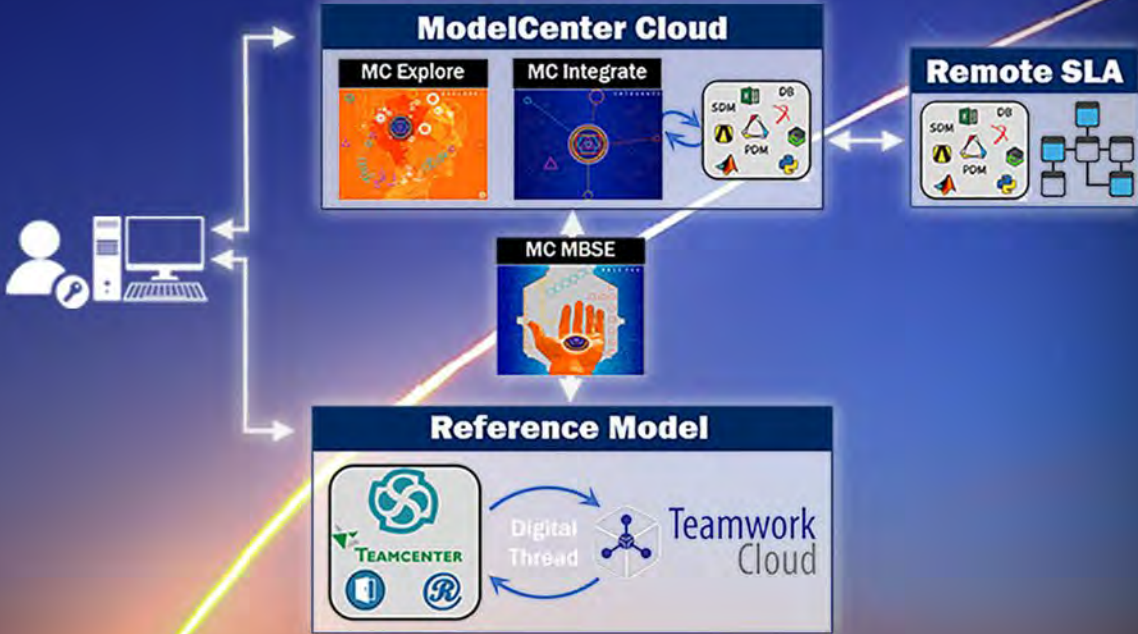


# ManTech's Distributed Integration Launch Assessment Approach

Tyler Peterson, M.S., PMP  
Lead Systems Architect



The image displays four overlapping screenshots of the ManTech software interface, each showing a different dashboard:

- Payload Dashboard:** Shows a 'PL Config' section with a 'Choose File' button and a table of 'Property Name' and 'Value'.
- Acoustics:** Displays 'Overall Sound Pressure Level' with a bar chart and a 'Results' section.
- Load Factors:** Features 'Quasi-Static Loads Optimization' with a table of variables and values, and two 3D model visualizations.
- Flight Design:** Shows 'Values and Flight Path Image' with a table of variables and values, and a video player for 'Launch and Orbital Maneuver Videos'.



**ManTech.**  
Securing the Future

# BLUF: **ManTech-A**ccelerated **D**igital **E**ngineering **P**rocess **T**echnology

## ManTech's prototype capability for Launch Enterprise

- **MBSE** (Model Based Systems Engineering) and **MDAO** (Multi-Disciplinary Analysis and Optimization)
  - Maximize Talent management in a workforce limited future
- Utilizes **Agile** methodologies to develop at the speed of relevance
  - Build a strong foundation for **iterative growth** towards mission integration, launch, and beyond
- Starts with Early Integration Studies (**EIS**)
  - **Real-time adjustments** and trade study results using less resources
  - Transition time and labor-intensive manual tools to **automated workflows**

# BLUF: **ManTech-ADEPT** and Early Integration Studies

## Mission Statement: Reduce 12-month process to a fraction of the time & cost

- Currently takes **3 years** of planning & executing to procure & launch a satellite
  - One-third of this time is required to produce, prepare, and assess a launch vehicle's ability with **thousands of hours** of **manual analysis** and engineering trade studies
- MT-ADEPT develops a **Digital Engineering Ecosystem** that enables Launch Enterprise to assess safety & efficacy of launch vehicle and satellite compatibility
  - Incorporates **off-the-shelf tools** for an integrated source (**digital thread & ASoT**) of regulatory requirements and providers' physical characteristics (**digital twin**) in a **secure cloud environment**
- MT-ADEPT combats anticipated future Launch staffing and budget reductions
  - Enables **rapid assessment** of optimal launch vehicle and satellite configurations

# Agenda

## Digital Engineering

- Background
- What is it?
- How can we start?

## Early Integration Studies (EIS): MT-ADEPT Solution

- Overarching Architecture
- Reference Model
- ModelCenter MBSE – Instance Data Framework
- ModelCenter Cloud
  - ModelCenter Integrate and Explore
- User Profiles – LV/PL and SV/Satellite

## EIS MT-ADEPT Prototype

- LV/PL User:
  - Input, workflows, results
- SV/Satellite User
  - Input, workflows, results
- Executive User
  - Executive Dashboard
  - Launch Manifest



# **Digital Engineering**

- **Background**
- **What is it?**
- **How can we start?**

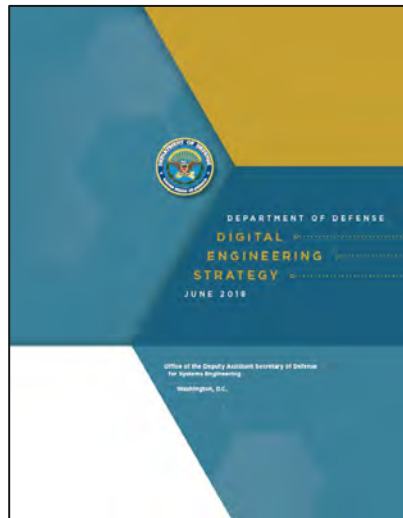
# Digital Engineering: Background

## Culture shift has reached 'critical mass'

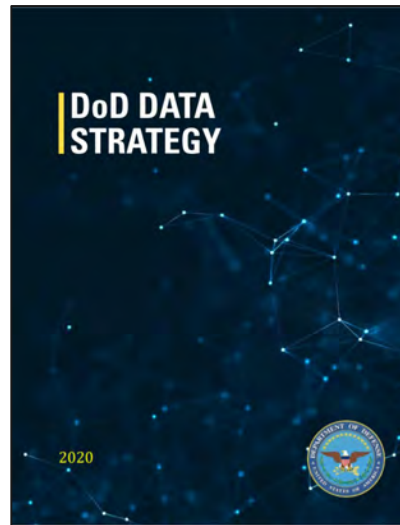
- Momentum
- Buy-in
- Path of Implementation



NDIA SE Conferences



DoD DE Strategy (2018)



DoD Data Strategy (2020)



The New Digital Acquisition Reality (2020)

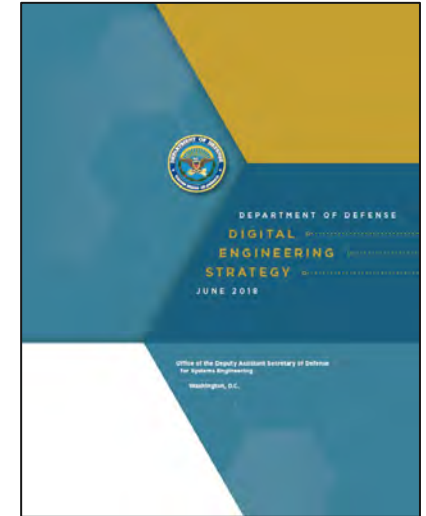


Cloud Based – Zero Trust Architecture

# Digital Engineering: What is it?

## Definition:

“**integrated** digital approach that uses **authoritative sources** of system data and models as a continuum **across disciplines** to support lifecycle activities from **concept through disposal**”



DoD DE Strategy (2018)

## Goal:

modernize how DoD “**designs, develops, delivers, operates, and sustains systems**”

## Optimized Approach to Mission Integration:

Document Supported Solution → **Model Based Systems Engineering (MBSE)**

Decentralized Information → **Network Centric Operations (Cloud)**

# Digital Engineering: How can we start?

## Early Integration Studies (EIS)

- complex tests → highly automated and easily repeatable workflows
- uncomplicated viewable results



Results Overview			
	Loads	Acoustics	Flight Design
Mission #123. SIS Category 1, LV A:	●	●	●
Mission #122. SIS Category 2, LV A:	●	●	●

Download Results

<b>Simple EIS</b> <ul style="list-style-type: none"><li>• Trajectory &amp; Mission Design Analysis</li><li>• Coupled-Loads Analysis</li></ul>	<b>Standard EIS</b> <ul style="list-style-type: none"><li>• Draft ICD</li><li>• Launch Site CONOPS</li></ul>
<b>Complex EIS</b> <ul style="list-style-type: none"><li>• Integrated Thermal Analysis</li><li>• Acoustic Analysis</li><li>• EMI/EMC Analysis</li></ul>	<ul style="list-style-type: none"><li>• Contamination Analysis</li><li>• LV/PL Interface Analysis</li></ul>
<b>Additional EIS Tasks</b> <ul style="list-style-type: none"><li>• Vibration/Shock Analysis</li><li>• Security Analysis</li><li>• GN2 Purge Analysis</li></ul>	<b>Other Special Studies</b> <ul style="list-style-type: none"><li>• Government Reviews</li><li>• Anomaly Resolution</li><li>• Mission Assurance Activities</li></ul>



# Digital Engineering: How can we start?

## Expand EIS Capabilities:

- assess compatibility of multi-payload mission sets

## Launch Verification Matrix Testing:

- tentative mission sets with refined system, big data, and machine learning

### Executive Dashboard

#### PL Echo: Secondary PL Configurations

Secondary PL	Launch Vehicle	Primary PL	Loads	Acoustics	Flight Design	Thermal	Contamination
Echo	A	Alpha	●	●	●	●	●
Echo	A	Bravo	●	●	●	●	●
Echo	B	Alpha	●	●	●	●	●
Echo	B	Bravo	●	●	●	●	●
Echo	C	Alpha	●	●	●	●	●

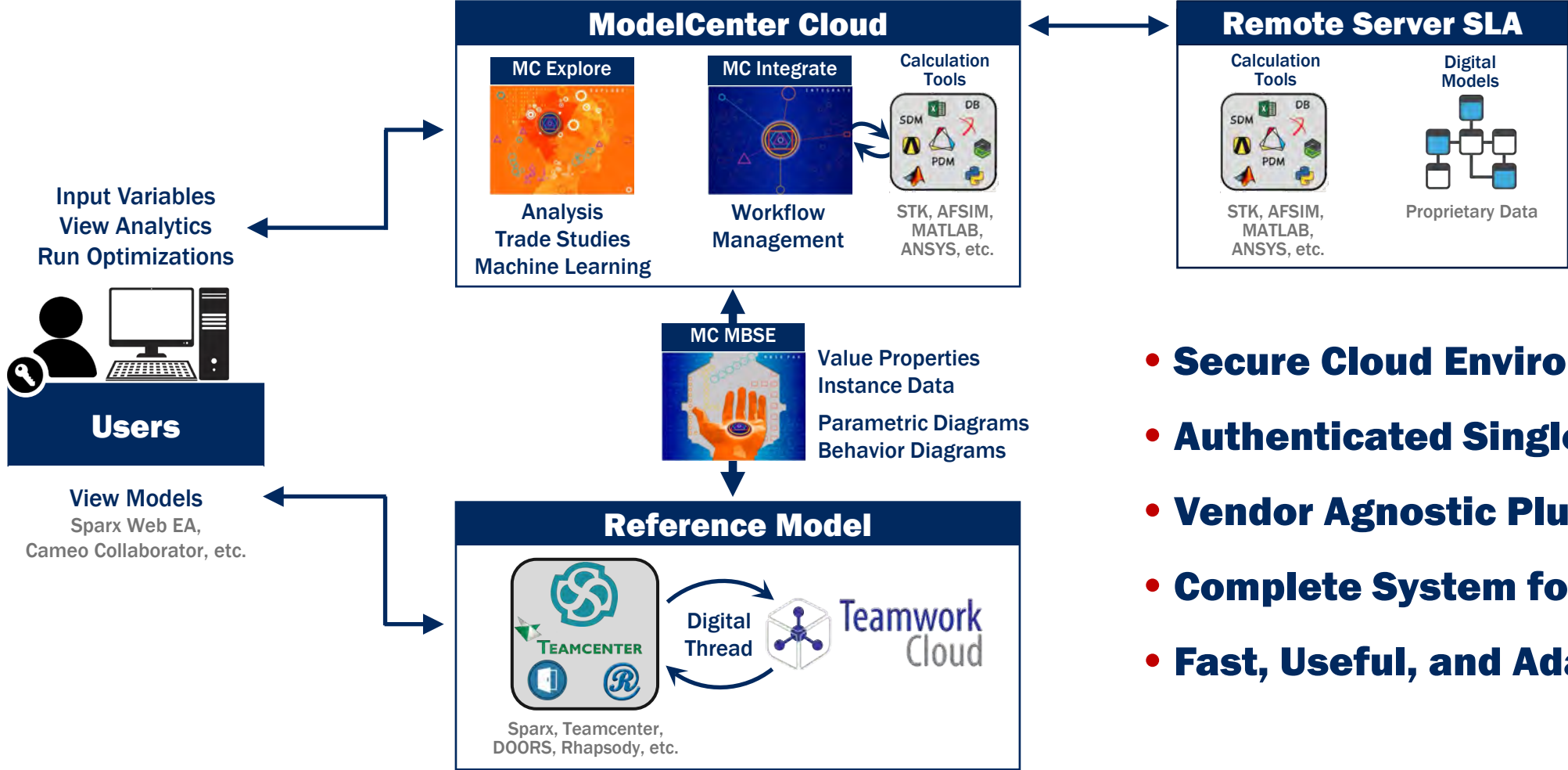
### Potential Launch Manifest

Mission	Date	Launch Vehicle	Primary PL	Secondary PL	Hosted PL	Status
Mission 1	2020-11-23	C	Payload Charlie	Payload Fox	Payload Hotel	●
Mission 2	2021-01-02	A	Payload Zulu	Payload Sierra	Payload Bravo	●
Mission 3	2021-01-18	D	Payload Dedicated			●
Mission 4	2021-02-13	A	Payload Alpha	Payload Mike	Payload Oscar	●
Mission 5	2021-3-28	E	Payload Delta	Payload Lima	Payload Juliet	●

