



Using Schedule Metrics to Provide Insight into Project Performance

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Introduction



- Programmatic assessments of small programs/projects such as Class D missions or similar can be challenging, since most do not have EVM reporting and/or formal IMS submission requirement
- Schedule metrics can provide valuable insights about recent performance and can help warn project management of potential issues
 - *Certain schedule metrics can be applied to lower level WBS elements to identify trends in performance that can be of value to decision makers*
- Certain types of metrics also tend to be more insightful than others, due to the nature of how these types of projects perform in implementation
- Schedule metrics can also be used for simple forecasting in the absence of more rigorous probabilistic methods
- This presentation will provide an overview of these schedule metrics and how they can be implemented
 - *The assumptions for application and examples for these metrics will also be discussed*

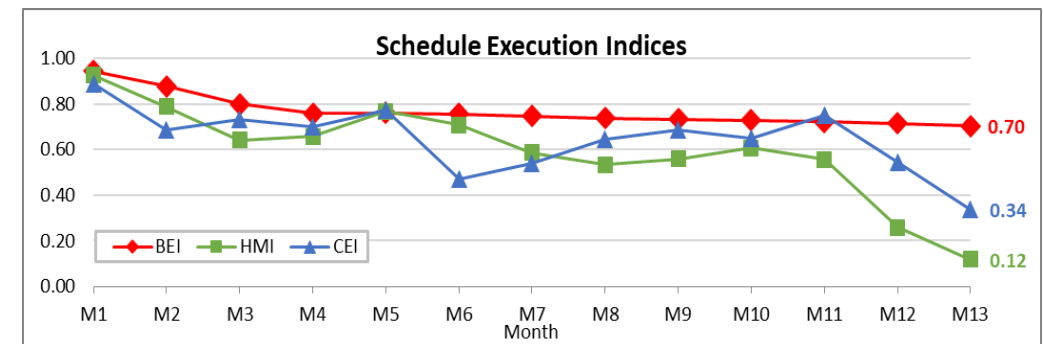
Schedule Metrics Trending Overview



- Standard schedule metrics provide insight into project efficiency with respect to baseline and forecast schedules
 - *Metrics are accepted across the schedule assessment community and are part of the GSFC Business Change Initiative (BCI) and other federal agency suite of schedule execution metrics*
 - BEI and BEI-adj
 - HMI and HMI-adj
 - CEI and CEI-adj
 - Schedule Workoff
 - *Metrics are applied at the total project level and at the WBS elements to highlight specific areas of concern*

Metric	What It Is	Primary Benefit
BEI	Cumulative measure against the baseline	Objectively indicates how efficient the project in executing to its schedule baseline
HMI	Monthly measure against the baseline	Early indicator of whether the schedule baseline is achievable
CEI	Monthly measure against the prior month's plan	Objective indicator of the quality of month-to-month schedule forecasts
Schedule Workoff	Measure of tasks 30-day late	Provides an early indication that a project may need more resources to work off late tasks

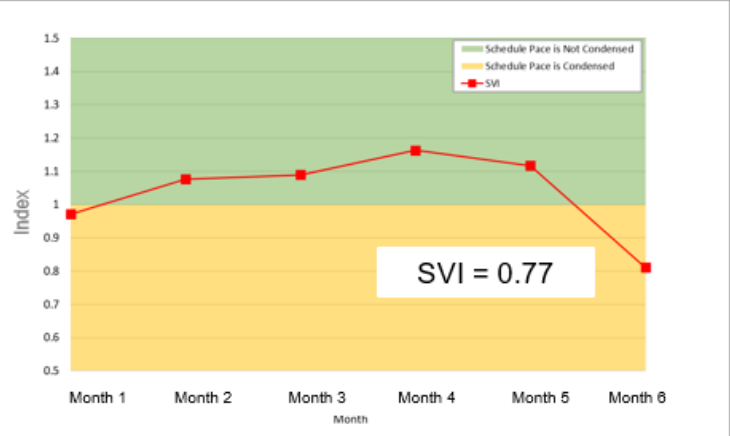
Additional information is provided in the Backup charts



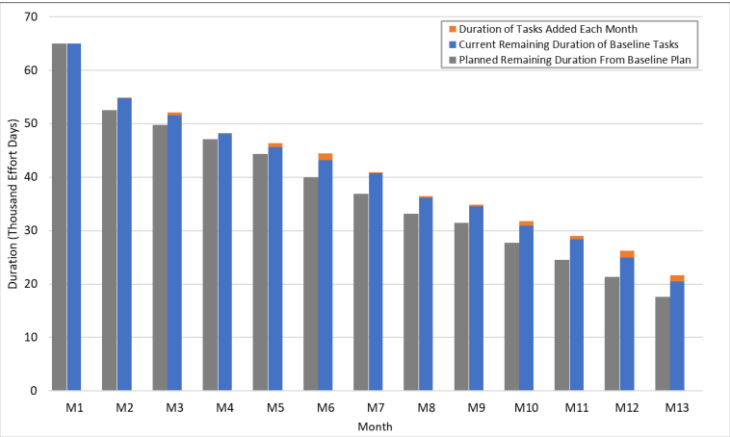
Schedule Metrics Trending Overview (cont.)

- Additional schedule metrics applied by the Aerospace Corporation may also provide a different perspective on the programs/projects' performance
 - *Schedule Velocity Index (SVI)*
 - *Task Duration Growth*
 - *Added Task Duration*
 - *Funded Schedule Margin (FSM) Usage*

Metric	What It Is	Primary Benefit
SVI	Measure of project completion rate	Indicator of whether the project is performing faster or slower than the plan and may need to implement schedule compression techniques
Task Duration Growth	Measure of overall schedule duration change	Indicates whether the schedule is growing or compressing significantly
Added Task Duration	Measure of schedule compression or growth	Indicates whether the schedule is growing significantly due to new tasks
FSM Usage	Comparison of remaining FSM	Indicates whether FSM is sufficient for the time remaining until delivery

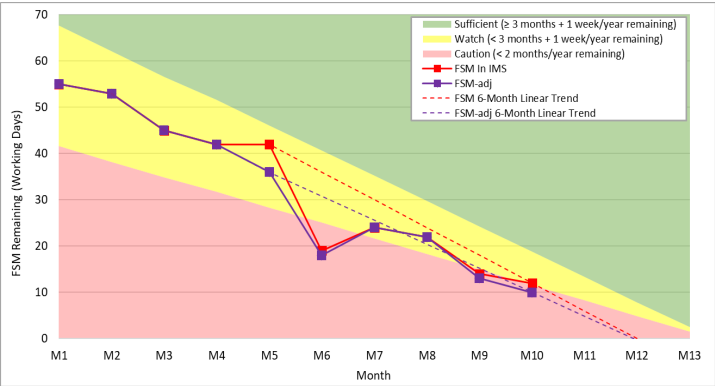


Schedule Velocity Index



Task Duration Growth
& Added Task Duration

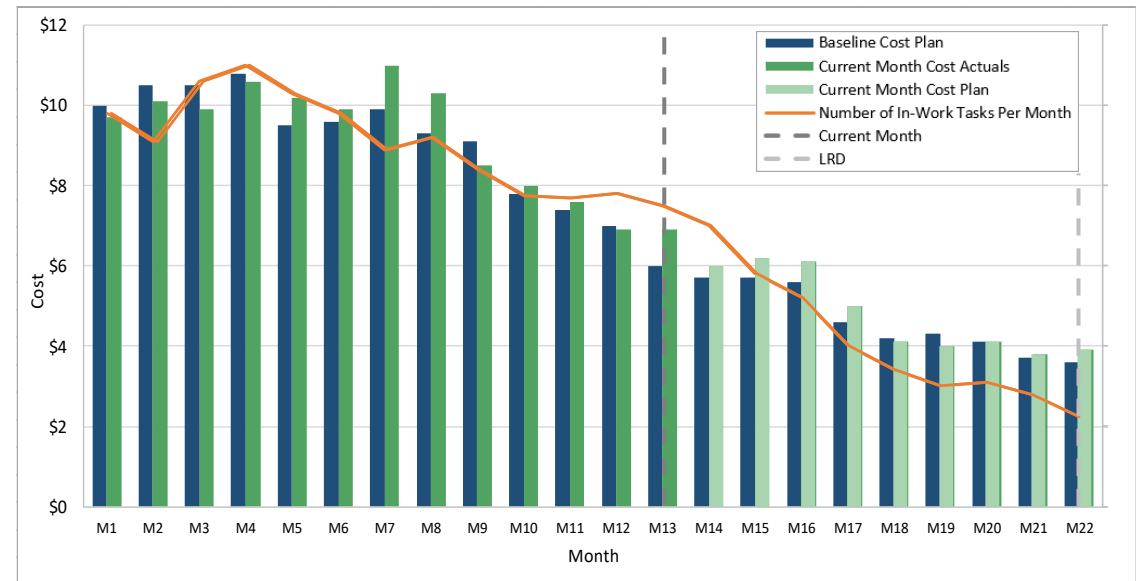
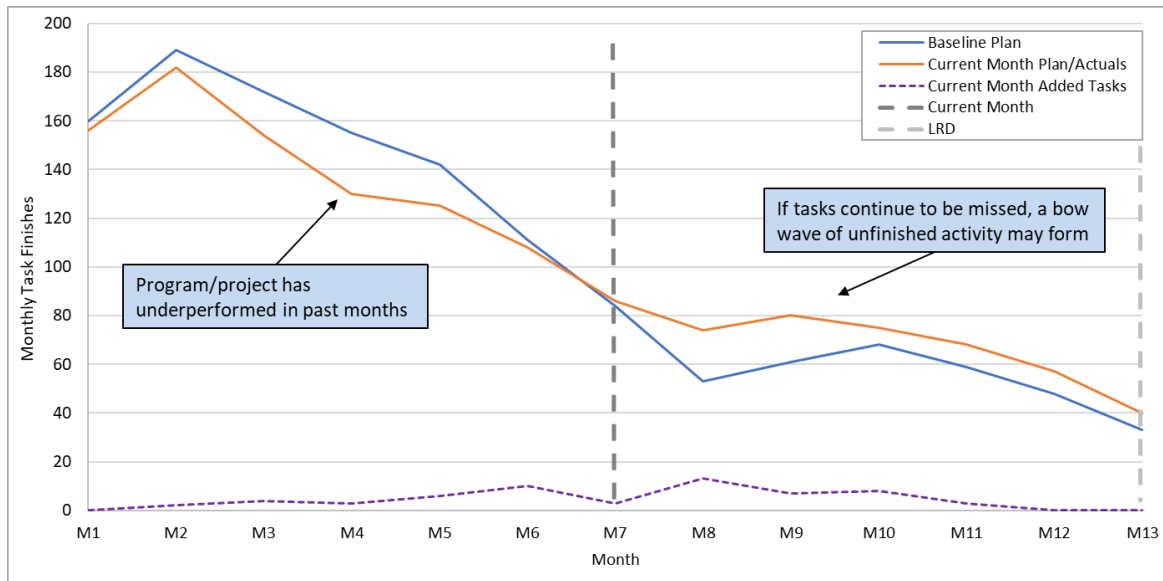
Additional information is provided in the Backup charts



FSM Usage

Task Completion Trending Overview

- Task completion trending is a comparison of task completion in the current month schedule to the baseline or previous month to qualitatively assess whether future tasks can be met
 - Actual task completions are compared to prior schedule plans to assess past program/project performance
 - Forecasted tasks are compared to prior plans to identify potential schedule impact due to missed tasks causing a bow wave of unfinished activity
- Forecasted tasks can also be compared to program/project cost plan to identify differences between the number of tasks planned and the amount of funding available





Forecasting Techniques Overview

Metrics to Be Used to Forecast a Delivery Date

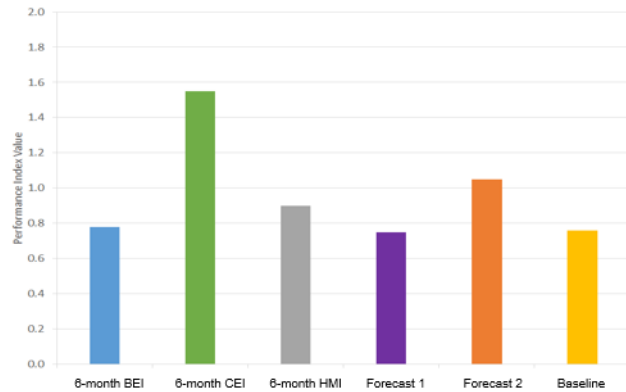
- Technique 1: Using task completion trending
 - *Calculating an average project task completions rate and applying this average task completions rate to the remaining tasks to forecast a delivery date*
 - This can also be used as one possible value of a 3-point estimate for a Schedule Risk Analysis (SRA) if desired; most likely as a best-case scenario
- Technique 2: Using Total Float Consumption Index (TFCI) metric
 - *According to NASA Schedule Management Handbook, TFCI calculates total float as an efficiency factor by applying the average rate of total float consumption to the remaining scope of work, thereby projecting a forecast finish date*
 - This can also be used as one possible value of a 3-point estimate for an SRA if desired; probably a most likely-case scenario
- Technique 3: Using schedule metrics
 - *BEI and CEI provide a performance-based activity duration to develop uncertainty distributions in an SRA to estimate a delivery date*
 - This can also be combined with baseline duration and/or durations derived from options 1 & 2 to determine possible values of a 3-point estimate for the SRA

Schedule metrics can also be used for simple forecasting in the absence of more rigorous probabilistic methods

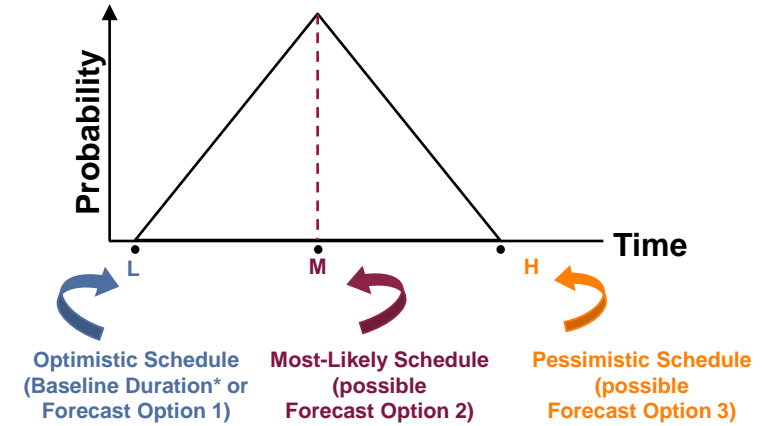
Forecasting Options with SRA

SRA Process

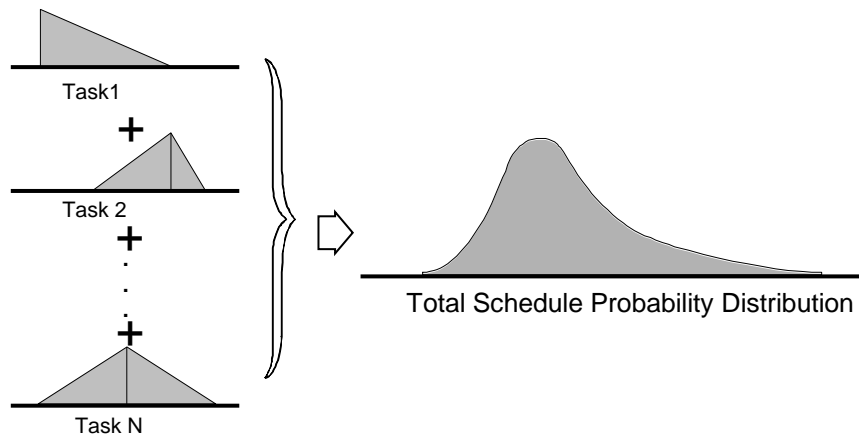
Estimates of Duration Tied to Variation in WBS Element Performance Indices



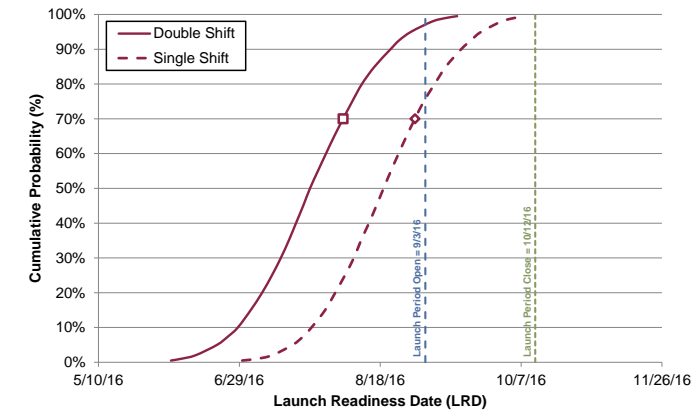
Triangular Distribution of Task Duration



