



Visualization and MBSE

Marc Sarrel

Jet Propulsion Laboratory

California Institute of Technology





Why MBSE?

- **Dynamic architecture, near continual updates – significant deltas to content**
- **Quick turn around required – broad effects, limited staff**
- **Approach applied to EFT-1 and half a dozen assessments for the NESC**

<h2>APOLLO</h2> <p>CREW MODULE DIAMETER: 12.8 FT. CREW SIZE: 3 SERVICE MODULE DIAMETER: 13 FT. SERVICE MODULE LENGTH: 24.5 FT. SERVICE MODULE MASS: 54,000 LBS. SERVICE MODULE THRUST: 20,500 LBS. POWER: BATTERIES, FUEL CELLS LANDING: WATER DOCKING: LUNAR MODULE DESTINATION: SKYLAB, ASTP, MOON</p>		<h2>ORION</h2> <p>CREW MODULE DIAMETER: 16.5 FT. CREW SIZE: 4 (6 TO ISS) SERVICE MODULE DIAMETER: 16.5 FT. SERVICE MODULE LENGTH: 15.7 FT. SERVICE MODULE MASS: 27,500 LBS. SERVICE MODULE THRUST: 7,500 LBS. POWER: SOLAR ARRAYS, BATTERIES LANDING: WATER DOCKING: MULTI PURPOSE DESTINATION: MOON, MARS, ASTEROIDS</p> <p>(THE FULL EUROPEAN SERVICE MODULE WILL FLY ORION'S SECOND TEST FLIGHT.)</p>	
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A Different Way to Apply MBSE



Extract from source documents

Integrate using MBSE

Analyze with automated tools

Assess results

Feedback gaps and conflicts



Bigger is not always better



Perception MBSE requires large teams, a lot of money and a lot of time

au contraire...

