



# JCL Implementation On A Human Spaceflight Program

*2013 NASA Cost Symposium*

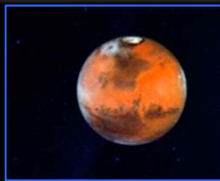
*Vyga Kulpa*

*Mike Karpowich*

*Diana Abel*

*Wes Archibale*

Space Launch System



August 27-29, 2013



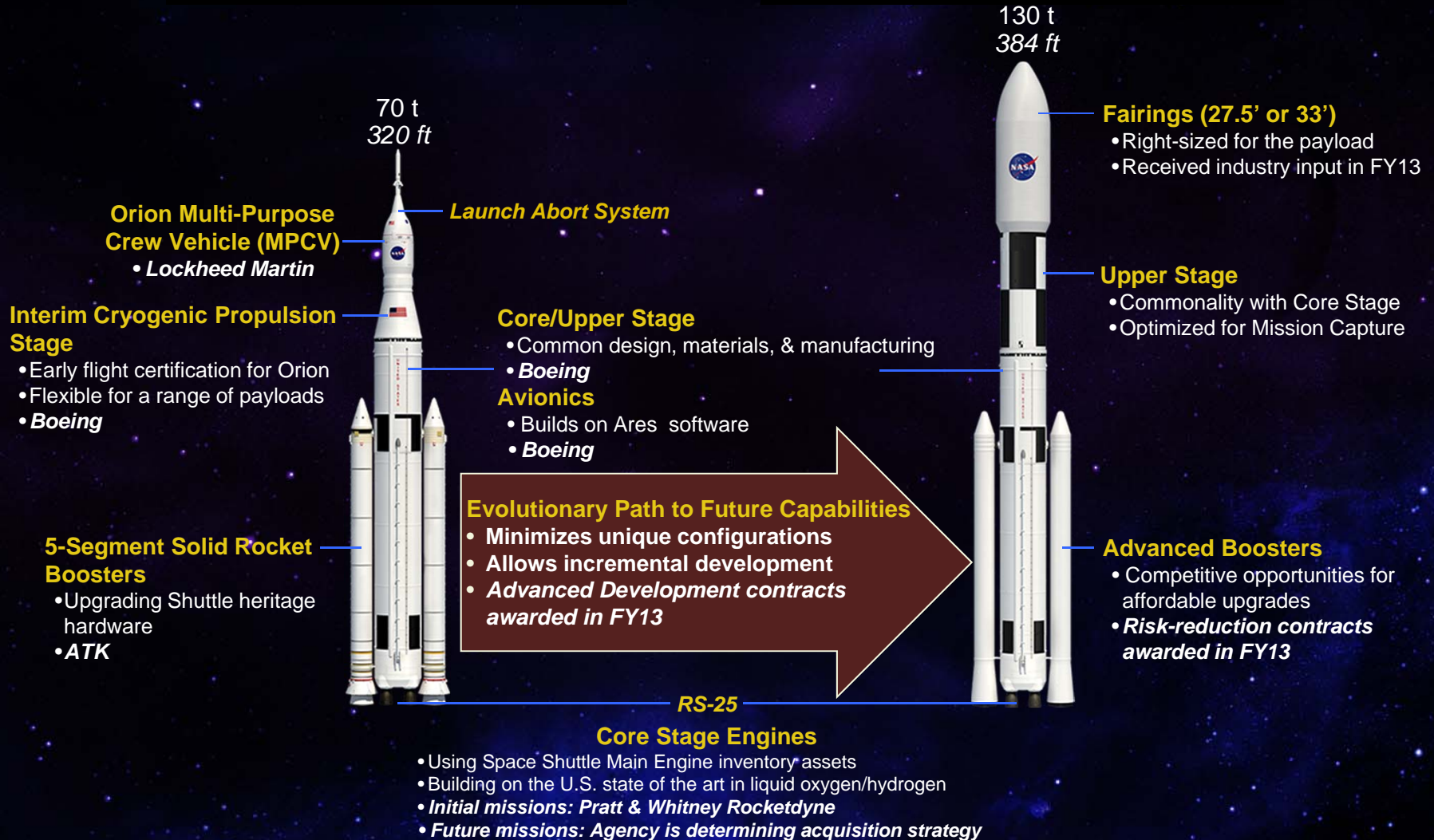
- ◆ **NASA's Human Spaceflight Program**
- ◆ **What is JCL Analysis?**
- ◆ **SLS JCL Architecture**
- ◆ **SLS JCL Implementation**
- ◆ **Future SLS JCL Considerations**

# Building on the U.S. Infrastructure



## INITIAL CAPABILITY, 2017–21

## EVOLVED CAPABILITY, Post-2021



# JCL Human Space Flight Implementation



## Human Exploration



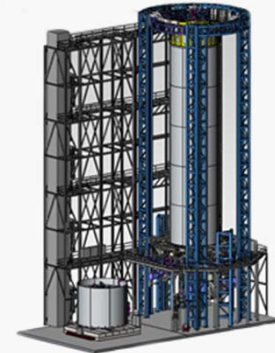
MPCV

+



SLS

+



GSDO

\$10B+



James Web Space Telescope (JWST)

\$1B

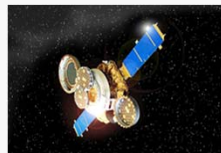


Mars Science Laboratory (MSL)



