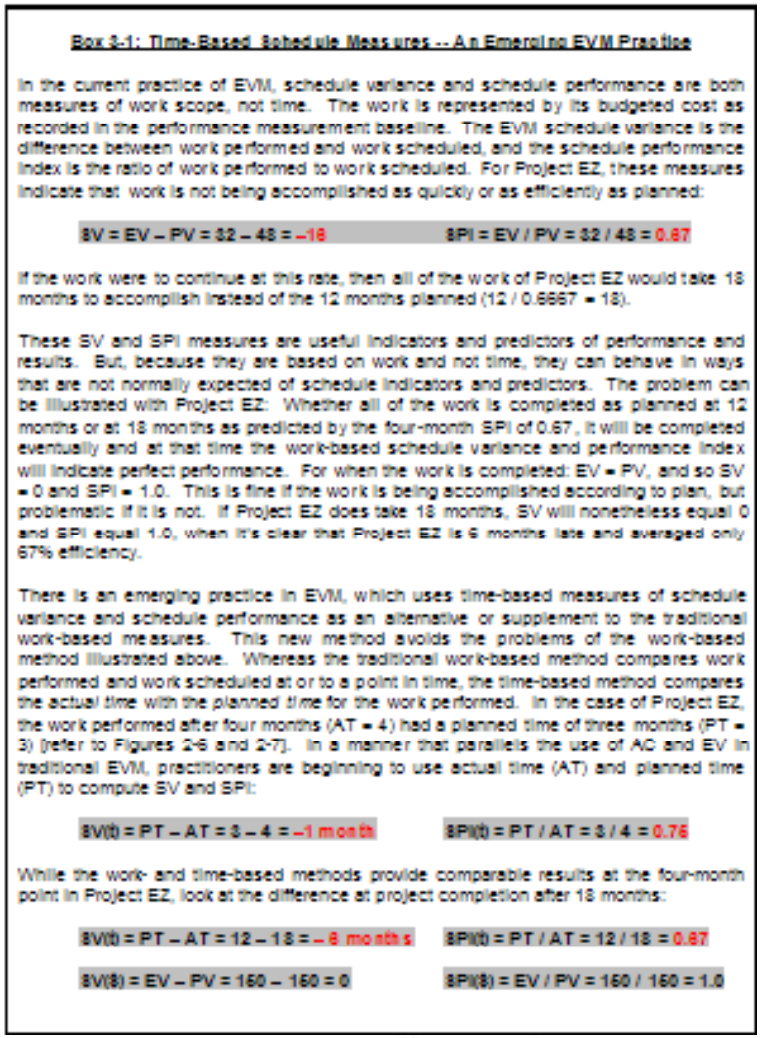
## Credibility of Methodology

- **Included as Emerging Practice in EVM Practice Standard (2004)**
  - Basic principles described
- **Method validated by a combination of research and case study examples**
  - Academic research
    - U of Ghent – Belgium using simulated network schedules
  - Practitioner research
    - Retrospective analysis using real project data. E.g. Henderson and Vandevoorde
  - Case study examples
    - Lew Hecht – US Navy case study
- **Global uptake of the method**
  - Reported practitioner experiences
- **See Earned Schedule website**



**Box 3-1: Time-Based Schedule Measures -- An Emerging EVM Practice**

In the current practice of EVM, schedule variance and schedule performance are both measures of work scope, not time. The work is represented by its budgeted cost as recorded in the performance measurement baseline. The EVM schedule variance is the difference between work performed and work scheduled, and the schedule performance index is the ratio of work performed to work scheduled. For Project EZ, these measures indicate that work is not being accomplished as quickly or as efficiently as planned:

SV = EV – PV = 32 – 48 = –16 SPI = EV / PV = 32 / 48 = 0.67

If the work were to continue at this rate, then all of the work of Project EZ would take 18 months to accomplish instead of the 12 months planned (12 / 0.6667 = 18).

These SV and SPI measures are useful indicators and predictors of performance and results. But, because they are based on work and not time, they can behave in ways that are not normally expected of schedule indicators and predictors. The problem can be illustrated with Project EZ: Whether all of the work is completed as planned at 12 months or at 18 months as predicted by the four-month SPI of 0.67, it will be completed eventually and at that time the work-based schedule variance and performance index will indicate perfect performance. For when the work is completed: EV = PV, and so SV = 0 and SPI = 1.0. This is fine if the work is being accomplished according to plan, but problematic if it is not. If Project EZ does take 18 months, SV will nonetheless equal 0 and SPI equal 1.0, when it's clear that Project EZ is 6 months late and averaged only 67% efficiency.

There is an emerging practice in EVM, which uses time-based measures of schedule variance and schedule performance as an alternative or supplement to the traditional work-based measures. This new method avoids the problems of the work-based method illustrated above. Whereas the traditional work-based method compares work performed and work scheduled at or to a point in time, the time-based method compares the actual time with the planned time for the work performed. In the case of Project EZ, the work performed after four months (AT = 4) had a planned time of three months (PT = 3) (refer to Figures 2-6 and 2-7). In a manner that parallels the use of AC and EV in traditional EVM, practitioners are beginning to use actual time (AT) and planned time (PT) to compute SV and SPI:

SV(t) = PT – AT = 3 – 4 = –1 month SPI(t) = PT / AT = 3 / 4 = 0.75

While the work- and time-based methods provide comparable results at the four-month point in Project EZ, look at the difference at project completion after 18 months:

SV(t) = PT – AT = 12 – 18 = – 6 months SPI(t) = PT / AT = 12 / 18 = 0.67

SV($) = EV – PV = 160 – 160 = 0 SPI($) = EV / PV = 160 / 160 = 1.0

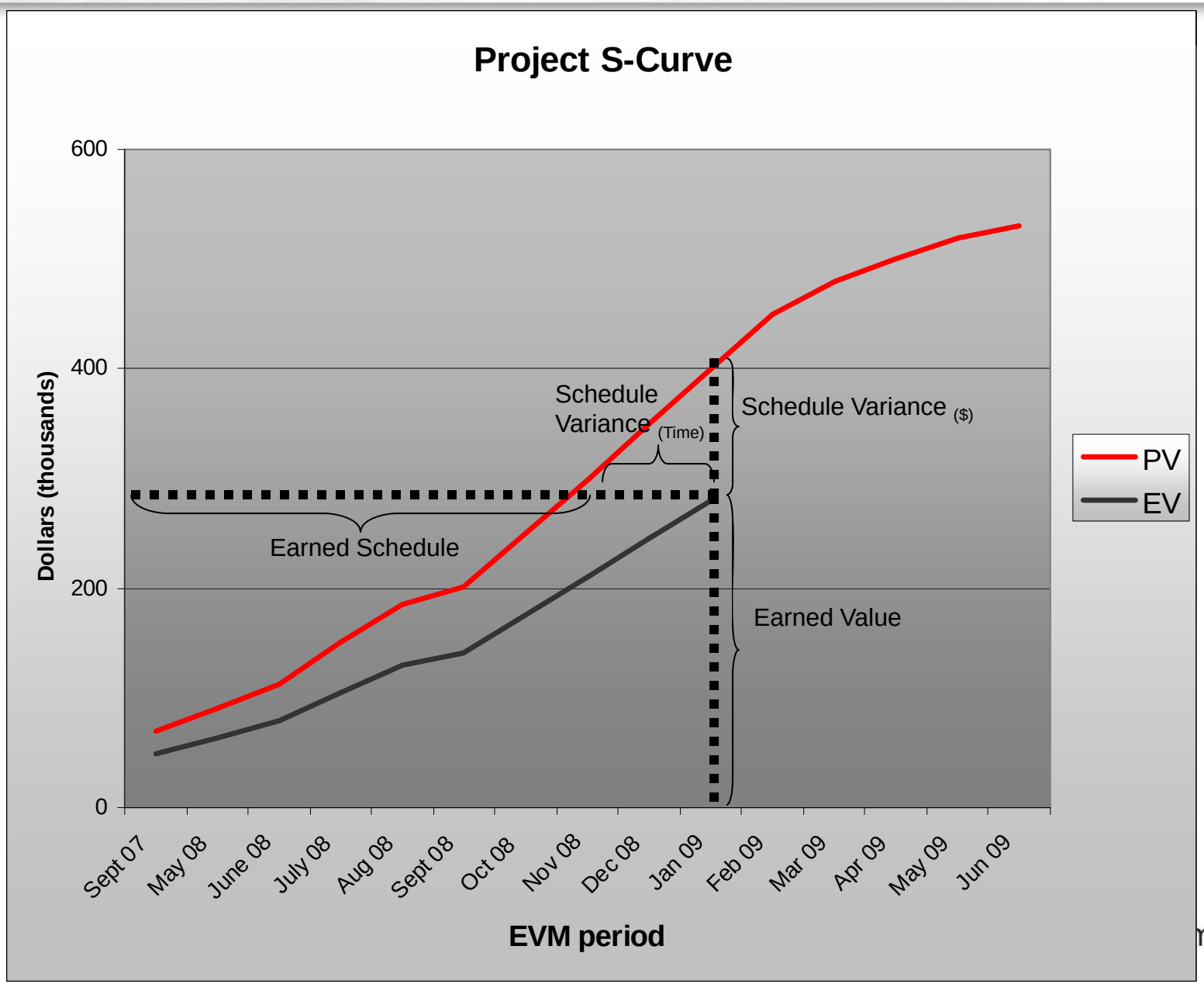
## Drivers for using Earned Schedule

- **Provide Reality Check for critical path date**
  - Provides an independent estimate at complete in time. This can be compared against the critical path to assess its reasonableness.
- **Provide project controls benefit for the investment into an EVMS on an FFP project**
- **Compensate for limitations of SPI and SV**
  - SPI and SV always show perfect schedule adherence at the end of every completed project
  - Most useful during part of project when SPI trends to 1.0
  - Thinking of schedule in terms of dollars is hard; ES converts dollars to time making schedule metrics more easily understood
- **Assess and compensate for reliability of IMS is in question**

## Earned Schedule metrics work in the same manner as Earned Value cost metrics

| **Earned Value** *Unit of Measurement: Dollars ($)* | **Earned Schedule** *Unit of Measurement: Time (t)* |
|---|---|
| Earned Value (EV) | Earned Schedule (ES) |
| Actual Cost (AC) | Actual Time (AT) |
| SV = EV-PV | $SV_t$ = ES-AT |
| SPI = EV/PV | $SPI_t$ = ES/AT |
| Estimate at Complete (EAC) | Estimate at Complete ($EAC_{time}$) |
| Budget at Complete (BAC) | Planned Duration (PD) number of periods |
| Budgeted Cost for Work Remaining (BCWR=BAC-$BCWP_{cum}$) | Planned Duration for Work Remaining (PDWR = PD-ES) |
| To Complete Performance Index (TCPI) = BCWR / ETC | To Complete Schedule Performance Index (TSPI) = PDWR / Time Remaining |