Small teams can be just as effective and lean models are still powerful



Focus on the Stakeholders

Control scope

Identify concerns early

Prototype viewpoints early

Show incremental progress often

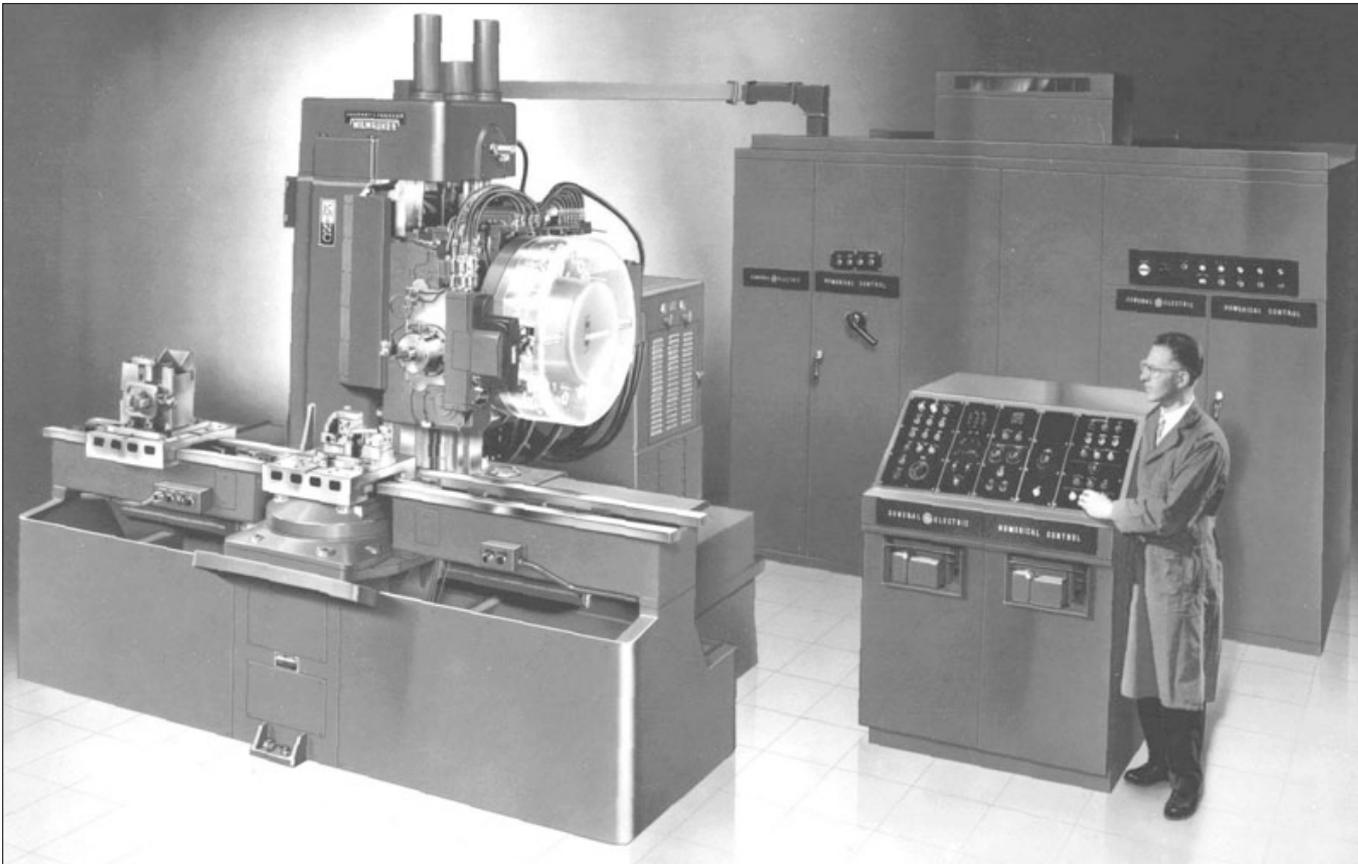
Respond to content updates quickly

Deliver quality products



I Analyze, Therefore I Model ~~I Draw, Therefore I Model~~

Automation Is Key



Simple modeling patterns

Gap and conflict checking

Automatic diagramming

DocGen

Quick assessments

Quick updates to customers



Why Automatic Diagramming?

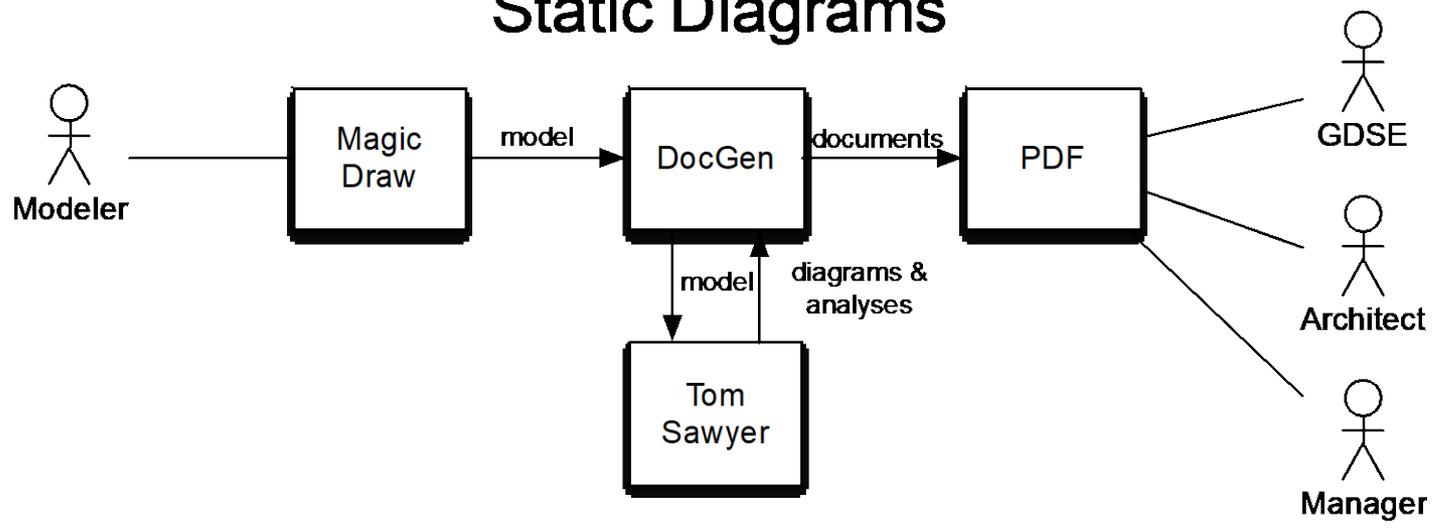
- **Automated diagrams always up to date and complete**
- **Diagramming *by hand* in MagicDraw is time-consuming**
 - MagicDraw is *not* a good drawing tool
 - Elements disappear when deleted from model
 - New elements don't automatically appear on all diagrams you want
- **Customers don't like SysML diagrams**
- **MagicDraw diagrams decay quickly – short half-life – losing battle**
- **Diagramming not a productive use of system engineers' time**
- **EFT-1 – recurring one hour per diagram by hand to update, 100+ diagrams in document.**