# **EIS: MT-ADEPT Solution**

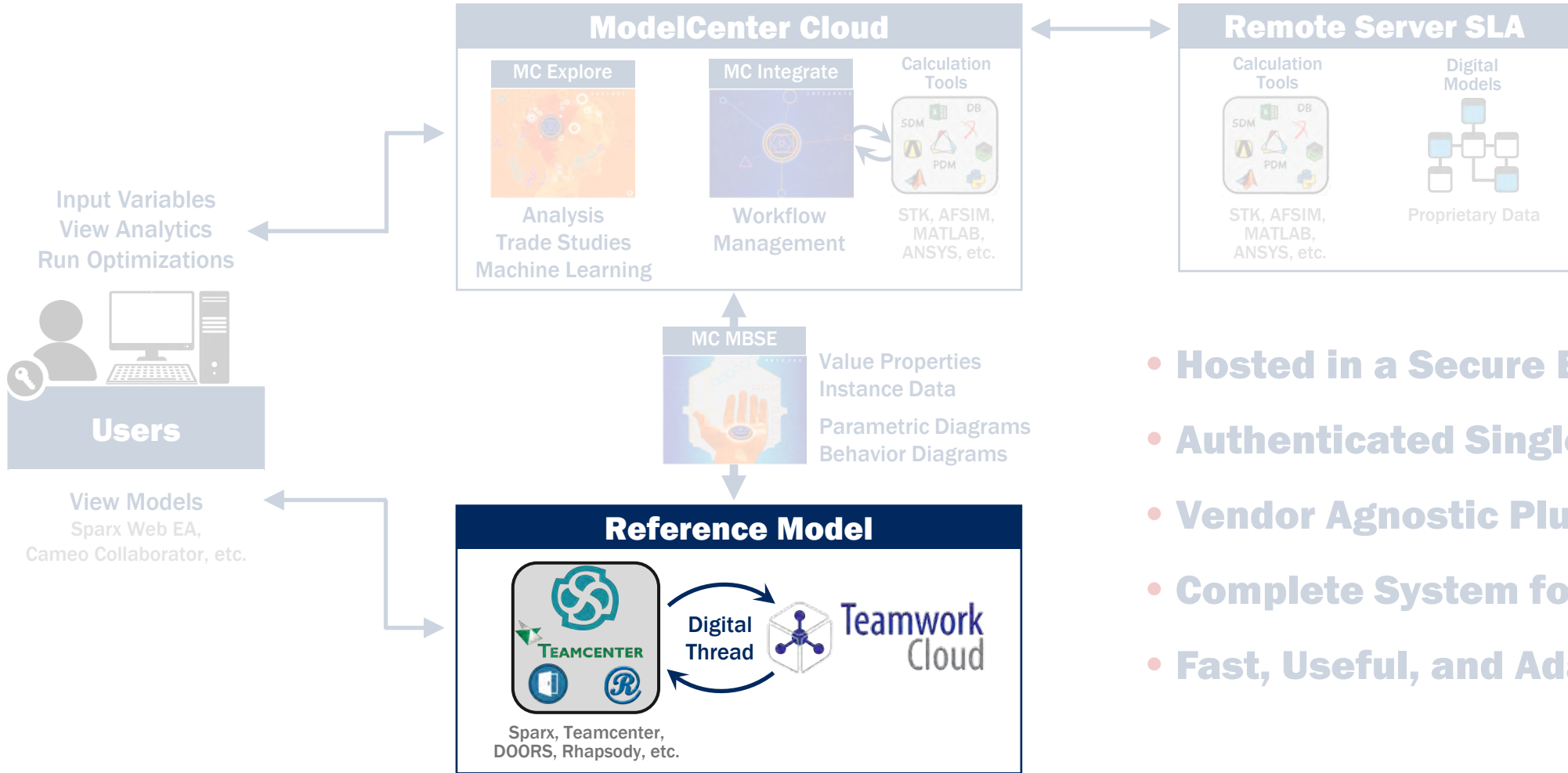
- Digital Engineering Ecosystem Architecture
- Reference Model
- ModelCenter Cloud
- User Profiles

# Digital Engineering Ecosystem Architecture



- **Secure Cloud Environment**
- **Authenticated Single-Sign-On**
- **Vendor Agnostic Plug-and-Play**
- **Complete System for Full Lifecycle**
- **Fast, Useful, and Adaptable**

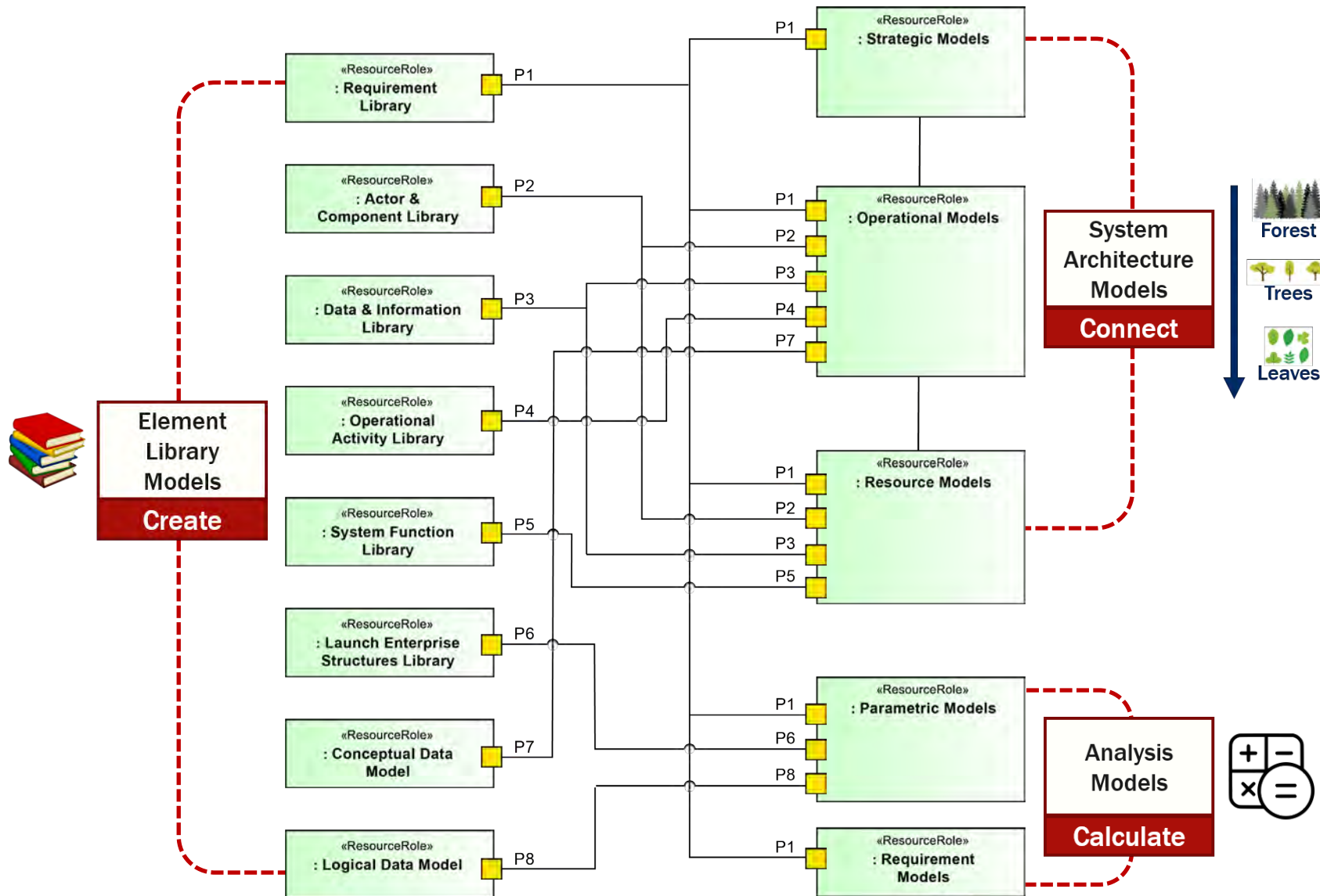
# Digital Engineering Ecosystem Architecture



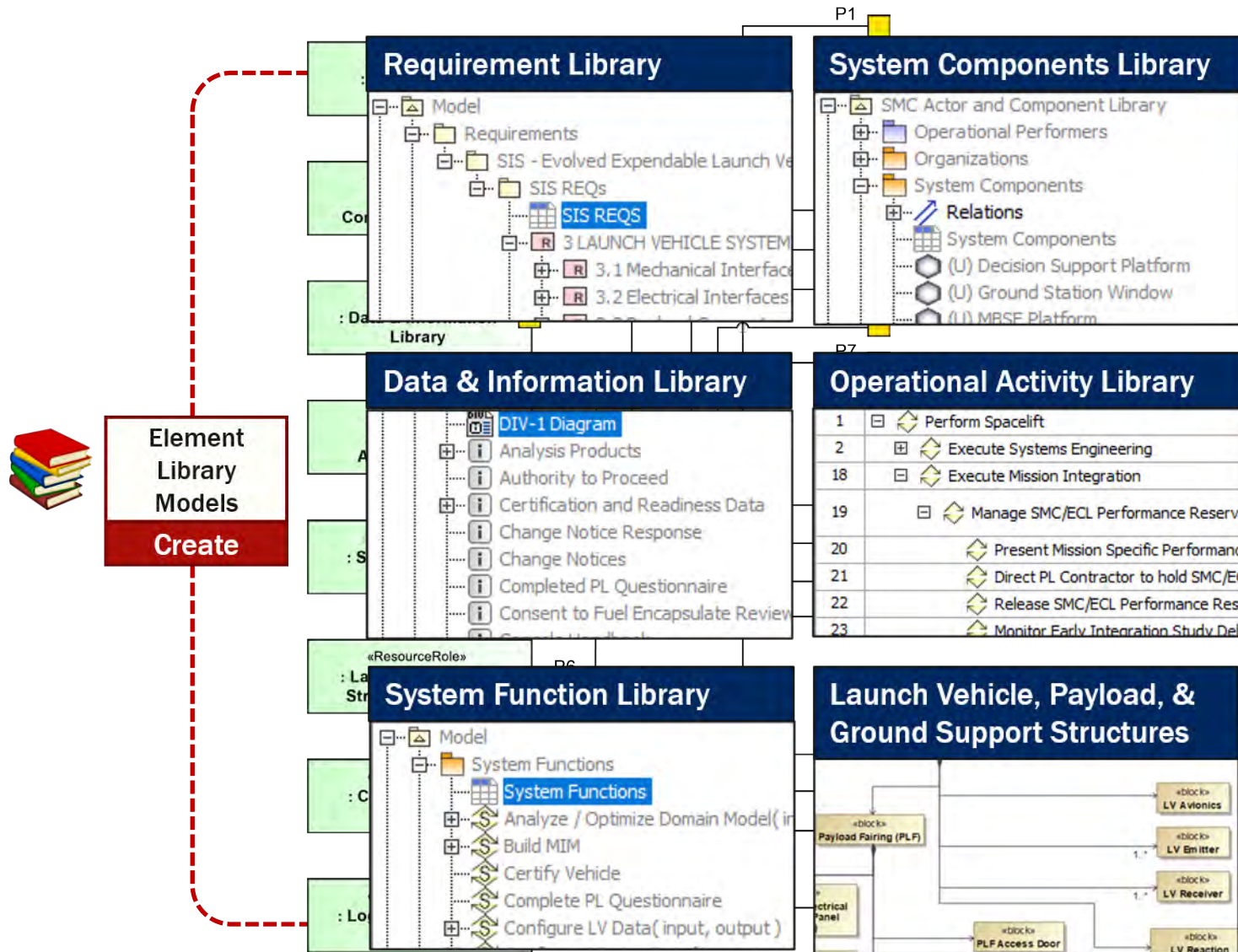
- Hosted in a Secure Environment
- Authenticated Single-Sign-On
- Vendor Agnostic Plug-and-Play
- Complete System for Full Lifecycle
- Fast, Useful, and Adaptable