# Ready for what's next.

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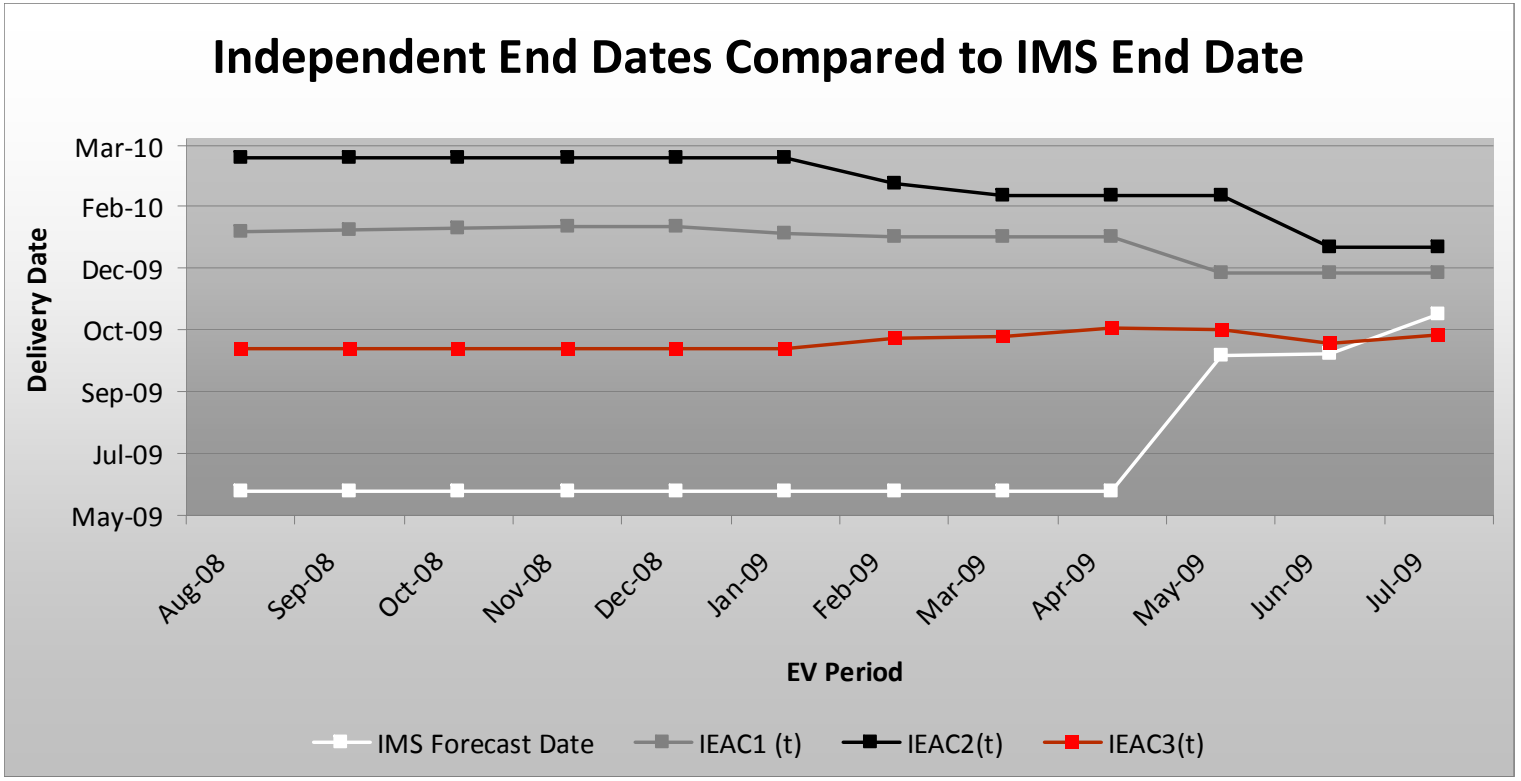
## Using Earned Schedule forecasts, in conjunction with other schedule forecasts can lead to early warning of late delivery



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# Background: Project objective and Booz Allen role

- The Project will replace the client's financial system with new software and business processes. The Project is a high-risk, high-impact system implementation project therefore a successful result is critical to the client.
- Booz Allen has provided support to The Agency in the following areas:
  - Project Management
  - Accounting and Financial Management Advisory Services
  - Data Standardization
  - CPIC Support
  - Data Migration Strategy
  - Review of Internal Controls