Total Distribution is Based on Schedule Simulation Distributions for Individual Tasks



Example Schedule Distribution



*Note: "Baseline Duration" refers to delivery date without margin to identify earliest possible delivery date



Implementation & Examples



Schedule Task Analysis Categories

- Task performance is analyzed at the lowest WBS elements for a task's performance status through detailed categories to be used for metrics calculations
 - *Delayed tasks*
 - in the baseline that were scheduled to complete but did not
 - from the prior month plan that were scheduled to complete but did not
 - *Revised tasks that were delayed*
 - in the baseline, then completed on time with the revised finish date
 - from previous month plan, then completed on time with the revised finish date
 - *Tasks completed on time*
 - in the baseline
 - from prior month plan
 - *Late finish tasks that were completed after planned date*
 - *Future complete tasks that were completed ahead of plan date*
 - *Tasks that were added and completed in the same month*
 - *Tasks were deleted or converted to Summary tasks*

These detailed categories help to define data inputs into the metrics calculation

Current Execution Index (CEI)

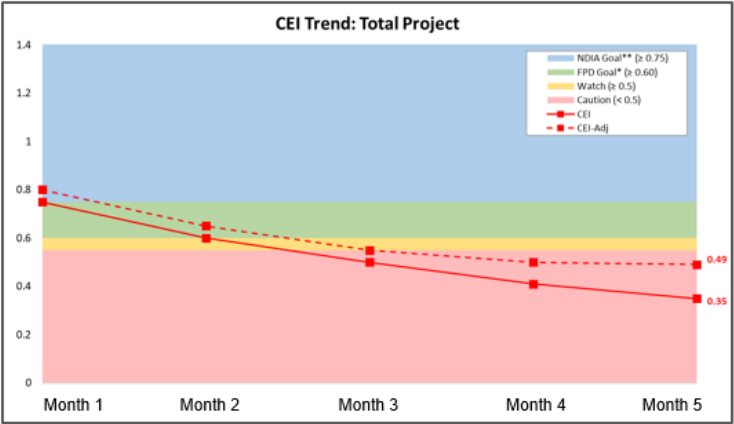
- Monthly measure of scheduled task performance compared to the prior month's plan

Formula:

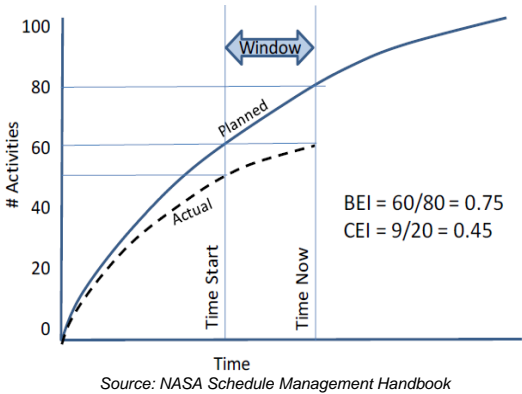
$$CEI = \frac{\text{Total forecast tasks completed (Curr. Mo.)}}{\text{Total forecast tasks planned (Prev. Mo.)}}$$

$$CEI_{adj} = \frac{\text{Total planned forecast tasks completed (Curr. Mo.)} + \text{Total off plan forecast tasks completed (Curr. Mo.)}}{\text{Total planned forecast tasks (Prev. Mo.)}}$$

Result Example:



Tasks added or deleted since the previous month are excluded



Interpretation:

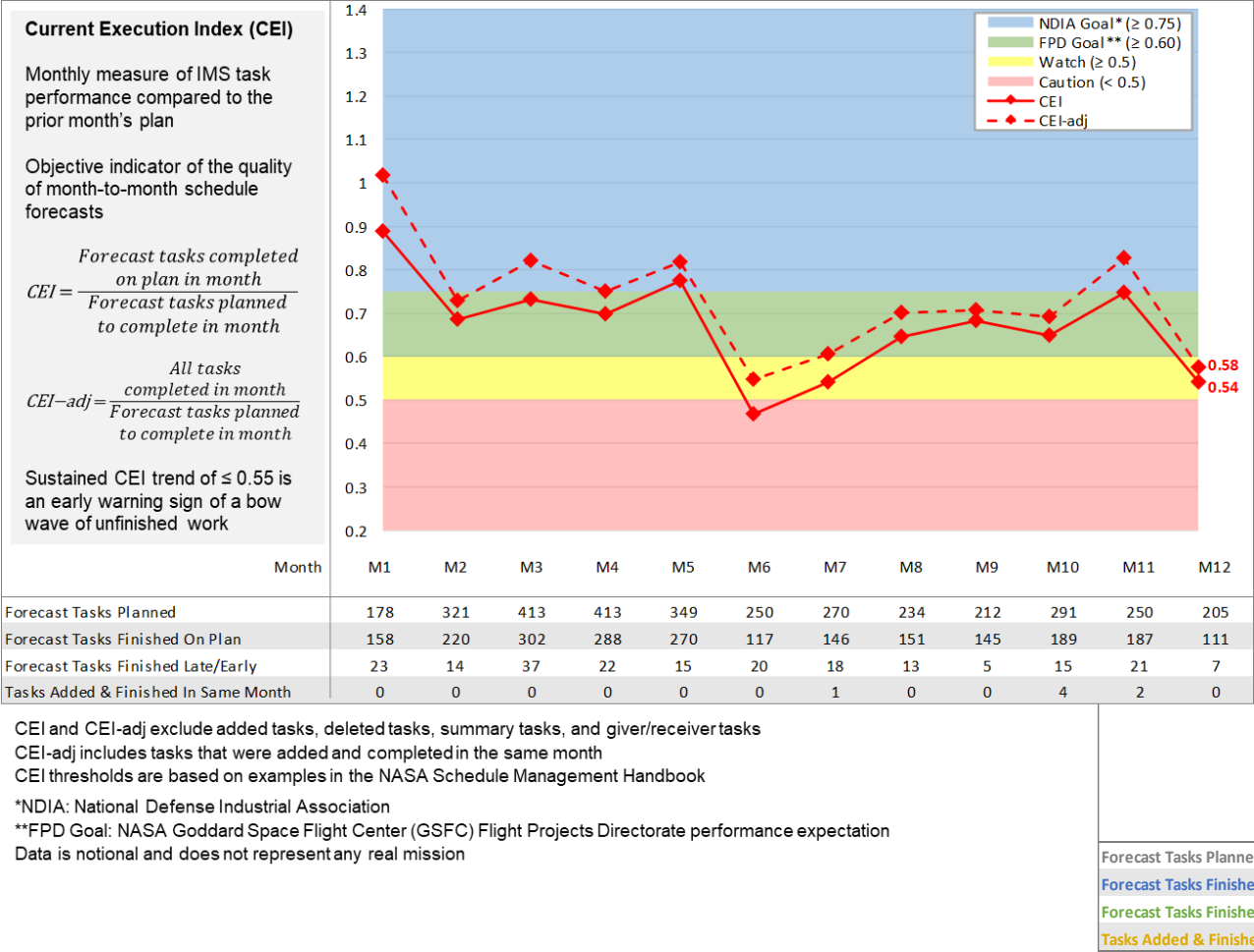
Index Value	Interpretation
CEI > 0.6 CEI-adj > 0.6	Project has completed more activities on time than planned in the prior month. Project has completed more activities overall than planned (including late finish and future complete tasks)
CEI/ECI-adj ≤ 0.6	Variance Analysis required
CEI vs. CEI-adj	CEI cannot go over 1

Thresholds are based on DCMA/NDIA, and FPD Goals

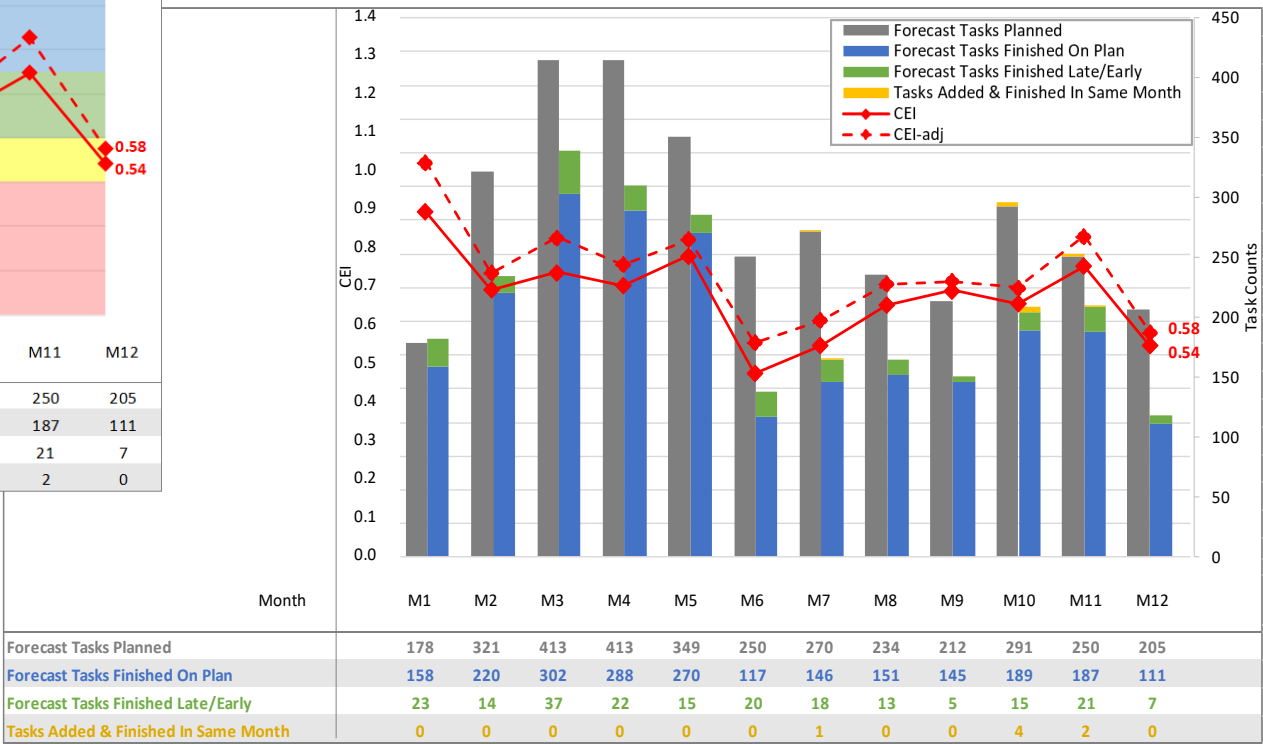
Objective indicator of the quality of month-to-month schedule forecasts



CEI Trend Threshold



CEI Trend & Tasks Counting

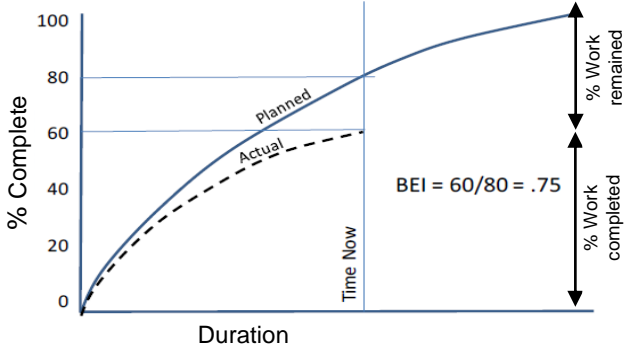


Schedule Velocity Index (SVI)

- Measure of project completion rate with respect to the remaining time left based on the project actual performance

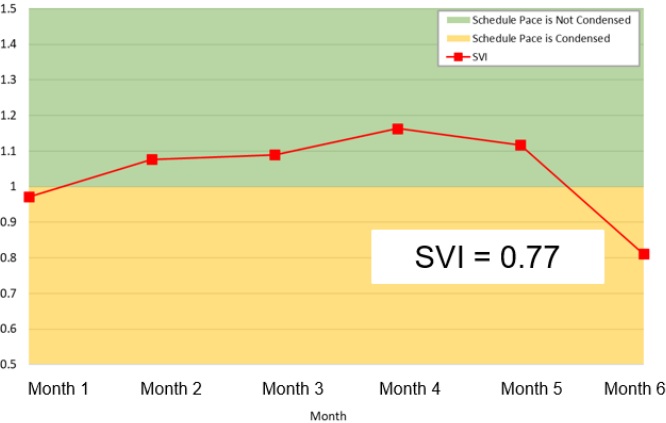
Formula:

$$SVI = \frac{\text{Actual remaining duration}}{\text{Completed duration} * \frac{\% \text{ work remaining}}{\% \text{ work completed}}}$$



Source: NASA Schedule Management Handbook

Result Example:



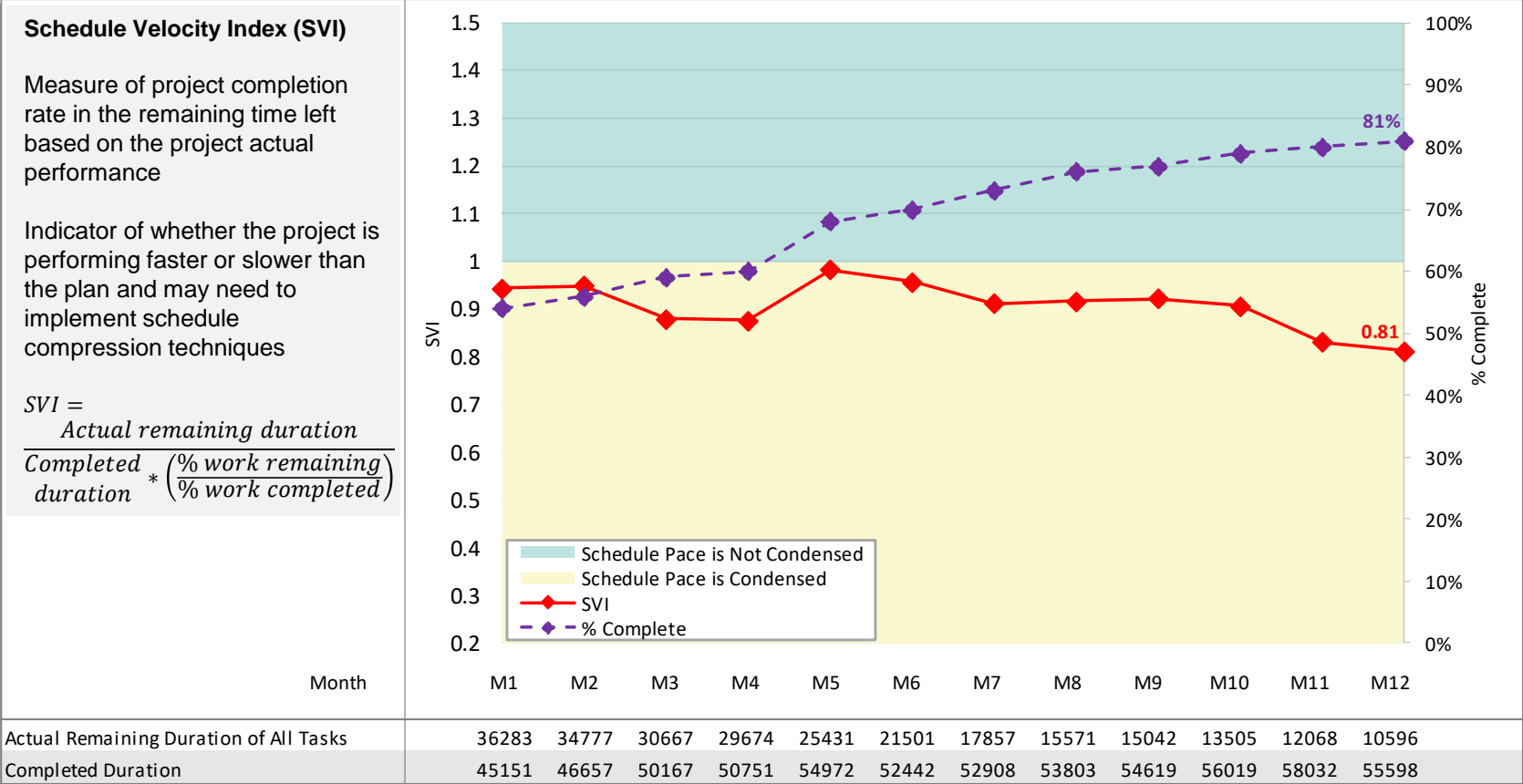
Interpretation:

SVI Value	Interpretation
SVI > 1.05	Project has more time to complete the planned activities on-time or early
SVI < 0.80	Schedule pace is condensed. The planned remaining duration only equals 80% or less of the time needed to complete the remaining work on time. Schedule compression techniques may be required to speed up the completion rate.