Kepler

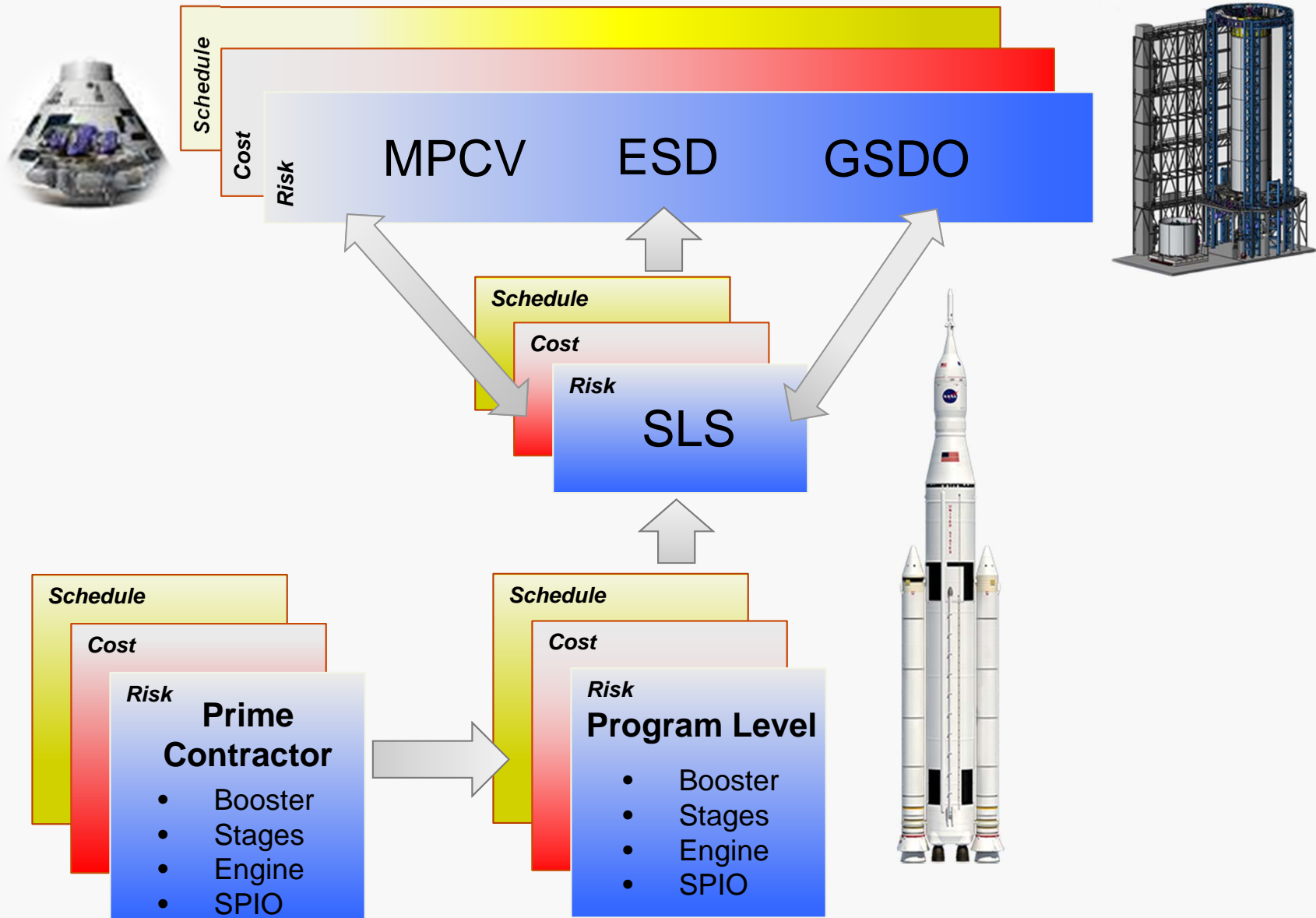
\$100M



Genesis

***Human Exploration is a costly endeavor - JCL analysis is a critical management tool to establish optimal cost and schedule resource allocations***

# Multiple SLS Elements/Multiple Primes

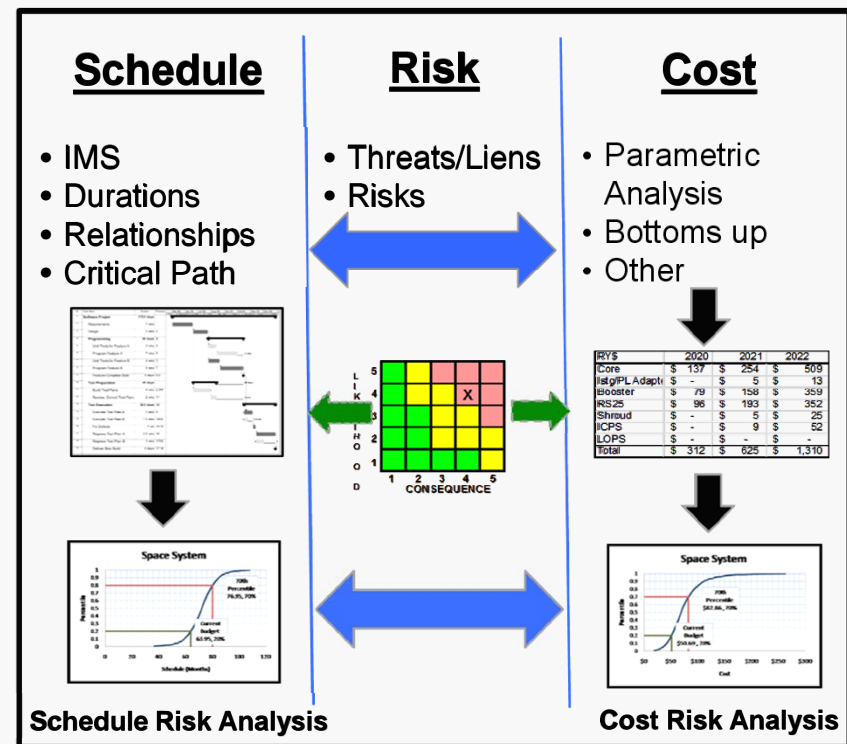
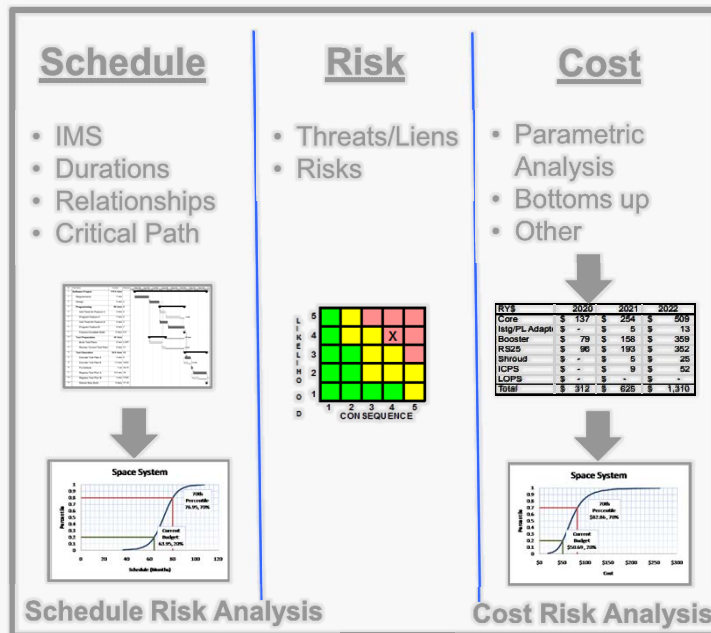