**Booz Allen support under the Project Management Task Order:**

✓PM Procedures

✓PM Tools analysis

✓PM Tools Configuration and Implementation

✓Project Management Plan

✓PMO operations

✓Risk Management

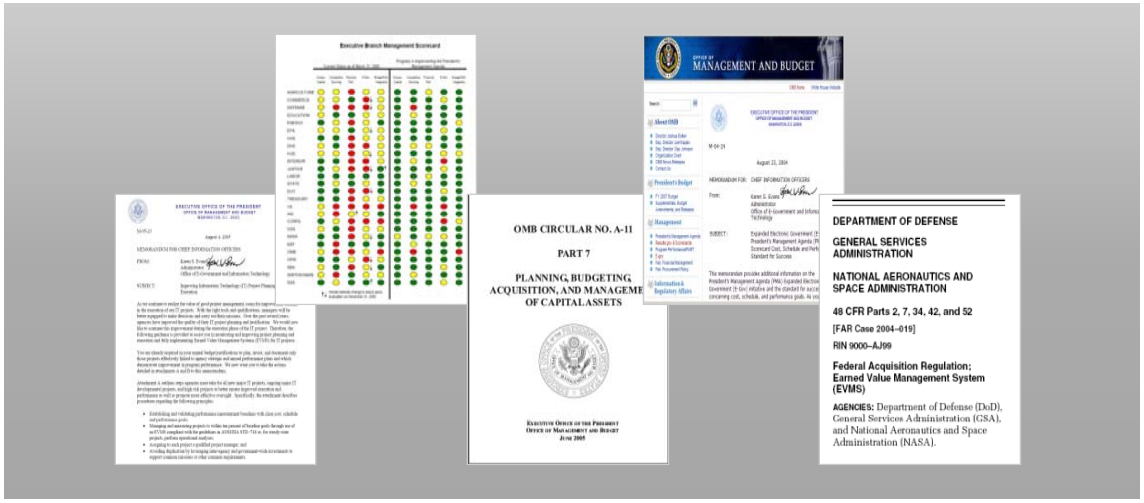
✓Quality Management

✓Integrated Baseline Review

✓Monthly EVM Status Process

## EVM-related business problem and challenges

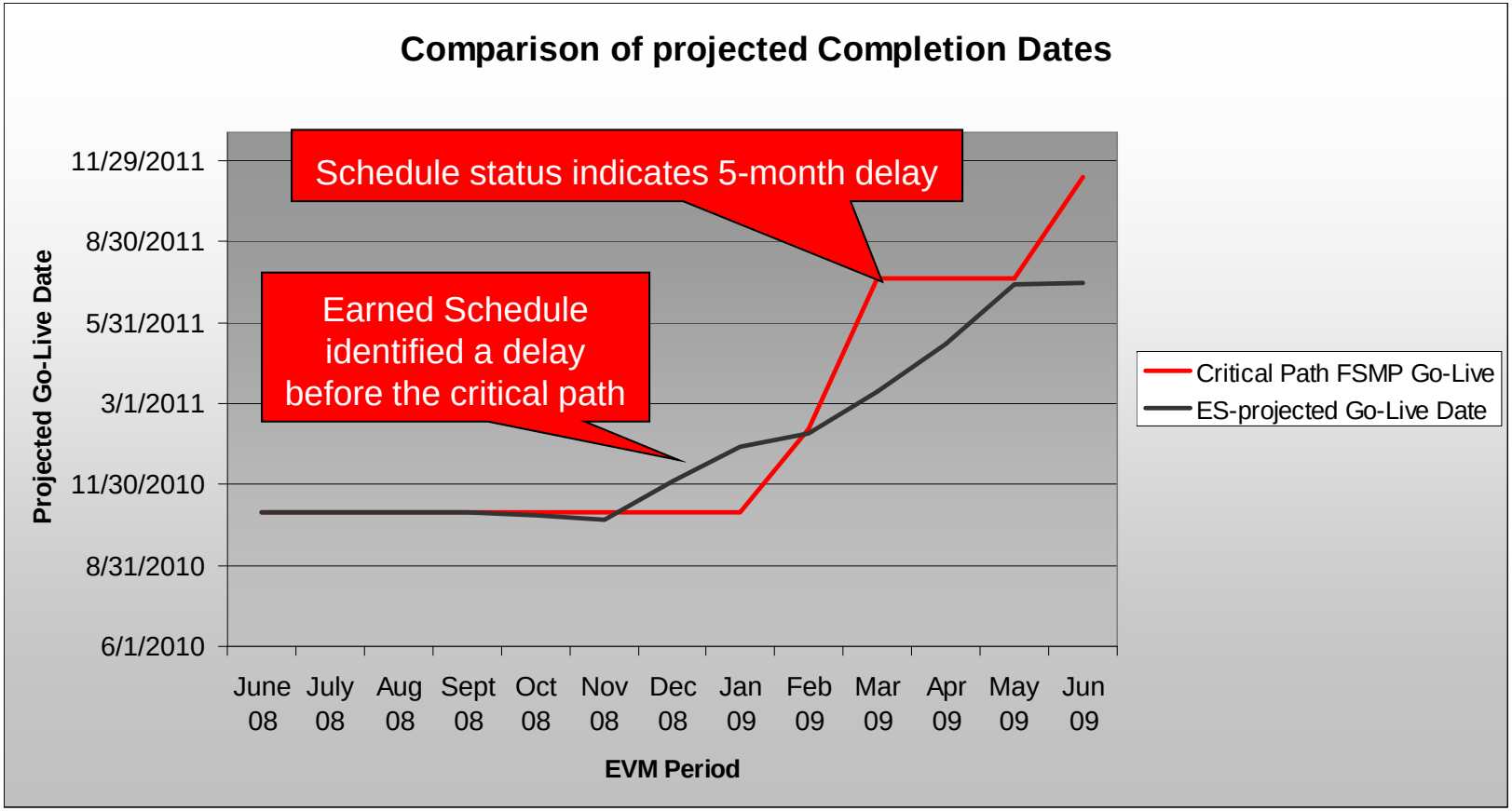
- OMB Mandate to maximize use of fixed priced contracting and OMB mandate to perform Earned Value Management
- Management's desire for accountability as well as compliance
- Definition roles and responsibilities (team lead, CAM, organizational role)
- Changing level of project controls maturity: Initial perception that the work is not integrated and that there were no dependencies between task areas to current integrated project plan with resources loaded at the activity level



# Project History

- April 2008 Implementation Contractor Award
- June 2008 Integrated Baseline Review
  - 10/1/2010 go-live
  - The Agency resources planned in LOE work packages
- Project experiences implementation delays
  - Account Code Structure delay
  - BPR Core Lead Staffing
- August 2009 Integrated Baseline Review
  - 11/14/2011 go-live
  - The Agency resources planned in detailed milestone-work packages

# Looking Back: Earned Schedule view of the project



# Looking Forward: How to present ES to the client

Estimate at Complete ($EAC_{\$}$)

$BAC_{\$}$: Budget at Complete

Independent Cost Estimates

$EAC_1 = AC + (BAC - BCWP_{cum})$
$EAC_2 = AC + (BAC - BCWP_{cum})/CPI$
$EAC_2 = AC + (BAC - BCWP_{cum})/(CPI*SPI)$
$EAC_3 = AC + (BAC - BCWP_{cum})/(0.8*CPI + 0.2*SPI)$

LRE: *Manager's latest revised estimate*

CAM's latest cost plan

Independent Time Estimates

Estimate at Complete ($EAC_{time}$)

Planned Duration: *number of months*
Planned End Date: *planned end date*

Status Date: *number of months since project start*
Earned Schedule: *number of months of work accomplished*

$IEAC_1(t) = AT + (cum\ SPI(t)* PDWR)$
$IEAC_2(t) = AT + (3\ month\ SPI(t) * PDWR)$
$IEAC_3(t) = AT + (PDWR)$

Project End Date: *date from MS Project Schedule*

Critical Path Analysis

CAM's latest schedule plan

# Sample with Metrics: Data conversion

Estimate at Complete ($EAC_{\$}$)

$BAC_{\$}$: 1,000,000

$EAC_1$ = 1,040,000
$EAC_2$ = 1,080,000
$EAC_2$ = 1,134,000
$EAC_3$ = 1,081,970

LRE: 1,100,000

Estimate at Complete ($EAC_{time}$)

Planned Duration: *21 Months*
Planned End Date: *October 2010*

Status Date: *7 Months*
Earned Schedule: *4 Months*

IEAC1(t) = *28 Months – May 2011*
IEAC2(t) = *30 Months – July 2011*
IEAC3(t) = 24 Months – January 2011

Project End Date: 22 Months – November 2010

Critical Path Analysis: Data Conversion is forecasted to be 2 months late, and is on the critical path. Therefore, it will push the go-live date out 2 months.

