National Aeronautics and Space Administration

JCL Implementation On A Human Spaceflight Program

2013 NASA Cost Symposium

Vyga Kulpa
Mike Karpowich
Diana Abel
Wes Archiable
William Carson

Space Launch System

August 27-29, 2013

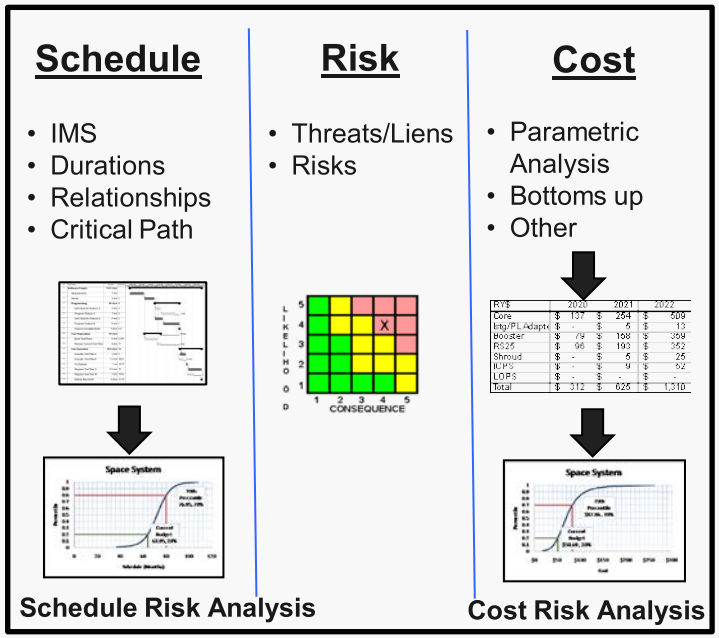
www.nasa.gov/sls

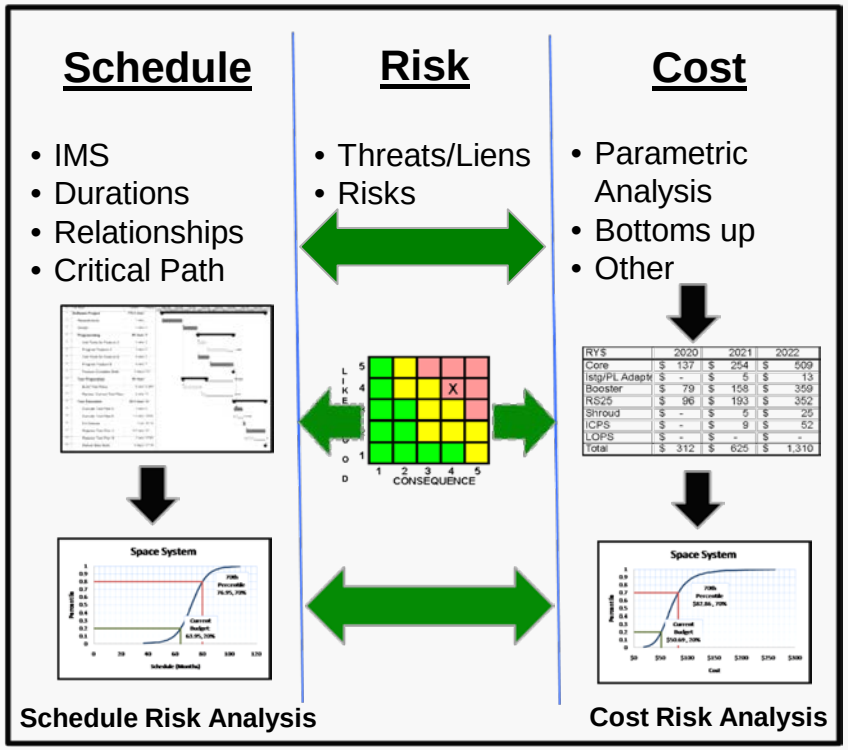
Outline

- What is JCL Analysis
- SLS Program
- SLS JCL Architecture & Modeling Example
- SLS JCL Implementation
- Future SLS JCL Considerations

What is JCL Analysis?

Joint Confidence Level (JCL) analysis focuses on the integration of 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.