# Reference Model

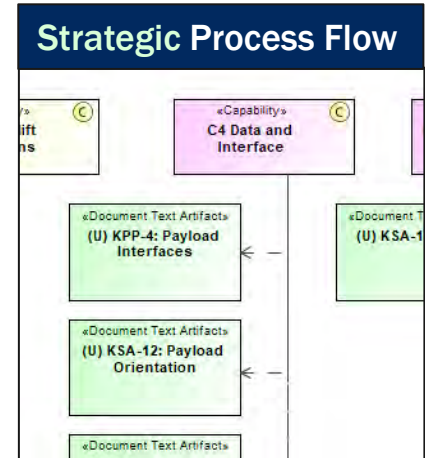
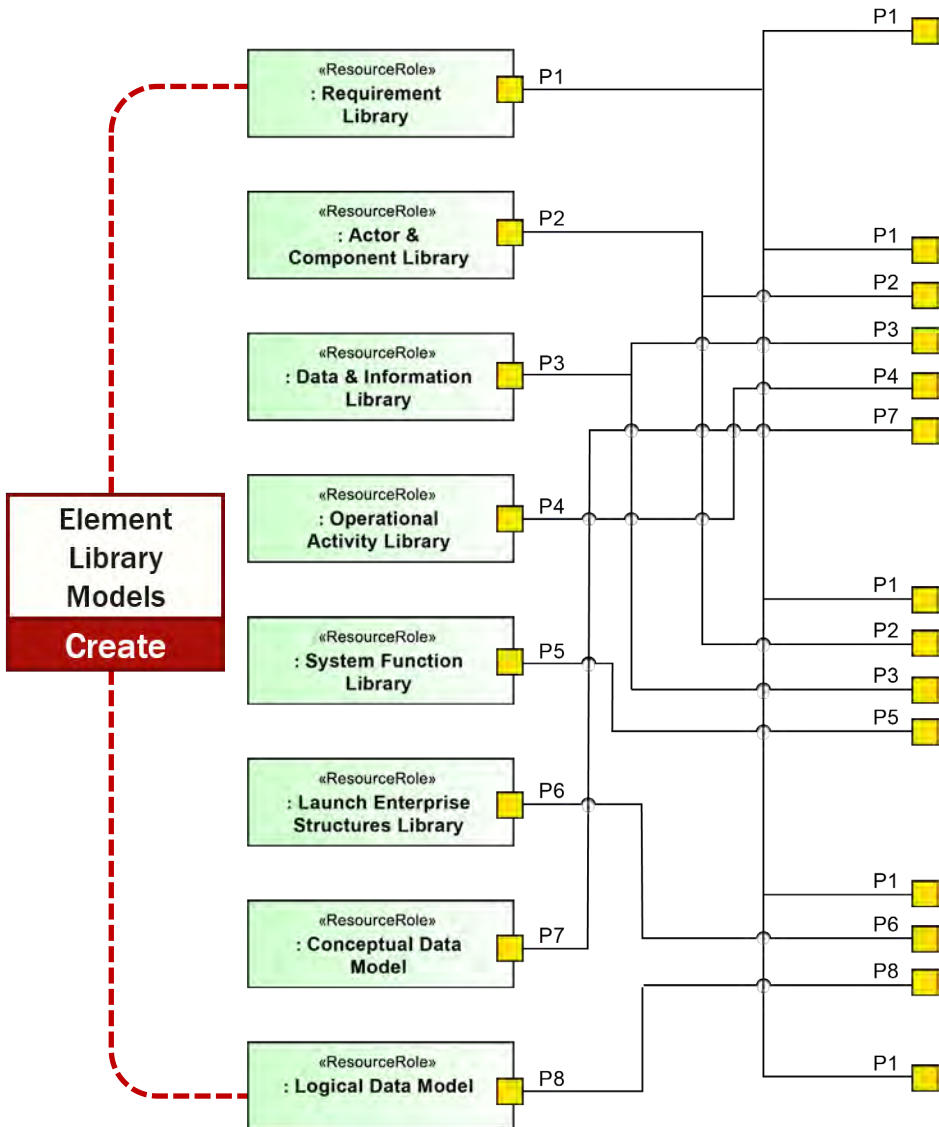
# Reference Model



# Reference Model

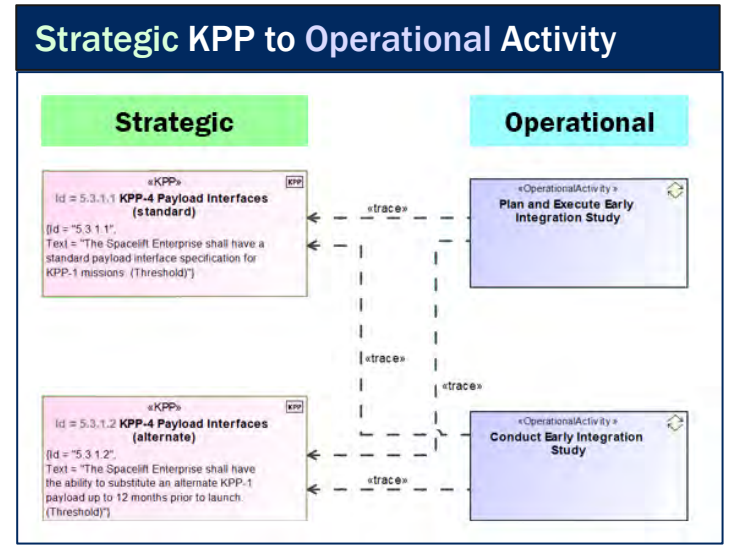
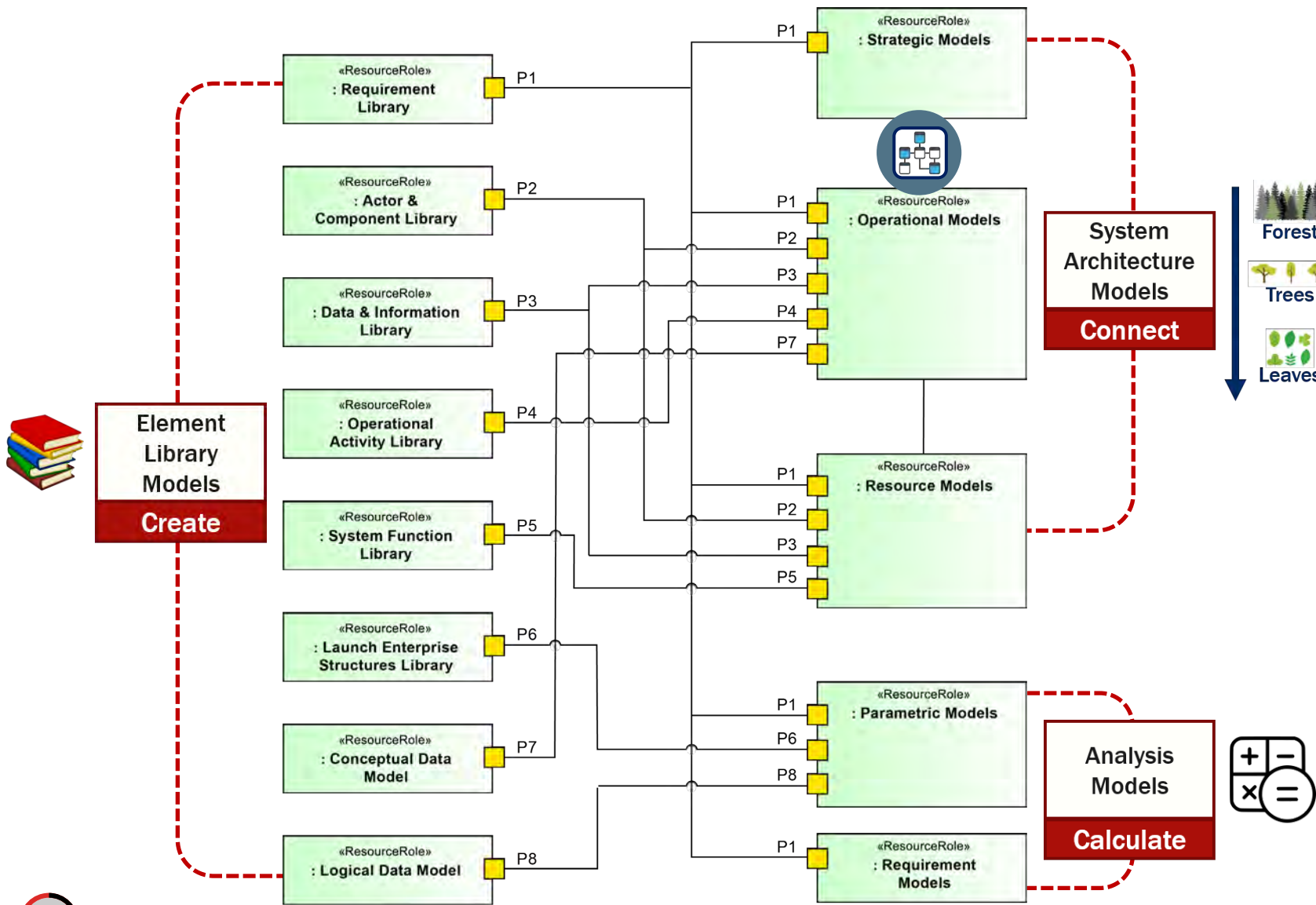


# Reference Model

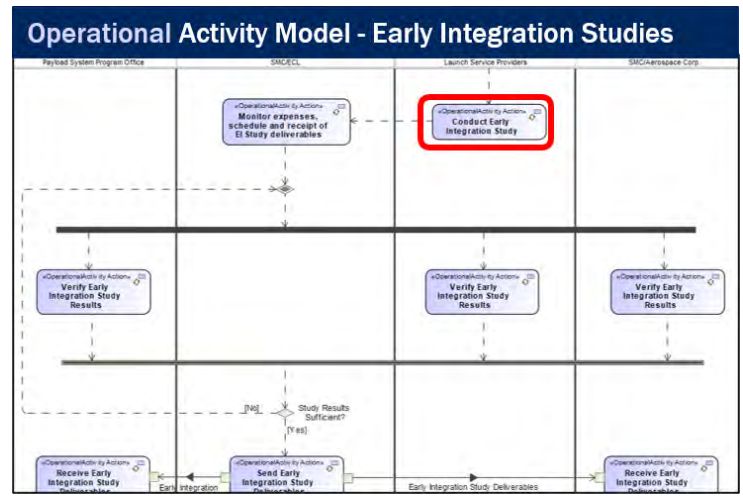
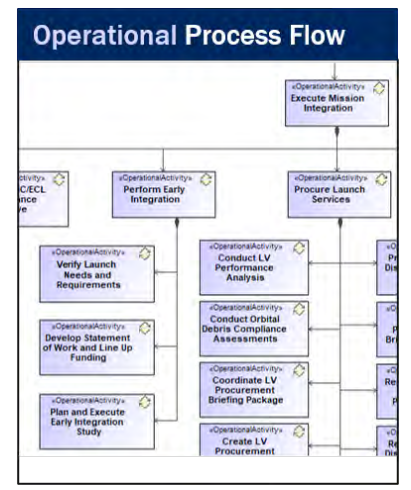
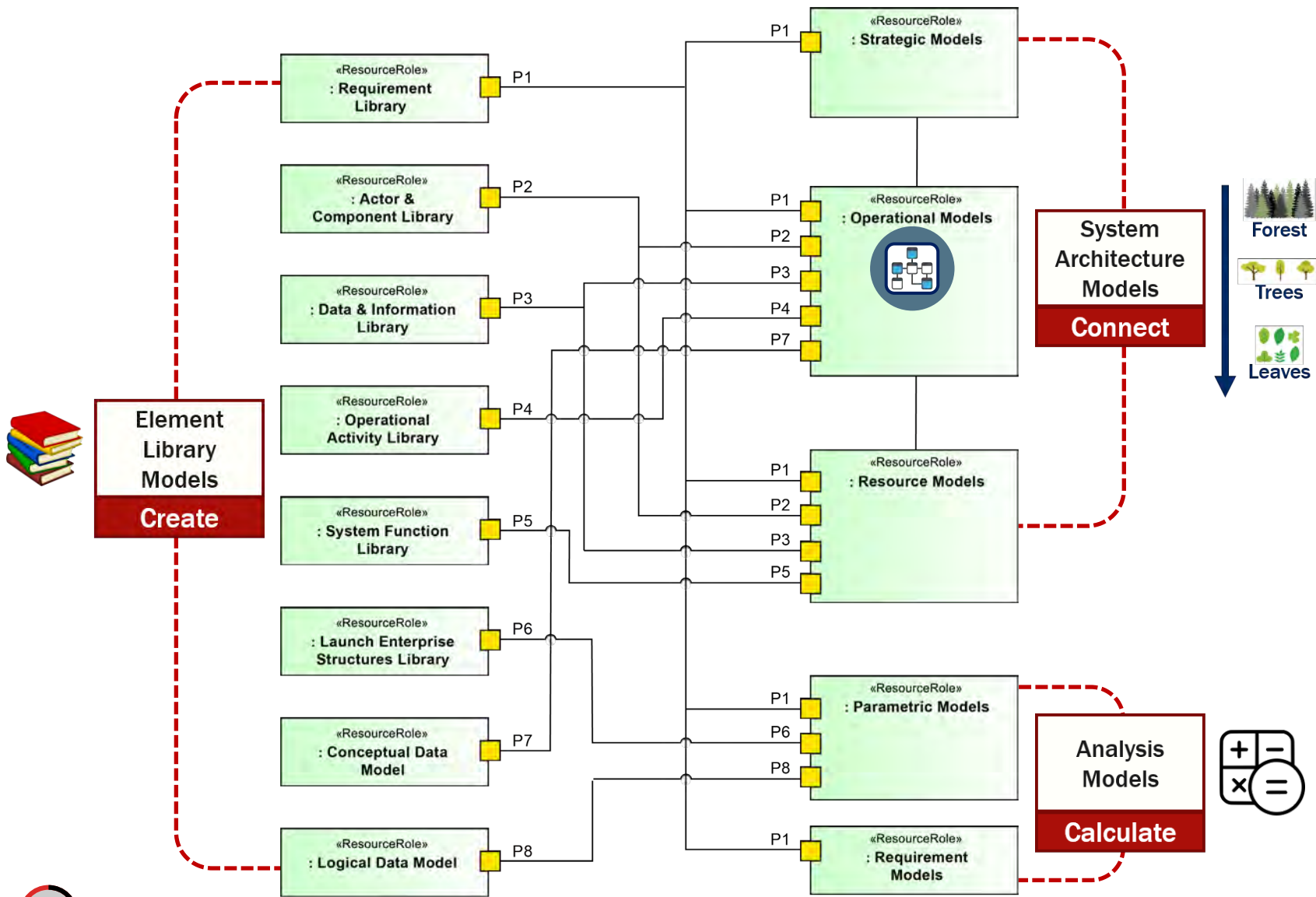