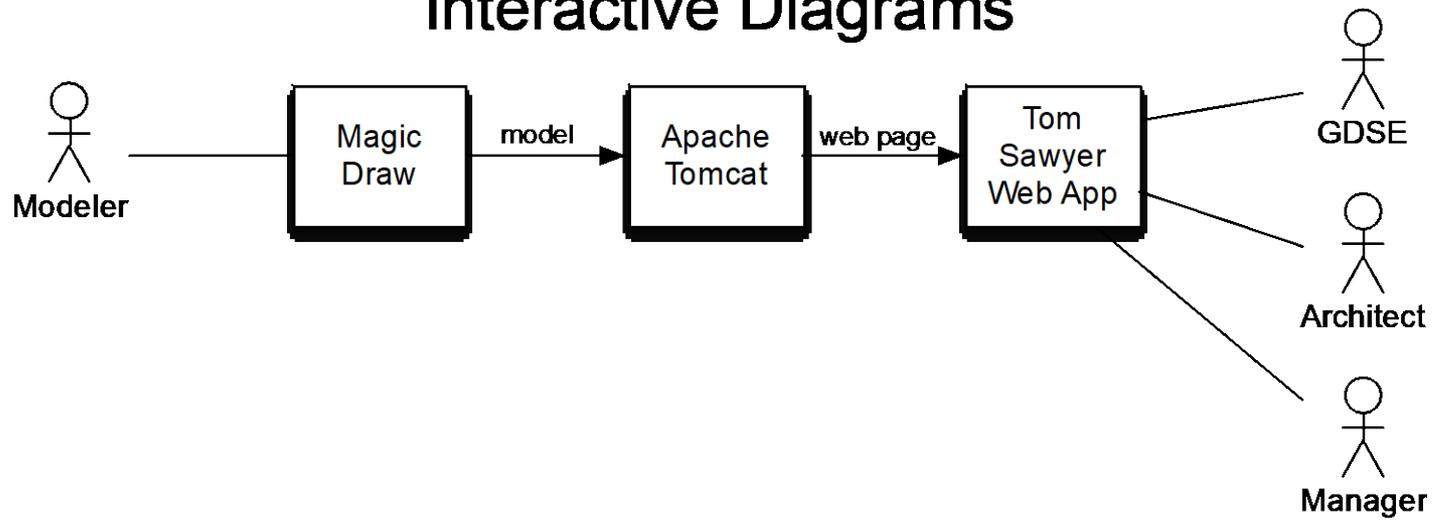


Deployment and Integration of Tom Sawyer

Static Diagrams



Interactive Diagrams





EFT-1 Physical Network Bedsheet

All components and connections extracted from model and diagram created automatically