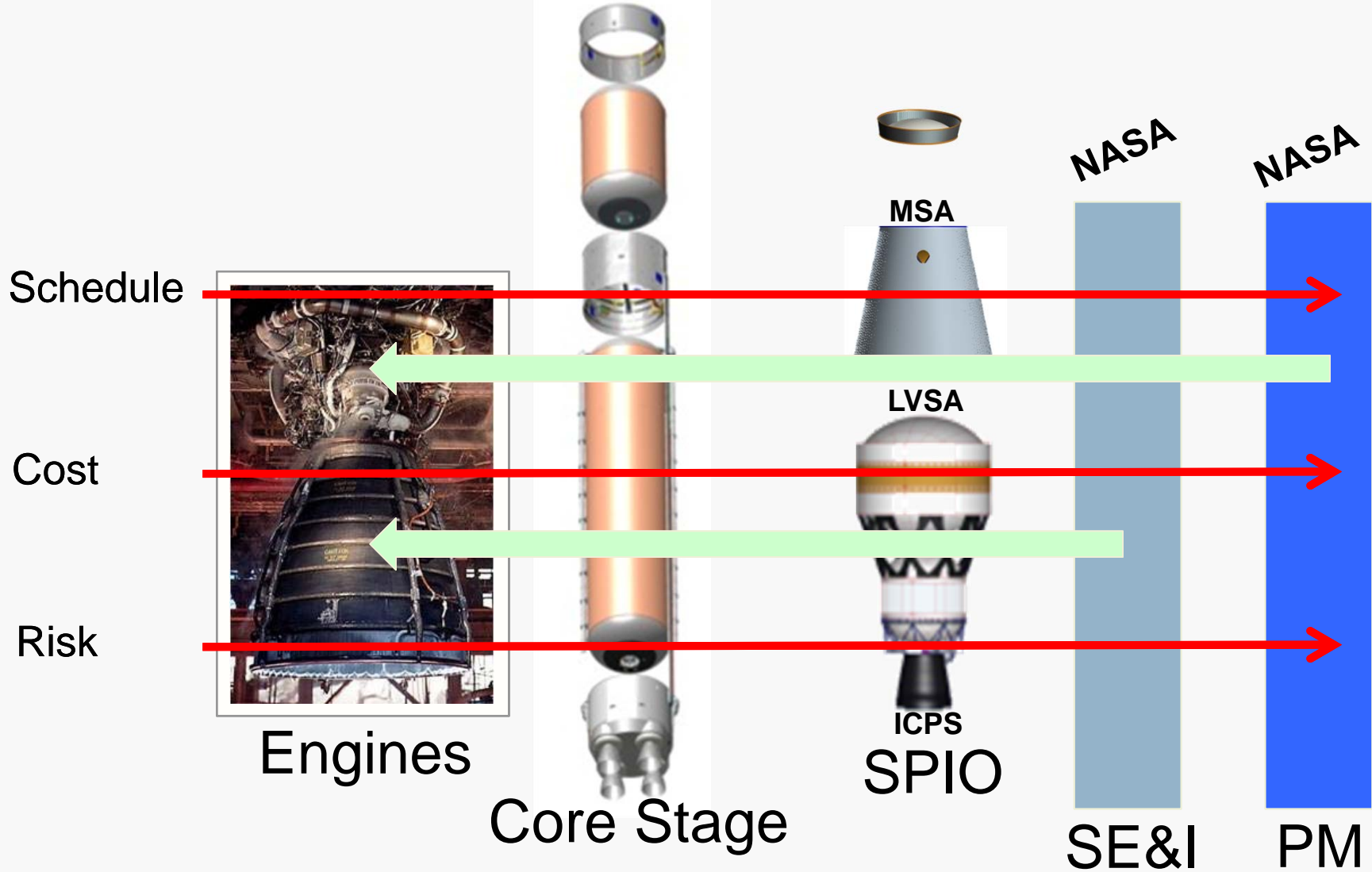
# What is JCL Analysis?

Joint Confidence Level (JCL) analysis focuses on the integration of these traditionally stove-piped programmatic components (schedule, cost and risk) to establish projected resource and schedule requirements at various confidence levels and to identify programmatic cost and schedule risk drivers.

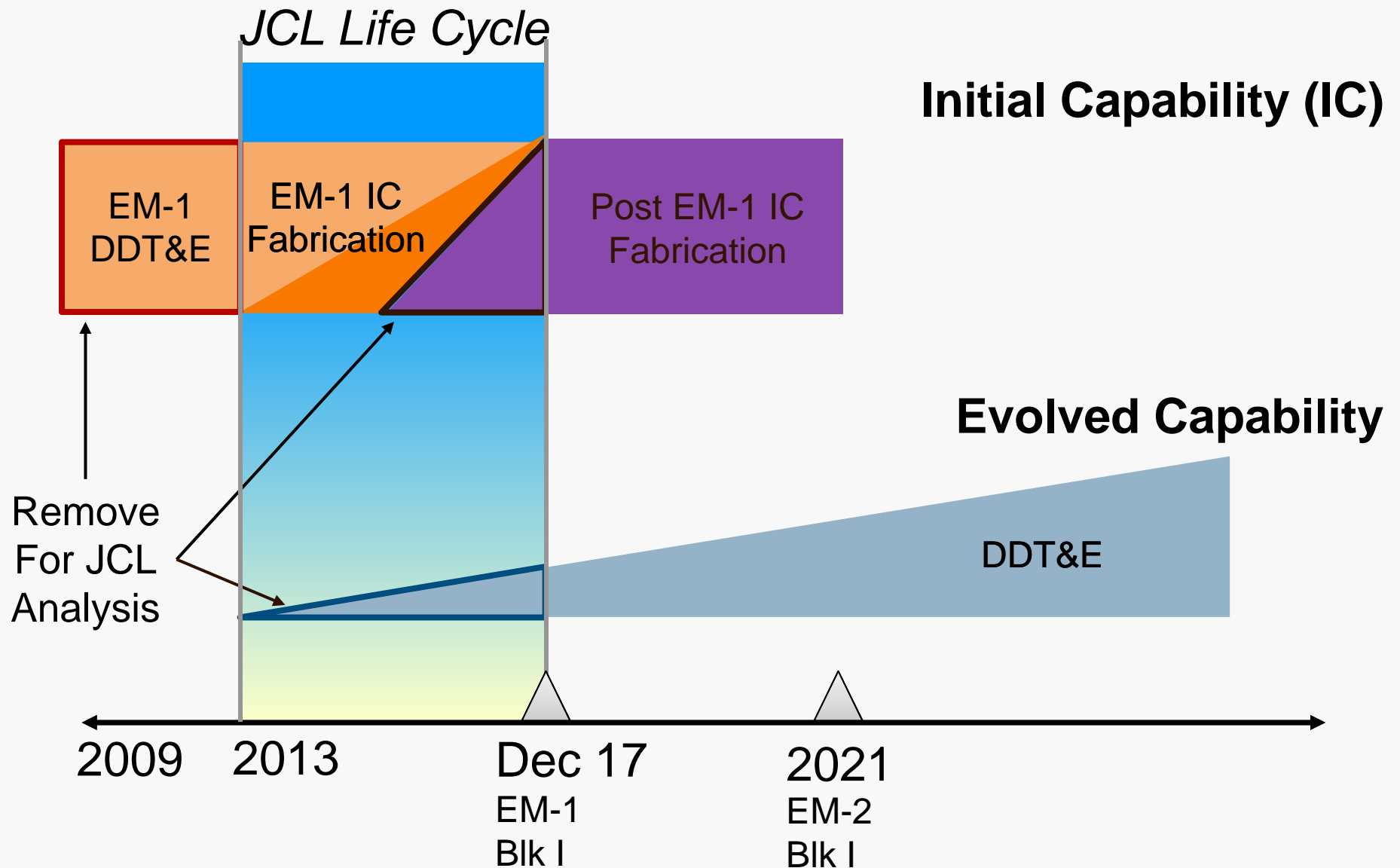
JCL analysis is required by NASA Procedural Requirement 7120.5.