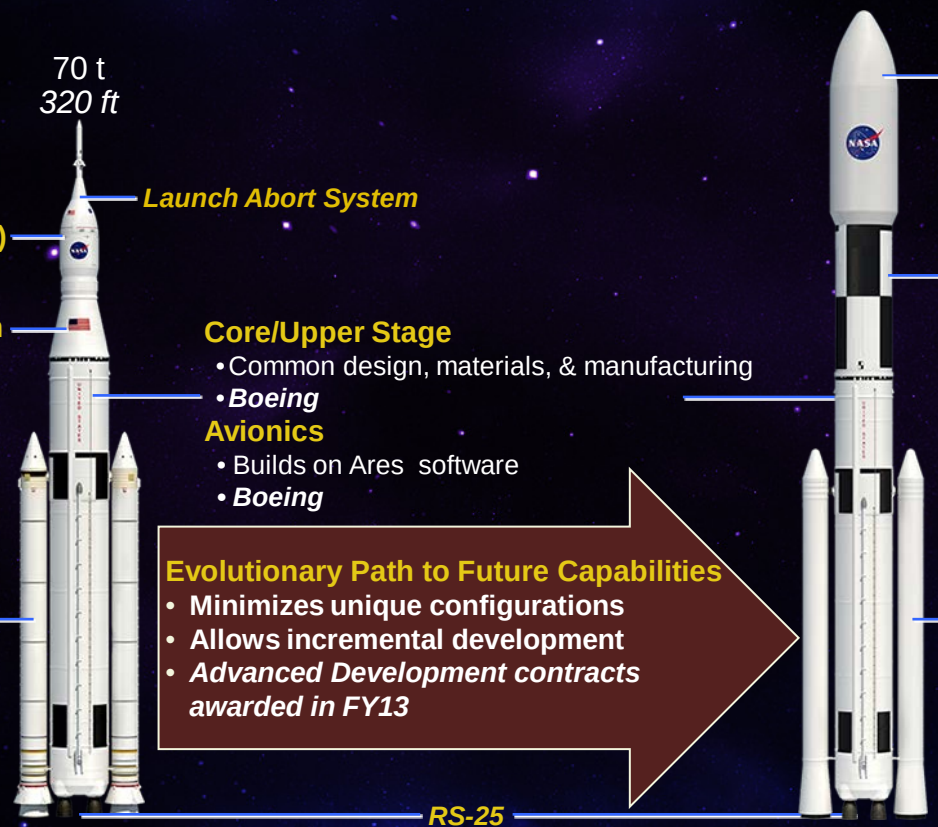
NASA's Human Spaceflight Program: Space Launch System (SLS) Program

INITIAL CAPABILITY, 2017–21

EVOLVED CAPABILITY, Post-2021

70 t
320 ft

130 t
384 ft



Orion Multi-Purpose Crew Vehicle (MPCV)
- ***Lockheed Martin***

Launch Abort System

Interim Cryogenic Propulsion Stage
- Early flight certification for Orion
- Flexible for a range of payloads
- ***Boeing***

Core/Upper Stage
- Common design, materials, & manufacturing
- ***Boeing***

Avionics
- Builds on Ares software
- ***Boeing***

Evolutionary Path to Future Capabilities
- **Minimizes unique configurations**
- **Allows incremental development**
- ***Advanced Development contracts awarded in FY13***

5-Segment Solid Rocket Boosters
- Upgrading Shuttle heritage hardware
- ***ATK***

Fairings (27.5' or 33')
- Right-sized for the payload
- Received industry input in FY13

Upper Stage
- Commonality with Core Stage
- Optimized for Mission Capture

Advanced Boosters
- Competitive opportunities for affordable upgrades
- ***Risk-reduction contracts awarded in FY13***

RS-25

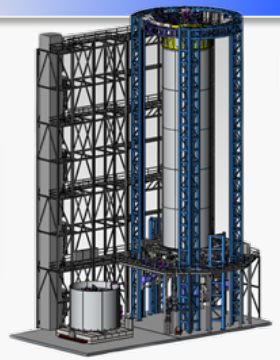
Core Stage Engines
- Using Space Shuttle Main Engine inventory assets
- Building on the U.S. state of the art in liquid oxygen/hydrogen
- ***Initial missions: Pratt & Whitney Rocketdyne***
- ***Future missions: Agency is determining acquisition strategy***