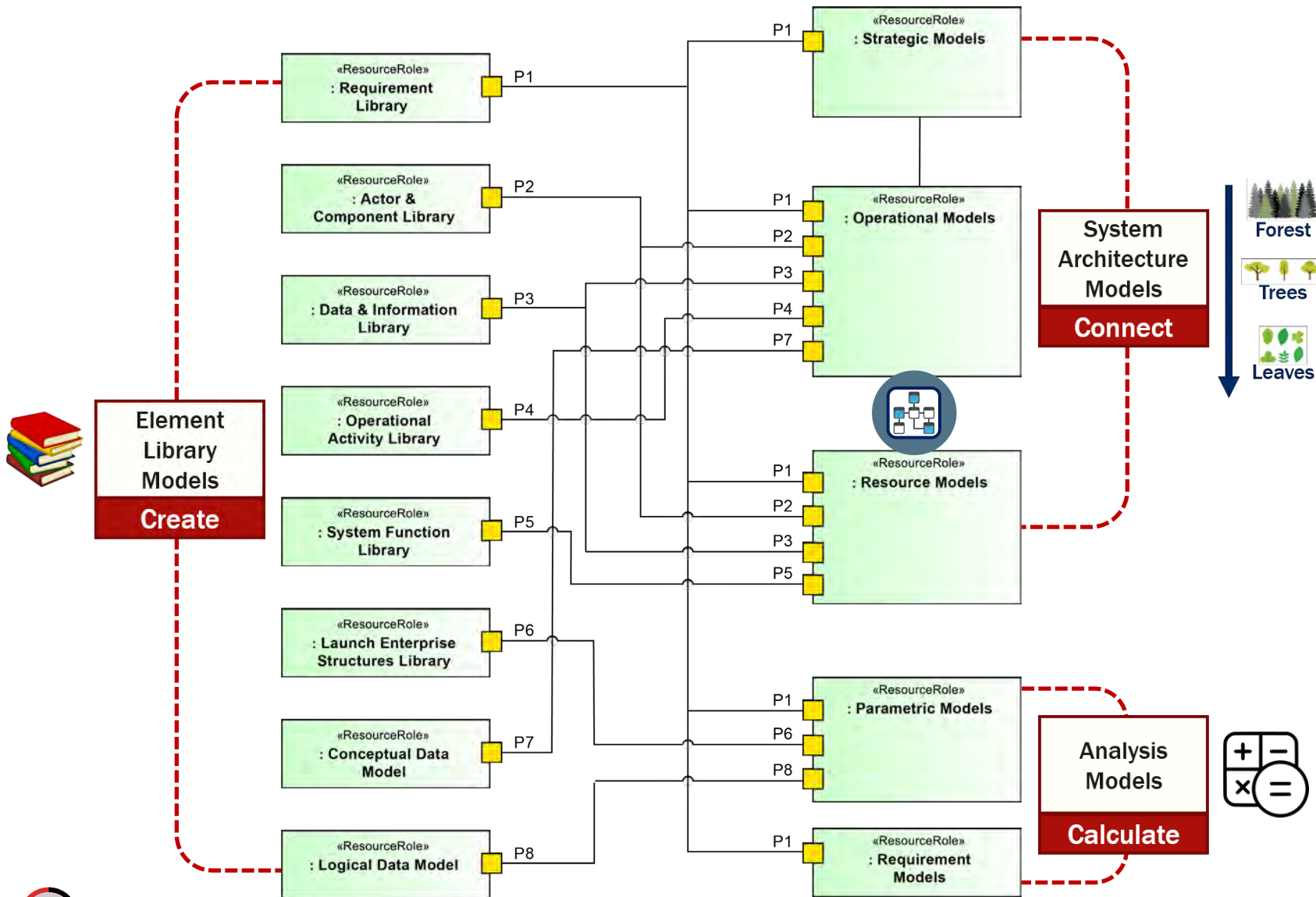
# Reference Model



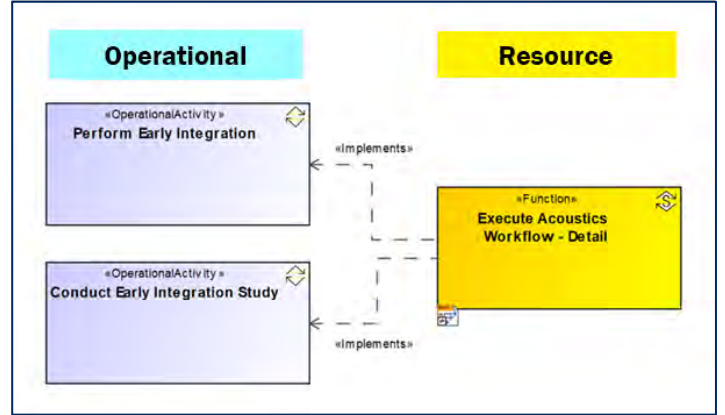
# Reference Model



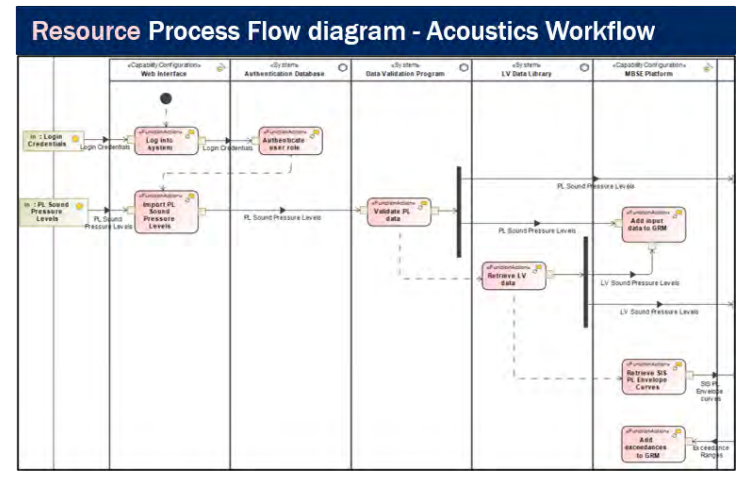
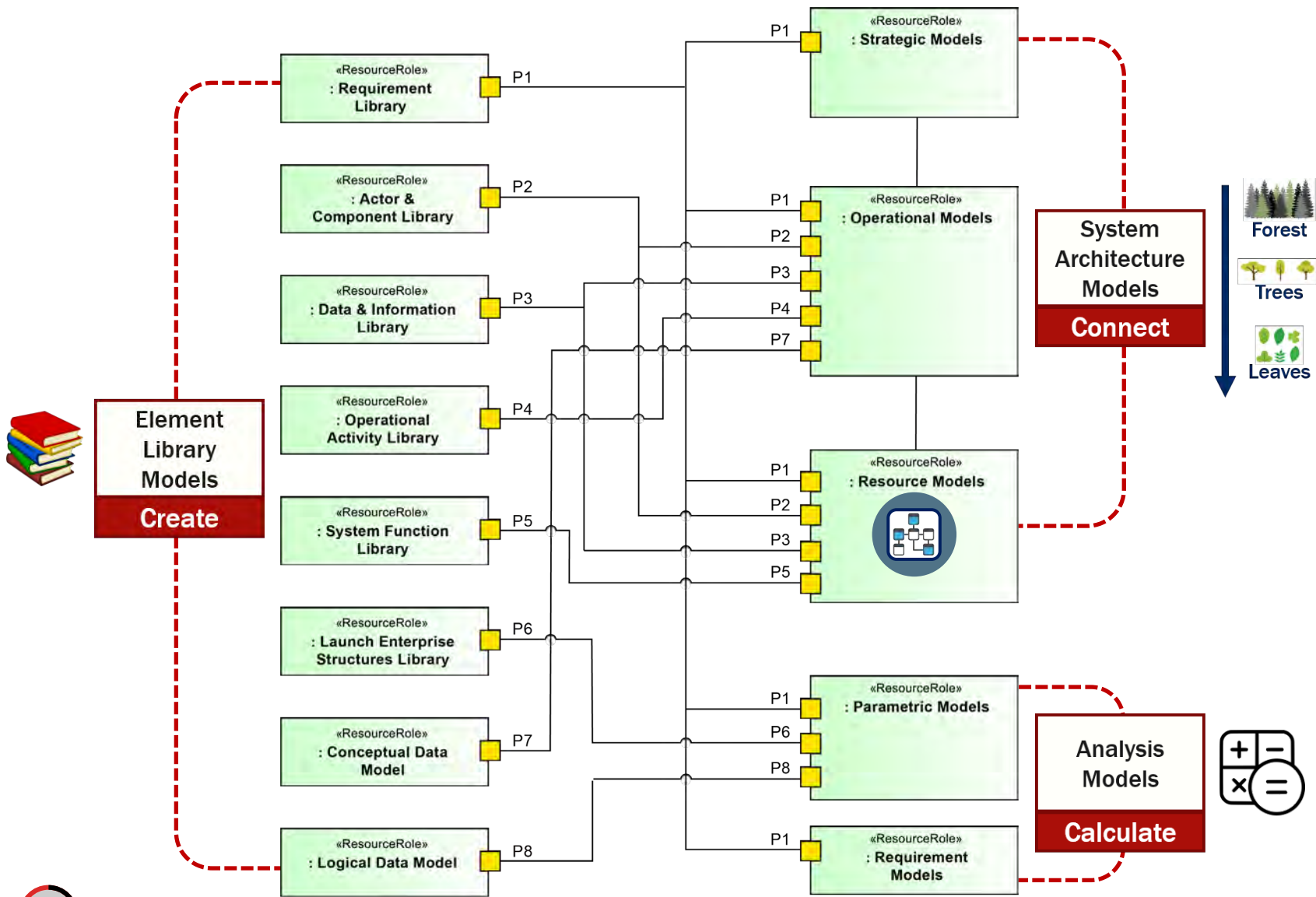
# Reference Model



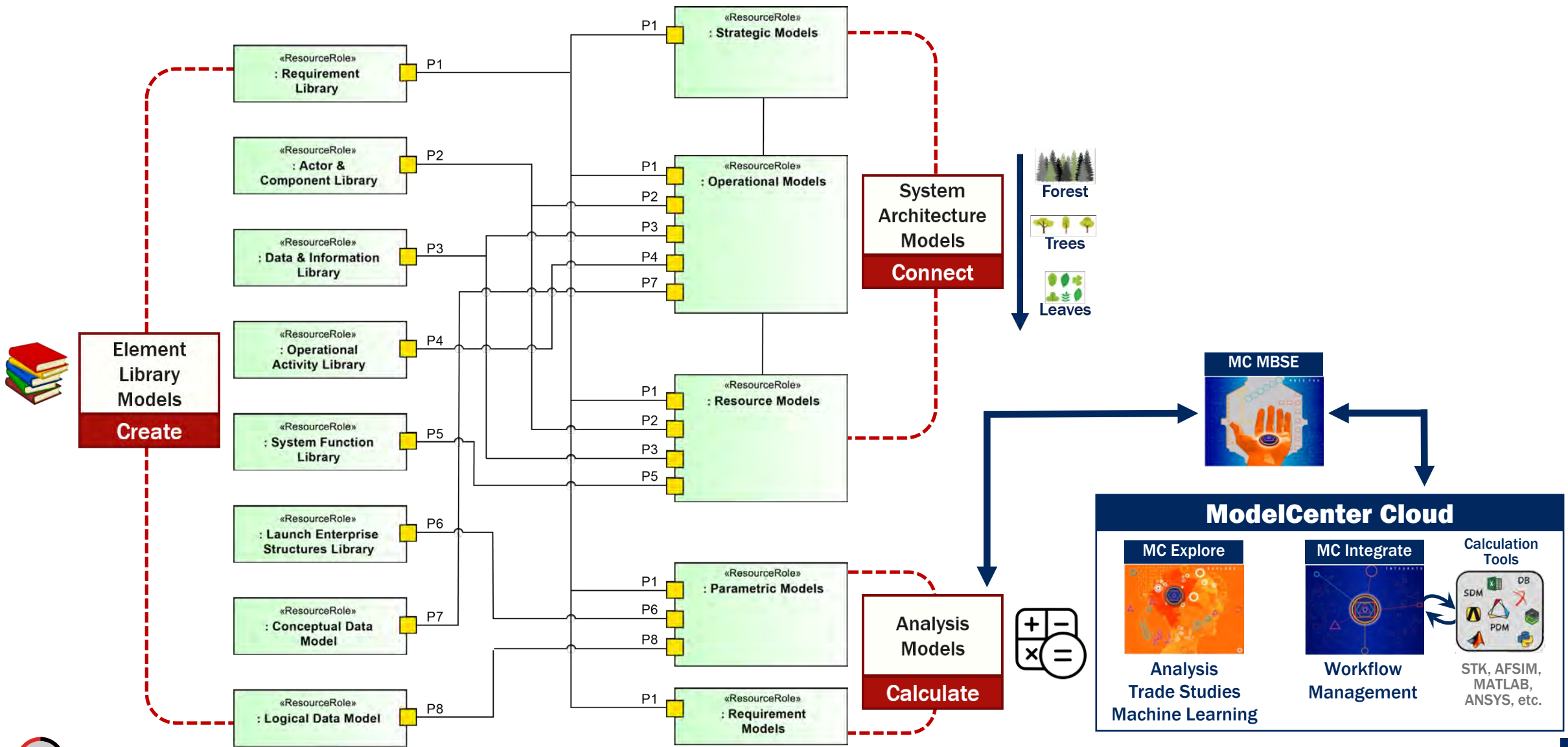
## Operational Activity to Resource Function