Objectively indicates the rate the project is completing its planned schedule

SVI Example

SVI Trend



Metrics exclude tasks added or deleted since the baseline month, summary tasks, and giver/receiver tasks
Data is notional and does not represent any specific mission

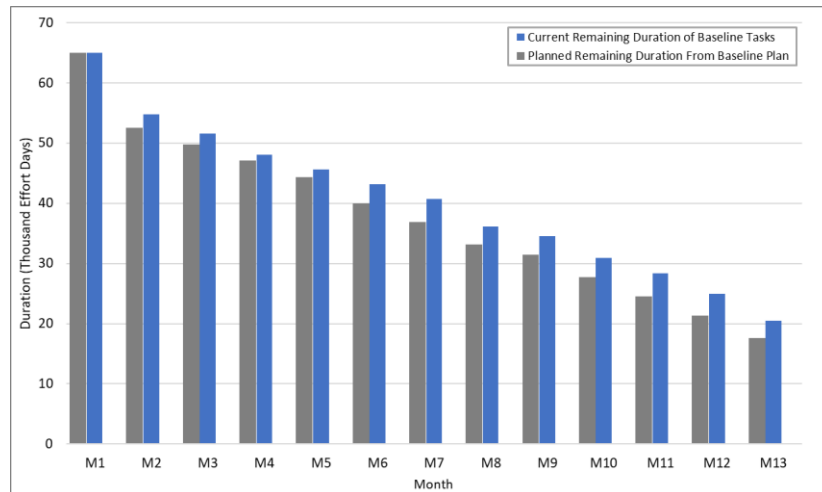
The 19% remaining work may need 21% more time than the planned remaining duration to complete on time. Schedule compression techniques may be required to speed up the completion rate

Task Duration & Growth

- Measure of overall schedule duration change due to task compression or growth

Formula:
$$Duration\ Growth = \frac{\frac{\text{Total current remaining duration of baseline tasks} - \text{Total baseline remaining duration}}{\text{Total baseline remaining duration}} \times 100$$

Result Examples:



Tasks added or deleted since the baseline month are excluded
Effort days are the sum of durations in days of individual (lowest-level WBS) tasks

WBS	Month						Change From Last Month	Duration Growth %
	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6		
Total Project	-8%	-13%	-14%	-19%	-20%	-21%	o	No tasks planned
1.0: Project Management	4%	4%	4%	6%	-12%	-12%	o	Comparison To Last Month + Improved from last month - Worsened from last month o Same as last month
2.0: Systems Engineering	138%	116%	89%	68%	45%	31%	+	
3.0: Mission Assurance								
4.0: Science	5%	0%	-2%	-2%	6%	8%	-	Task Duration Growth Measure of overall schedule duration change due to task compression/growth Indicates whether the schedule is growing significantly Task Duration Growth % = $\frac{\text{Actual rem. duration} - \text{Baseline rem. duration}}{\text{Baseline rem. duration}}$
5.0: Payload	0%	0%	0%	0%	0%	0%	o	
5.2: Instrument 1	4%	3%	78%	73%	69%	63%	+	
5.3: Instrument 2	7%	5%	-1%	-1%	-1%	0%	-	Current month duration growth > 100%
5.4: Instrument 3	34%	38%	46%	49%	38%	35%	+	
6.0: Spacecraft	0%	0%	0%	0%	0%	0%	o	
6.1: S/C PM	4%	4%	4%	0%	0%	0%	o	Duration metrics exclude added tasks, deleted tasks, summary tasks, and giver/receiver tasks with durations ≤ 1 day Data is notional and does not represent any real mission
6.2: S/C SE	13%	11%	2%	2%	2%	2%	o	
6.3: S/C MA								
6.4: S/C AI&T	-4%	-11%	-10%	-18%	-11%	-1%	-	Current month duration growth > 100%
6.5: Mechanisms & Structures	232%	184%	124%	77%	85%	51%	+	
6.6: Avionics	10%	15%	9%	1466%	459%	259%	+	
6.7: Software	0%	-2%	1%	-7%	5%	11%	-	Current month duration growth > 100%
6.8: Navigation Hardware	1290%	1410%	788%	1175%	388%	938%	-	
6.9: Communications	17%	5%	4%	4%	6%	8%	-	
6.10: Thermal	-17%	-27%	-48%	-66%	-47%	-57%	+	Current month duration growth > 100%
6.11: Power Systems	140%	104%	116%	58%	-14%	-55%	+	
7.0: Operations	-19%	-25%	-27%	-35%	-34%	-28%	-	
8.0: Launch Services	-2%	7%	12%	7%	8%	15%	-	Current month duration growth > 100%
9.0: Ground Systems	-1%	-2%	-4%	-7%	-7%	-12%	+	
10.0: Systems Integration & Test	-53%	-55%	-59%	-61%	-66%	-71%	+	

Indicator of how much the schedule is growing or compressing from the baseline

Added Task Duration & Growth

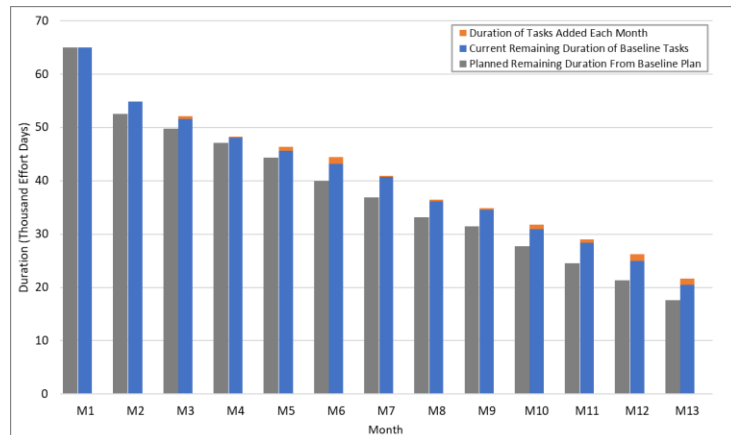
- Measure of schedule growth due to newly-added tasks

Formula:

$$\text{Added Duration vs. Baseline} = \frac{\text{Total duration of newly tasks added since baseline}}{\text{Total current remaining duration of baseline tasks}} \times 100$$

$$\text{Added Duration vs. Previous Mo.} = \frac{\text{Total duration of newly tasks added since last month}}{\text{Total current remaining duration of all tasks from previous month}} \times 100$$

Result Examples:



Tasks added or deleted since the baseline month are excluded
Effort days are the sum of durations in days of individual (lowest-level WBS) tasks

WBS	Month						Change From Last Month	Duration Growth %
	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6		
Total Project	15%	16%	15%	23%	25%	25%	○	No tasks planned
1.0: Project Management	0%	0%	0%	10%	54%	53%	+	Comparison To Last Month
2.0: Systems Engineering	0%	0%	0%	81%	117%	113%	+	+ Improved from last month
3.0: Mission Assurance								- Worse from last month
4.0: Science	0%	0%	0%	0%	0%	0%	○	○ Same as last month
5.0: Payload	8%	8%	4%	4%	4%	4%	○	Added Task Duration
5.1: Payload Management								Measure of overall schedule duration change due to newly-added tasks
5.2: Instrument 1	10%	11%	8%	8%	9%	10%	-	Indicates whether the schedule is growing significantly
5.3: Instrument 2	12%	8%	3%	1%	1%	1%	○	Added Task Duration % =
6.0: Spacecraft	24%	27%	30%	45%	49%	51%	-	Duration of newly added tasks
6.1: S/C PM	0%	0%	0%	0%	0%	0%	○	Remaining duration
6.2: S/C SE	0%	0%	0%	0%	0%	0%	○	Current month duration growth > 100%
6.3: S/C MA								
6.4: S/C AI&T	27%	31%	31%	31%	31%	22%	+	
6.5: Mechanisms & Structures	16%	7%	0%	0%	0%	0%	○	
6.6: Avionics	18%	10%	24%	5%	0%	0%	○	
6.7: Software	13%	18%	44%	184%	236%	325%	-	
6.8: Navigation Hardware	21%	20%	49%	47%	101%	44%	+	
6.9: Communications	19%	38%	14%	22%	28%	70%	-	
6.10: Thermal	102%	71%	66%	71%	43%	67%	-	
6.11: Power Systems	12%	24%	31%	75%	270%	158%	+	
7.0: Operations	0%	0%	4%	7%	6%	6%	-	
8.0: Launch Services	0%	0%	1%	0%	1%	3%	-	
9.0: Ground Systems	0%	0%	0%	0%	0%	0%	○	
10.0: Systems Integration & Test	24%	25%	17%	18%	13%	13%	○	

Duration metrics exclude added tasks, deleted tasks, summary tasks, and giver/receiver tasks with durations ≤ 1 day
Data is notional and does not represent any real mission

Indicator of how much the schedule is growing due to new tasks



Funded Schedule Margin (FSM) Usage

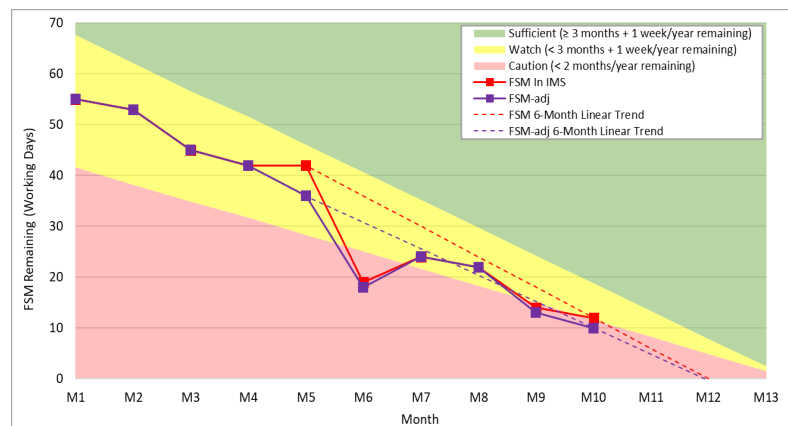


- Comparison of remaining FSM to recommended thresholds

Process:

- Extract FSM data from the duration of “FSM” task in the monthly schedule
- FSM of less than 2 months of schedule margin per year remaining is low
- If the schedule contains negative slack, subtract monthly total negative slack from the FSM to show an FSM-adj trend
- An FSM burn-down trend can also be added with a 6-mo or 12-mo linear trend

Result Example:



Data is notional and does not represent any specific mission

Sources:

- + Caution Threshold: NASA Schedule Management Handbook
- + Watch Threshold: Recommendation from the Aerospace Study titled “Reserves on Schedule to Go (STG) Based on Historical Data”

Indicates whether FSM is sufficient for the time remaining until delivery

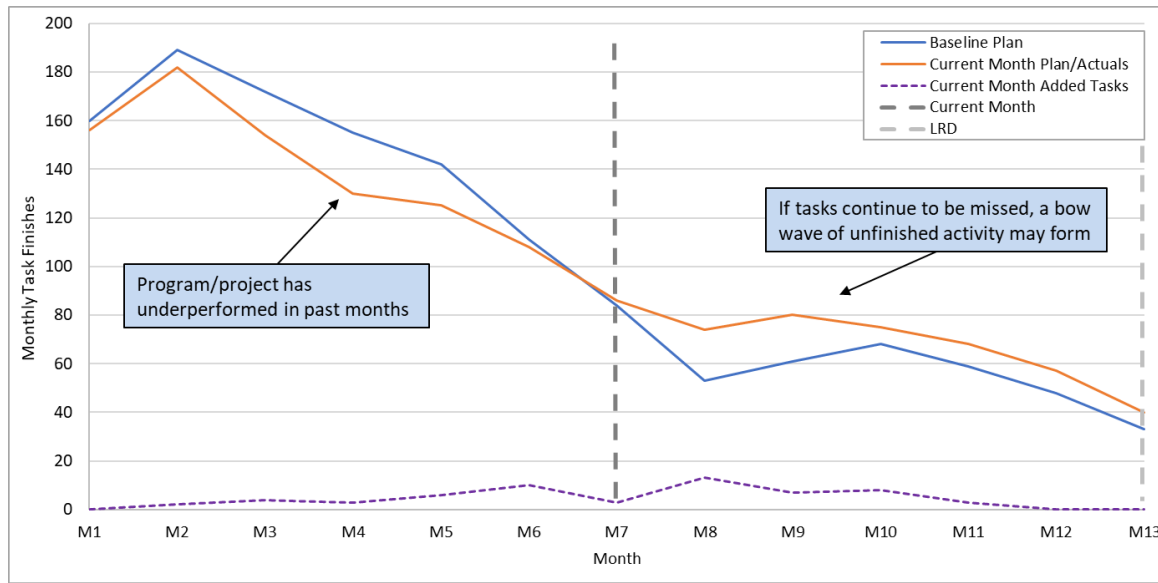
Task Completion Trending

- Comparison of two monthly schedules to qualitatively assess whether future tasks can be met

Process:

- For each schedule, plot the number of tasks actually finished or planned to finish over time
- Program/project performance is determined based on changes in schedule planning and analyst expertise

Result Example:



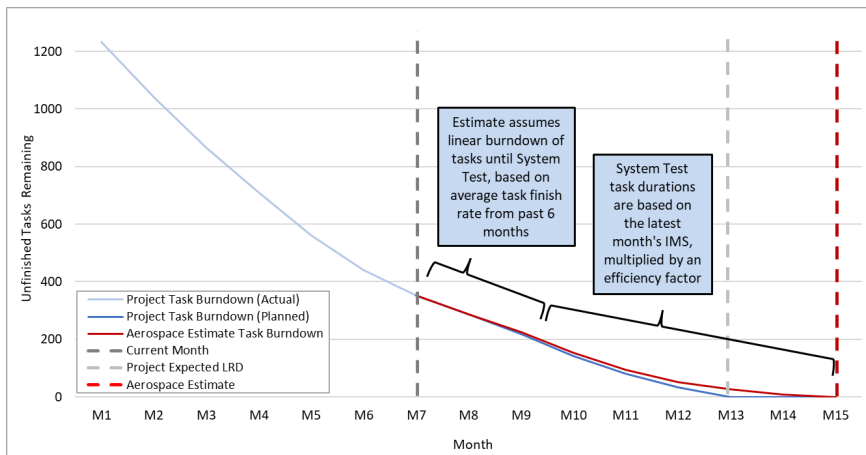
An indicator of potential schedule impact due to missed tasks forming a bow wave of unfinished activity



Forecasting Using Task Completion Trending

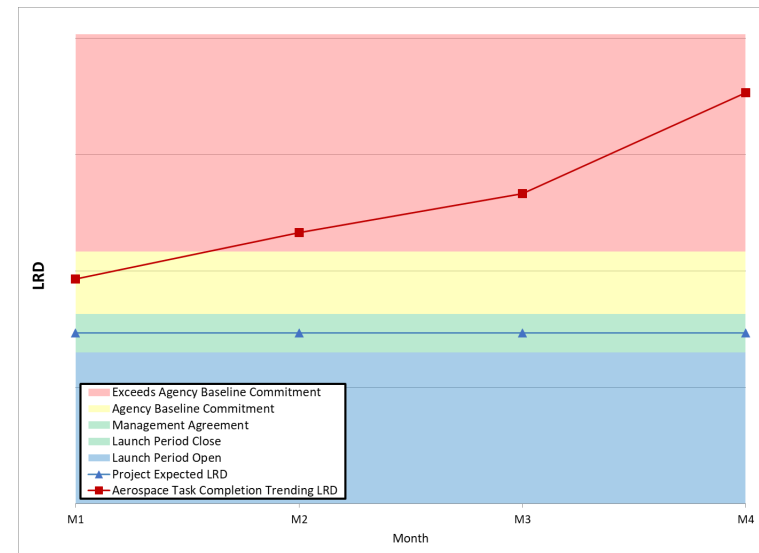


- The average project task completion rate for 6-month period or a year, depending on project phase, can be applied to the remaining tasks to forecast a completion date
- Calculations only include tasks that represent actual work and are common to both months' schedules
 - Summary tasks and giver/receiver tasks may be excluded
 - Tasks with zero duration may be included if some zero duration tasks appear to represent actual work
 - Tasks added or deleted from the first month's schedule to the next should be excluded
 - All tasks are valued the same