# Multiple SLS Elements/Multiple Primes



# Complex Life Cycle Considerations

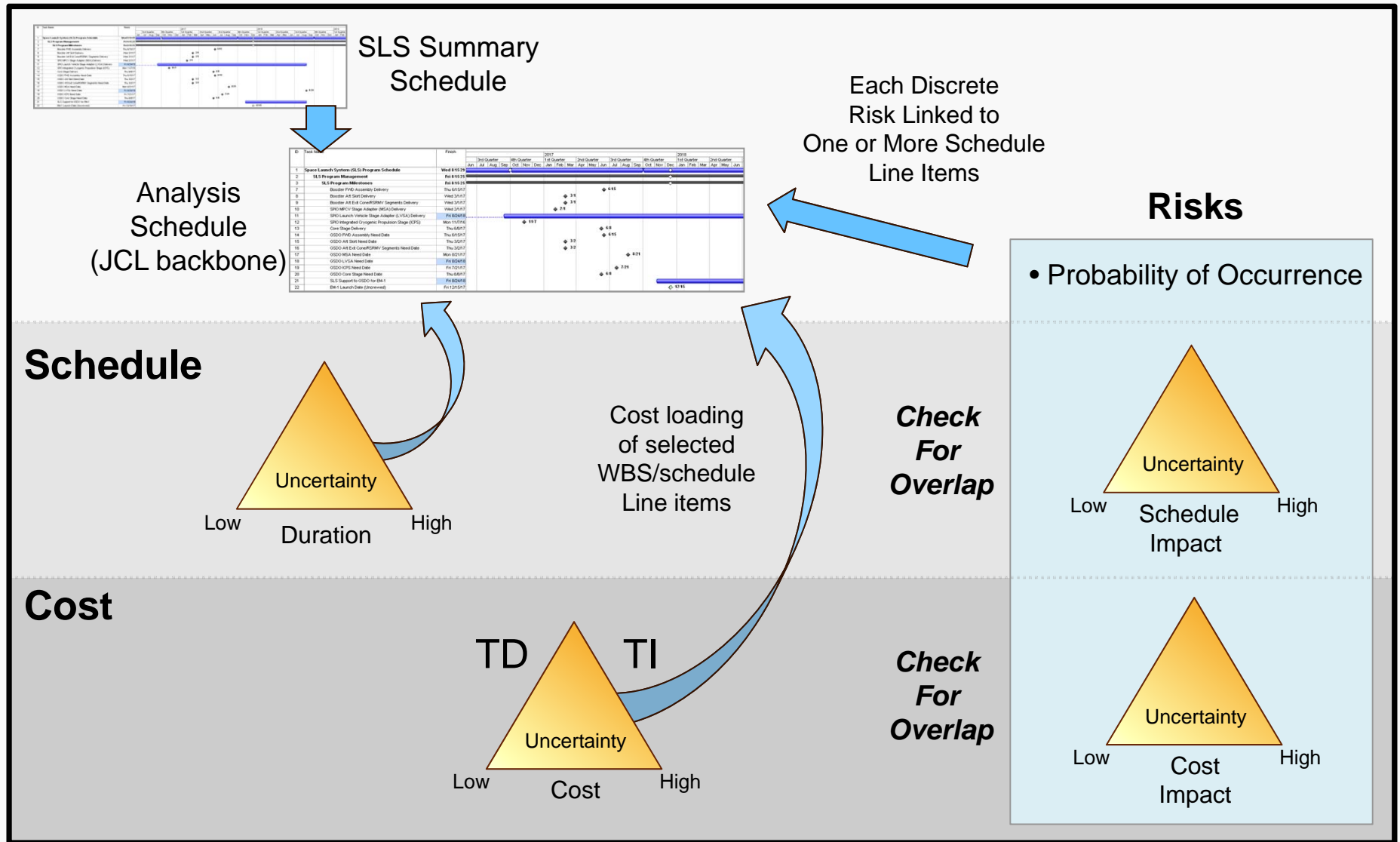




# SLS JCL Architecture



## Monte Carlo Simulation Analysis



# JCL Model Input Example



Assigned Cost:  
\$73 M

Summary Task

TI = 20% \$14.6 M	+	TD = 80% \$58.4 M	+	Subtask \$154 M	=	Total Cost \$227 M
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• No risks assigned

Duration: 600 Days

Rate = \$58.4 M / 600 = \$97,333/day

Subtask A

TI	TD	Assigned Cost
\$154 M	0	\$154 M

• No risks assigned

Duration: 250 days

Subtask B

TI	TD	Assigned Cost
0	0	\$0 M

Multiple risks assigned  
 - Risk 1: \$10 M impact  
 - Risk 2: 42 day impact  
 - Risk 3: 42 day impact