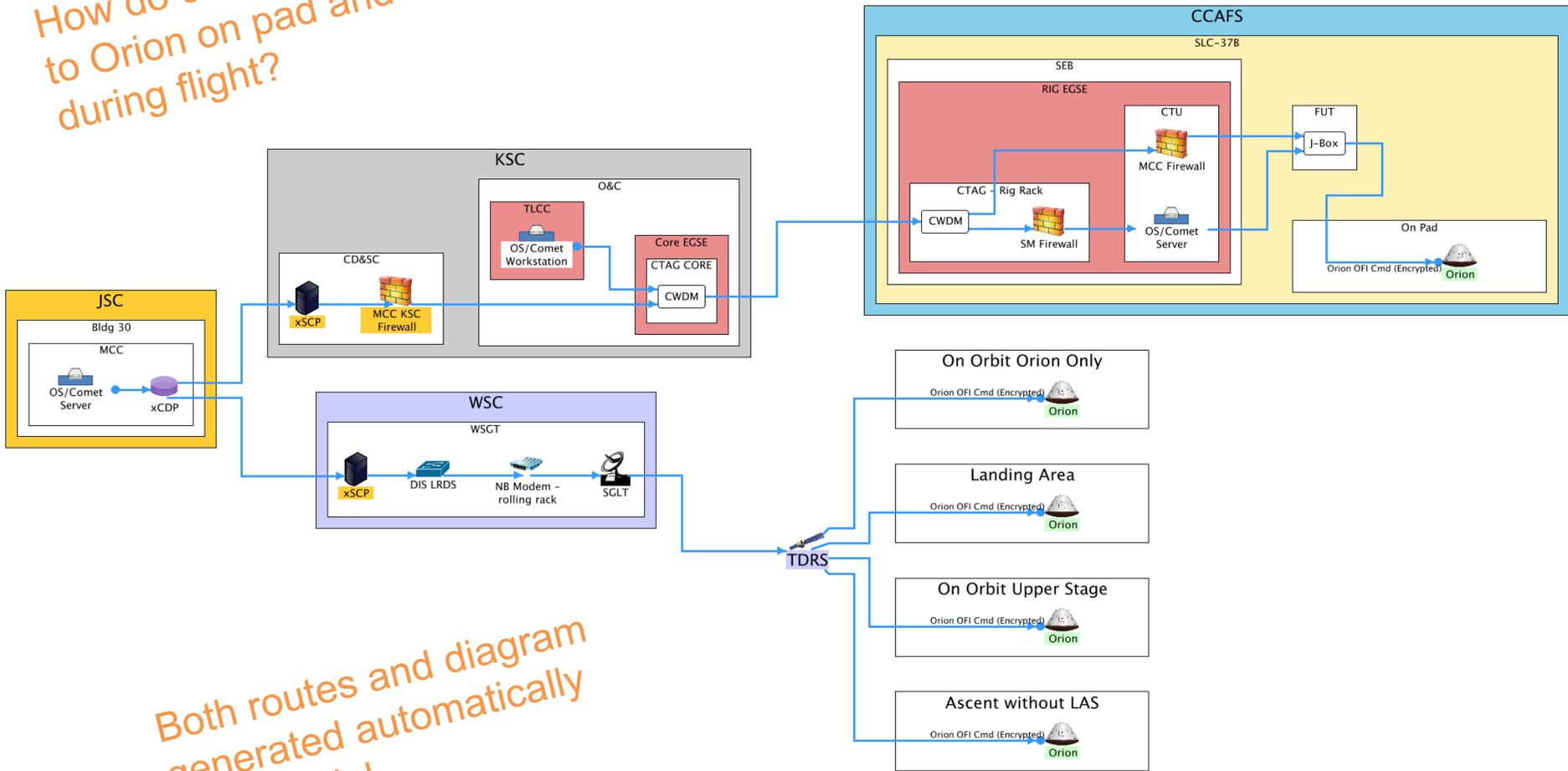


Color = Organization
Grey = KSC
Orange = JSC
Red = LM
etc.



