



Jet Propulsion Laboratory
California Institute of Technology

FROM CONCEPT TO FLIGHT: **Engineering Systems Software at JPL**

Laura Mann, Software Engineer

JPL

March 1st, 2018

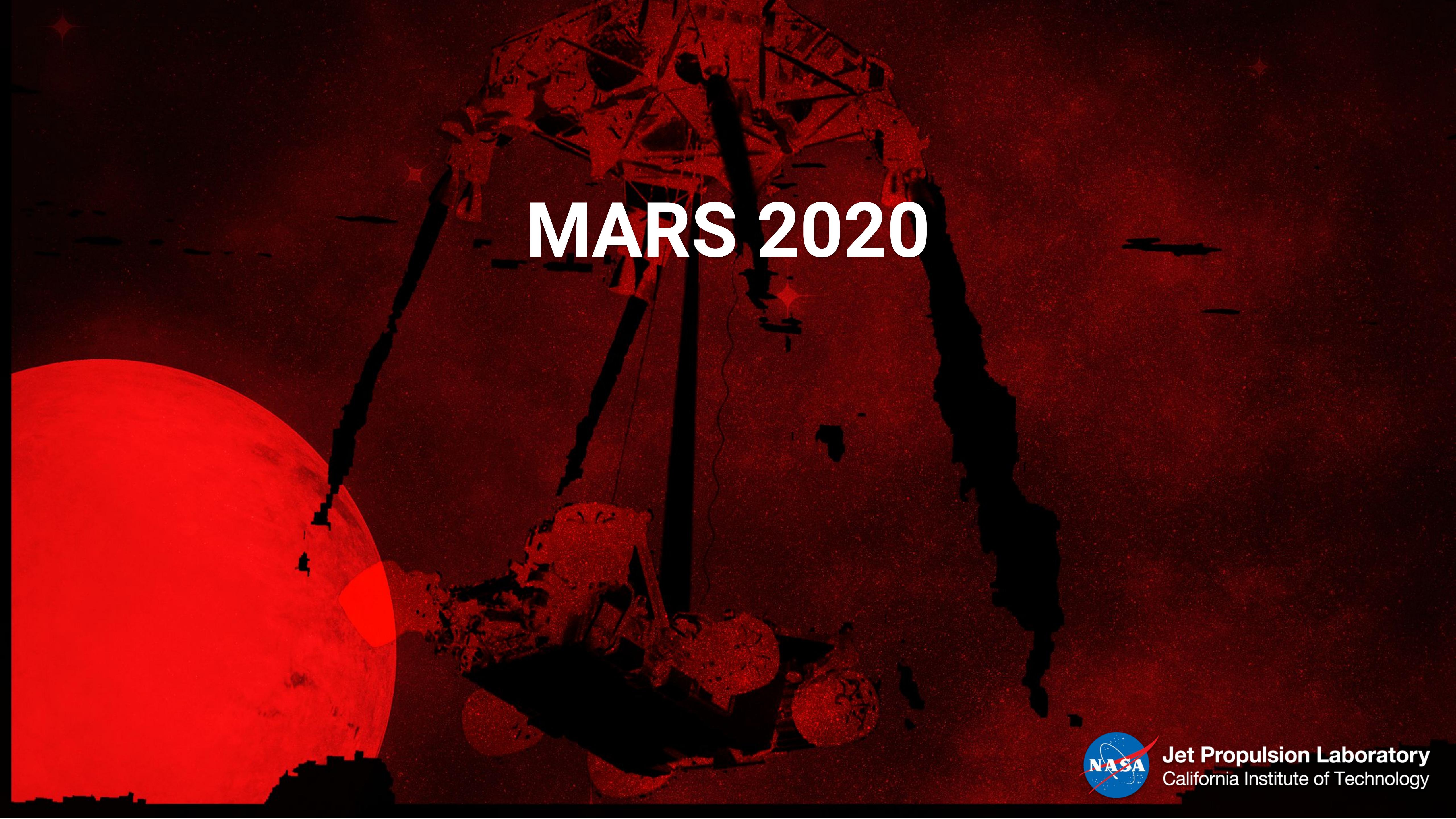
© 2018 California Institute of Technology. Government sponsorship acknowledged.