Metrics exclude tasks added or deleted since the baseline month, summary tasks, and giver/receiver tasks

Data is notional and does not represent any specific mission



Data is notional and does not represent any specific mission

Forecasting Using Total Float Consumption Index



- TFCI, the total float likely at the schedule baseline finish date, is an efficiency factor that considers the rate of total float consumption with relation to the remaining scope of work

$$\text{TFCI} = \frac{\text{Project Actual Duration} + \text{Critical Path Total Float}}{\text{Project Actual Duration}}$$

- Use TFCI to calculate Predicted Critical Path Total Float (CPTF)
- Predicted CPTF = Planned Duration * (TFCI - 1)
- Calculate the forecast delivery date
- Forecast Finish Date = Baseline Finish Date + Predicted CPTF

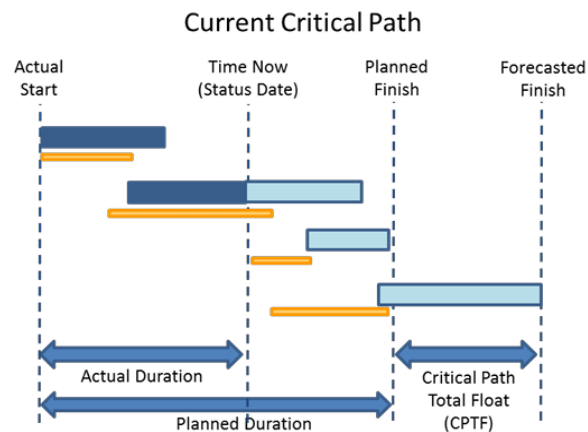
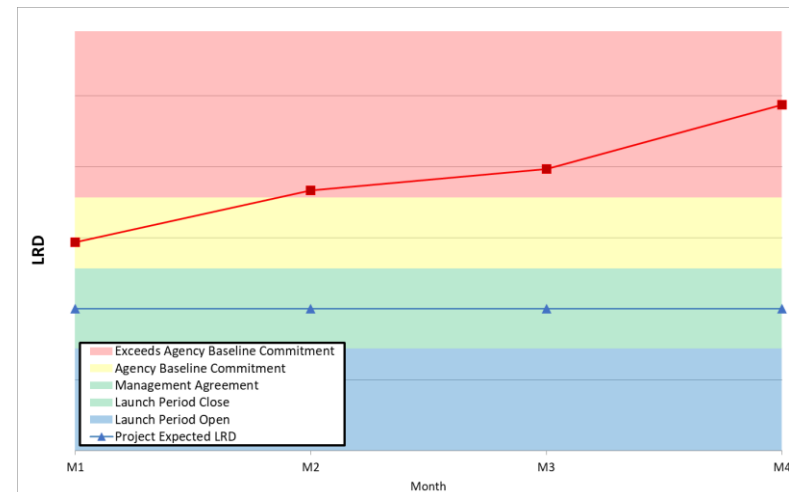


Figure 7-37. This figure illustrates an example TFCI chart.

Source: NASA Schedule Management Handbook



Data is notional and does not represent any specific mission

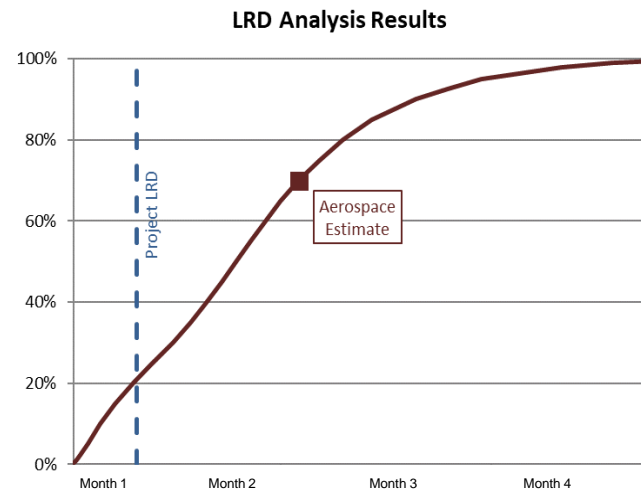
Forecasting Using BEI and CEI indices



- Performance factors of BEI, CEI, or HMI can be used to develop uncertainty distributions for schedule risk analysis to estimate a delivery date

$$\text{Projected Months to completion} = \frac{\text{Remaining Duration} - \text{Schedule Margin}}{\text{Performance Factor}}$$

- *Inverse of 6-mo average CEI may be used to calculate the pessimistic or worst-case scenario*
 - A specific subsystem 6-month average CEI = 0.65
 - Use inverse of CEI to develop pessimistic multiplier of $1/0.65 = 1.54$
 - Apply this multiplier to the remaining duration of each task at the lowest WBS elements for the pessimistic duration uncertainty



This option can also be used alone or with other performance data to provide a rational uncertainty distribution for the SRA simulation



Conclusion

- Schedule metrics are common practices, but commercial schedule models can be hard to use with small programs/projects that do not have EVM reporting and formal IMS submission requirements
- These schedule metrics calculation can be implemented in Excel
 - *Can be tailored or adjusted when appropriate to provide additional insights in concerned areas*
 - *Can be used with any schedule format via exporting to Excel at its lowest level WBS tasks/elements*
 - *Schedule network is not needed*
- These schedule metrics can provide valuable insights about recent performance and may also help warn project management of potential issues for certain small programs/projects such as Class D missions or similar
 - *These projects often do not replan or rebaseline; therefore, a combination view of CEI, SVI, and Task Completion Trending seem to be the most useful metrics to measure monthly performance and to provide warning of a bow wave of delayed work*
 - *Using performance indices to forecast delivery date is a viable alternative to standard SRA estimates*

Contact Information

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Backup

Schedule Metrics Details
Analysis Examples



Schedule Metrics Details



Schedule Metrics Descriptions

Metric	What It Is	Primary Benefit
Baseline Execution Index (BEI)* (<i>BEI and BEI-adj</i>)	Cumulative measure of scheduled task performance against the baseline	Objectively indicates how efficient the project in executing to its schedule baseline
Hit or Miss Index (HMI)* (<i>HMI and HMI-adj</i>)	Monthly measure of scheduled task performance against the baseline	Early indicator of whether the schedule baseline is achievable
Current Execution Index (CEI)* (<i>CEI and CEI-adj</i>)	Monthly measure of scheduled task performance compared to the prior month's plan	Objective indicator of the quality of month-to-month schedule forecasts
Schedule Velocity Index (SVI)	Measure of project completion rate in the remaining time left based on the project actual performance	Indicator of whether the project is performing faster or slower than the plan and may need to implement schedule compression techniques
Task Duration Growth Percent	Measure of overall schedule duration change due to task compression or growth	Indicates whether the schedule is growing or compressing significantly
Added Task Duration Percent	Measure of schedule compression or growth due to newly-added tasks	Indicates whether the schedule is growing significantly due to new tasks
Funded Schedule Margin (FSM) Usage (<i>FSM and FSM-adj</i>)	Comparison of remaining FSM to recommended thresholds	Indicates whether FSM is sufficient for the time remaining until delivery
Schedule Workoff**	Measure of tasks that are more than 30 calendar days late	Provides an early indication that a project may need more resources to work off late tasks

*BEI, HMI, and CEI are part of the GSFC Business Change Initiative (BCI)

**Schedule Workoff is part of a federal agency suite of schedule execution metrics

Schedule Metrics Formulas



Metric	Formula	Threshold
Baseline Execution Index (BEI) (BEI and BEI-adj*)	$\frac{\text{Total baseline tasks completed}}{\text{Total baseline tasks planned}}$	BEI of < 0.7 indicates a significant number of unfinished tasks compared to the baseline plan
Hit or Miss Index (HMI) (HMI and HMI-adj*)	$\frac{\text{Baseline tasks completed in month}}{\text{Baseline tasks planned to complete in month}}$	HMI of ≤ 0.4 indicates an unsustainable baseline; margin erosion and baseline completion delays are likely
Current Execution Index (CEI) (CEI and CEI-adj*)	$\frac{\text{Forecast tasks completed in month}}{\text{Forecast tasks planned to complete in month}}$	Sustained CEI trend of ≤ 0.55 is an early warning sign of a bow wave of unfinished work
Schedule Velocity Index (SVI)	$\frac{\text{Actual remaining duration}}{\text{Completed duration} * \frac{\% \text{ work remaining}}{\% \text{ work completed}}}$	SVI of less than 1 indicates the schedule is compressed and more resources may be needed to complete the remaining work
Task Duration Growth Percent	$\frac{\text{Actual remaining duration} - \text{Baseline remaining duration}}{\text{Baseline remaining duration}}$	Over 100% indicates significant duration growth
Added Task Duration Percent	$\frac{\text{Duration of newly added tasks}}{\text{Remaining duration}}$	Over 100% indicates significant duration growth
Funded Schedule Margin (FSM) Usage (FSM and FSM-adj**)	FSM is based on duration of "FSM" task in monthly schedule	FSM of less than 2 months per year remaining is low
Schedule Workoff	Tasks are late if the current month's schedule has a planned or actual finish date over 30 calendar days later than the baseline	Over 50% late tasks scheduled for a month indicates a significant backlog of work

*BEI-adj and HMI-adj includes tasks finished behind plan; CEI-adj includes tasks finished ahead of or behind plan

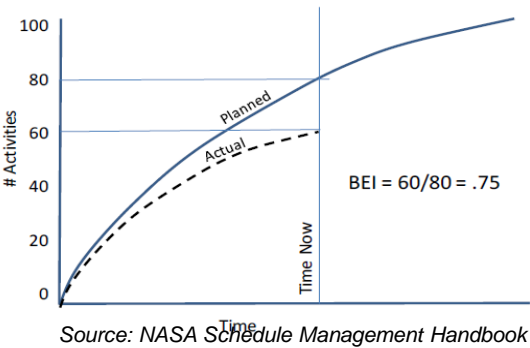
**FSM adjusted metric is to account for negative slack in the schedule; FSM-adj is FSM minus negative slack in the schedule

Baseline Execution Index (BEI)

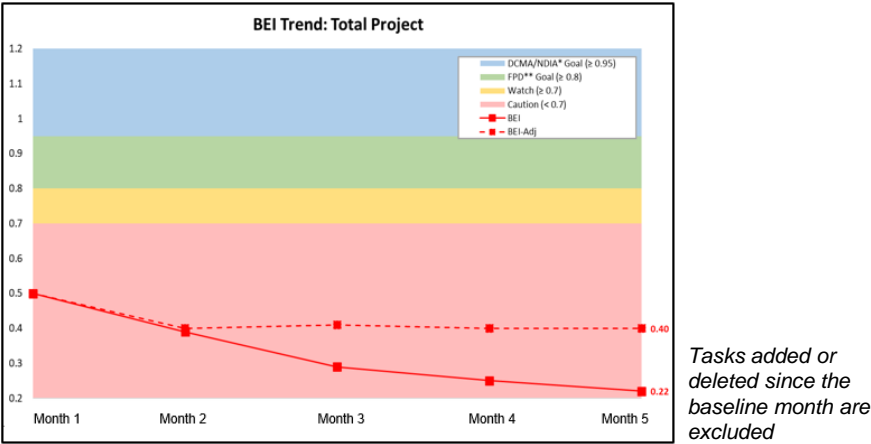
- **Cumulative** measure of scheduled task performance against the **baseline**
 - The index becomes less useful as the program/project nears completion, since BEI-adj gets closer to 1 while BEI will not reach 1 unless 0 late tasks.

Formula:
$$BEI = \frac{\text{Total planned baseline tasks completed (Cum)}}{\text{Total planned baseline tasks (Cum)}}$$

$$BEI_{adj} = \frac{\text{Total planned baseline tasks completed (Cum)} + \text{Total off plan baseline tasks completed (Cum)}}{\text{Total planned baseline tasks (Cum)}}$$



Result Example:



Interpretation:

Index Value	Interpretation
BEI > 1.05	Project has completed more activities on time or earlier than planned.
BEI-adj > 1.05	Project has completed more activities overall than planned (including late finish tasks)
1.05 > BEI/BEI-adj > 0.95	Project is close to completing activities on time
BEI/BEI-adj < 0.95	Project has completed fewer activities than planned
BEI vs. BEI-adj	If BEI-adj is much higher than BEI, it means that many tasks were completed late

Thresholds are based on DCMA/NDIA, and FPD Goals

Objectively indicates how efficient the project is in executing to its schedule baseline

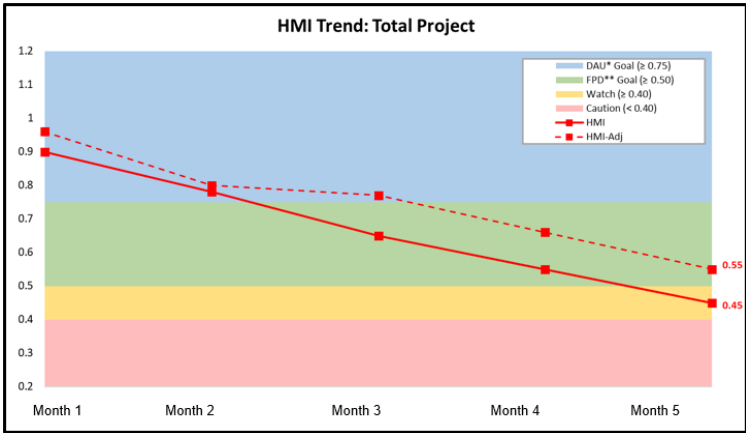
Hit or Miss Index (HMI)

- **Monthly** measure of scheduled task performance against the **baseline**
 - *The index could also become less useful as the program/project nears completion or deviate significantly from the baseline*

Formula:

$$\text{HMI} = \frac{\text{Total planned baseline tasks completed (Curr. Mo.)}}{\text{Total planned baseline tasks (Prev. Mo.)}}$$
$$\text{HMI}_{\text{adj}} = \frac{\text{Total planned baseline tasks completed (Curr. Mo.)} + \text{Total off plan baseline tasks completed (Curr. Mo.)}}{\text{Total planned baseline tasks (Prev. Mo.)}}$$

Result Example:



Tasks added or deleted since the baseline month are excluded

Interpretation:

Index Value	Interpretation
HMI/HMI-adj ≤ 0.4	An early warning sign of an unsustainable baseline

Threshold	Indicator	Explanation
≥ .75	Blue	DAU Goal
≥ .50	Green	FPD Goal
.40 - .49	Yellow	Watch
≤ .39	Red	Caution

Thresholds are based on DCMA/NDIA, and FPD Goals

Early indicator of whether the schedule baseline is achievable

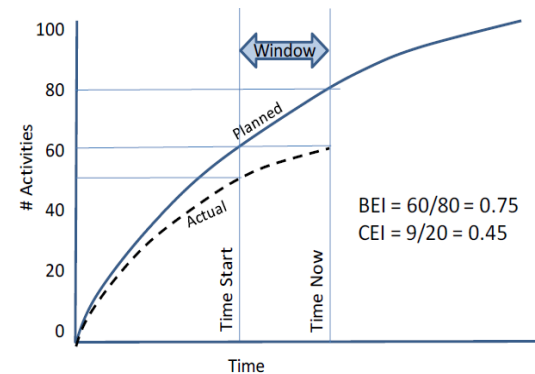
Current Execution Index (CEI)

- **Monthly** measure of scheduled task performance compared to the **prior month's plan**

Formula:

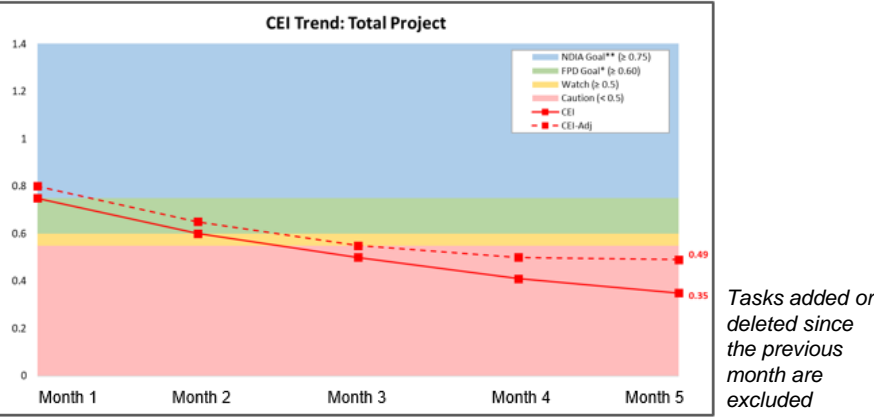
$$CEI = \frac{\text{Total forecast tasks completed (Curr. Mo.)}}{\text{Total forecast tasks planned (Prev. Mo.)}}$$

$$CEI_{adj} = \frac{\text{Total planned forecast tasks completed (Curr. Mo.)} + \text{Total off plan forecast tasks completed (Curr. Mo.)}}{\text{Total planned forecast tasks (Prev. Mo.)}}$$



Source: NASA Schedule Management Handbook
The figure shows the Current Execution Index is indicating a downward trend of deteriorating performance.