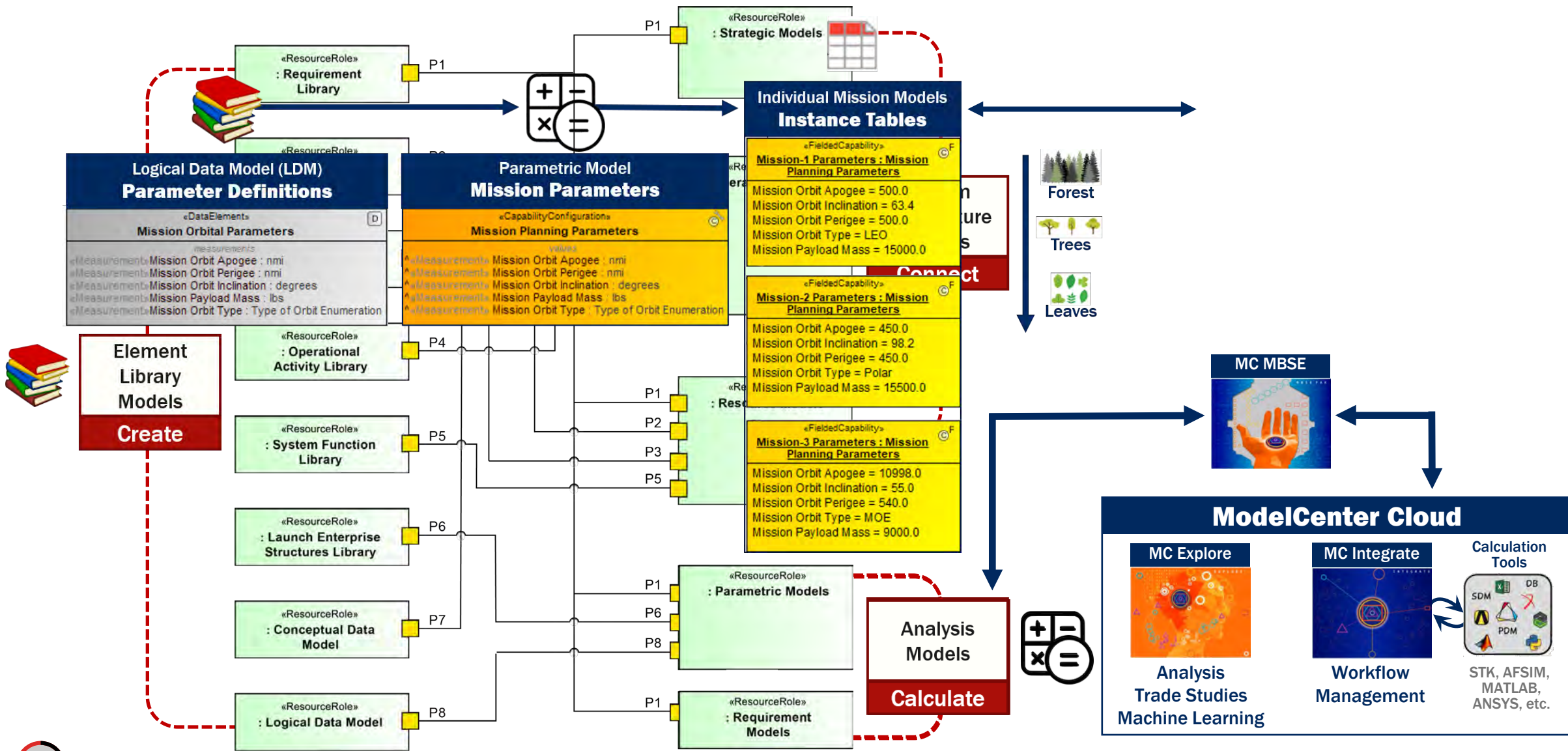
# Reference Model



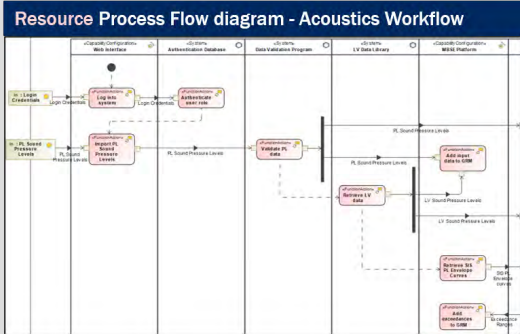
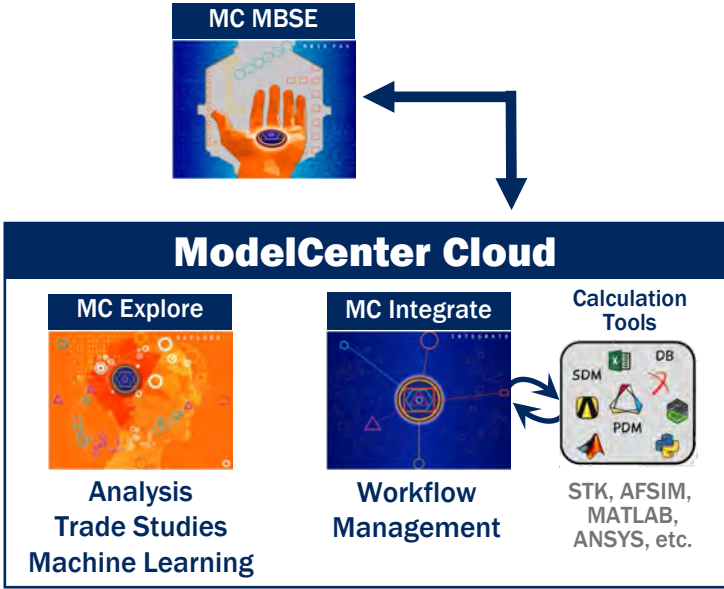
# Reference Model



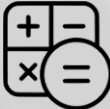
# Reference Model



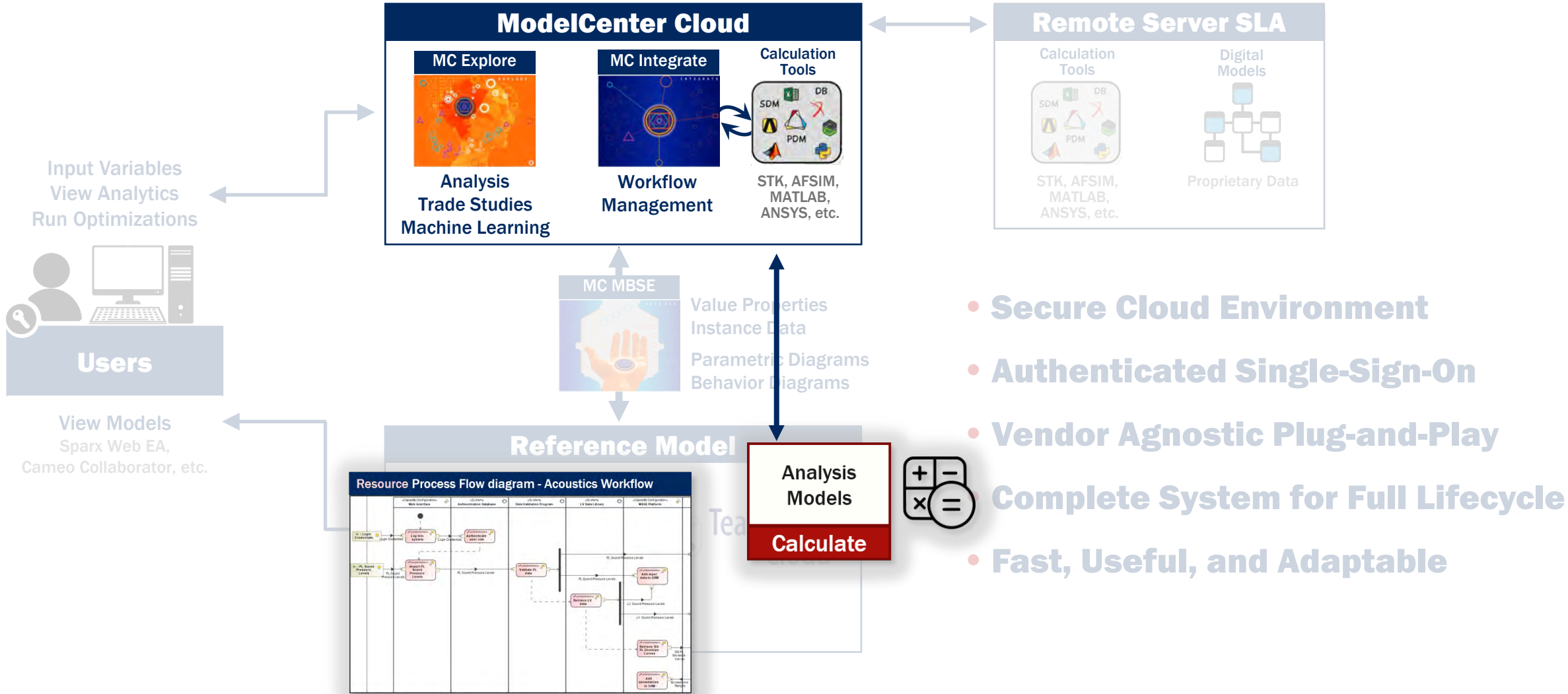
# Digital Engineering Model Ecosystem Architecture



Analysis Models  
Calculate



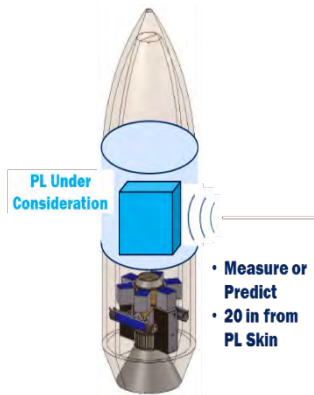
# Digital Engineering Ecosystem Architecture



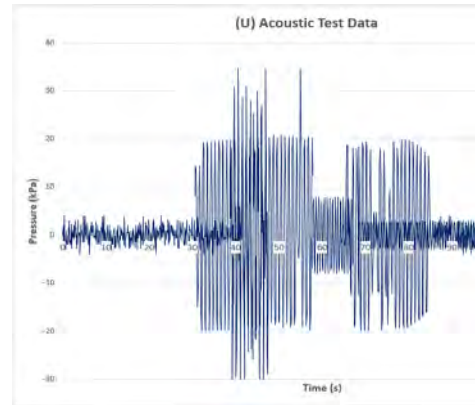
- **Secure Cloud Environment**
- **Authenticated Single-Sign-On**
- **Vendor Agnostic Plug-and-Play**
- **Complete System for Full Lifecycle**
- **Fast, Useful, and Adaptable**



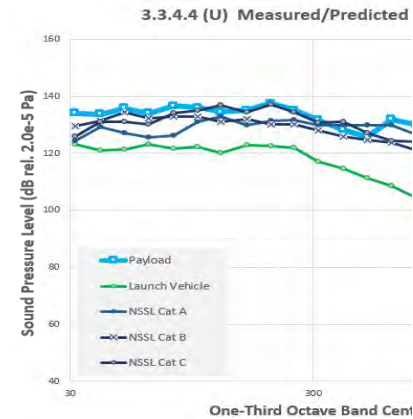
# Acoustic Analysis Context



PL or Digital Representation

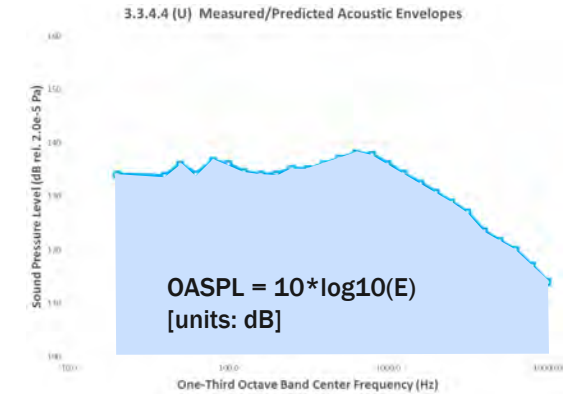


Data Capture



Threshold Crossing

Sound Pressure Level at each dB (SPL)