CL#18-0981

FLIGHT PROJECTS



Jet Propulsion Laboratory
California Institute of Technology



MARS 2020



Jet Propulsion Laboratory
California Institute of Technology



EUROPA



Jet Propulsion Laboratory
California Institute of Technology



PSYCHE

Planned Mission



Jet Propulsion Laboratory
California Institute of Technology

PHASES/LIFECYCLES

- Pre-Phase A: Concept Studies
- Phase A: Concept and technology Development
- Phase B: Preliminary Design and Technology Completion
- Phase C: Final Design and Fabrication
- Phase D: Assembly, Integration, Test and Launch
- Phase E: Operations and Sustainment
- Phase F: Close Out



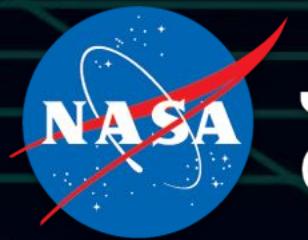
DOMAINS/SUBSYSTEMS

A spacecraft has many subsystems, a general model including:

- Thermal
- Communication
- Mechanical
- Propulsion
- Command and Data handling
- Power
- Harness
- Integration and Test
- Payload
- Guidance, Navigation and control

In addition to the subsystems of a spacecraft,
we must also design and implement:

- Navigation
- S/C Planning and Sequencing
- Instrument Science Planning and Analysis
- Communications & Tracking
- Telemetry, Tracking and Command
- Ground Infrastructure



Jet Propulsion Laboratory
California Institute of Technology

SYSTEMS ENGINEERING

What is a Systems Engineer?

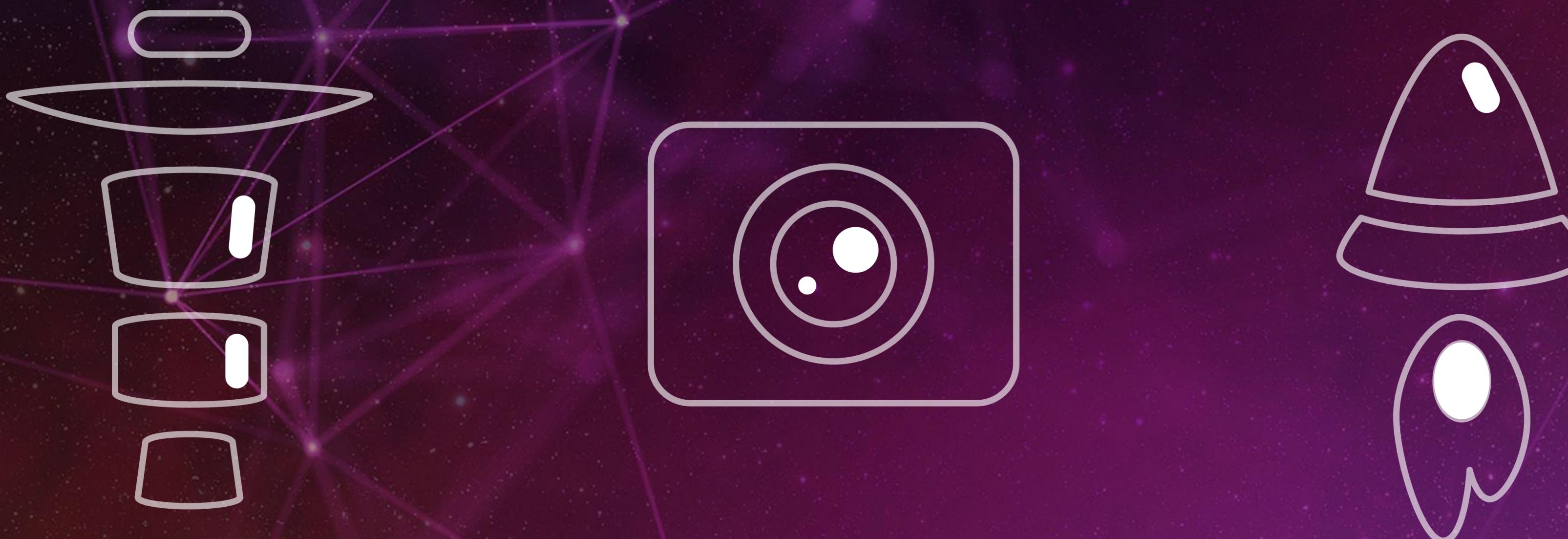
The sum of the parts is constructively greater than the whole