SLS Integration Complexity

Integrated Working Groups
* CATWG * ISWG * IRWG

Schedule
Cost
Risk
MPCV

Schedule
Cost
Risk
GSDO



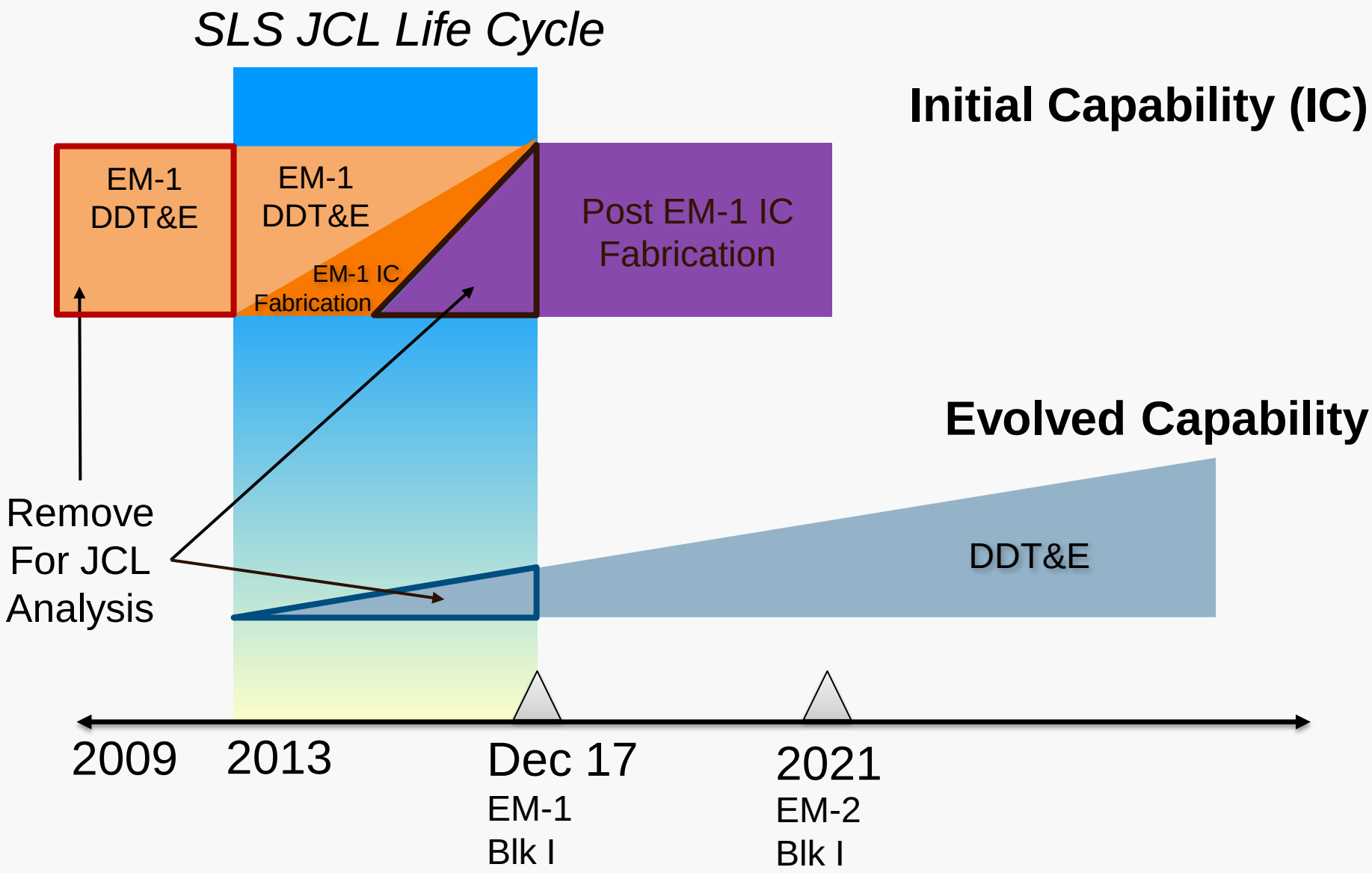
Schedule
Cost
Risk
SLS
- PO
- SE&I

Schedule
Cost
Risk
Prime Contractor
- Booster
- Stages
- Engine
- SPIO

Schedule
Cost
Risk
Element Level
- Booster
- Stages
- Engine
- SPIO

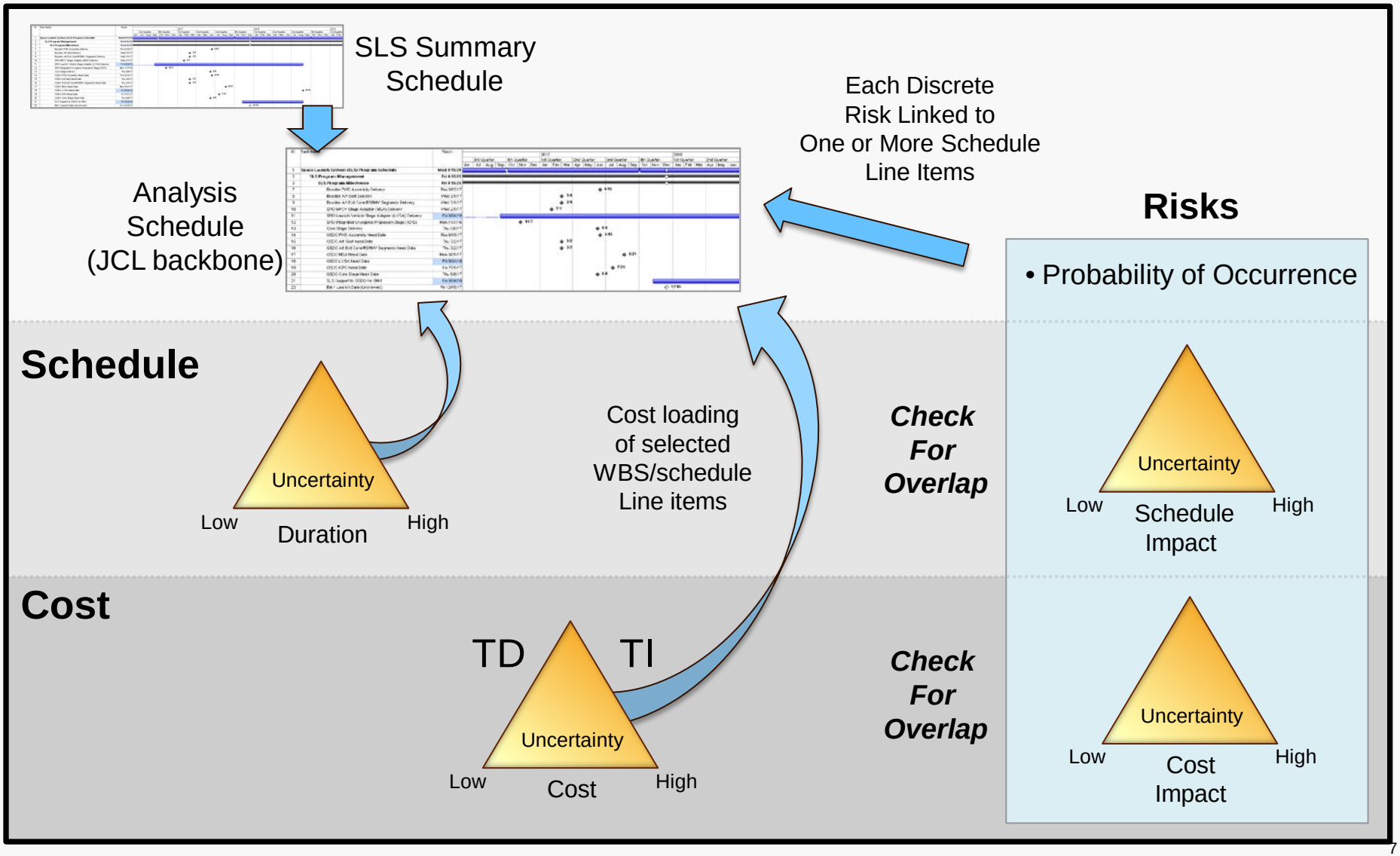
- SLS Program consists of multiple Prime Contractors managed by independent SLS Elements which are integrated using SE&I and Program Management.
- SLS further integrates with GSDO and MPCV through ESD integrated working groups.