Result Example:



Interpretation:

Index Value	Interpretation
CEI > 0.6	Project has completed more activities on time than planned in the prior month.
CEI-adj > 0.6	Project has completed more activities overall than planned (including late finish and future complete tasks)
CEI/ECI-adj ≤ 0.6	Variance Analysis required
CEI vs. CEI-adj	CEI cannot go over 1

Thresholds are based on DCMA/NDIA, and FPD Goals

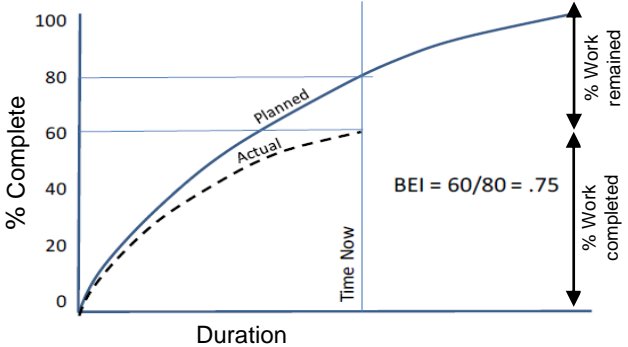
Objective indicator of the quality of month-to-month schedule forecasts

Schedule Velocity Index (SVI)

- Measure of project completion rate with respect to the remaining time left based on the project actual performance

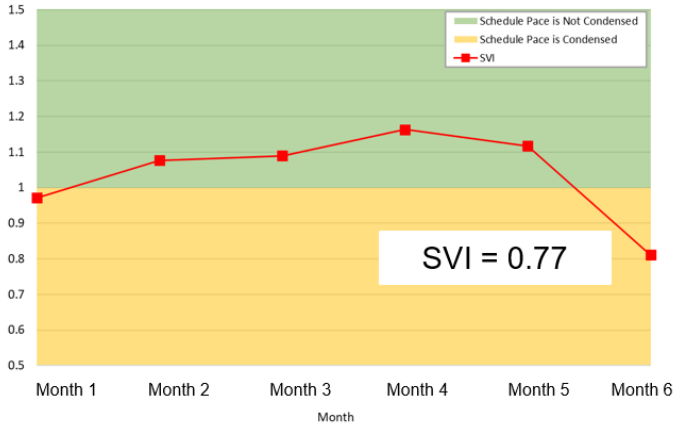
Formula:

$$SVI = \frac{\text{Actual remaining duration}}{\text{Completed duration} * \frac{\% \text{ work remaining}}{\% \text{ work completed}}}$$



Source: NASA Schedule Management Handbook

Result Example:



Interpretation:

SVI Value	Interpretation
SVI > 1.05	Project has more time to complete the planned activities on-time or early
SVI < 0.80	Schedule pace is condensed. The planned remaining duration only equals to 80% or less of the time needed to complete the remaining work on time. Schedule compression techniques may be required to speed up the completion rate.

Objectively indicates the velocity rate the project is completing its planned schedule

Task Durations & Duration Growth Percentage

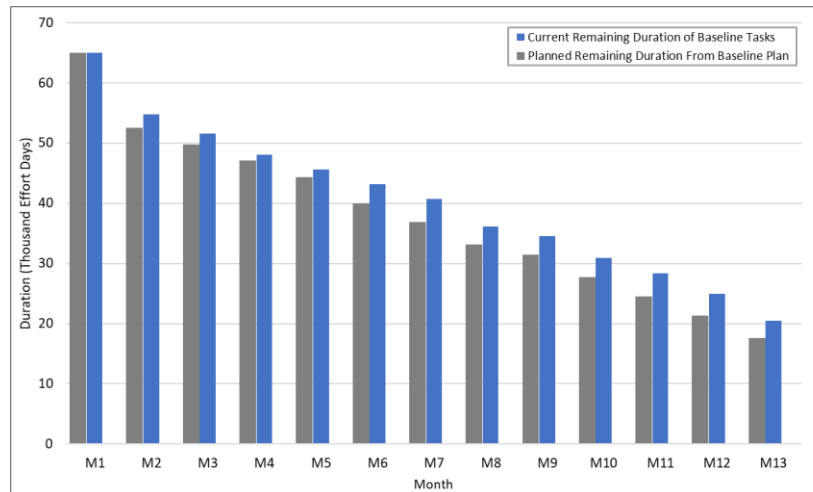


- Measure of overall schedule duration change due to task compression or growth

Formula:

$$\text{Duration Growth} = \frac{\text{Total current remaining duration of baseline tasks} - \text{Total baseline remaining duration}}{\text{Total baseline remaining duration}} \times 100$$

Result Example:



Tasks added or deleted since the baseline month are excluded
Effort days are the sum of durations in days of individual (lowest-level WBS) tasks

Indicator of how much the schedule is growing or compressing from the baseline

Added Task Durations & Growth Percentage



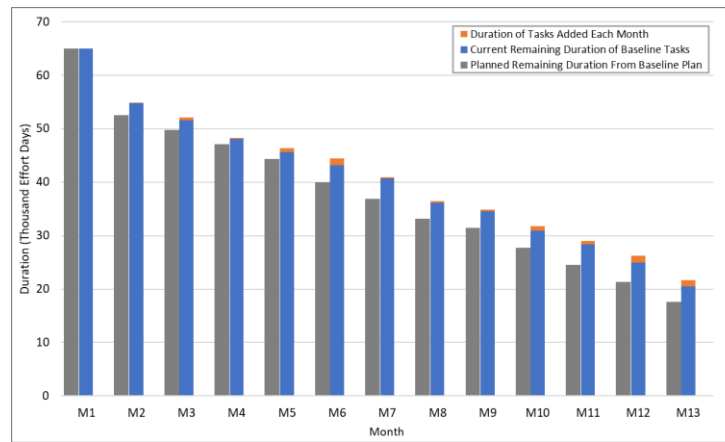
- Measure of schedule growth due to newly-added tasks

Formula:

$$\text{Added Duration vs. Baseline} = \frac{\text{Total duration of newly tasks added since baseline}}{\text{Total current remaining duration of baseline tasks}} \times 100$$

$$\text{Added Duration vs. Previous Mo.} = \frac{\text{Total duration of newly tasks added since last month}}{\text{Total current remaining duration of all tasks from previous month}} \times 100$$

Result Example:



Tasks added or deleted since the baseline month are excluded
Effort days are the sum of durations in days of individual (lowest-level WBS) tasks

Indicator of how much the schedule is growing due to new tasks

Funded Schedule Margin (FSM) Usage

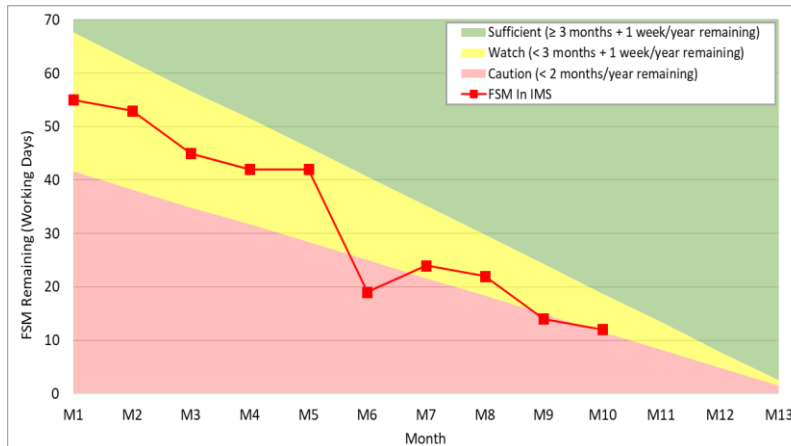


- Comparison of remaining FSM to recommended thresholds

Formula:

- Extract FSM data from the duration of “FSM” task in the monthly schedule
- FSM of less than 2 months of schedule margin per year remaining is low
- If the schedule contains negative slack, subtract monthly total negative slack from the FSM total to show an FSM-adj trend
- An FSM burn-down trend can also be added with a 6-mo or 12-mo linear trend

Result Example:



Sources:

- + Caution Threshold: NASA Schedule Management Handbook
- + Watch Threshold: Recommendation from the Aerospace Study titled “Reserves on Schedule to Go (STG) Based on Historical Data”

Indicates whether FSM is sufficient for the time remaining until delivery

Schedule Workoff

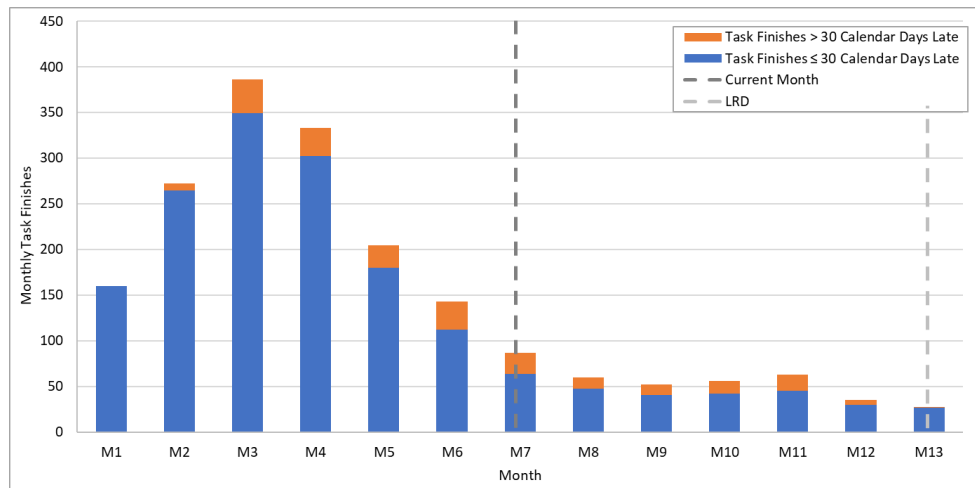


- Measure of tasks that are more than 30 calendar days late

Formula:

- Count tasks as being late if the current month's schedule has a planned or actual finish date over 30 calendar days later than the baseline
- Rules of Thumb: Over 50% late tasks scheduled for a month indicates a significant backlog of work

Result Example:



An early indication that a project may need more resources to work off late tasks

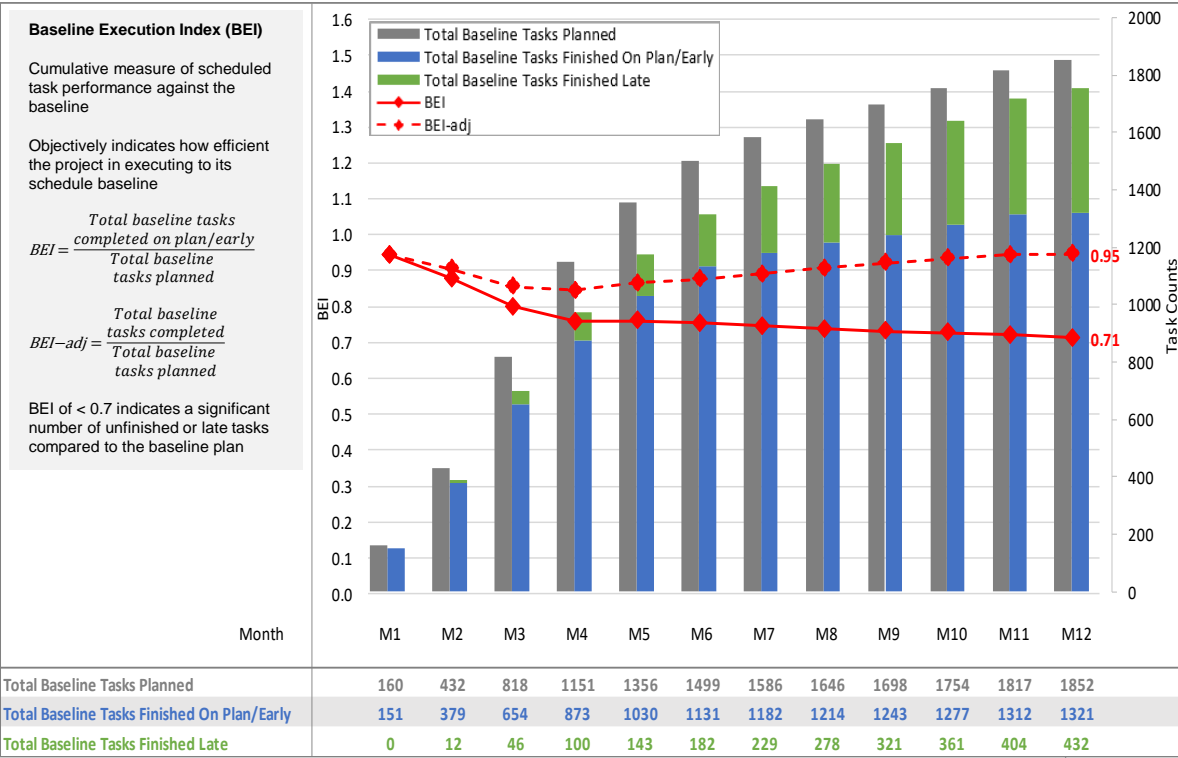


Analysis Examples

BEI Examples

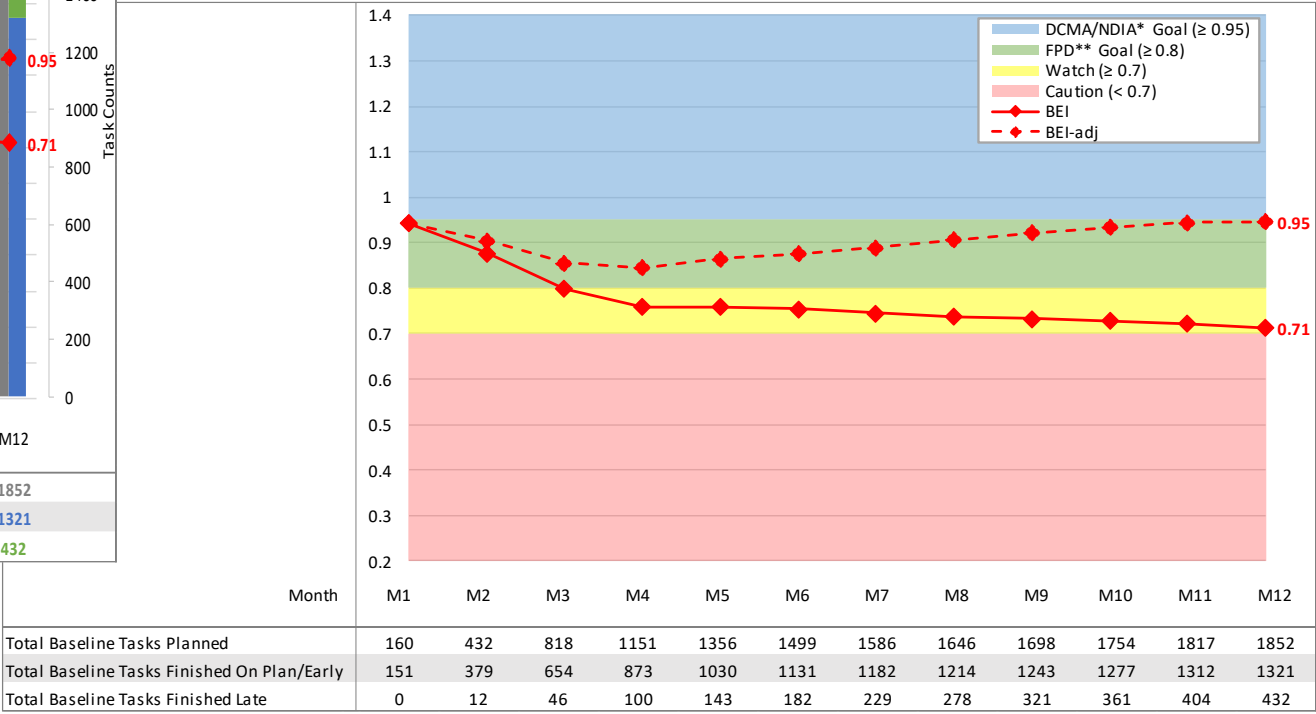


BEI Trend & Tasks Counting



BEI and BEI-adj exclude added tasks, deleted tasks, summary tasks, and giver/receiver tasks
Data is notional and does not represent any specific mission