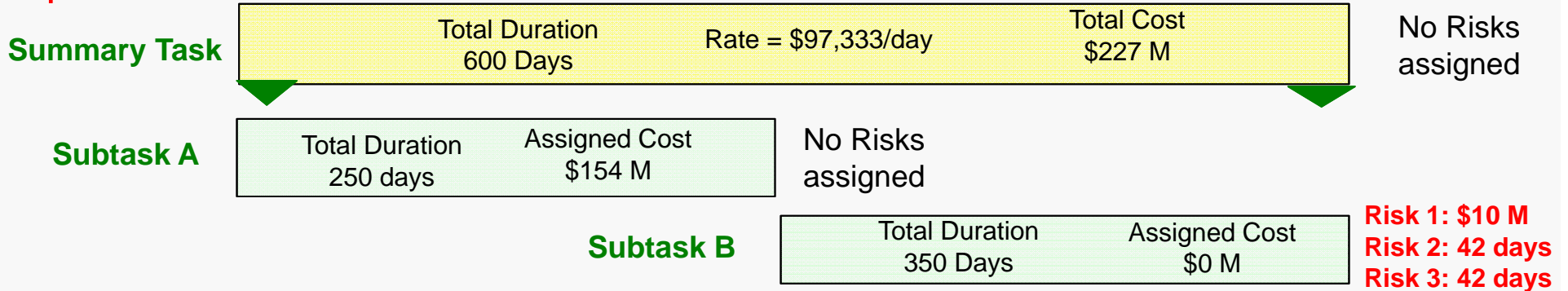
Duration: 350 days

Notional Gantt View

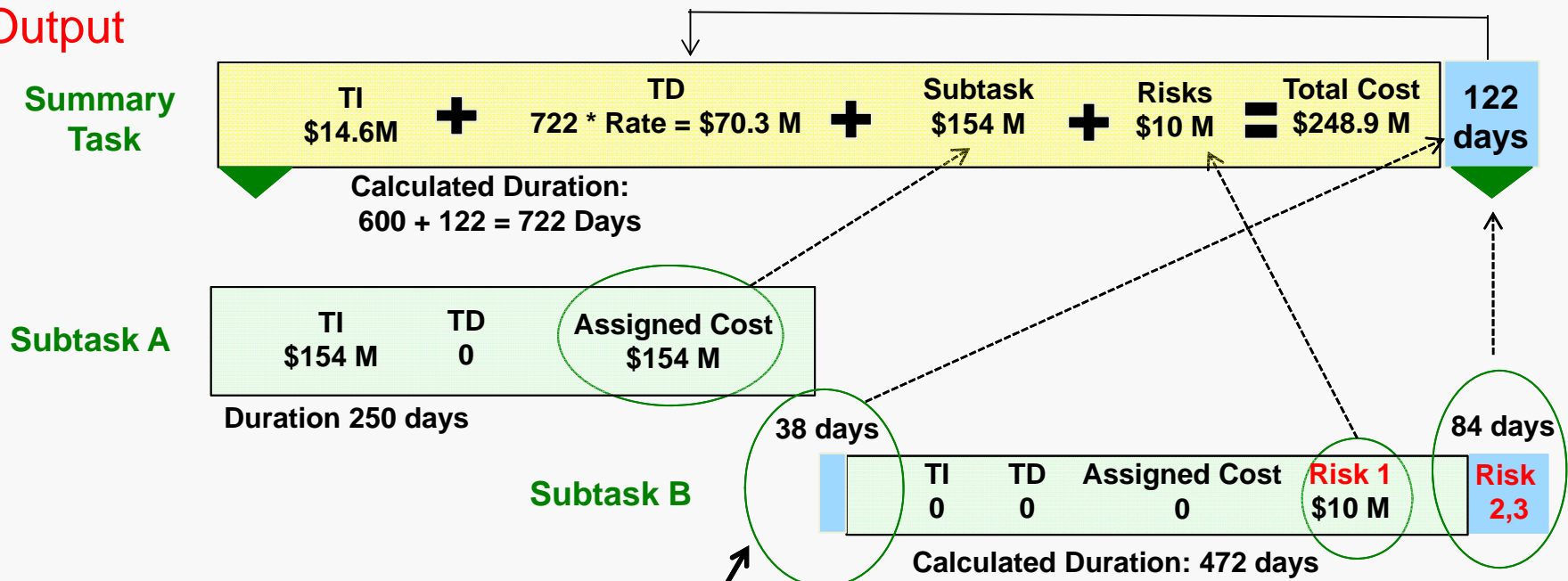
# JCL Model Output Example (cont'd)