Integrating for Area

Overall Sound Pressure Level (OASPL)

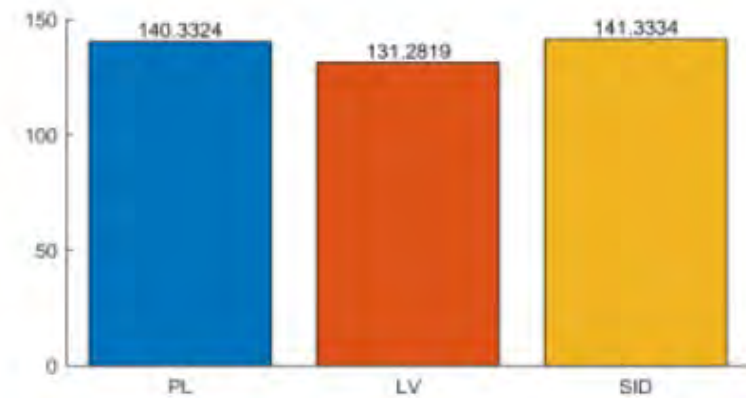
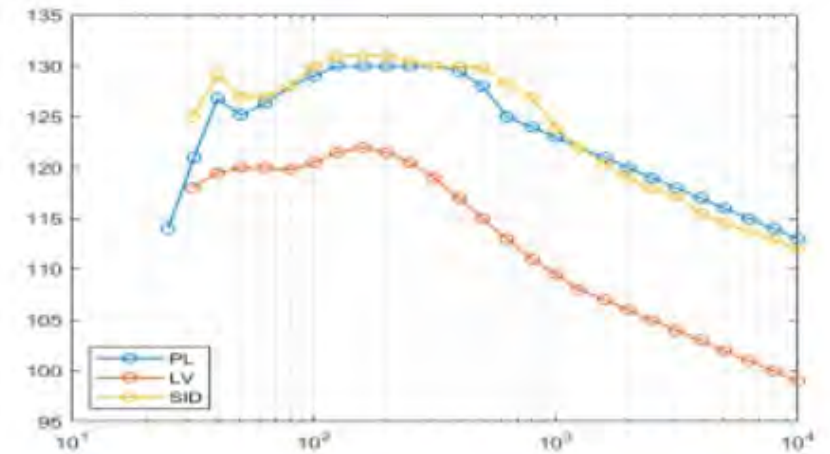
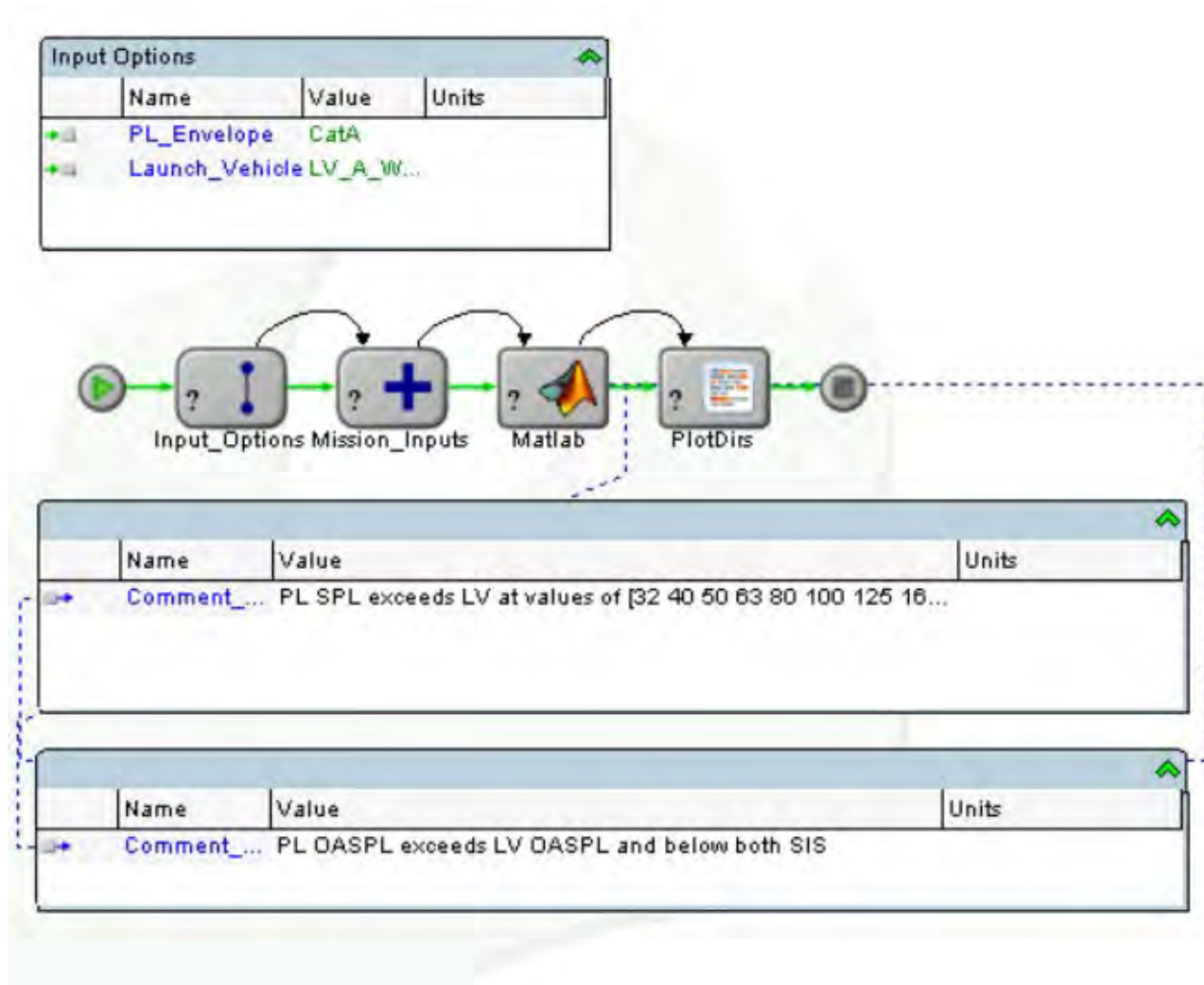
## Assumptions

- P95/50 (95% Probability with 50% Confidence)
- PL shall be designed to tolerate the acoustic levels generated by LV
- From liftoff through SV separation
- Reference pressure 20  $\mu$ Pa

## Workflow Steps

1. Obtain  $V(t)$  [voltage time trace from microphone]
2. Calc  $p'(t) = \text{mic.constant} * V(t)$ , where  $p'(t) = \text{pressure fluctuation}$
3. Normalize  $p'(t)$  using reference pressure 20  $\mu$ Pa
4. Calc  $S(f)$  using FFT, where  $S(f) = \text{spectrum of normalized } p'(t)$
5. Correct  $S(f)$  for mic response and atmospheric absorption
6. Compute Sound Pressure Level (SPL) Spectrum  $SPL(f) = 10 * \log_{10}(S(f))$  [units: dB/Hz]
7. Compute Overall Sound Pressure Level (OASPL)  $E = \int S(f) df$  [total energy contained in the spectrum]  $OASPL = 10 * \log_{10}(E)$  [units: dB]
8. Identify SPL and OASPL exceedances

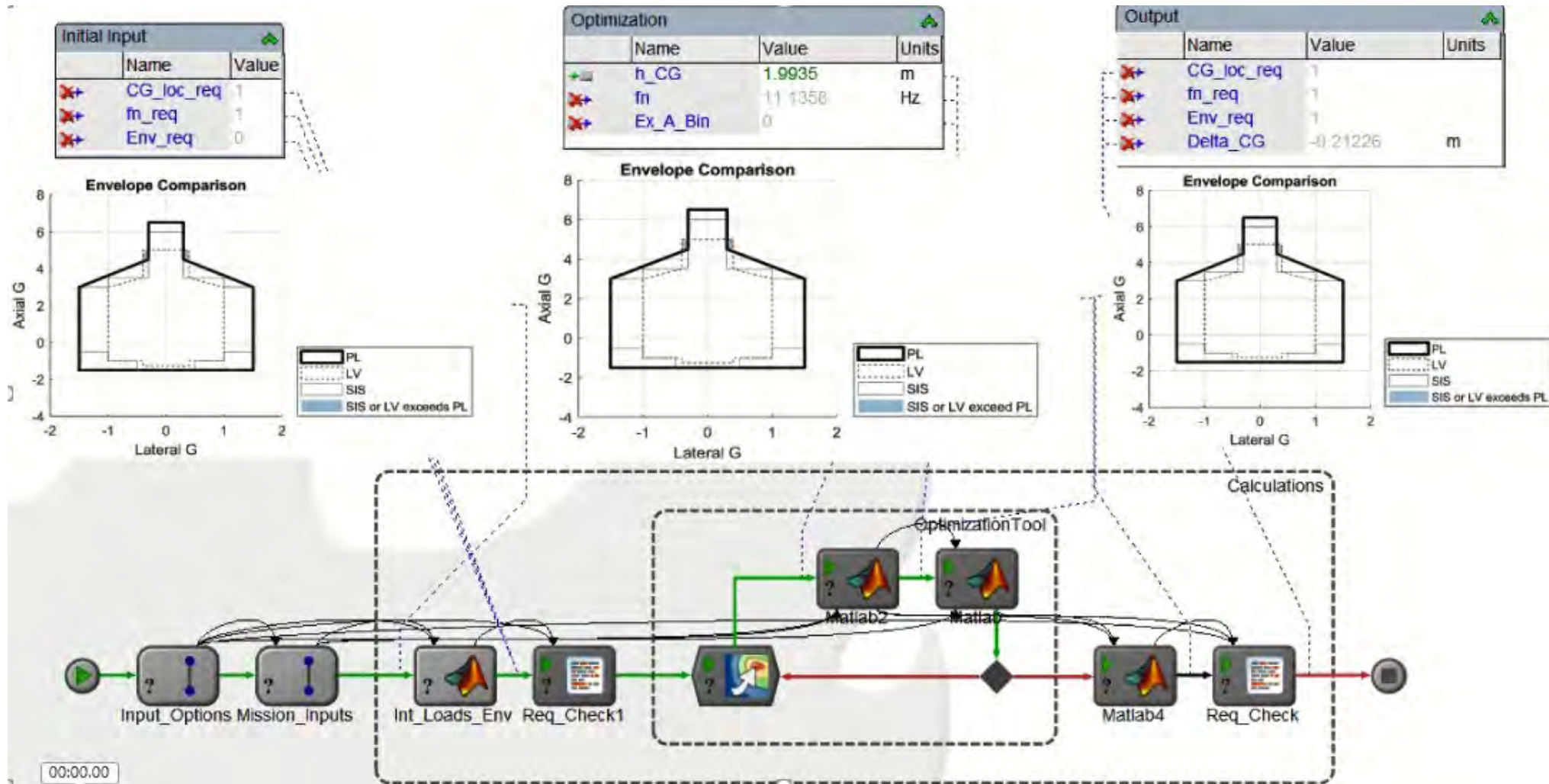
# ModelCenter Integrate: Acoustics Analysis