## Using Earned Schedule to enhance Control Account accountability

| Control Account | Critical Path Milestone |
|---|---|
| Business Process Reengineering | Process Maps Approved |
| Configuration | Compiled Configuration Guides Complete |
| Conversion | Production Conversion Complete |
| Integration | Integration Test Complete |
| Testing | User Acceptance Test Complete |
| Training | Refresher Training Complete |
| The Project Project | The Project Go-Live |

## Case Study take aways

- Earned Schedule projected the delay before the IMS did
- Earned Schedule is useful, even if the project schedule is not robust
- For analysis and reporting purposes, we need to calculate Earned Schedule at the project level. For management and accountability purposes, we need to calculate it at the task area level.
- This client needed to perform detailed planning in order to develop an executable plan
- Earned Schedule is only as good as your Earned Value data. If the data does not accurately represent the state of the project, it will not be a provide an accurate Estimate At Complete
- While the PM Lead appreciated the significance of Forecasting ES, consideration of Team Lead EVM maturity postponed rollout
- Earned Schedule calculations by task area require an Excel Spreadsheet, and are not supported by EVM tools… yet

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## Government Asset Acquisition Program

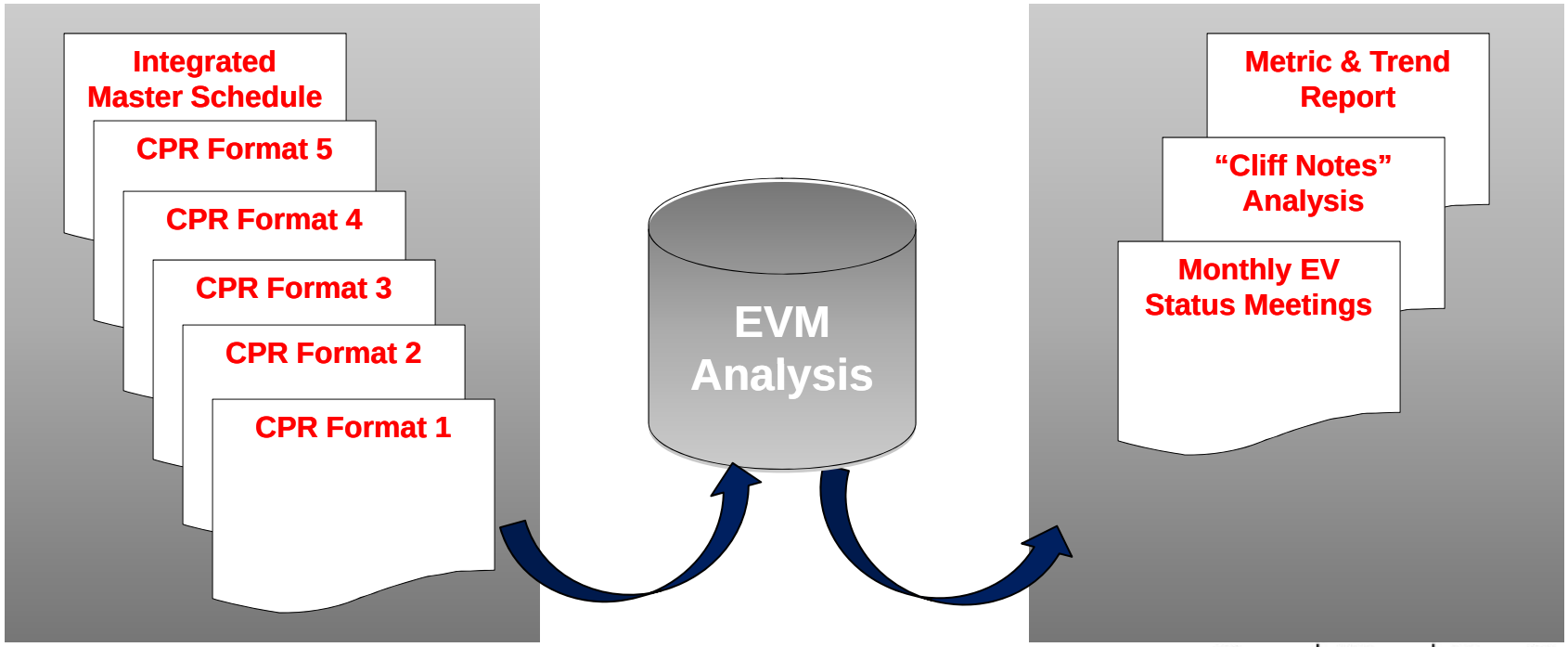
- Background
  - A $20+ billion, 25 year project aimed at updating the agency's entire fleet of assets
  - The agency awarded the contract to a major contractor who integrated the efforts of two major primes
  - The lead integrator was in charge of all Project Management activities
  - The client worked closely with contractors yet had little access to early warning signs into many of the eventual problems on the project

## Programmatic problems forced the agency to assume sole ownership of project management roles

- After major programmatic and operational problems and highly negative media attention on one of its higher-profile projects, the agency took sole ownership of the integration and management activities
- Since 2007 the agency has matured its project management capabilities including Earned Value (EV) analysis and IMS analysis/management; Booz Allen has been the lead in collecting, analyzing, and reporting on this data