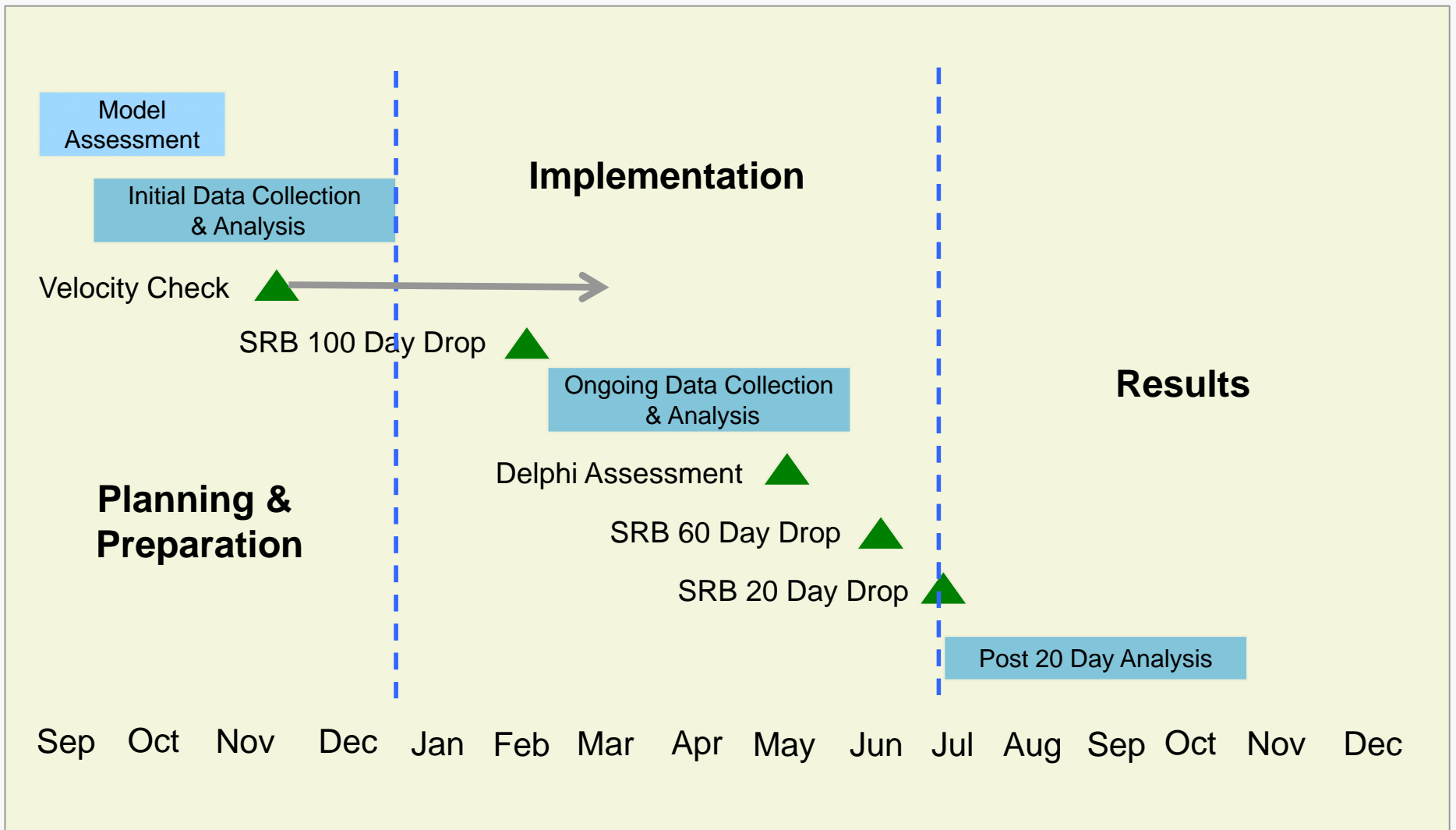
## Input



## Output



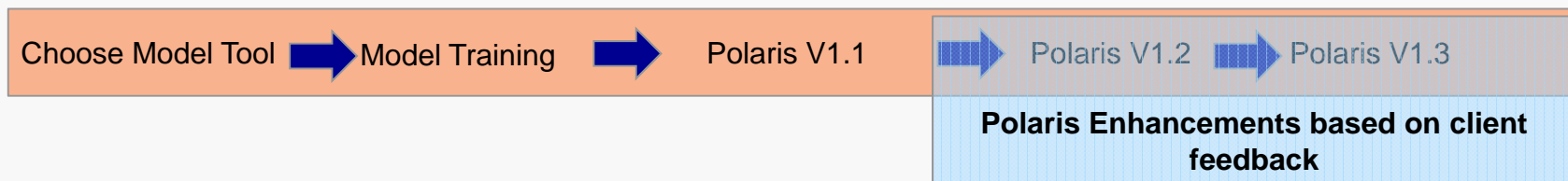
# SLS JCL Implementation



# Model Assessment Hyperlink



- ◆ NASA HQ CAD identified that a tool was needed to perform JCL analysis.
- ◆ HQ CAD sponsored the development of two unique JCL simulation tools.
- ◆ SLS evaluated the two tools and selected Polaris for implementation on SLS.
- ◆ Polaris developer (Booz Allen Hamilton) helped train the SLS team on Polaris and modeling techniques and provided real time enhancements to the software base on SLS feedback.



Example enhancements.....



# Velocity Check Hyperlink



## ◆ **Goals:**

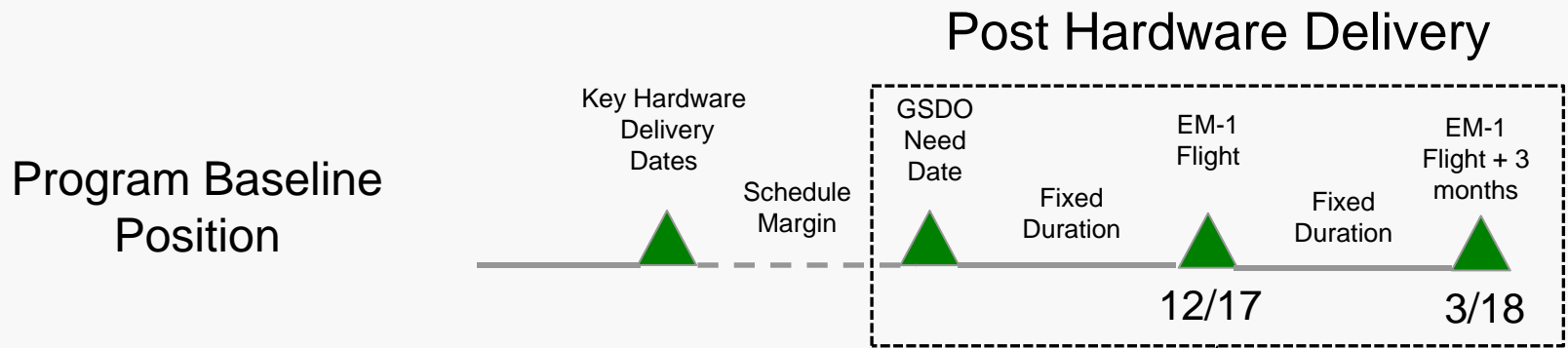
- Obtain stakeholder (SLS and external) consensus on JCL architecture and modeling approach
- Review preliminary JCL ground rules and assumptions
- Communicate process to date with NASA CAD