SLS Life Cycle Complexity

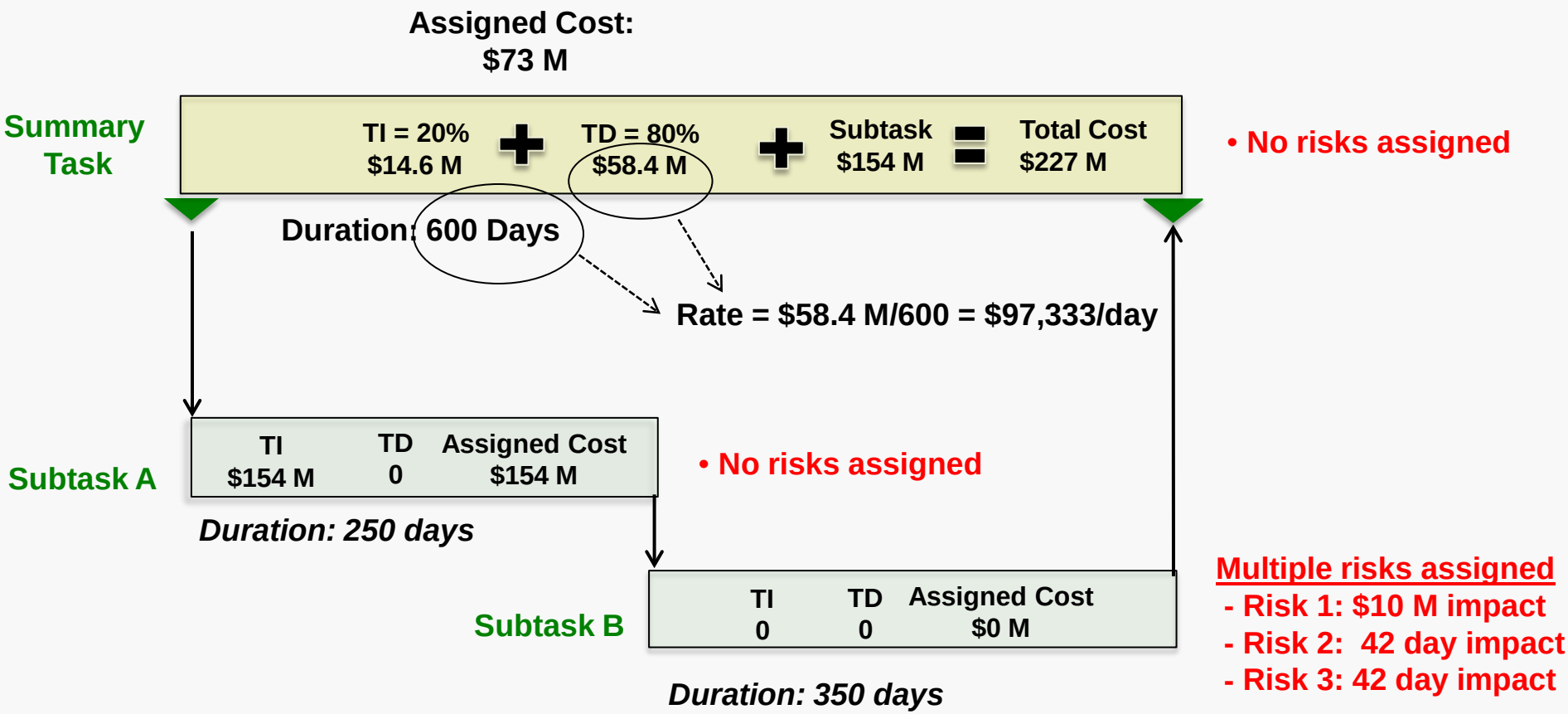


SLS JCL Architecture

Monte Carlo Simulation Analysis



JCL Model Input Sample



Notional Gantt View

JCL Model Output Sample

Input

Summary Task

Total Duration 600 Days | Rate = $97,333/day | Total Cost $227 M

No Risks assigned

Subtask A

Total Duration 250 days | Assigned Cost $154 M

No Risks assigned

Subtask B

Total Duration 350 Days | Assigned Cost $0 M

Risk 1: $10 M
Risk 2: 42 days
Risk 3: 42 days

Output

Summary Task

TI $14.6M + **TD 722 * Rate = $70.3 M** + **Subtask $154 M** + **Risks $10 M** = **Total Cost $248.9 M** | **122 days**