Jet Propulsion Laboratory
California Institute of Technology

SYSTEMS ENGINEERING

Example #1: Field of View Example



Jet Propulsion Laboratory
California Institute of Technology

SYSTEMS ENGINEERING

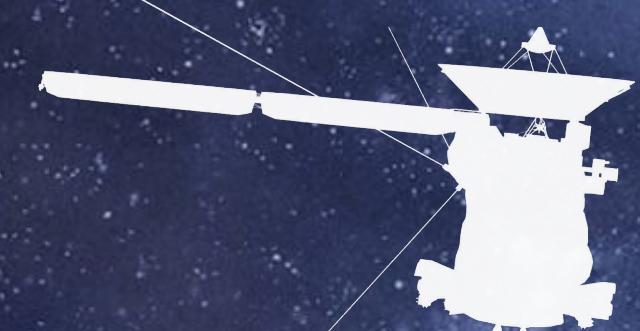
Example #2- Subsystems and Parts Visual



Jet Propulsion Laboratory
California Institute of Technology

SYSTEMS ENGINEERING

Example #3

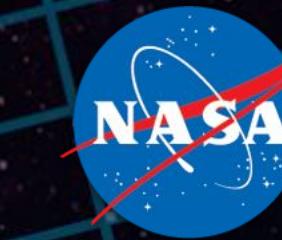


Jet Propulsion Laboratory
California Institute of Technology

SYSTEMS ENGINEERING

What System Engineers DO

- Develop the system specification
- Create requirements
- Verify and validate



Jet Propulsion Laboratory
California Institute of Technology

SYSTEMS ENGINEERING

What System Engineers Do

- Use modeling languages and tools,
requirements management tools and
office productivity software



Jet Propulsion Laboratory
California Institute of Technology

OUR SOFTWARE

- Our responsibility is to provide the platform for engineering and development of the mission
- We provide tools (COTS) and custom development of software
- Enable users to write web applications against the data in the system model



Requirements

- Composite structure: class inheritance, property (read: variable) typing, separation of definition (read: instantiation or location in memory) and usage (read: pointer)
- Views: constructed from the model
- Key-value store for data, i.e. “documentation” => “Lorem ipsum.”
- Represent model as a graph
- Technical search



SERVICES LAYER

- CRUD
- Version Control Operations
- Search
- Query
- Analysis
- Notifications

DATABASE LAYER

ELASTICSEARCH

- Elasticsearch v5.6
- Types (multiple versions of metadata used a document store):
- Elements
- Artifacts
- Commits

RDBMS

- Tables (current version of the graph)
- Nodes
- Edges
- Artifacts
- Commits



RESULTS

- Substantial increase in performance
- A versioned facsimile of a graph
- Versioned data is inserted into elasticsearch
- Engineers are searching against the model



Jet Propulsion Laboratory
California Institute of Technology

FUTURESCOPE

In Planning

- Graph database systems
- A distributive model
- Improving technical search
- Optimize versioned queries

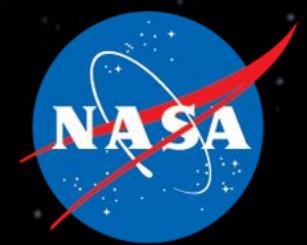


Jet Propulsion Laboratory
California Institute of Technology

WHAT WE NEED

New Methodology

In systems engineering the data comes highly structured in a dense versioned graph. We need novel solutions in software architecture, storage and retrieval as the data becomes more complex and dense over time.



Jet Propulsion Laboratory
California Institute of Technology

IN CONCLUSION

New Methodology

Please visit: <http://www.openmbee.org/>

Links to our open source software (<https://github.com/Open-MBEE>)

Links to associated papers (<http://www.omgysml.org>)

Links to our open source model the TMT

(<https://github.com/Open-MBEE/TMT-SysML-Model>)



Jet Propulsion Laboratory
California Institute of Technology

Thank You!



Jet Propulsion Laboratory
California Institute of Technology