## ◆ **Activities:**

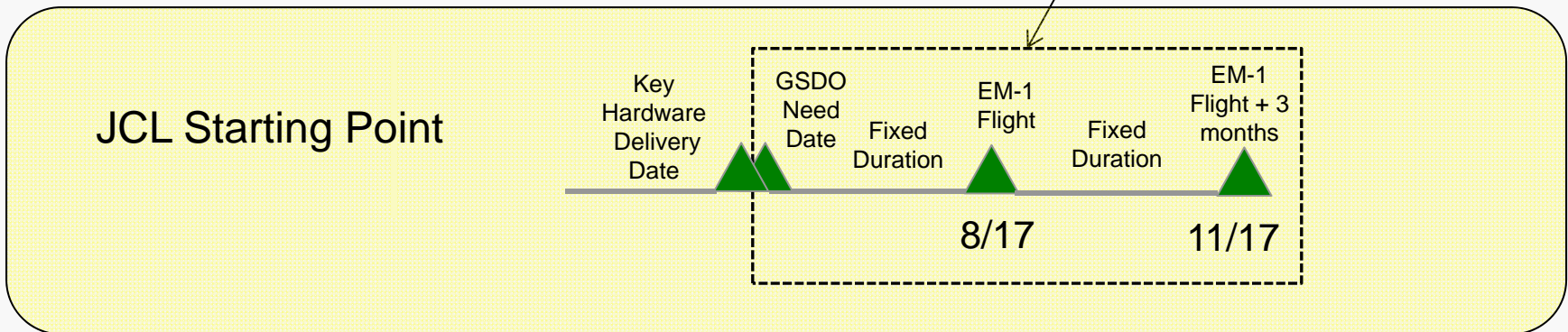
- Determined need to use a unique “JCL analysis schedule” versus the Program’s schedule
- Identified need to include external Program (GSDO) tasks to fully capture the SLS JCL life cycle
- Identified preliminary sources for cost inputs
- Discussed need for TI/TD breakout
- Established sources for risk data/inputs



# JCL Analysis Schedule Logic



**Remove Schedule Margin and Constraints**



Represents best case before application of risk and uncertainty



# 100 Day Drop Hyperlink



## ◆ **Goals:**

- First cut at validation of model structure and ground rules/assumptions
- Initial runs/analysis with JCL Analysis Schedule and preliminary cost and risk data (no emphasis on results)
- Initial presentation/education of modeling approach and outputs to SLS and SRB cost/schedule team

## ◆ **Activities:**

- First use of JCL Analysis Schedule with modifications from Program Summary Schedule
- First cut at methodology for modeling external Program (GSDO) schedule linkages
- Initial cut at breakdown and linkage of costs to schedule
- Initial cut at linkage of risks to Analysis Schedule
- Initial format established for presenting JCL results







## ◆ **Goals:**

- Independent look at JCL input parameters prior to formal 60 Day Drop
- Second set of eyes

## ◆ **Activities:**

- Emphasized closer of review of schedule uncertainty values
- Identified linkage concerns
- Assessed cost uncertainties and identified areas requiring further refinement
- Questioned level of resource loading



# 60 Day Drop Hyperlink



## ◆ **Goals:**

- Present first formal JCL results, and associated Basis of Estimate (BOE) for input data, to SLS and SRB

## ◆ **Activities:**

- Established BOE template for schedule, cost and risk parameters
- First opportunity to evaluate results with individual SLS Elements
- Conducted initial sensitivity analysis to better understand effect of schedule, cost and risk parameters on model output
- Worked with individual Elements to investigate effect of their discrete risks on model output



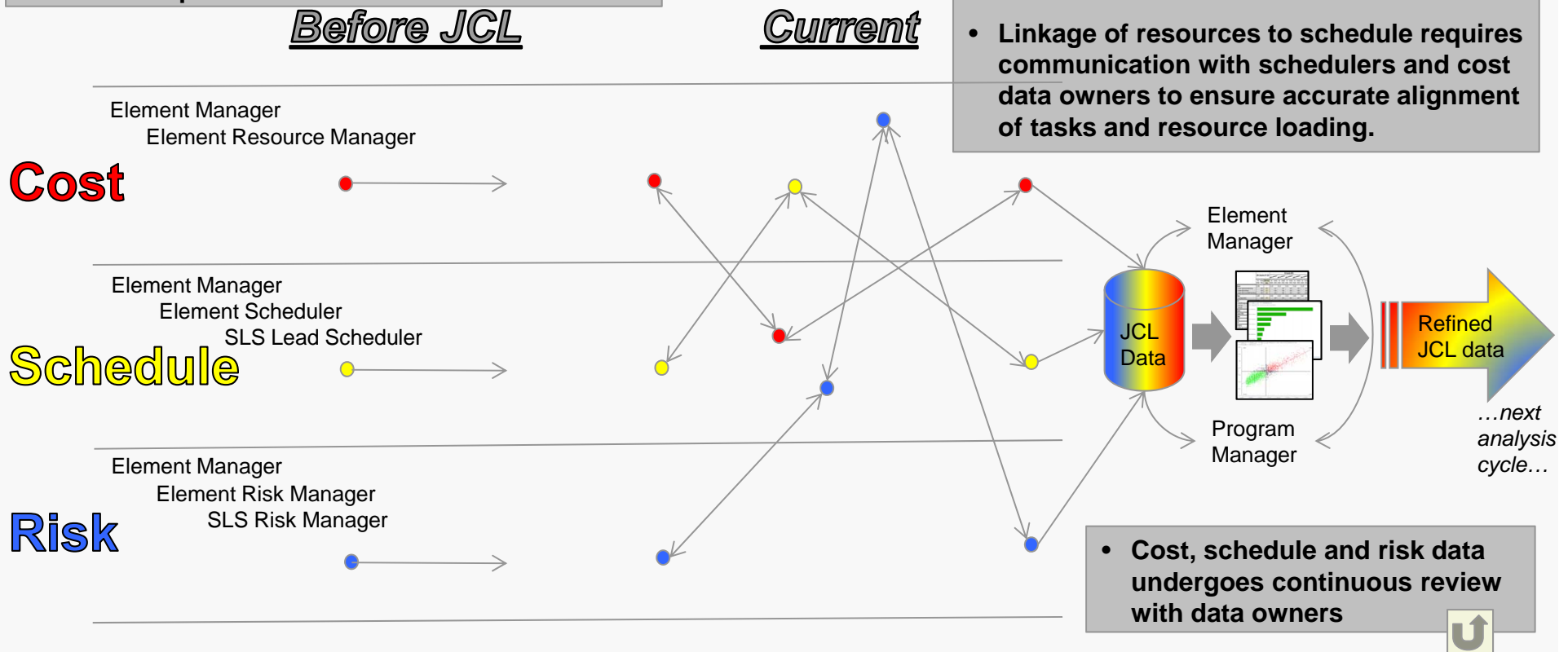
# 20 Day Drop Hyperlink - JCL Data Gathering Process Impact on Integration



- ◆ The JCL data gathering and analysis process has led to data exchange, integration and communication between cost, schedule, and risk data owners within each Element/SE&I as well as between Elements/SE&I and the SLS Program Manager.