$$SPL(f) = 10 * \log_{10}(S(f))$$

$$OASPL = 10 * \log_{10}(\int S(f) df)$$

# ModelCenter Explore: Load Factors Optimization

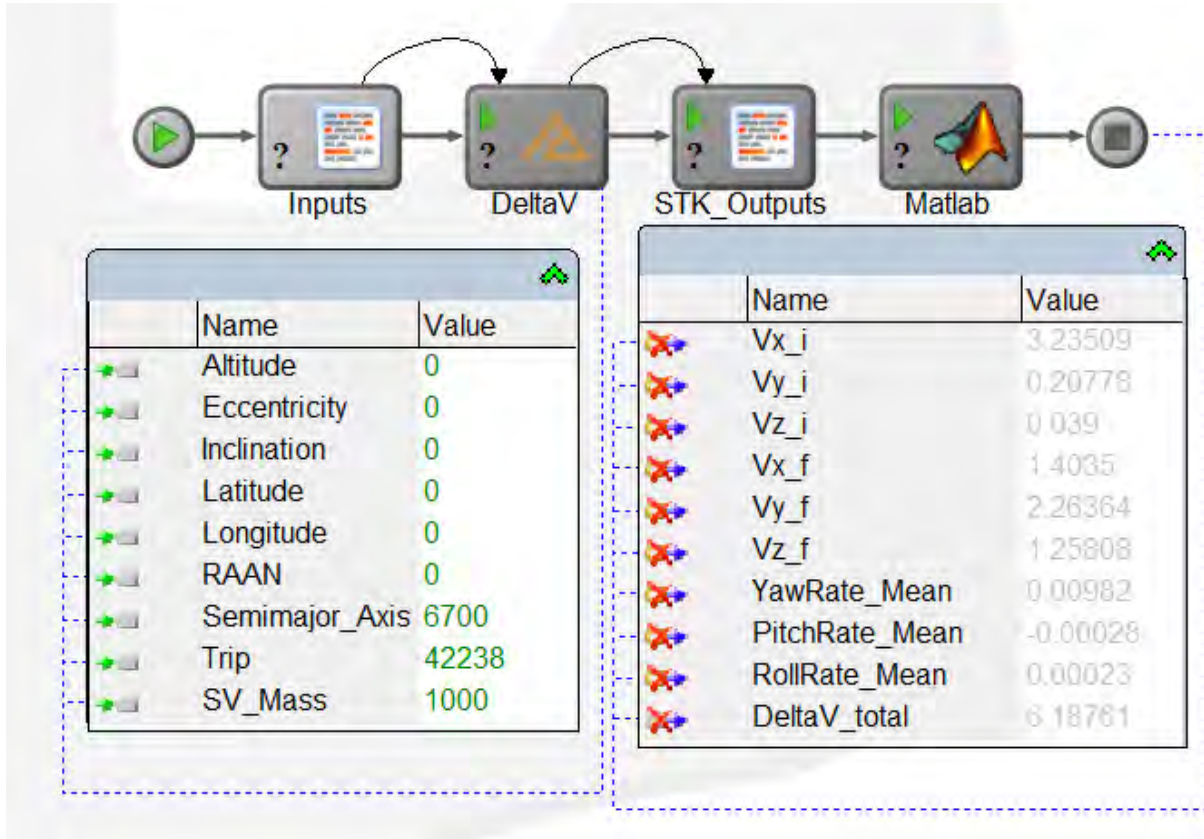


$CG_{Height} \propto \text{Lateral Loads Envelope}$

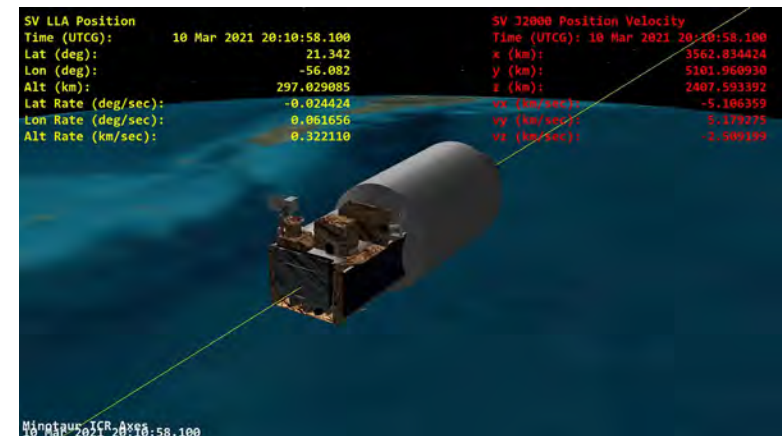
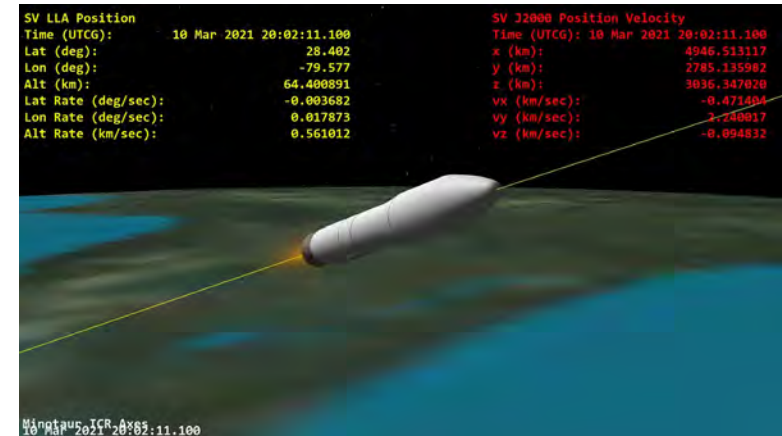
$$\Delta = \delta + h\theta$$

$$f_n = \frac{1}{2\pi} \sqrt{\frac{1}{\Delta}}$$

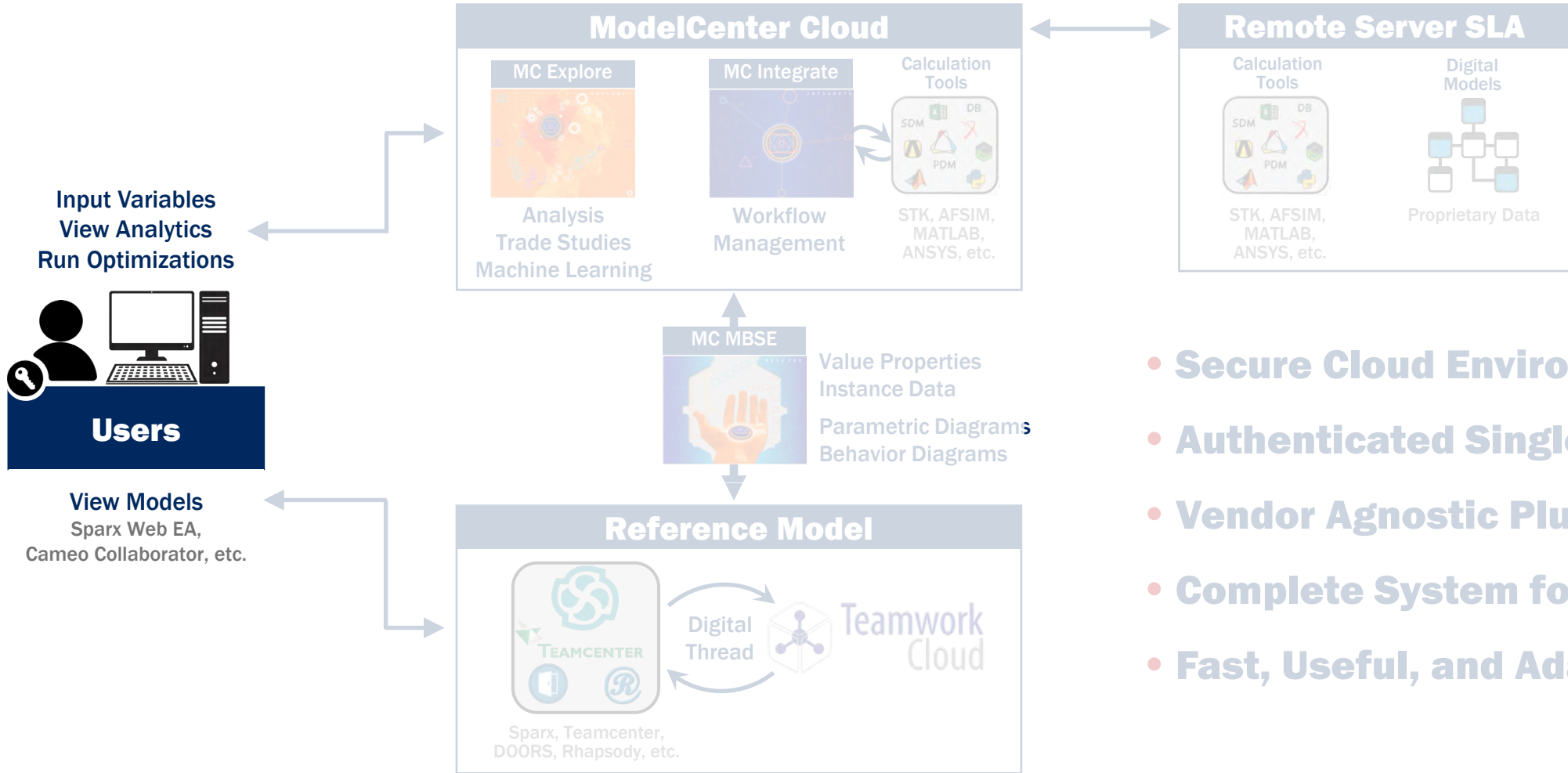
# Modeling Tools: Flight Design



$$\Delta v = \int_{t_0}^{t_1} \frac{|T(t)|}{m(t)} dt$$

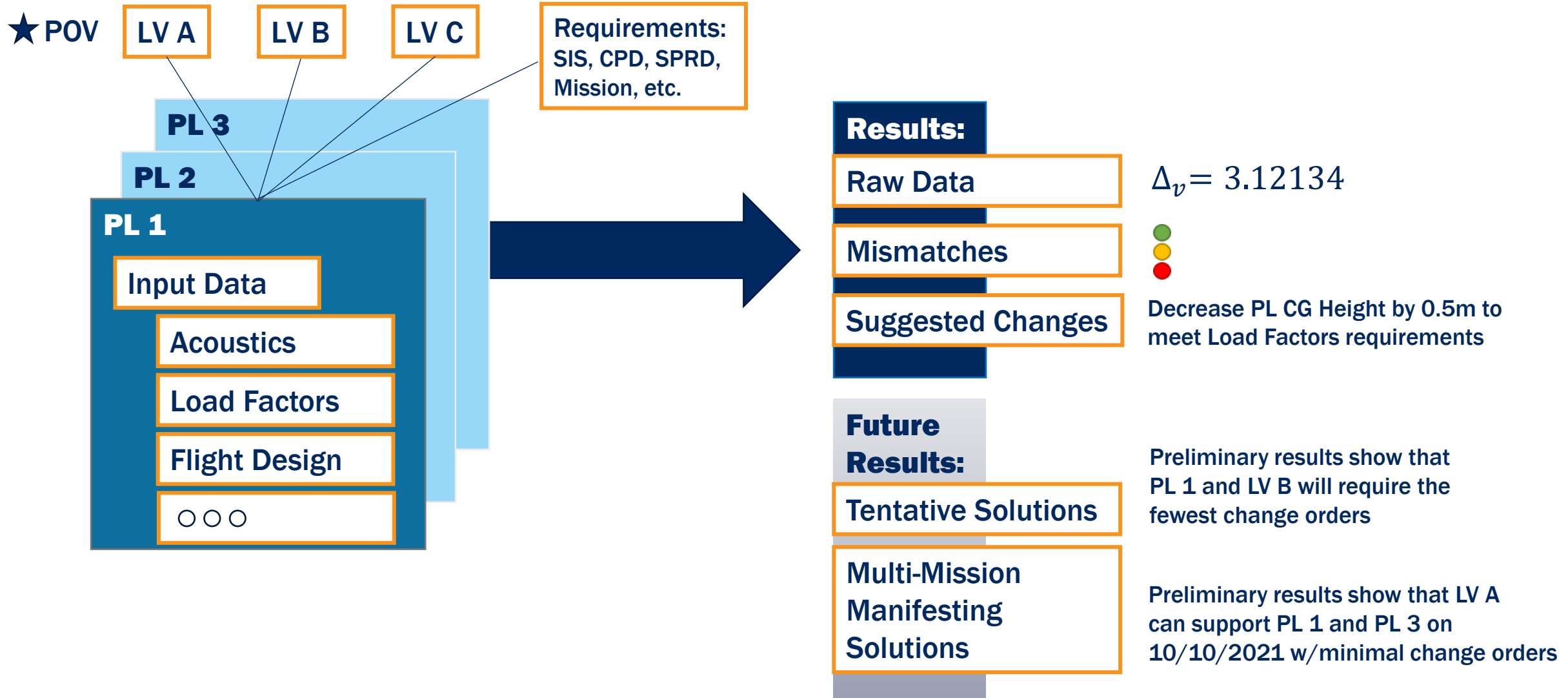


# Digital Engineering Ecosystem Architecture



- **Secure Cloud Environment**
- **Authenticated Single-Sign-On**
- **Vendor Agnostic Plug-and-Play**
- **Complete System for Full Lifecycle**
- **Fast, Useful, and Adaptable**

# User Profiles: LV and PL Perspective



# User Profile

LVA

SV3

SV2

class optical antenna

**PL\_Input::Loads\_LateralAcceleration**

```

«column»
COLUMN1: VARCHAR2(50) = 0
COLUMN2: VARCHAR2(50) = 0.5
COLUMN3: VARCHAR2(50) = 0.5
COLUMN4: VARCHAR2(50) = 1.5
COLUMN5: VARCHAR2(50) = 1.5
COLUMN6: VARCHAR2(50) = 1
COLUMN7: VARCHAR2(50) = -1
COLUMN8: VARCHAR2(50) = -1.5
COLUMN9: VARCHAR2(50) = -1.5
COLUMN10: VARCHAR2(50) = -0.5
COLUMN11: VARCHAR2(50) = -0.5
COLUMN12: VARCHAR2(50) = 0
    
```

**PL\_Input::GeneralProperties\_PL3**

```

«column»
NAME: VARCHAR2(50) = OpticalAssembly
MASS: NUMBER(8,2) = 3500
CG_HEIGHT: NUMBER(8,2) = 1.25
    
```

**PL\_Input::Loads\_Optical\_AssemblyAxialAcceleration**

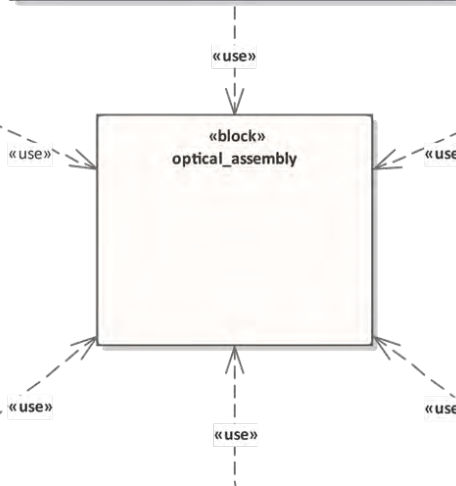
```

«column»
COLUMN1: VARCHAR2(50) = 6.5
COLUMN2: VARCHAR2(50) = 6.5
COLUMN3: VARCHAR2(50) = 4
COLUMN4: VARCHAR2(50) = 4
COLUMN5: VARCHAR2(50) = 1
COLUMN6: VARCHAR2(50) = -2
COLUMN7: VARCHAR2(50) = -2
COLUMN8: VARCHAR2(50) = 1
COLUMN9: VARCHAR2(50) = 4
COLUMN10: VARCHAR2(50) = 4
COLUMN11: VARCHAR2(50) = 6.5
COLUMN12: VARCHAR2(50) = 6.5
    
```