Calculated Duration: 600 + 122 = 722 Days

Subtask A

TI $154 M | **TD 0** | **Assigned Cost $154 M**

Duration 250 days

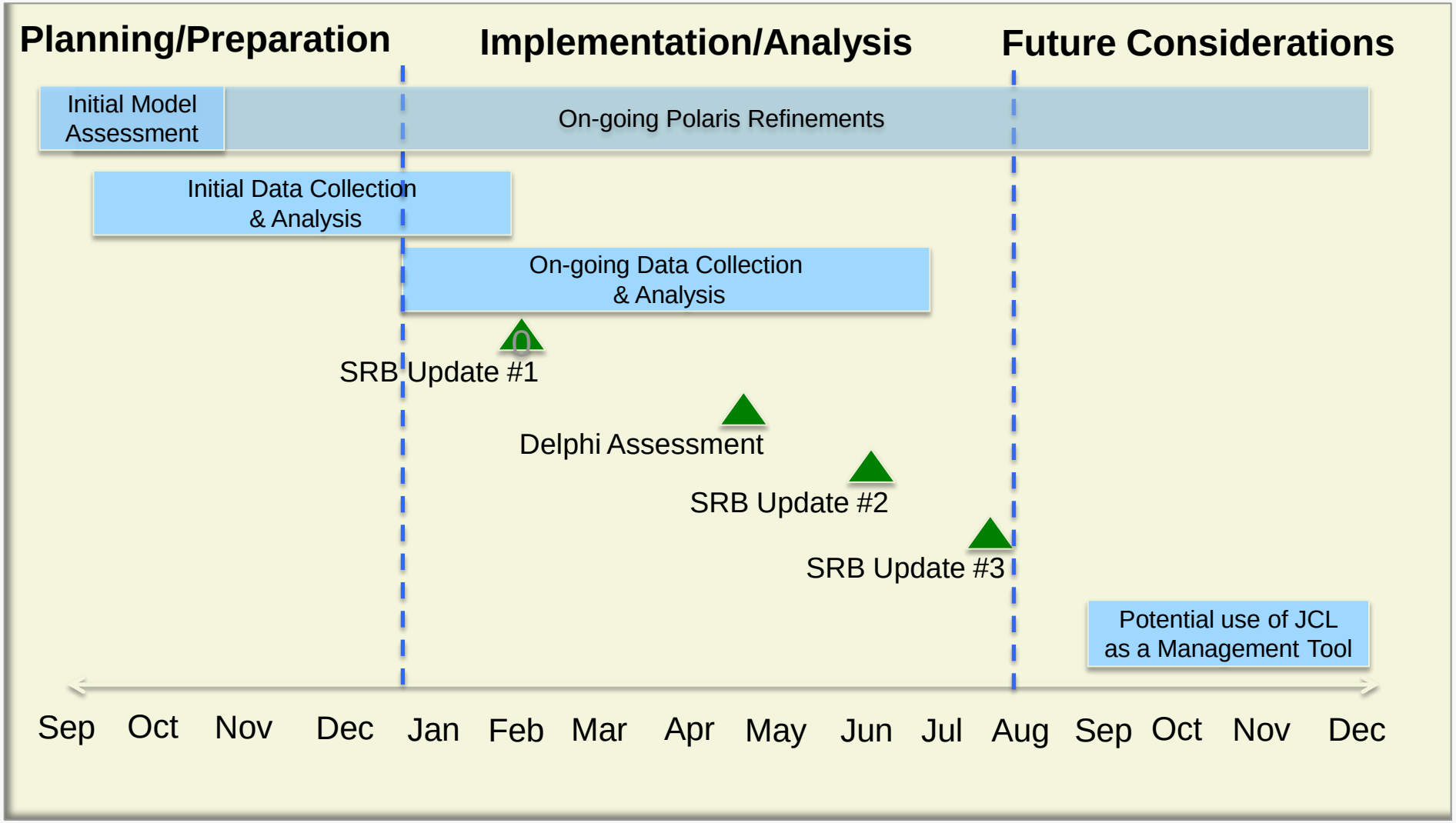
Subtask B

38 days | **TI 0** | **TD 0** | **Assigned Cost 0** | **Risk 1 $10 M** | **Risk 2,3** | **84 days**