- Cost, schedule and risk data is stove-piped and communication channels between data owners are not required

- Linkage of risk to schedule line item requires communication with schedulers to understand sequence of tasks and their resource loading.
- Linkage of resources to schedule requires communication with schedulers and cost data owners to ensure accurate alignment of tasks and resource loading.



# Global Lessons Learned



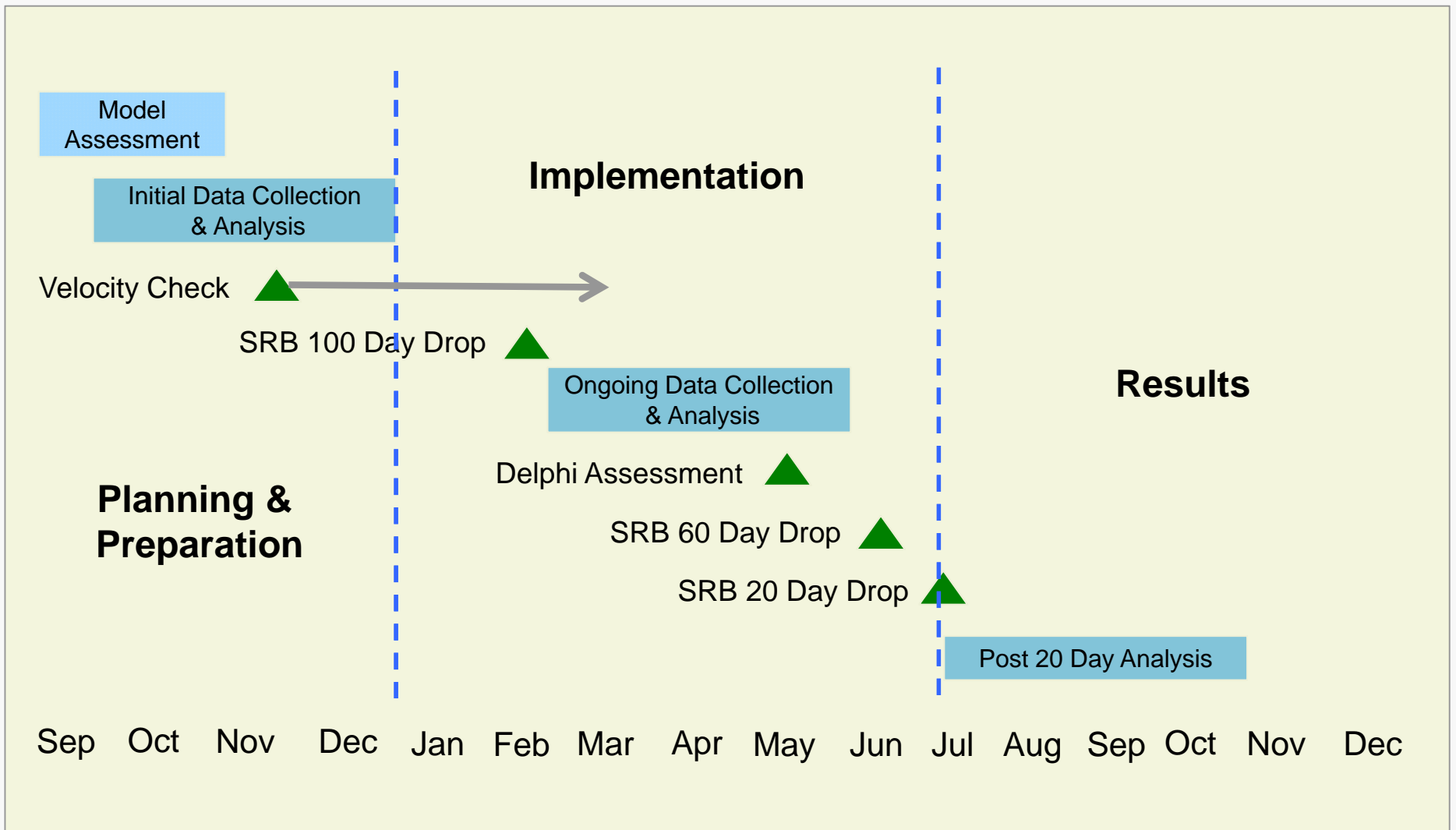
- ◆ **Early socialization of JCL modeling is needed**
  - Time is needed to educate risk “owning organizations” on how the JCL works
- ◆ **Communication of initial model results, in conjunction with SLS Management emphasis on JCL importance, led to enhanced organizational interest and desire to refine their inputs**
- ◆ **You do not get the right “JCL answer” on the first pass**
  - It requires ongoing tuning of parameters
- ◆ **Independent review was value-added and identified key items/concerns that were quickly resolved**
  - Catalyst for data refinement prior to next SRB data drop
- ◆ **JCL definitions are important**
  - Need to be consistent and well documented
- ◆ **Segregation of costs into Time Dependent and Time Independent requires judgment**
  - Not much historical basis available
  - Requires best judgment based on historical experience
- ◆ **Costs need to be linked to the schedule at a level of detail that allows the model to properly calculate results when including discrete risks and uncertainty**
  - There is no “one size fits all” answer on the proper level

# Global Lessons Learned



- ◆ **Organizational top down support for JCL implementation makes a SIGNIFICANT difference.**
  - We had it on SLS
- ◆ **Although the JCL analysis returns a projected cost and schedule at a selected confidence level, the real benefit of the analysis is the ongoing communication and interaction across the organization, that is needed to properly establish the right inputs and to tune the model**
- ◆ **Start the JCL analysis early**
  - It takes time to collect the data, normalize the data, educate the organization, conduct the analysis, refine the analysis, and understand the results.
- ◆ **Be prepared to deal with cost, schedule and risk data that is undergoing constant change**
  - Patience is needed
- ◆ **Emphasize good organization and documentation throughout the JCL process**
- ◆ **The JCL “story telling” is not an easy thing to do**
  - Leave time to prepare presentations that document JCL process and results to a variety of audiences
  - Don’t fall into the trap of presenting too much “modeling detail”

# SLS JCL Implementation



# Future JCL Considerations



- ◆ **How is SLS already using JCL to manage schedule, cost, risk**
- ◆ **Potential future uses of JCL related to Program Management**