Routed Logical Data Flows For Commands

How do commands get to Orion on pad and during flight?



Both routes and diagram generated automatically from model.

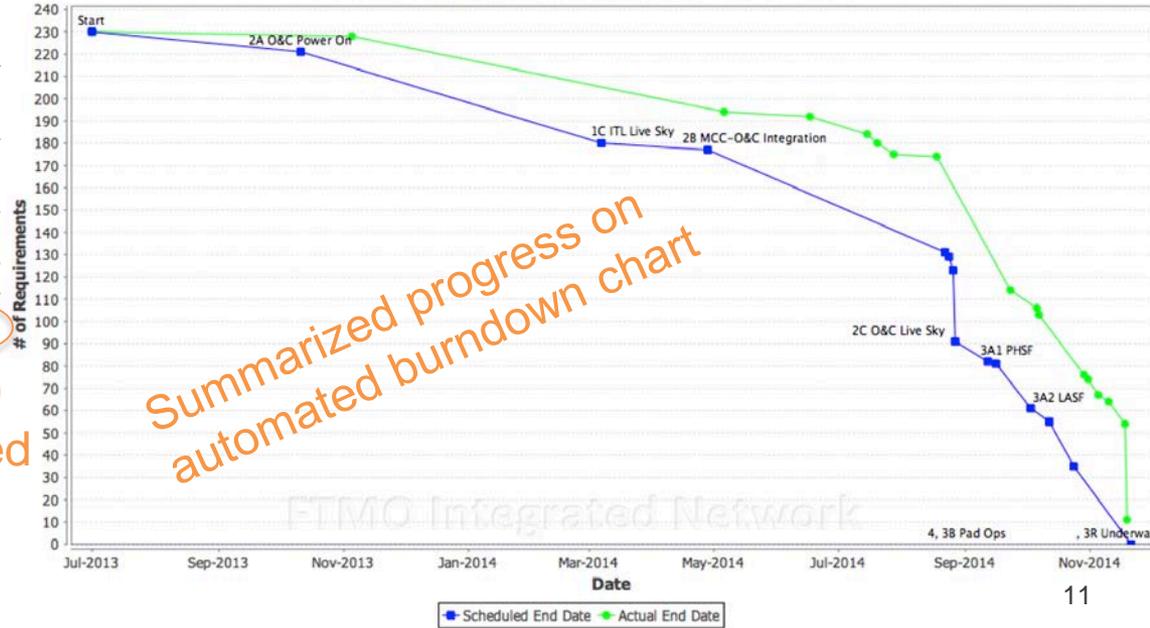


V&V Reporting

	GSB 2A O&C (Internal)	GSB 1C ITL to MCC - E2E-03 (External)	GSB 2B O&C to MCC Hardline (External)	GSB 2C O&C Test Support (External)	GSB 3A1 PHSF Integration	GSB 3A2 LASF Integration	GSB 3B On-Pad Operations (External)	GSB 3R Underway Test (External)	GSB 3C Mission Operations (External)	GSB 4
Compatibility Test										
ORN-T-0102 (Williams)					4					
ORN-T-0103 (Rahnefeld)				3						
ORN-T-0167 (Ramos)	3			2	4		16			
ORN-T-0175 (Bristol)				35						
ORN-T-0187 (Roca)									4	
ORN-T-0188_JIS4									5	
ORN-T-0273 (Black)									8	
ORN-T-0281 (Bristol)									2	
ORN-T-AV-0562 (O'Hagan)		38								
PRD Inspection Report (Sylvia Segura)										
PRD Inspection Reports (Joe Aquino)		2	2	5						
PRD Inspection Reports (Olivia Fuentes)	5									
Procedure TBD (Tom Walker)										
Unallocated										