## Booz Allen leads the Earned Value analysis

- Because of Booz Allen's role within the agency, the team was able to seamlessly implement ES analysis on one of the bigger projects in order to enhance monthly support



## Case Study: Multi-million dollar asset acquisition project
## Why Earned Schedule?

- Although the agency assumed integrator role, the prime still maintains the IMS
  - IMS is very large (over 10,000 lines)
  - IMS is integrated with dozens of projects
  - Contractor attrition has led to delay in IMS updates as well as a lag in delivery
  - IMS not resource loaded
  - Critical path issues
  - The IMS delivered to the agency is populated through other internal reporting systems therefore the IMS is not used as an agile project management tool by the contractor; rather it is merely a static deliverable delivered to the agency on a monthly basis

  - *All of these factors have made timely schedule analysis difficult to perform*

## Case Study:
## Why Earned Schedule?

- As the lead integrator, and in response to the poor cost performance on the first in class asset, the agency has matured their cost estimation capabilities on in-progress projects
- The first asset experienced both cost *and* schedule slips, yet schedule prediction capabilities have not matured at the same rate as cost prediction capabilities
- Because the agency did not fully trust the IMS data and they were not maturing their schedule prediction capabilities at the same rate as their cost prediction capabilities, Booz Allen implemented the use of ES on this contract

# Case Study:
# Earned Schedule as a schedule predictor – Inputs

- The Booz Allen EV support team implemented the use of Earned Schedule analysis on this project using Lipke and Henderson's available tools in Jan '09
- Lipke's ES Calculator is now used to derive ES metrics
  - Uses only EV data taken from the format 1 and contract
  - Example shown below

| | Initial Project Data | | | | | | | | | | | Project at Complete Data | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Status Date 7/26/2009 | Actual Start Date 1st Day of the Next Month 1st Month Fraction | | 10/27/2007 11/26/2007 0.9667 | Planned Completion Date Last Day of Previous Month Last Month Fraction | | | 6/15/2009 5/27/2009 0.6000 | Planned Duration Remain 2.8 Original Duration 19.6 Budget at Complete 28,511.43 | | | Actual Compl Date = Last Day Previous Mo = Last mo Fraction (Act) = 0.0000 | | | |
| Date | BCWPcum | BCWScum | # Pc=>Sc | E-Count | Numerator | enominat | InterpVal | EScum | ESmo | SPI(t)mo | SPI(t)cum | A-Count | AT | SV(t)mo | SV(t)cum |
| 11/25/2007 | 895.49 | 893.46 | 1 | 0.9667 | 2 | 1495 | 0.0014 | 0.9680 | 0.9680 | 1.0014 | 1.0014 | 1 | 0.9667 | 0.0014 | 0.0014 |
| 12/23/2007 | 1,792.57 | 2,387.99 | 1 | 0.9667 | 899 | 1495 | 0.6016 | 1.5683 | 0.6002 | 0.6002 | 0.7974 | 2 | 1.9667 | -0.3998 | -0.3984 |
| 1/27/2008 | 2,652.34 | 3,141.29 | 2 | 1.9667 | 264 | 753 | 0.3509 | 2.3176 | 0.7493 | 0.7493 | 0.7812 | 3 | 2.9667 | -0.2507 | -0.6491 |
| 2/24/2008 | 4,045.69 | 4,853.52 | 3 | 2.9667 | 904 | 1712 | 0.5282 | 3.4949 | 1.1773 | 1.1773 | 0.8811 | 4 | 3.9667 | 0.1773 | -0.4718 |
| 3/23/2008 | 4,975.78 | 6,375.50 | 4 | 3.9667 | 122 | 1522 | 0.0803 | 4.0470 | 0.5521 | 0.5521 | 0.8148 | 5 | 4.9667 | -0.4479 | -0.9197 |
| 4/27/2008 | 6,549.87 | 8,107.34 | 5 | 4.9667 | 174 | 1732 | 0.1007 | 5.0674 | 1.0204 | 1.0204 | 0.8493 | 6 | 5.9667 | 0.0204 | -0.8993 |
| 5/25/2008 | 7,238.17 | 9,717.40 | 5 | 4.9667 | 863 | 1732 | 0.4981 | 5.4648 | 0.3974 | 0.3974 | 0.7844 | 7 | 6.9667 | -0.6026 | -1.5019 |
| 6/22/2008 | 8,708.07 | 11,106.35 | 6 | 5.9667 | 601 | 1610 | 0.3731 | 6.3398 | 0.8750 | 0.8750 | 0.7958 | 8 | 7.9667 | -0.1250 | -1.6269 |
| 7/27/2008 | 9,773.59 | 12,536.05 | 7 | 6.9667 | 56 | 1389 | 0.0405 | 7.0071 | 0.6673 | 0.6673 | 0.7815 | 9 | 8.9667 | -0.3327 | -1.9595 |
| 8/24/2008 | 11,052.40 | 13,908.63 | 7 | 6.9667 | 1335 | 1389 | 0.9612 | 7.9278 | 0.9207 | 0.9207 | 0.7954 | 10 | 9.9667 | -0.0793 | -2.0388 |
| 9/21/2008 | 11,647.55 | 15,085.90 | 8 | 7.9667 | 541 | 1430 | 0.3785 | 8.3452 | 0.4174 | 0.4174 | 0.7610 | 11 | 10.9667 | -0.5826 | -2.6215 |
| 10/26/2008 | 12,985.19 | 16,353.77 | 9 | 8.9667 | 449 | 1373 | 0.3272 | 9.2939 | 0.9487 | 0.9487 | 0.7766 | 12 | 11.9667 | -0.0513 | -2.6728 |
| 11/30/2008 | 13,798.95 | 17,371.17 | 9 | 8.9667 | 1263 | 1373 | 0.9201 | 9.8868 | 0.5929 | 0.5929 | 0.7625 | 13 | 12.9667 | -0.4071 | -3.0799 |
| 12/21/2008 | 14,617.10 | 18,514.85 | 10 | 9.9667 | 708 | 1177 | 0.6018 | 10.5685 | 0.6817 | 0.6817 | 0.7567 | 14 | 13.9667 | -0.3183 | -3.3982 |
| 1/25/2009 | 15,342.95 | 19,335.17 | 11 | 10.9667 | 257 | 1268 | 0.2027 | 11.1694 | 0.6010 | 0.6010 | 0.7463 | 15 | 14.9667 | -0.3990 | -3.7973 |
| 2/22/2009 | 16,195.52 | 20,239.84 | 11 | 10.9667 | 1110 | 1268 | 0.8752 | 11.8418 | 0.6724 | 0.6724 | 0.7417 | 16 | 15.9667 | -0.3276 | -4.1248 |
| 3/22/2009 | 17,074.91 | 21,077.74 | 12 | 11.9667 | 721 | 1017 | 0.7088 | 12.6755 | 0.8336 | 0.8336 | 0.7471 | 17 | 16.9667 | -0.1664 | -4.2912 |
| 4/26/2009 | 18,103.71 | 21,821.50 | 13 | 12.9667 | 733 | 1144 | 0.6405 | 13.6072 | 0.9317 | 0.9317 | 0.7574 | 18 | 17.9667 | -0.0683 | -4.3595 |
| 5/24/2009 | 19,027.52 | 22,679.42 | 14 | 13.9667 | 513 | 820 | 0.6250 | 14.5916 | 0.9844 | 0.9844 | 0.7693 | 19 | 18.9667 | -0.0156 | -4.3750 |
| 6/21/2009 | 20,165.68 | 23,522.63 | 15 | 14.9667 | 831 | 905 | 0.9180 | 15.8847 | 1.2931 | 1.2931 | 0.7956 | 20 | 19.9667 | 0.2931 | -4.0820 |
| 7/26/2009 | 20,948.23 | 23,874.77 | 16 | 15.9667 | 708 | 838 | 0.8454 | 16.8121 | 0.9274 | 0.9274 | 0.8018 | 21 | 20.9667 | -0.0726 | -4.1546 |