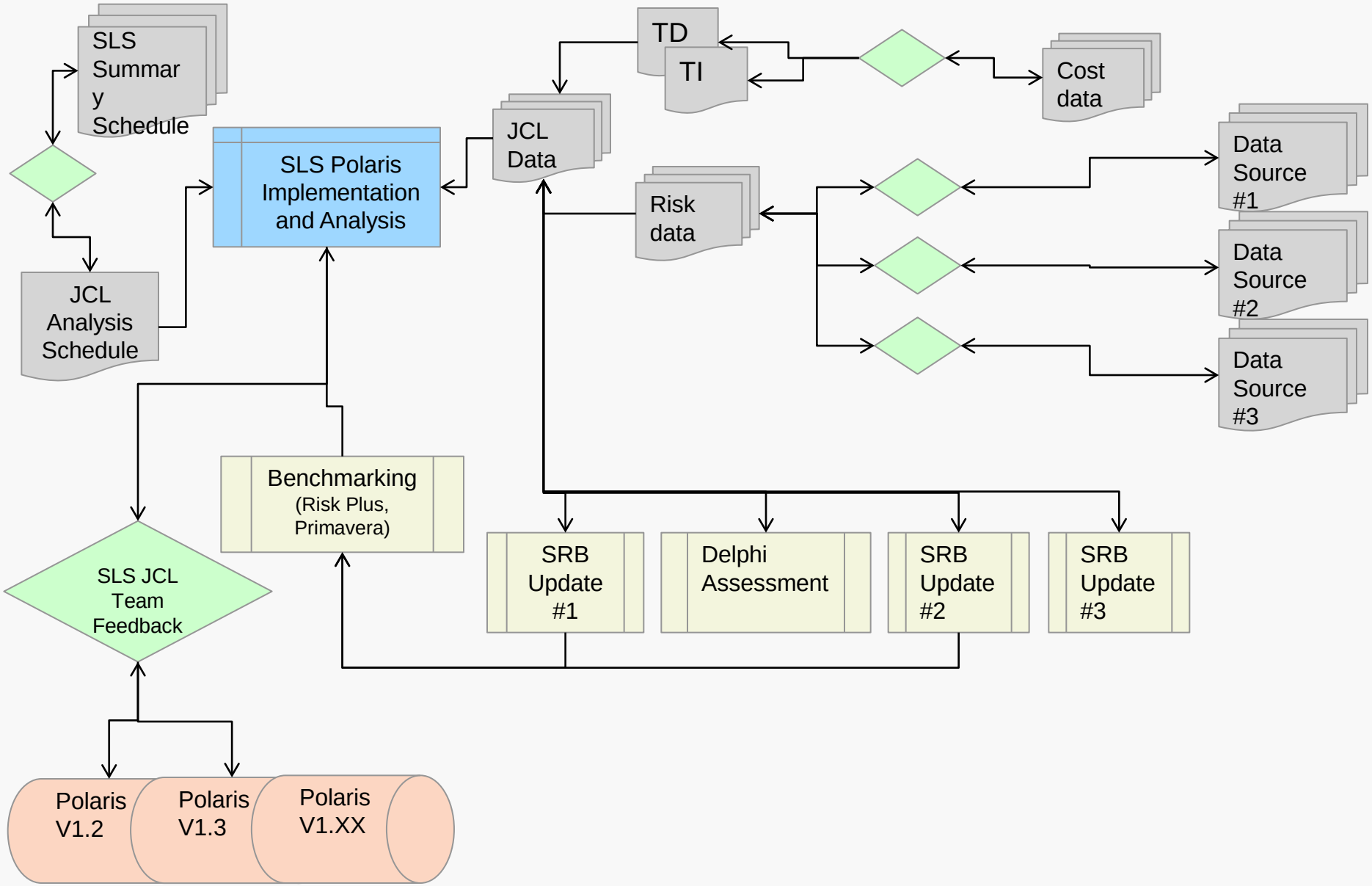
Calculated Duration: 472 days

Increase due to external logic links

SLS JCL Implementation



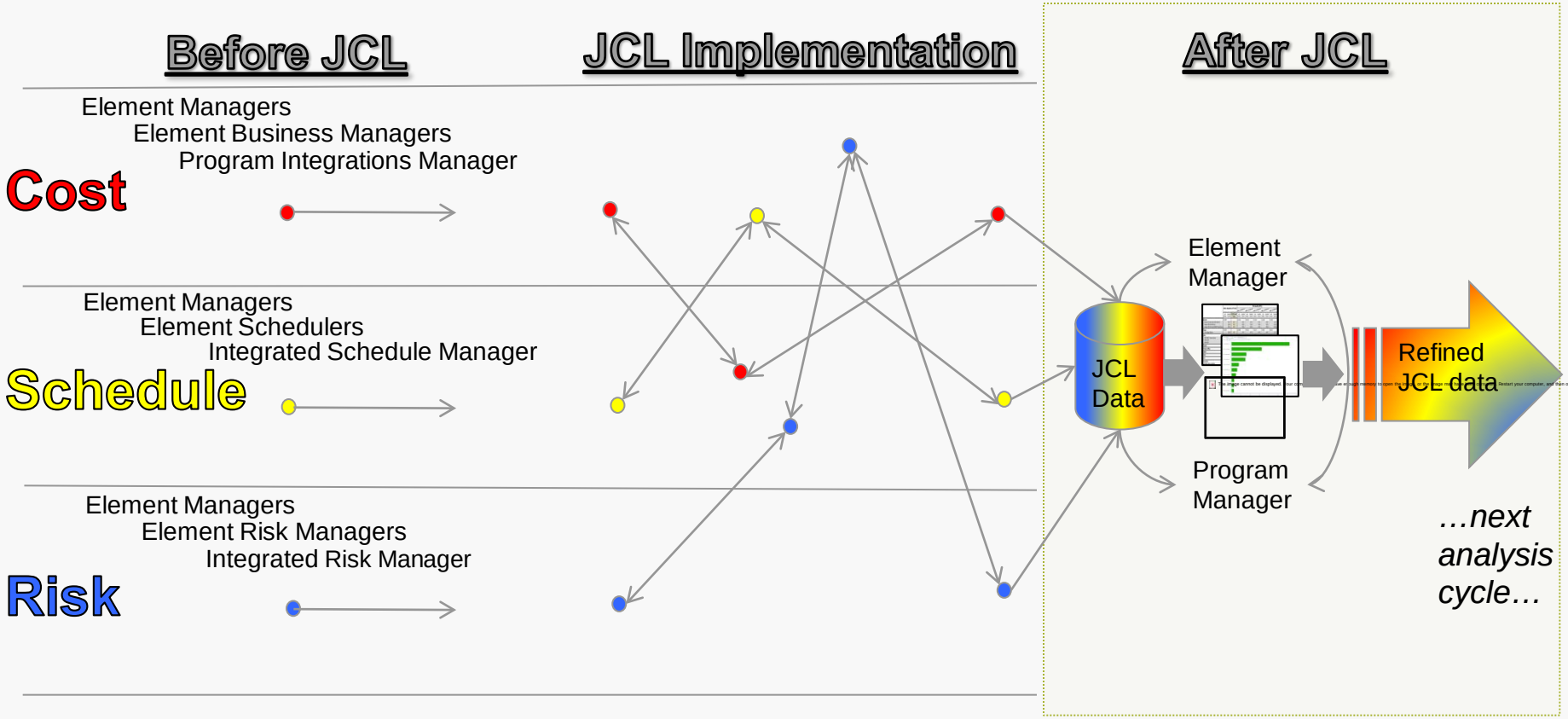
On-going Data Collection & Analysis



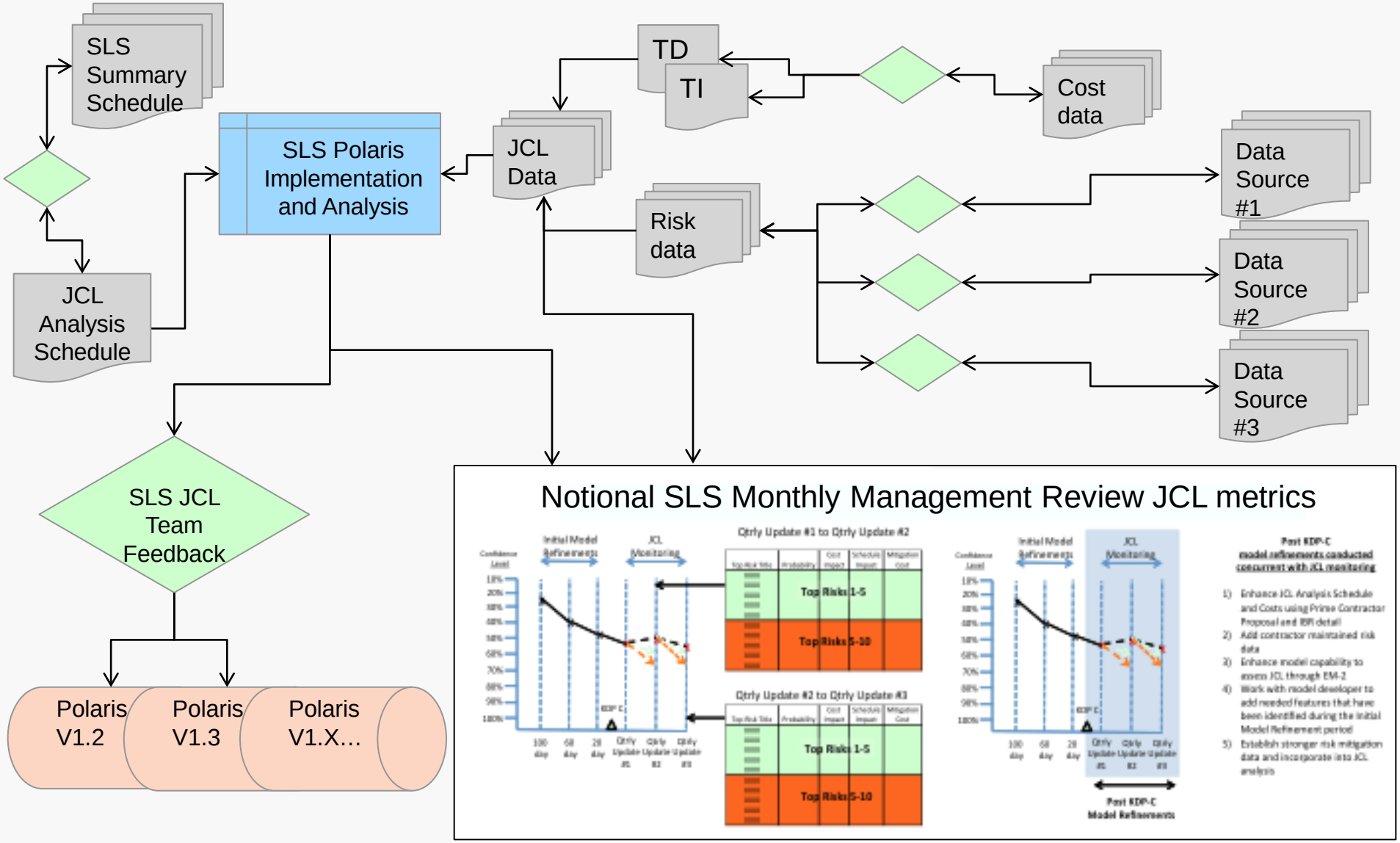
SRB Update #3

- **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.**

- **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.**

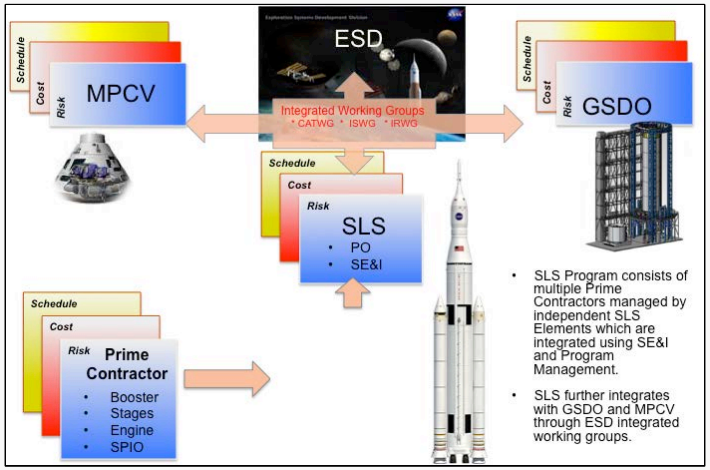


Potential use of JCL as a Management Tool



SLS JCL Process is Scalable for Smaller Programs

Large Scale Programs



- **Large Scale programs require multiple levels of schedule cost and risk**
  - 4 JCL team analysts
  - 6 resource managers
  - 6+ risk managers
  - 6+ schedulers
  - 10+ Integration team (risk managers, schedule team resource management)
  - Cross program working groups
  - 6-8 months of JCL data collection, evaluation, analysis and documentation
  - Education of large audience on JCL input parameters requirements

JCL Implementation process remains the same, and is scalable, for both large and small scale programs

Smaller Scale Programs

- **Smaller Programs require less time and resources, but can follow similar process as large scale programs.**
  - 1 JCL Analyst
  - 1 resource manager
  - 1 risk manager
  - 1 Scheduler
  - Minimal integration team
  - Working groups integrated in existing organizations
  - Minimal education on JCL parameter requirements
  - 1-2 months data collection analysis and documentation

Lessons Learned

- **Organizational top down support for JCL implementation makes a SIGNIFICANT difference.**
  - We had it on SLS
  - 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**
- **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.
- **Do not expect the right "JCL answer" on the first pass**
  - It requires on-going tuning of parameters
- **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"
- **Be prepared to deal with cost, schedule and risk data that is undergoing constant change**
  - Patience is needed