Allocated 84 requirements to procedures through repeatable reporting process management could understand

EFT-1 GS Requirement Burndown - 2014-11-29



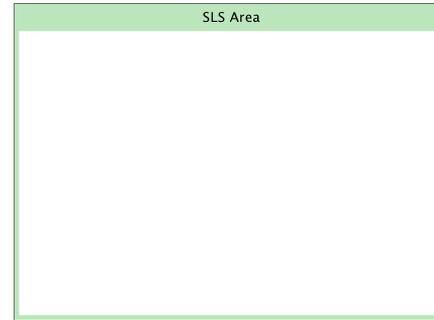
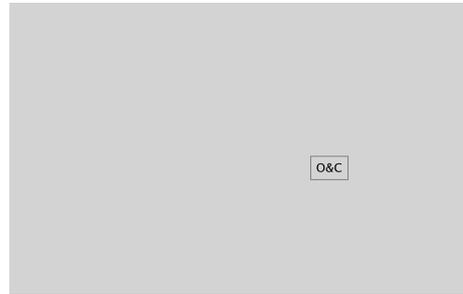
Total number of requirements: 230; Total unallocated requirements: 0; Total closed requirements: 219

230 total 0 no procedure closed 219

FTMO Integrated Network



Summary of all locations, equipment and software



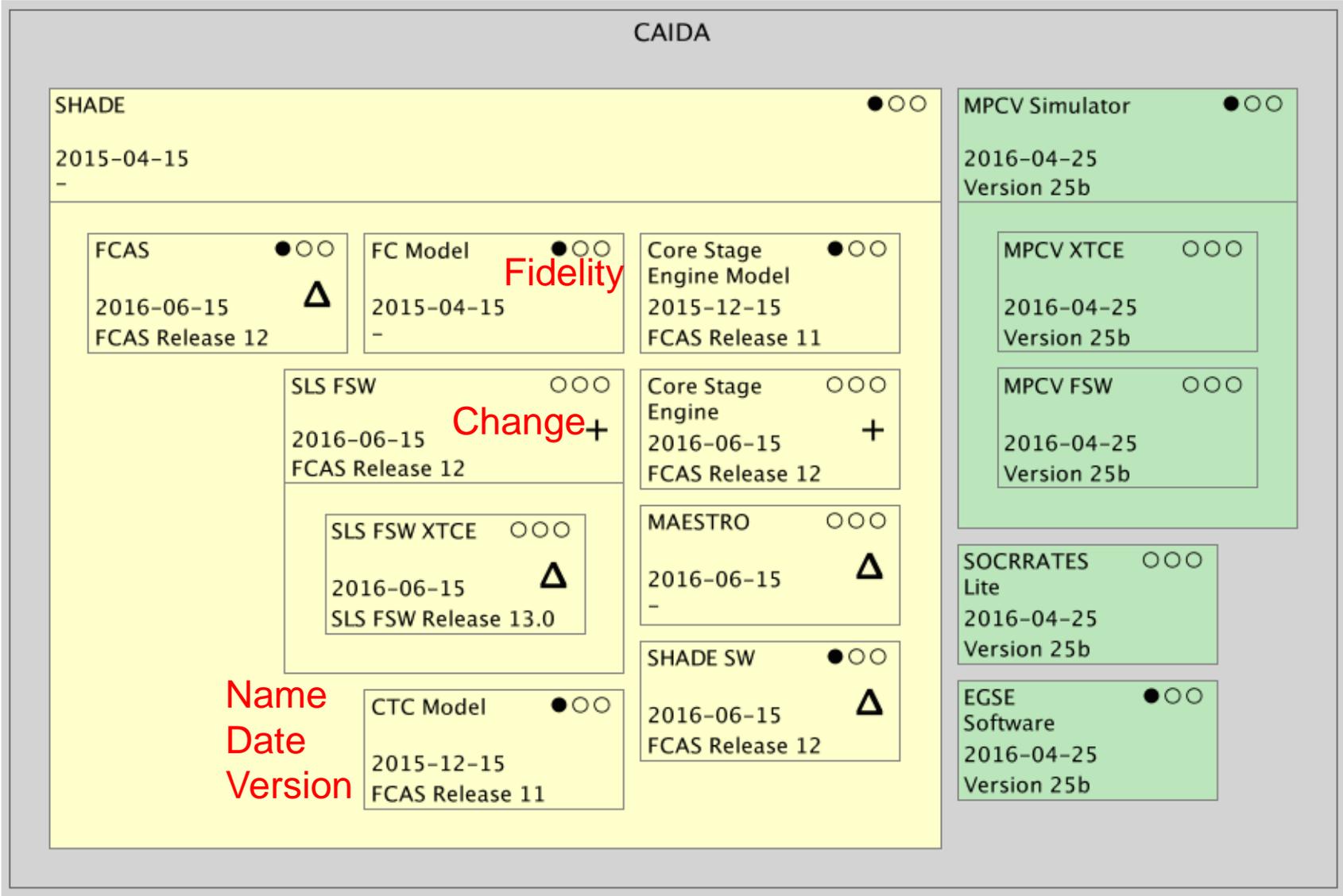


Integrated Delivery Timeline

updated



Example Configuration Diagram



Name
Date
Version



Integrated Delivery Timeline

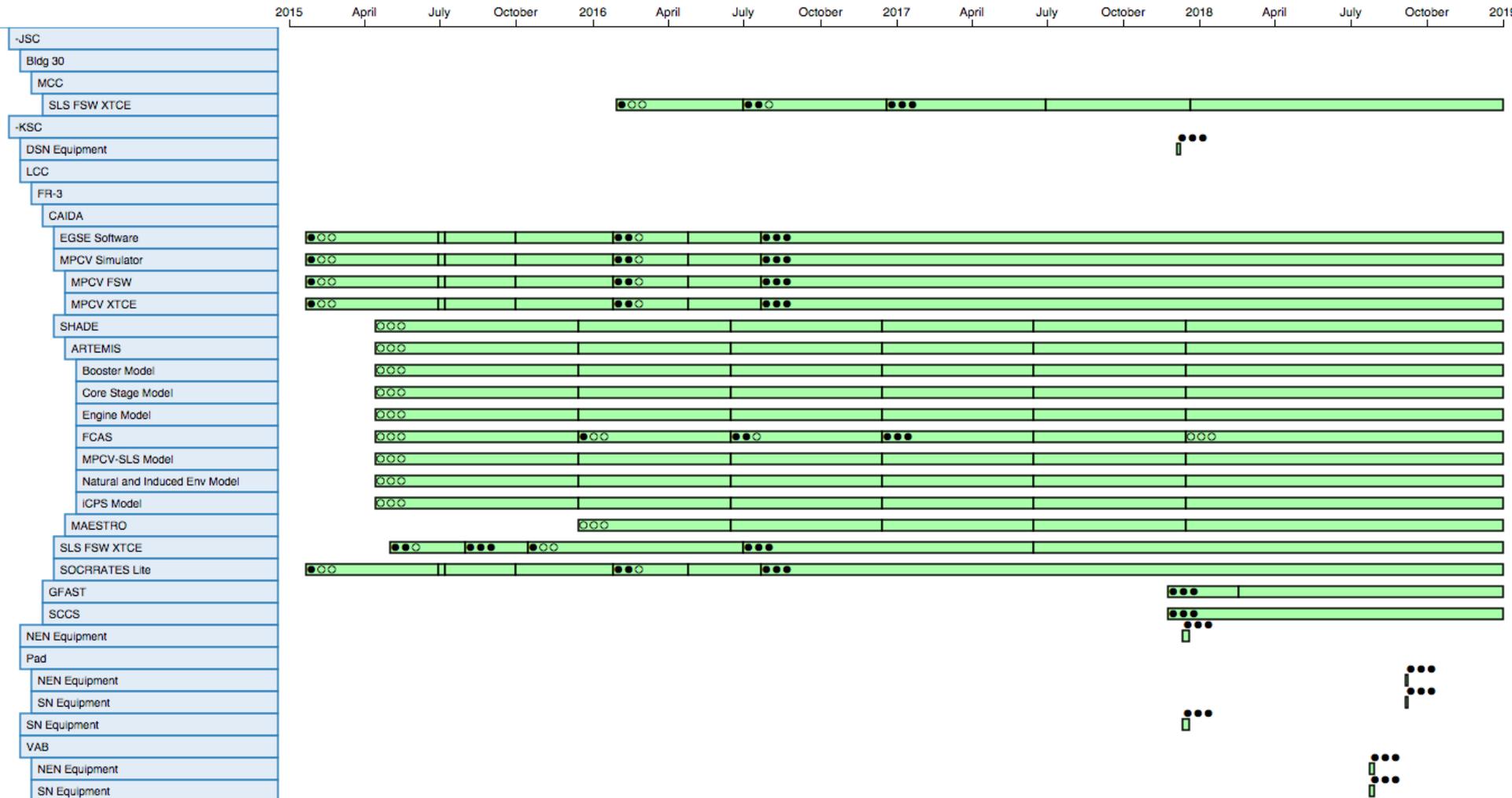
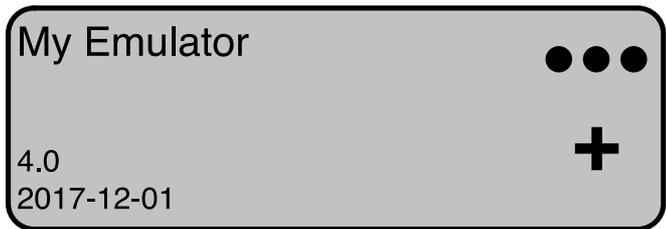