BEI Trend Threshold

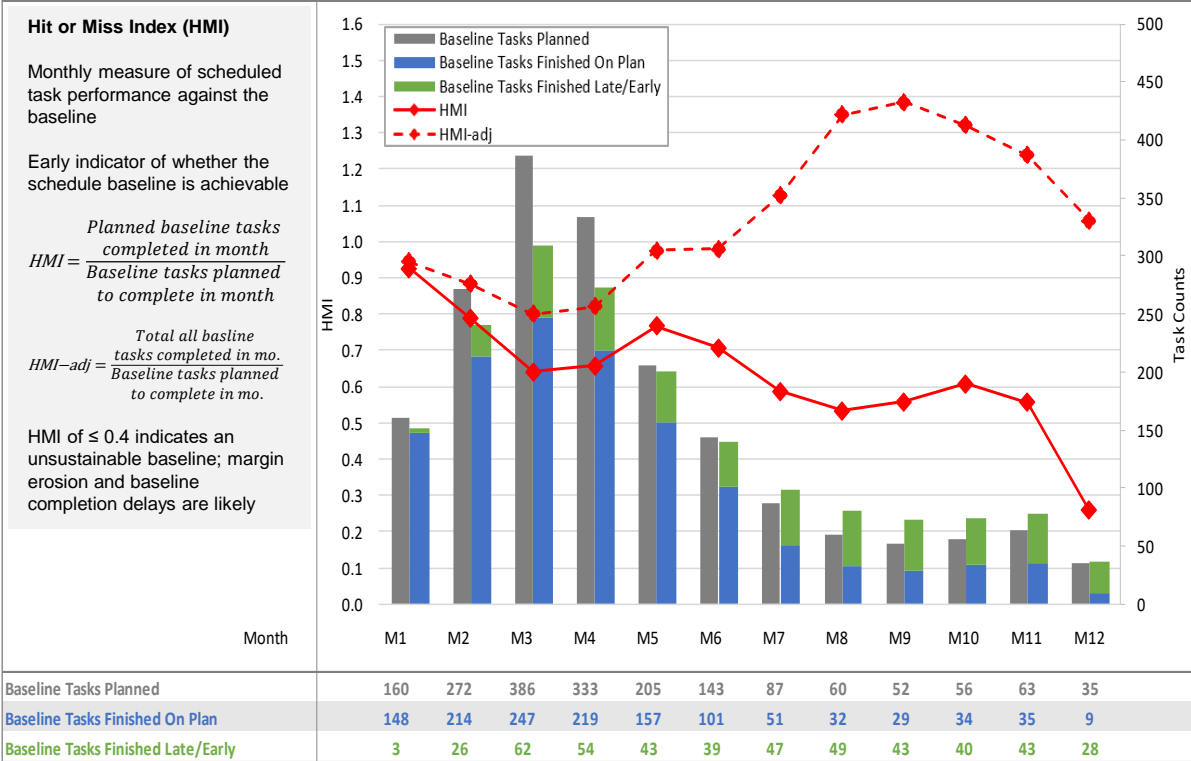


BEI and BEI-adj exclude added tasks, deleted tasks, summary tasks, and giver/receiver tasks
BEI thresholds are based on examples in the NASA Schedule Management Handbook
*DCMA/NDIA: Defense Contract Management Association / National Defense Industrial Association
**FPD Goal: NASA Goddard Space Flight Center (GSFC) Flight Projects Directorate performance expectation
Data is notional and does not represent any specific mission

BEI declined slightly but BEI-adj improved



HMI Trend & Tasks Counting

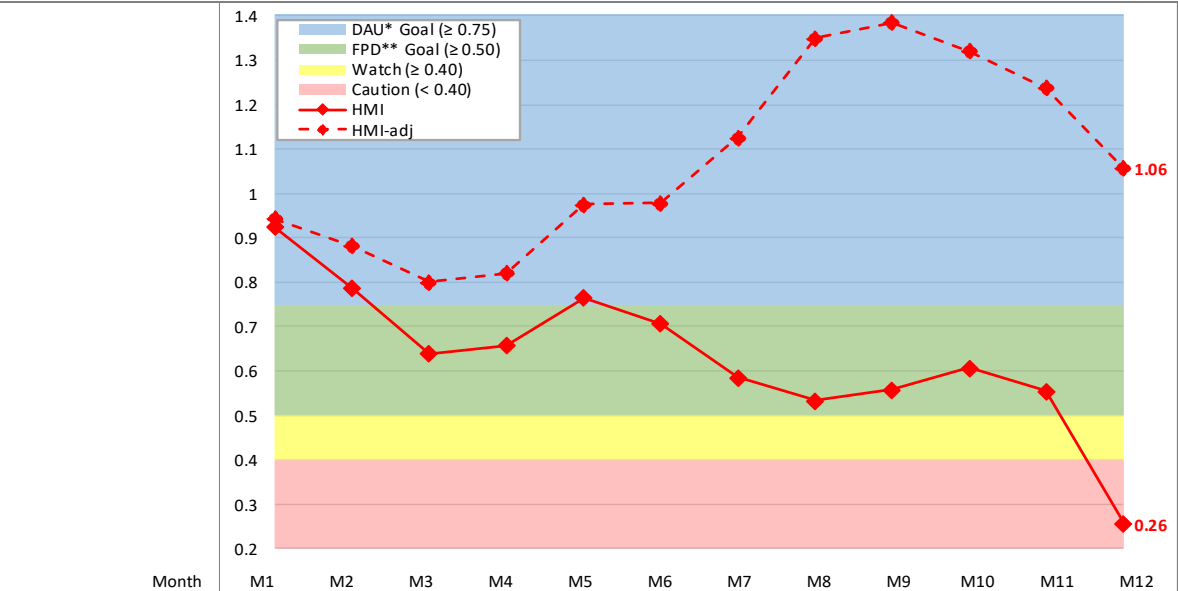


HMI and HMI-adj exclude added tasks, deleted tasks, summary tasks, and giver/receiver tasks
Data is notional and does not represent any specific mission

Baseline Tasks Planned	160	272	386	333	205	143	87	60	52	56	63	35
Baseline Tasks Finished On Plan	148	214	247	219	157	101	51	32	29	34	35	9
Baseline Tasks Finished Late/Early	3	26	62	54	43	39	47	49	43	40	43	28

HMI and HMI-adj exclude added tasks, deleted tasks, summary tasks, and giver/receiver tasks
HMI thresholds are based on examples in the NASA Schedule Management Handbook
*DAU: Defense Acquisition University
**FPD Goal: NASA Goddard Space Flight Center (GSFC) Flight Projects Directorate performance expectation
Data is notional and does not represent any specific mission

HMI Trend Threshold

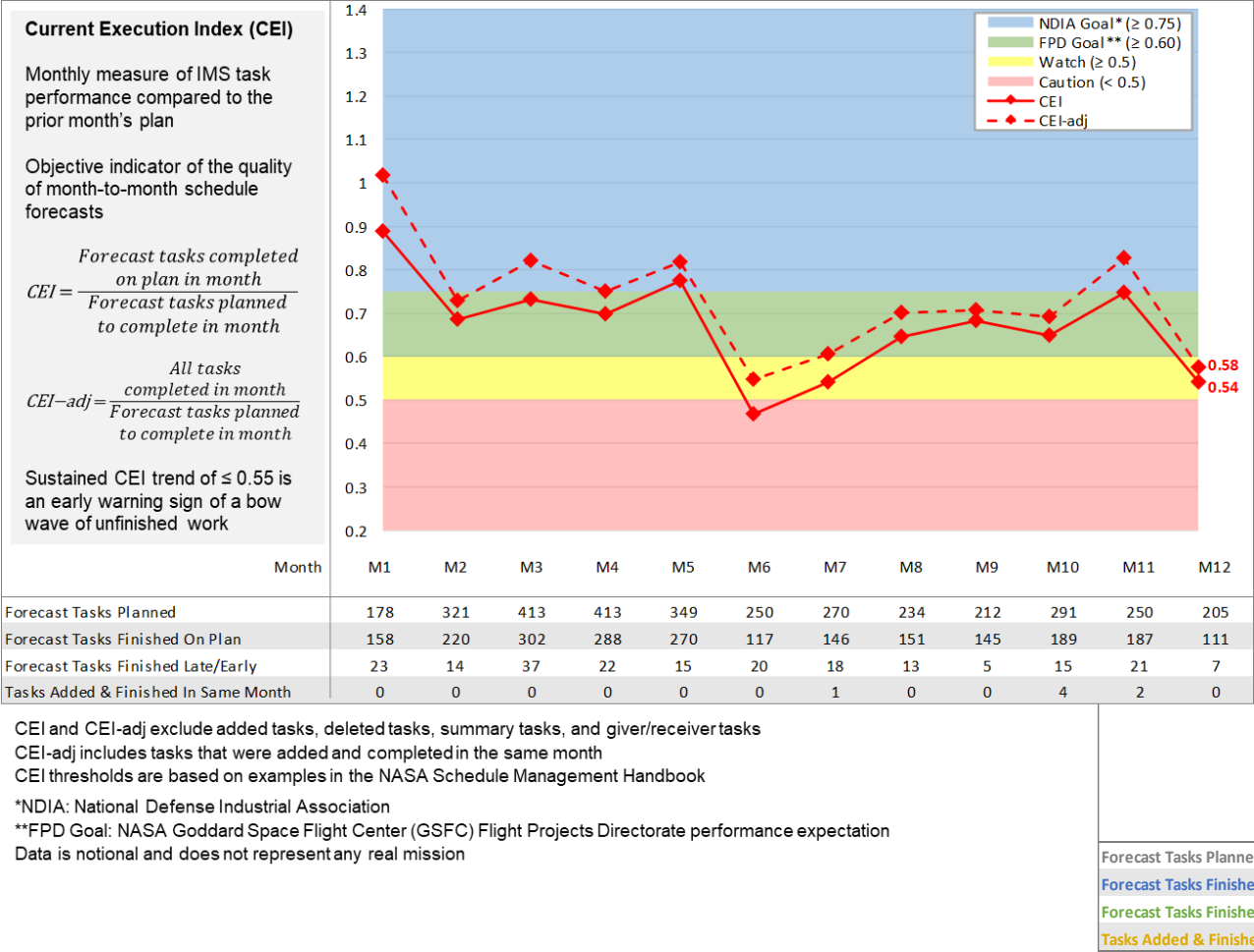


HMI and HMI-adj exclude added tasks, deleted tasks, summary tasks, and giver/receiver tasks
HMI thresholds are based on examples in the NASA Schedule Management Handbook
*DAU: Defense Acquisition University
**FPD Goal: NASA Goddard Space Flight Center (GSFC) Flight Projects Directorate performance expectation
Data is notional and does not represent any specific mission

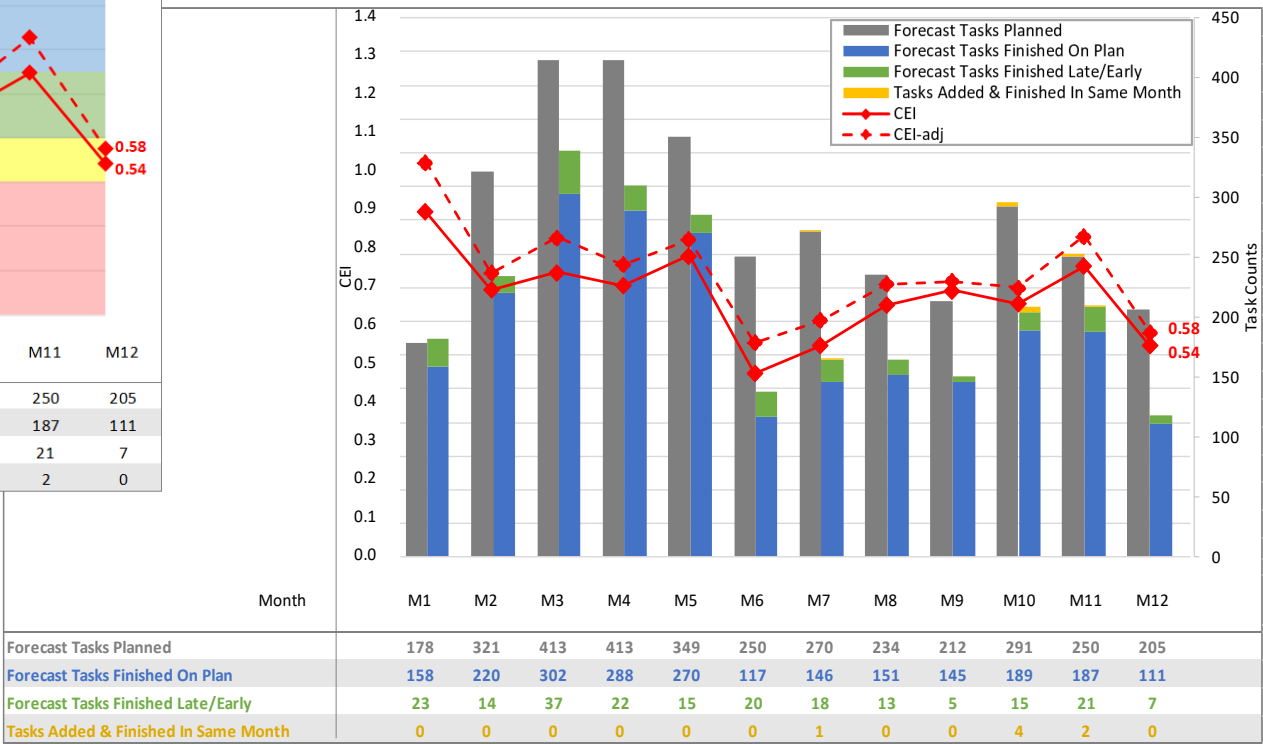
Both HMI and HMI-adj continued to decline due to fewer baseline tasks being planned



CEI Trend Threshold

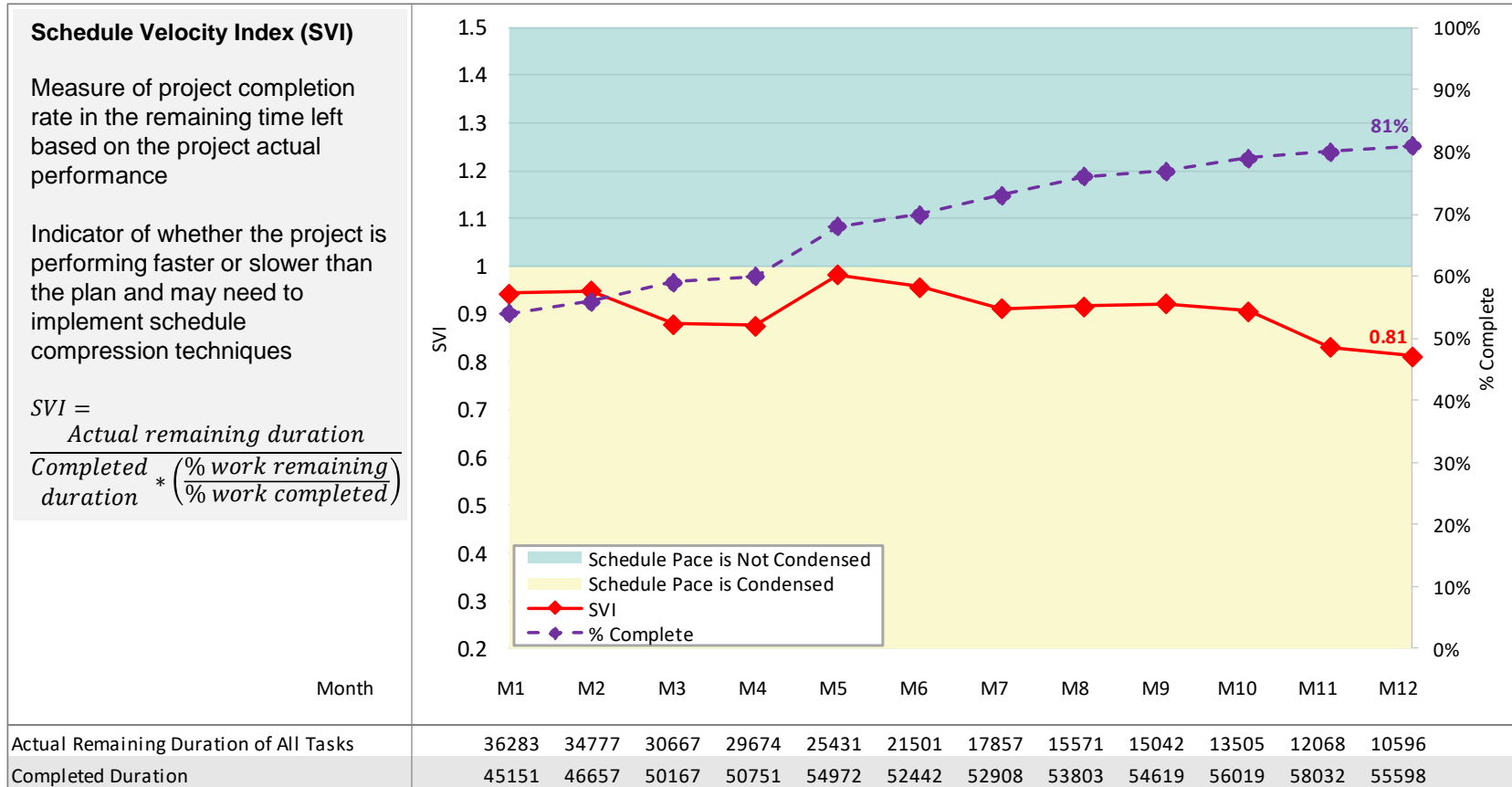


CEI Trend & Tasks Counting



SVI Example

SVI Trend



Metrics exclude tasks added or deleted since the baseline month, summary tasks, and giver/receiver tasks