## Case Study:
## Earned Schedule as a schedule predictor – Outputs

- **Lipke and Henderson's template feeds these tables which show current metrics**
  - The SPI($) has since began to trend back to 1.00 where the ES data shows a more realistic view of schedule performance

Jan '09 Data

| Earned Schedule Metrics | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Actual Time (AT) | Earned Schedule (ES) | SV[t] | Planned Duration Work Remaining | Baseline Duration | SPI Trend | SPI(t) | TSPI | SPI($) |
| 14.97 Months Elapsed (since Rebaseline) | 11.17 Months Worth of Work Complete | 3.8 Months Behind Schedule | 8.46 Months of Work Remaining | 4.66 Months To Original Delivery | ↓ | 0.75 | 1.81 | 0.79 |

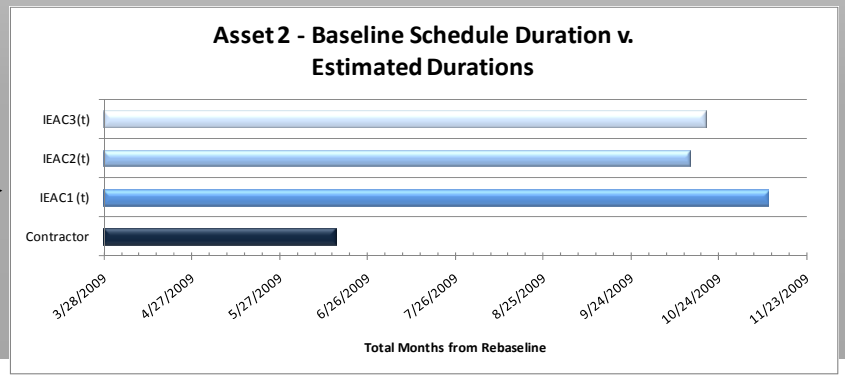
Jul '09 Data

| Earned Schedule Metrics | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Actual Time (AT) | Earned Schedule (ES) | SV[t] | Work Remaining | Baseline Duration | Trend | SPI(t) | TSPI | SPI($) |
| 20.97 Months Elapsed (since Rebaseline) | 16.81 Months Worth of Work Complete | 4.15 Months Behind Schedule | 2.82 Months of Work Remaining | -1.34 Months To Original Delivery | ↑ | 0.80 | -2.10 | 0.88 |

# Case Study:
# Earned Schedule as a schedule predictor – Outputs

- Metrics are used to create end dates based on schedule performance
  - The tables below compare contractor to three independent estimates
    - IEAC1 (t) = Uses cumulative SPI (t)
    - IEAC2 (t) = Uses three month rolling SPI (t)
    - IEAC3 (t) = Assumes all work will complete as scheduled with an SPI(t) of 1.00

| Status Date | 7/26/2009 | Estimated Completion Dates | | |
|---|---|---|---|---|
| | Contractor | IEAC1 (t) | IEAC2(t) | IEAC3(t) |
| End Date | 6/15/2009 | 11/9/2009 | 10/14/2009 | 10/19/2009 |
| Total Months from Rebaseline | 20 | 24.5 | 23.6 | 23.8 |