Diagram Legend



- ● ● EAVV High Fidelity
- ● ○ EAVV Medium Fidelity
- ○ ○ EAVV Low Fidelity
- ○ ○ *unknown*

△ Updated
removed



Test Activity

C-160



Changes Table

elity

Lists changes to this configuration



Requirements That Might Be Tested

Table B.27. Cross Program V&V Opportunities 2016-09-30 to 2016-10-06

ID	Venue	Source Document
I.MPCV-SLS.2283	LM Denver . IRF . ITL	Test Windows rev4 - chart 5
I.MPCV-SLS.2302	LM Denver . IRF . ITL	Test Windows rev4 - chart 5
I.MPCV-SLS.2722	LM Denver . IRF . ITL	Test Windows rev4 - chart 5
I.MPCV-SLS.2723	LM Denver . IRF . ITL	Test Windows rev4 - chart 5
I.MPCV-SLS.3002	LM Denver . IRF . ITL	Test Windows rev4 - chart 5
I.MPCV-SLS.3003	LM Denver . IRF . ITL	Test Windows rev4 - chart 5
I.MPCV-SLS.3006	LM Denver . IRF . ITL	Test Windows rev4 - chart 5
I.MPCV-SLS.3007	LM Denver . IRF . ITL	Test Windows rev4 - chart 5
I.MPCV-SLS.3008	LM Denver . IRF . ITL	Test Windows rev4 - chart 5
I.MPCV-SLS.3009	LM Denver . IRF . ITL	Test Windows rev4 - chart 5
I.MPCV-SLS.3052	LM Denver . IRF . ITL	Test Windows rev4 - chart 5
I.MPCV-SLS.3053	LM Denver . IRF . ITL	Test Windows rev4 - chart 5

Shows V&V Opportunities