Data is notional and does not represent any specific mission

Task Duration Growth Example

Task Duration Growth Trend

WBS	Month						Change From Last Month
	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	
Total Project	-8%	-13%	-14%	-19%	-20%	-21%	○
1.0: Project Management	4%	4%	4%	6%	-12%	-12%	○
2.0: Systems Engineering	138%	116%	89%	68%	45%	31%	+
3.0: Mission Assurance							
4.0: Science	5%	0%	-2%	-2%	6%	8%	-
5.0: Payload	0%	0%	0%	0%	0%	0%	○
5.2: Instrument 1	4%	3%	78%	73%	69%	63%	+
5.3: Instrument 2	7%	5%	-1%	-1%	-1%	0%	-
5.4: Instrument 3	34%	38%	46%	49%	38%	35%	+
6.0: Spacecraft	0%	0%	0%	0%	0%	0%	○
6.1: S/C PM	4%	4%	4%	0%	0%	0%	○
6.2: S/C SE	13%	11%	2%	2%	2%	2%	○
6.3: S/C MA							
6.4: S/C AI&T	-4%	-11%	-10%	-18%	-11%	-1%	-
6.5: Mechanisms & Structures	232%	184%	124%	77%	85%	51%	+
6.6: Avionics	10%	15%	9%	1466%	459%	259%	+
6.7: Software	0%	-2%	1%	-7%	5%	11%	-
6.8: Navigation Hardware	1290%	1410%	788%	1175%	388%	938%	-
6.9: Communications	17%	5%	4%	4%	6%	8%	-
6.10: Thermal	-17%	-27%	-48%	-66%	-47%	-57%	+
6.11: Power Systems	140%	104%	116%	58%	-14%	-55%	+
7.0: Operations	-19%	-25%	-27%	-35%	-34%	-28%	-
8.0: Launch Services	-2%	7%	12%	7%	8%	15%	-
9.0: Ground Systems	-1%	-2%	-4%	-7%	-7%	-12%	+
10.0: Systems Integration & Test	-53%	-55%	-59%	-61%	-66%	-71%	+

Duration metrics exclude added tasks, deleted tasks, summary tasks, and giver/receiver tasks with durations ≤ 1 day
Data is notional and does not represent any specific mission

Duration Growth %
No tasks planned

Comparison To Last Month
+ Improved from last month
- Worsened from last month
○ Same as last month

Task Duration Growth

Measure of overall schedule duration change due to task compression/growth

Indicates whether the schedule is growing significantly

$$\text{Task Duration Growth \%} = \frac{\text{Actual rem. duration} - \text{Baseline rem. duration}}{\text{Baseline rem. duration}}$$

Current month duration growth > 100%

Navigation schedule duration worsened and remained significantly longer than baseline plan; Systems I&T schedule duration compressed further





Added Task Duration Example

Added Task Duration vs Baseline Trend

WBS	Month						Change From Last Month
	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	
Total Project	15%	16%	15%	23%	25%	25%	o
1.0: Project Management	0%	0%	0%	10%	54%	53%	+
2.0: Systems Engineering	0%	0%	0%	81%	117%	113%	+
3.0: Mission Assurance							
4.0: Science	0%	0%	0%	0%	0%	0%	o
5.0: Payload	8%	8%	4%	4%	4%	4%	o
5.1: Payload Management							
5.2: Instrument 1	10%	11%	8%	8%	9%	10%	-
5.3: Instrument 2	12%	8%	3%	1%	1%	1%	o
6.0: Spacecraft	24%	27%	30%	45%	49%	51%	-
6.1: S/C PM	0%	0%	0%	0%	0%	0%	o
6.2: S/C SE	0%	0%	0%	0%	0%	0%	o
6.3: S/C MA							
6.4: S/C AI&T	27%	31%	31%	31%	31%	22%	+
6.5: Mechanisms & Structures	16%	7%	0%	0%	0%	0%	o
6.6: Avionics	18%	10%	24%	5%	0%	0%	o
6.7: Software	13%	18%	44%	184%	236%	325%	-
6.8: Navigation Hardware	21%	20%	49%	47%	101%	44%	+
6.9: Communications	19%	38%	14%	22%	28%	70%	-
6.10: Thermal	102%	71%	66%	71%	43%	67%	-
6.11: Power Systems	12%	24%	31%	75%	270%	158%	+
7.0: Operations	0%	0%	4%	7%	6%	6%	-
8.0: Launch Services	0%	0%	1%	0%	1%	3%	-
9.0: Ground Systems	0%	0%	0%	0%	0%	0%	o
10.0: Systems Integration & Test	24%	25%	17%	18%	13%	13%	o

Duration metrics exclude added tasks, deleted tasks, summary tasks, and giver/receiver tasks with durations ≤ 1 day
Data is notional and does not represent any specific mission

Duration Growth %
No tasks planned

Comparison To Last Month
+ Improved from last month
- Worsened from last month
o Same as last month

Added Task Duration
Measure of overall schedule duration change due to newly-added tasks

Indicates whether the schedule is growing significantly

$$\text{Added Task Duration \%} = \frac{\text{Duration of newly added tasks}}{\text{Remaining duration}}$$

Current month duration growth > 100%

Software schedule has grown more than 300% due to tasks added since the baseline



Added Task Duration Example (cont.)

Added Task Duration vs Prior Month Trend

WBS	Month						Change From Last Month
	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	
Total Project	2%	2%	2%	8%	1%	1%	o
1.0: Project Management	0%	0%	0%	10%	38%	0%	+
2.0: Systems Engineering	0%	0%	0%	146%	0%	0%	o
3.0: Mission Assurance							
4.0: Science	0%	0%	0%	0%	0%	0%	o
5.0: Payload	0%	0%	0%	0%	3%	0%	+
5.1: Payload Management							
5.2: Instrument 1	0%	0%	0%	0%	0%	0%	o
5.3: Instrument 2	0%	0%	0%	0%	0%	0%	o
6.0: Spacecraft	3%	6%	4%	13%	1%	3%	-
6.1: S/C PM	0%	0%	0%	0%	0%	0%	o
6.2: S/C SE	0%	0%	0%	0%	0%	0%	o
6.3: S/C MA							
6.4: S/C AI&T	3%	7%	1%	4%	0%	4%	-
6.5: Mechanisms & Structures	15%	0%	0%	0%	0%	0%	o
6.6: Avionics	2%	0%	0%	20%	0%	0%	o
6.7: Software	4%	4%	33%	112%	0%	0%	o
6.8: Navigation Hardware	0%	0%	280%	25%	125%	0%	+
6.9: Communications	0%	0%	0%	0%	0%	0%	o
6.10: Thermal	17%	0%	0%	0%	0%	8%	-
6.11: Power Systems	0%	16%	8%	0%	4%	0%	+
7.0: Operations	0%	0%	3%	1%	0%	0%	o
8.0: Launch Services	0%	0%	1%	0%	0%	3%	-
9.0: Ground Systems	0%	0%	0%	0%	0%	0%	o
10.0: Systems Integration & Test	1%	1%	0%	1%	0%	0%	o

Duration metrics exclude added tasks, deleted tasks, summary tasks, and giver/receiver tasks with durations ≤ 1 day
Data is notional and does not represent any specific mission

Duration Growth %
No tasks planned

Comparison To Last Month
+ Improved from last month
- Worsened from last month
o Same as last month

Added Task Duration
Measure of overall schedule duration change due to newly-added tasks
Indicates whether the schedule is growing significantly
$$\text{Added Task Duration \%} = \frac{\text{Duration of newly added tasks}}{\text{Remaining duration}}$$

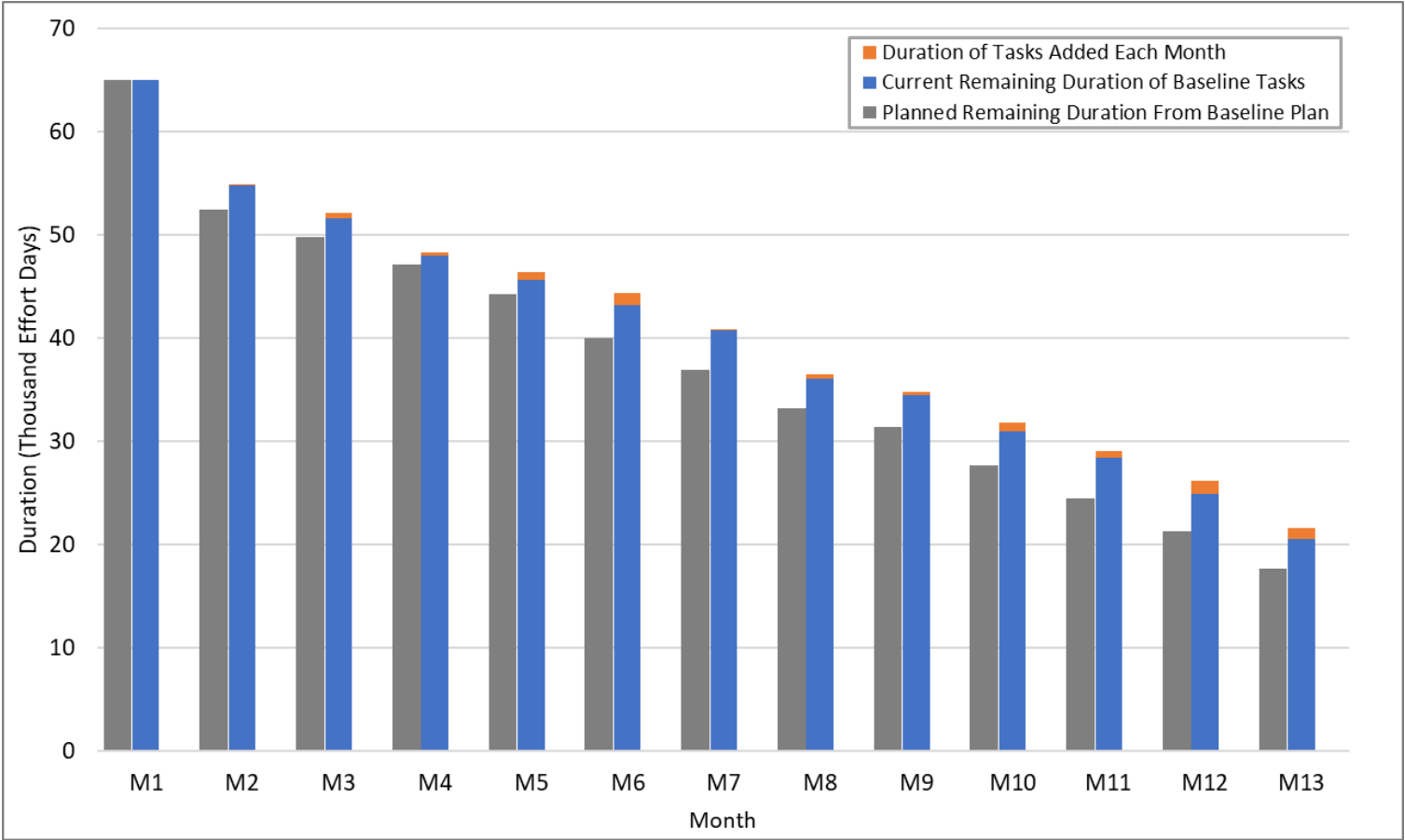
Current month duration growth > 100%

No WBS element schedules grew significantly due to tasks added in Month 6



Task Duration Example

Remaining Schedule Duration



Durations are measured in effort days, which are equal to the summed durations of lowest-level WBS tasks (akin to man hours)
Effort days can be worked in parallel
Durations exclude tasks deleted since the baseline month, summary tasks, and giver/receiver tasks
Data is notional and does not represent any specific mission

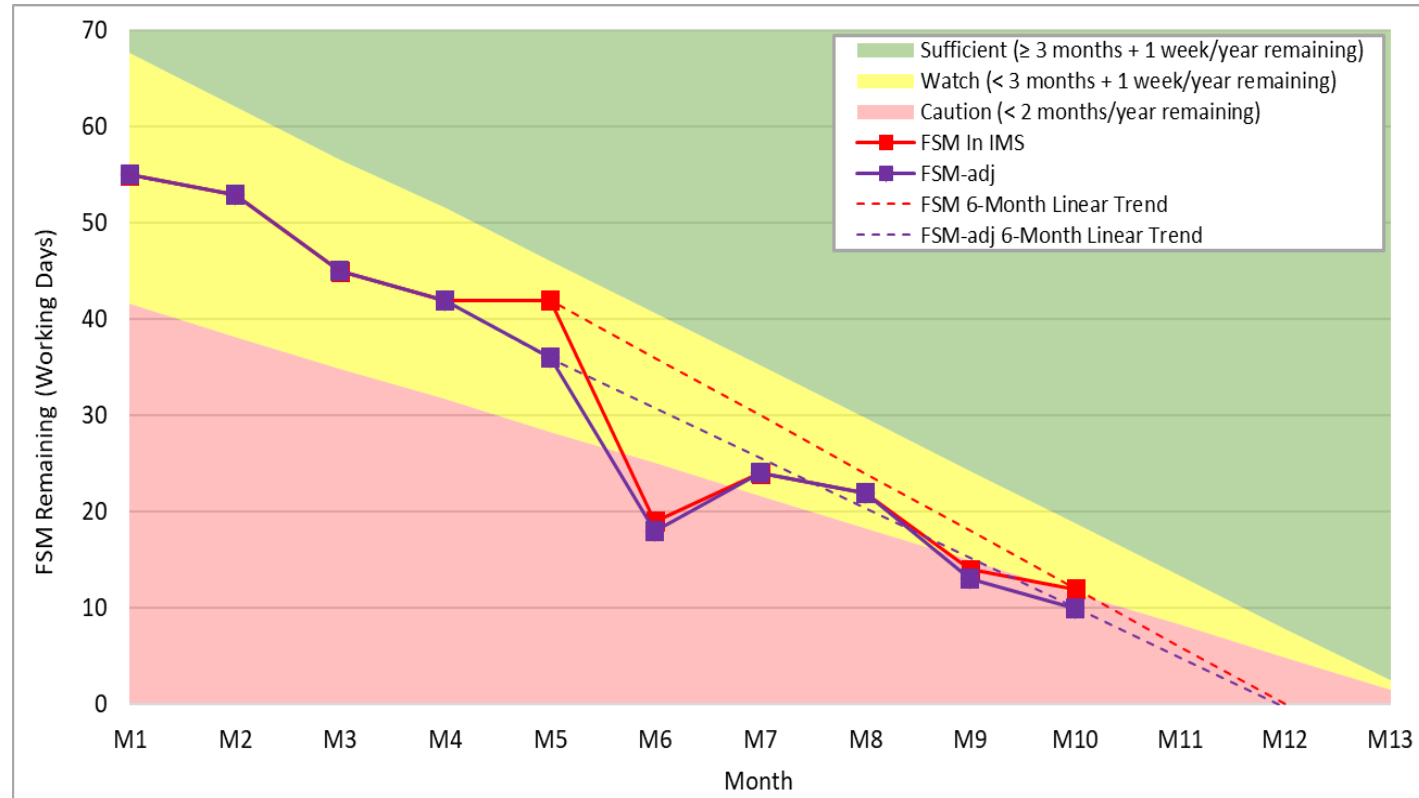
Many tasks have grown over time compared to the baseline plan