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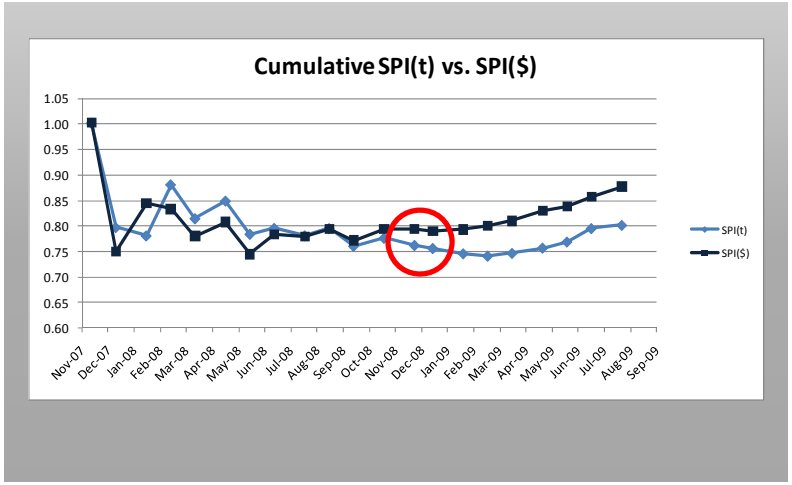
## Case Study:
## Synopsis of the project before implementation of ES

- Before Earned Schedule Implementation (December '08 Data):
  - Delivery Date in the schedule: 6/16/09
  - Contractor admitted to a 12 week slip that IMS did not reflect
  - SPI($) was beginning to track back to 1.00

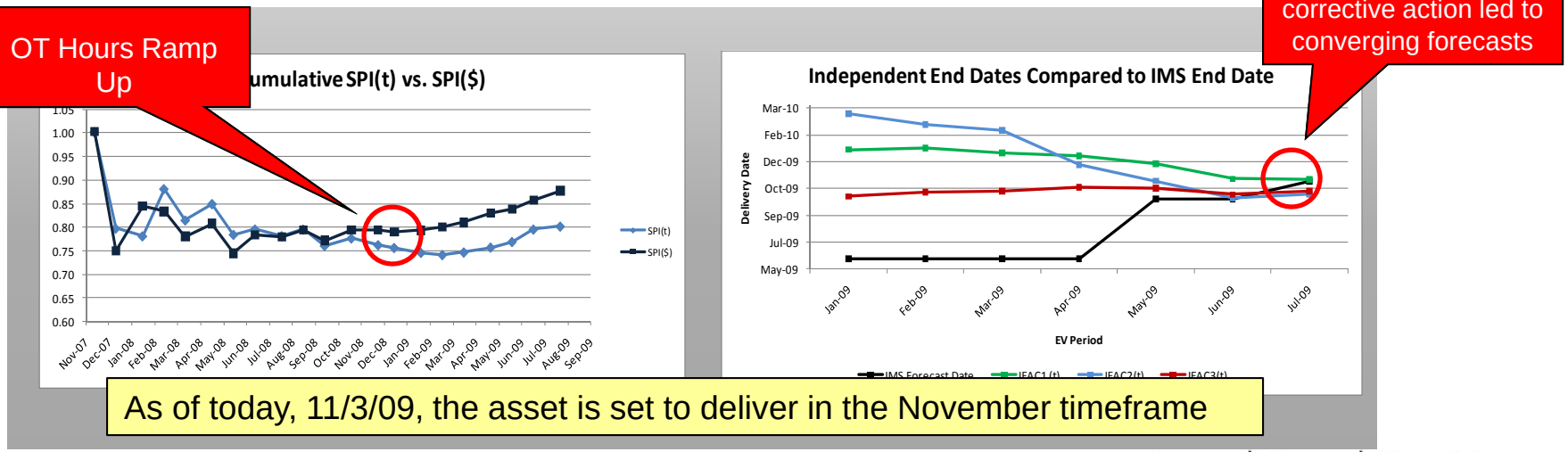


## Case Study:
## Synopsis of the project during implementation of ES

- After Earned Schedule Implementation (January '09 Data):
  - ES predicted a 6-8 month slip in delivery
  - Agency has since allowed the use of OT hours to catch up
  - As delivery nears, schedule has improved dramatically and both agency and contractor have agreed that a mid November delivery is possible. Therefore early warning signs allowed agency to correct a potential 8 month slip to only 5 months

OT Hours Ramp Up

Early detection and corrective action led to converging forecasts




As of today, 11/3/09, the asset is set to deliver in the November timeframe

## Case Study:
## ES is then used in conjunction with other forecasts

- ES is not used as a stand-alone predictor however; it is used in conjunction with other sources of input
  - CPR format 5 and informal communication coming from the contractor
  - Cost data, invoices, estimates
  - Burn Rates
  - Integrated Master Schedule
  - Senior level management expectations and goals

- Ultimately ES is used with these sources of input in order to gain a more thorough picture of schedule performance so that the agency has a better idea of when their assets will be delivered

## Government Agency Case Study – Take aways

- Earned Schedule is a better predictor than the information that was being provided by integrator
- ES has become a good add-on to verify end dates and keep the contractor accountable
- ES is a reliable add-in for any EV project but it should not be used as a stand-alone tool because of many factors affecting the reliability of the data
  - Material tasks earn the same schedule as labor tasks
  - Control Accounts hold both Labor and LOE tasks effectively washing out true schedule performance
  - At the level we applied it, ES does not weigh critical path tasks differently than non critical path tasks
  - More reliable at the control account level; but that was not possible on this project
- Ultimately only as good as the PMB

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## Resources for adopting Earned Schedule

- **Earned Schedule Website, including papers and training resources**
  - http://www.earnedschedule.com/Home.shtml
- **Wikipedia Site**
  - http://en.wikipedia.org/wiki/Earned_Schedule

## Earned Schedule Implementation Tips

- Educate your client or customer
- Make take time for adoption
- Even if you don't present ES metrics, they could contribute to better variance analysis
- Needs solid EVM data and a well constructed project schedule
  - LOE Tasks, Material Costs can dilute ES Data
- Run time before presenting to your client or customer is helpful
  - Helps detect IMS/EV integration problems
- Needs to be used in context of all PM tools
- When project is rebaselined you must set ES back to 0

## Speaker Points of Contact


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