**PL\_Input::Acoustics\_OneThirdOctaveBandCenterFrequencyHz**

```

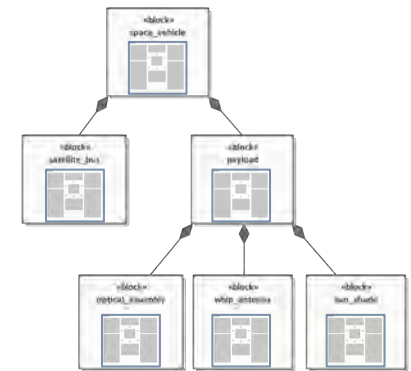
«column»
COLUMN1: VARCHAR2(50) = 25
COLUMN2: VARCHAR2(50) = 32
COLUMN3: VARCHAR2(50) = 40
COLUMN4: VARCHAR2(50) = 50
COLUMN5: VARCHAR2(50) = 63
COLUMN6: VARCHAR2(50) = 80
COLUMN7: VARCHAR2(50) = 100
COLUMN8: VARCHAR2(50) = 125
COLUMN9: VARCHAR2(50) = 160
COLUMN10: VARCHAR2(50) = 200
COLUMN11: VARCHAR2(50) = 250
COLUMN12: VARCHAR2(50) = 315
COLUMN13: VARCHAR2(50) = 400
COLUMN14: VARCHAR2(50) = 500
COLUMN15: VARCHAR2(50) = 630
COLUMN16: VARCHAR2(50) = 800
COLUMN17: VARCHAR2(50) = 1000
COLUMN18: VARCHAR2(50) = 1250
COLUMN19: VARCHAR2(50) = 1600
COLUMN20: VARCHAR2(50) = 2000
COLUMN21: VARCHAR2(50) = 2500
COLUMN22: VARCHAR2(50) = 3150
COLUMN23: VARCHAR2(50) = 4000
COLUMN24: VARCHAR2(50) = 5000
COLUMN25: VARCHAR2(50) = 6300
COLUMN26: VARCHAR2(50) = 8000
COLUMN27: VARCHAR2(50) = 10000
    
```



**PL\_Input::Acoustics\_Optical\_Assembly\_SoundPressureLeveldB**

```

«column»
COLUMN1: VARCHAR2(50) = 114
COLUMN2: VARCHAR2(50) = 125
COLUMN3: VARCHAR2(50) = 134
COLUMN4: VARCHAR2(50) = 130
COLUMN5: VARCHAR2(50) = 127
COLUMN6: VARCHAR2(50) = 115
COLUMN7: VARCHAR2(50) = 113
COLUMN8: VARCHAR2(50) = 125
COLUMN9: VARCHAR2(50) = 128
COLUMN10: VARCHAR2(50) = 130
COLUMN11: VARCHAR2(50) = 130
COLUMN12: VARCHAR2(50) = 130
COLUMN13: VARCHAR2(50) = 129.5
COLUMN14: VARCHAR2(50) = 128
COLUMN15: VARCHAR2(50) = 125
COLUMN16: VARCHAR2(50) = 124
COLUMN17: VARCHAR2(50) = 123
COLUMN18: VARCHAR2(50) = 122
COLUMN19: VARCHAR2(50) = 121
COLUMN20: VARCHAR2(50) = 120
COLUMN21: VARCHAR2(50) = 119
COLUMN22: VARCHAR2(50) = 118
COLUMN23: VARCHAR2(50) = 117
COLUMN24: VARCHAR2(50) = 116
COLUMN25: VARCHAR2(50) = 115
COLUMN26: VARCHAR2(50) = 114
COLUMN27: VARCHAR2(50) = 113
    
```



12134

**PL\_Input::GeneralProperties\_PL2**

```

«column»
NAME: VARCHAR2(50) = SunShade
MASS: NUMBER(8,2) = 2000
CG_HEIGHT: NUMBER(8,2) = 0.75
    
```

**PL\_Input::Loads\_Sun\_Shade\_AxialAcceleration**

```

«column»
COLUMN1: VARCHAR2(50) = 6
COLUMN2: VARCHAR2(50) = 6
COLUMN3: VARCHAR2(50) = 4
COLUMN4: VARCHAR2(50) = 4
COLUMN5: VARCHAR2(50) = 0
COLUMN6: VARCHAR2(50) = -1.5
COLUMN7: VARCHAR2(50) = -1.5
COLUMN8: VARCHAR2(50) = 0
COLUMN9: VARCHAR2(50) = 4
COLUMN10: VARCHAR2(50) = 4
COLUMN11: VARCHAR2(50) = 6
COLUMN12: VARCHAR2(50) = 6
    
```

**PL\_Input::Acoustics\_Sun\_Shade\_SoundPressureLeveldB**

```

«column»
COLUMN1: VARCHAR2(50) = 114
COLUMN2: VARCHAR2(50) = 121
COLUMN3: VARCHAR2(50) = 126.8
COLUMN4: VARCHAR2(50) = 125.2
COLUMN5: VARCHAR2(50) = 126.3
COLUMN6: VARCHAR2(50) = 128
COLUMN7: VARCHAR2(50) = 129
COLUMN8: VARCHAR2(50) = 130
COLUMN9: VARCHAR2(50) = 130
COLUMN10: VARCHAR2(50) = 130
COLUMN11: VARCHAR2(50) = 130
COLUMN12: VARCHAR2(50) = 130
COLUMN13: VARCHAR2(50) = 129.5
COLUMN14: VARCHAR2(50) = 128
COLUMN15: VARCHAR2(50) = 125
COLUMN16: VARCHAR2(50) = 124
COLUMN17: VARCHAR2(50) = 110
COLUMN18: VARCHAR2(50) = 115
COLUMN19: VARCHAR2(50) = 100
COLUMN20: VARCHAR2(50) = 95
COLUMN21: VARCHAR2(50) = 94
COLUMN22: VARCHAR2(50) = 94
COLUMN23: VARCHAR2(50) = 93
COLUMN24: VARCHAR2(50) = 92
COLUMN25: VARCHAR2(50) = 93
COLUMN26: VARCHAR2(50) = 91
COLUMN27: VARCHAR2(50) = 91
    
```

**PL\_Input::FlightDesign\_PL2**

```

«column»
* LATITUDE: VARCHAR2(50) = 0
LONGITUDE: VARCHAR2(50) = 0
ALTITUDE: VARCHAR2(50) = 0
SEMIMAJOR AXIS PL 1 ORBIT: VARCHAR2(50) = 6700
ECCENTRICITY: VARCHAR2(50) = 0
INCLINATION: VARCHAR2(50) = 0
RAAN: VARCHAR2(50) = 0
SEMIMAJOR AXIS PL 2 ORBIT: VARCHAR2(50) = 42238
    
```



# Executive Profiles: Higher Perspective

## Executive Dashboard:

- No PL/SV input
- Overview of results comparing “approved” or “tentative” LV/SV/PLs

### Executive Dashboard

#### PL Echo: Secondary PL Configurations

Secondary PL	Launch Vehicle	Primary PL	Loads	Acoustics	Flight Design	Thermal	Contamination
Echo	A	Alpha	●	●	●	●	●
Echo	A	Bravo	●	●	●	●	●
Echo	B	Alpha	●	●	●	●	●
Echo	B	Bravo	●	●	●	●	●
Echo	C	Alpha	●	●	●	●	●

## Launch Manifest:

- Tentative configuration of LV/SV/PLs given complimentary cohesiveness and mission requirements

### Potential Launch Manifest

Mission	Date	Launch Vehicle	Primary PL	Secondary PL	Hosted PL	Status
Mission 1	2020-11-23	C	Payload Charlie	Payload Fox	Payload Hotel	●
Mission 2	2021-01-02	A	Payload Zulu	Payload Sierra	Payload Bravo	●
Mission 3	2021-01-18	D	Payload Dedicated			●
Mission 4	2021-02-13	A	Payload Alpha	Payload Mike	Payload Oscar	●
Mission 5	2021-3-28	E	Payload Delta	Payload Lima	Payload Juliet	●



# ✦ **EIS: MT-ADEPT Prototype**

- **Cloud-Based Workflow Example**

# Live Demo



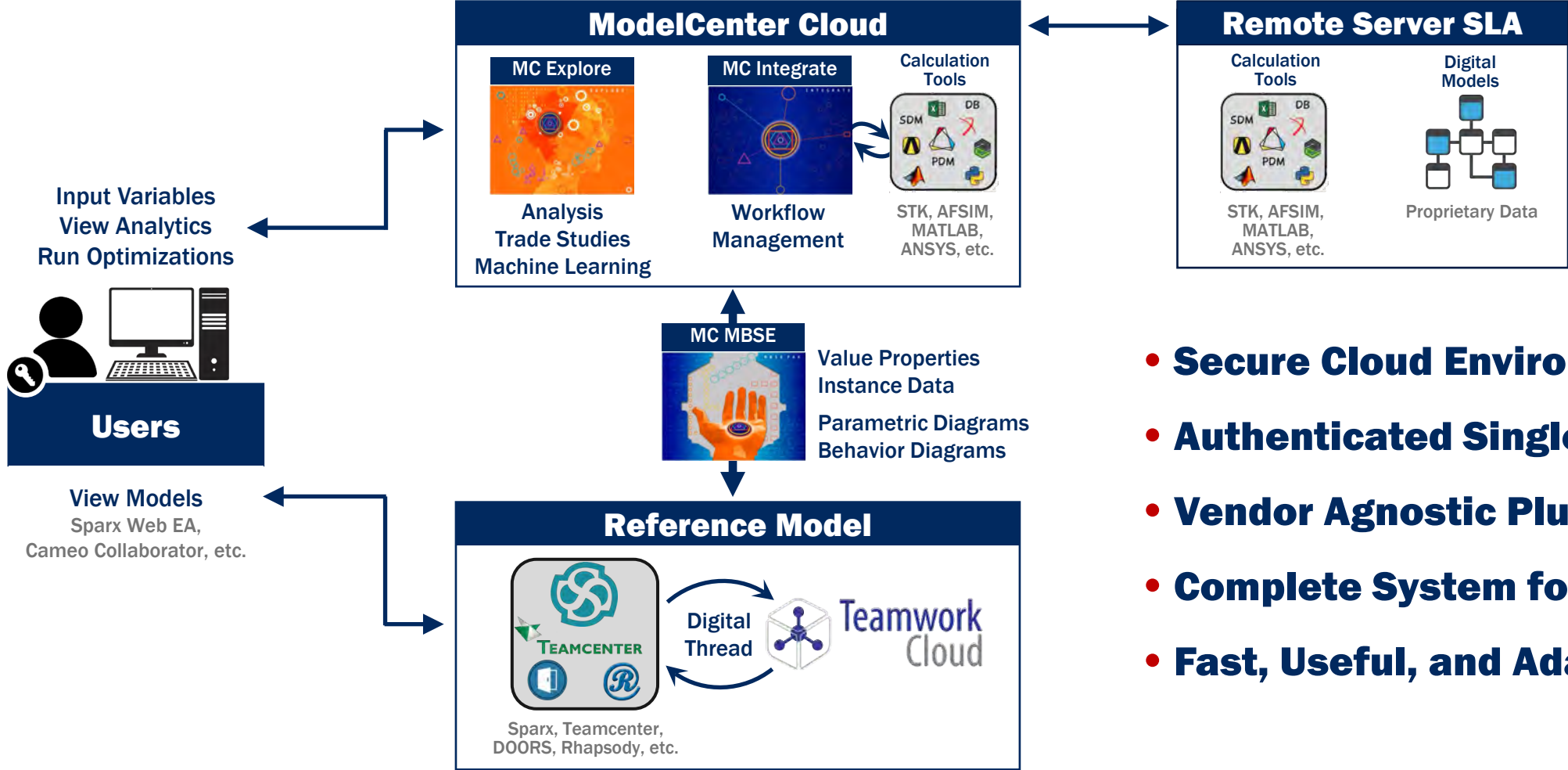
# ManTech-ADEPT Benefits

## Reduces Time and Labor Cost

## Maintains Decision Quality Results

- Allows for real-time adjustments and resource-unconstrained studies
- Enables automated Monte Carlo experiments and other trade studies
- Eliminates error-prone and work-intensive human data exchange
- Builds a scalable foundation for future developments
  
- Next Steps:
  - Refining workflows, maturing analytics, including additional EIS workflows
  - Building digital twin Reference Model and exploring a model based digital thread innovation

# Digital Engineering Ecosystem Architecture



- **Secure Cloud Environment**
- **Authenticated Single-Sign-On**
- **Vendor Agnostic Plug-and-Play**
- **Complete System for Full Lifecycle**
- **Fast, Useful, and Adaptable**