Schedule Metrics FSM Example

Funded Schedule Margin (FSM) Usage

- Comparison of remaining FSM to recommended thresholds



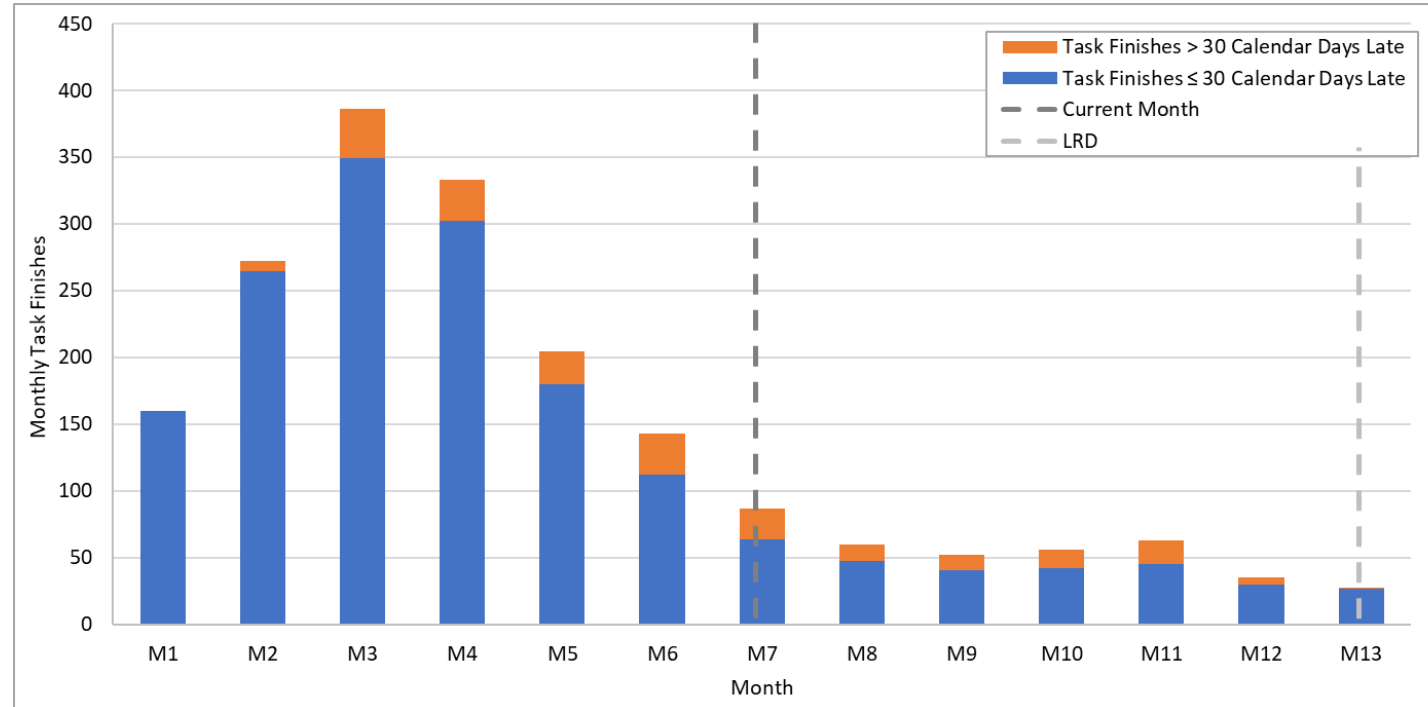
Indicates whether FSM is sufficient for the time remaining until delivery



Schedule Metrics Workoff Example

Schedule Workoff

- Measure of tasks that are more than 30 days late



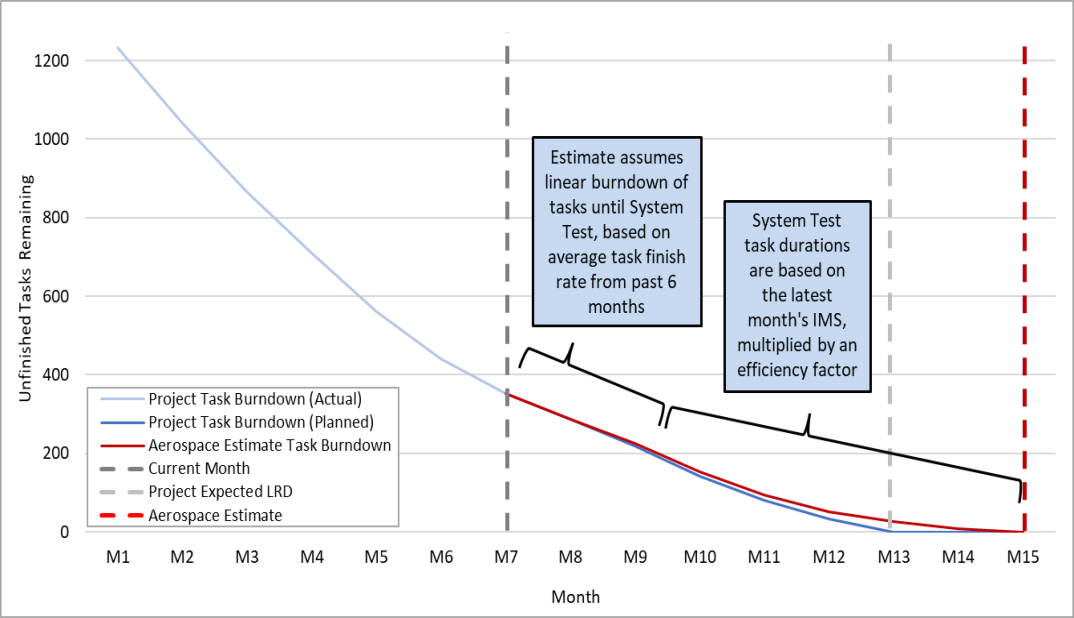
Metrics exclude tasks added or deleted since the baseline month, summary tasks, and giver/receiver tasks
Data is notional and does not represent any specific mission

An early indication that a project may need more resources to work off late tasks

Forecasting Technique 1 Examples

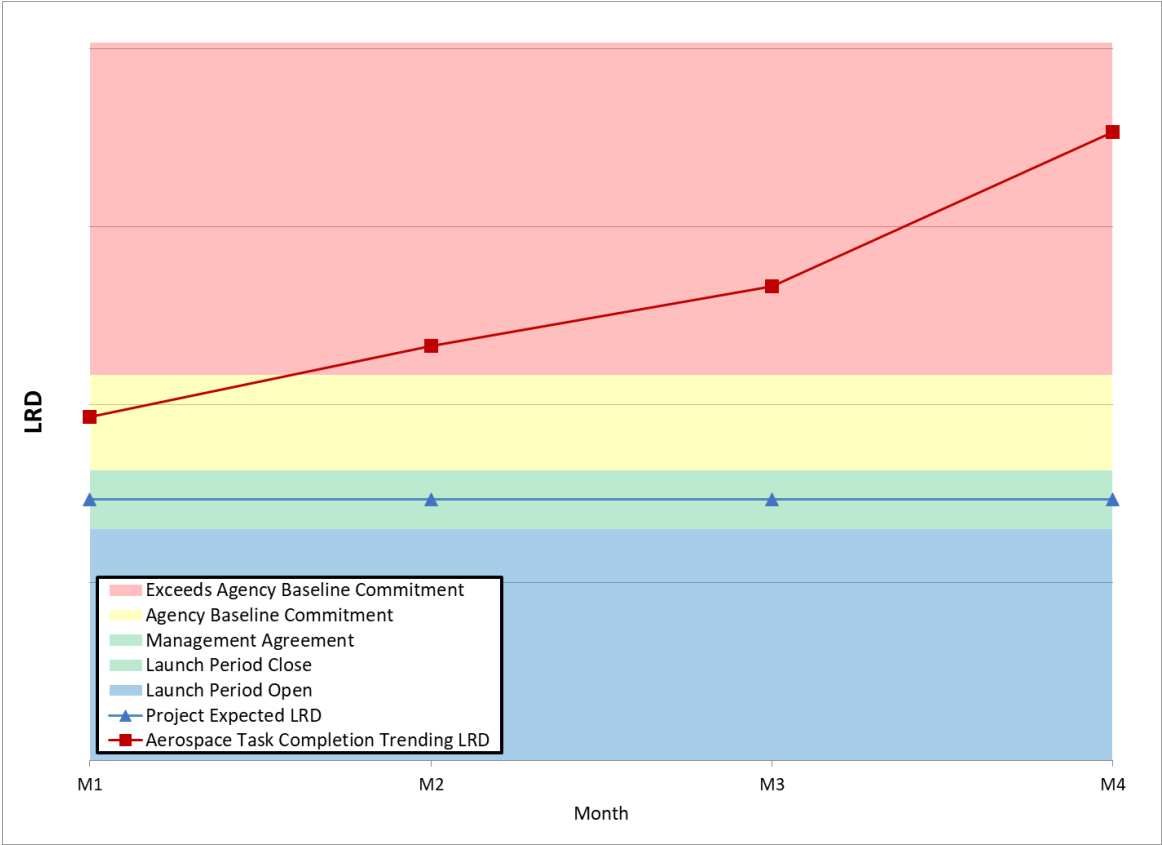


Task Burndown Estimate



Metrics exclude tasks added or deleted since the baseline month, summary tasks, and giver/receiver tasks
Data is notional and does not represent any specific mission

Forecast Results Trend



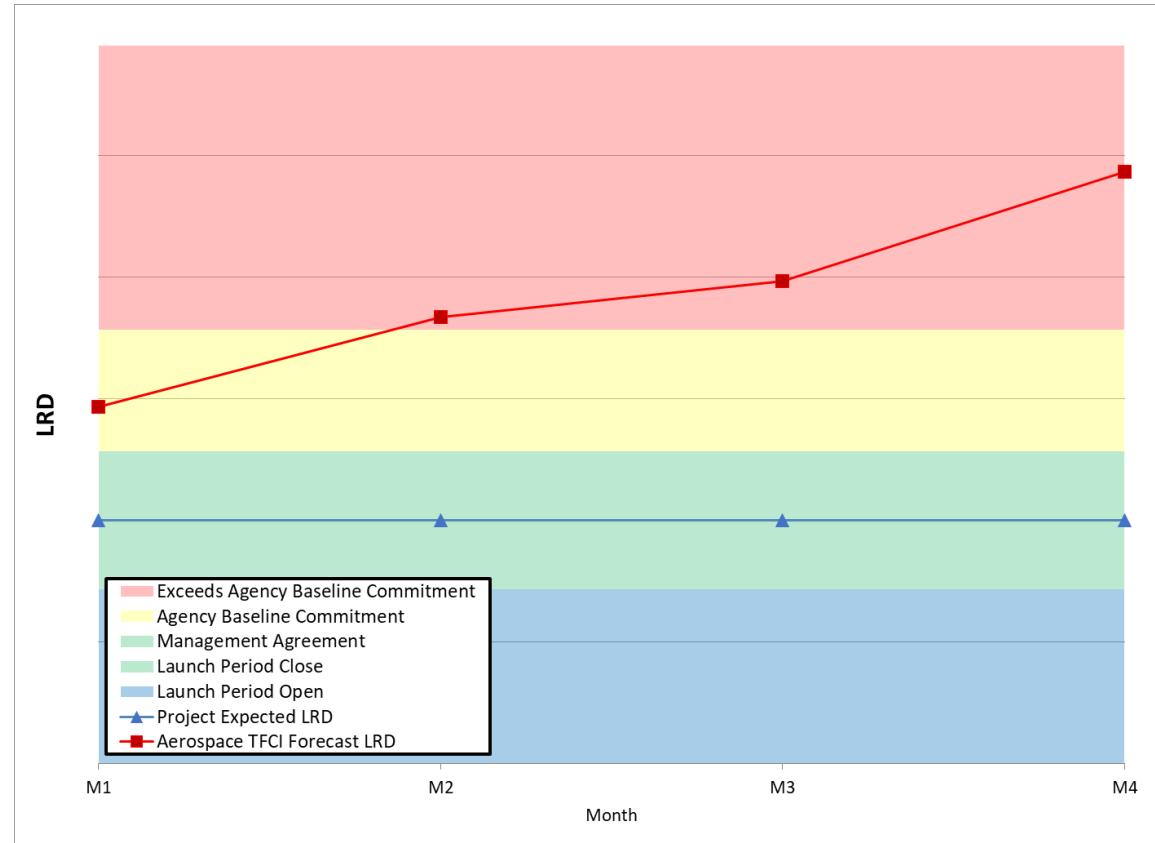
Data is notional and does not represent any specific mission

Forecast result changes over time due to change in program/project average task completion rate

Forecasting Technique 2 Example

Delivery Estimate Trend

- Forecast result changes over time due to change in program/project TFCI



Data is notional and does not represent any specific mission

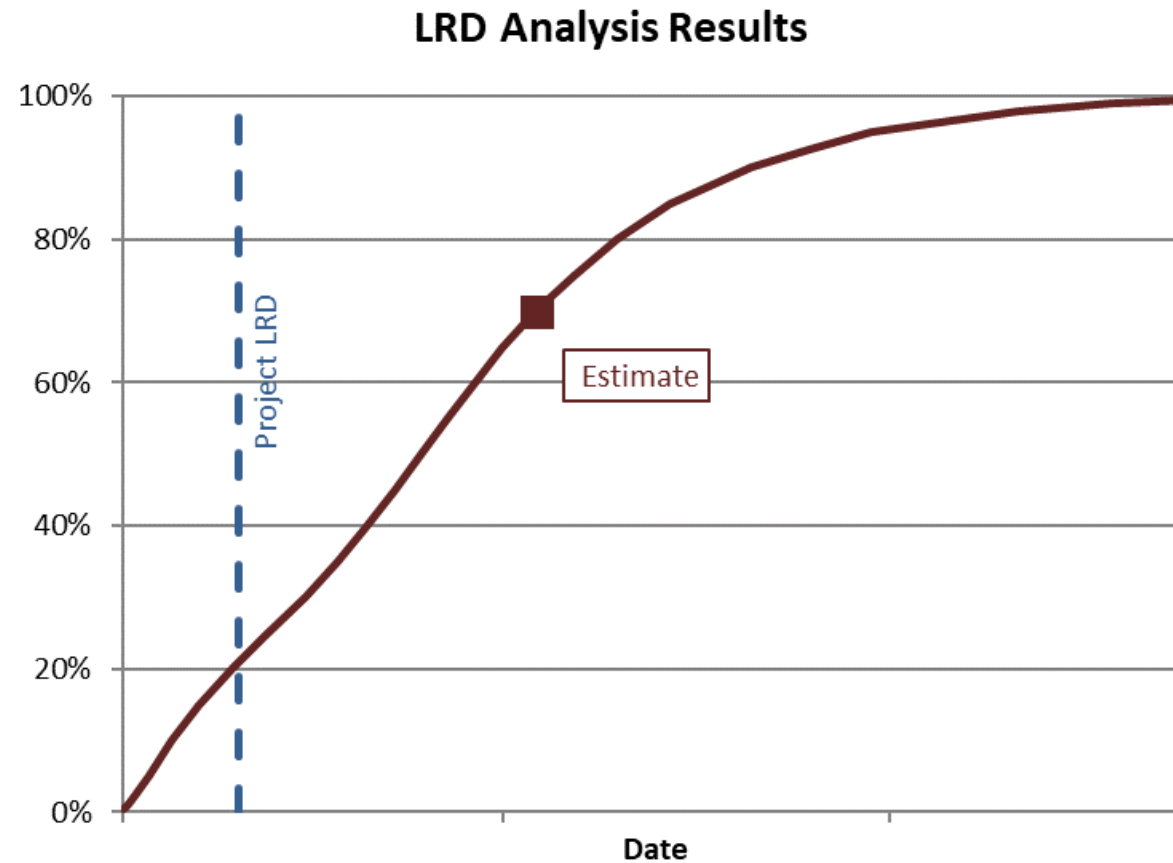
Delivery estimate worsened compared to last month



Forecasting Technique 3 Example

Delivery Estimate Trend

- Forecast result changes over time due to change in program/project schedule metrics performance indices



Data is notional and does not represent any specific mission

