INCQUERY

Modellezéssel Budapestről a Marsig,

avagy hogyan lehet egy BME spinoff a NASA Jet Propulsion Laboratory beszállítója?

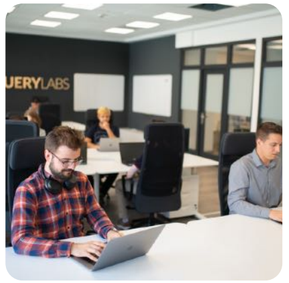
Dr. Ráth István
CEO, IncQuery Group

About Us

Origins

Founded in 2012 by members of the Fault-Tolerant Systems Research Group at Budapest University of Technology and Economics.
Engineering staff mostly alumni from the University's established computer science and engineering programs.

Present



Extended network with strong international relationships with global companies in multiple industries.
Developing own product portfolio since 2017.
IncQuery Labs became part of the IncQuery Group with offices in the **USA**, **Austria** and **Hungary**.

Future

Ever-expanding team of qualified young and motivated employees.
Strategy is to maintain sustainable growth as a family-friendly deep-tech organisation.

In numbers

147+ Projects

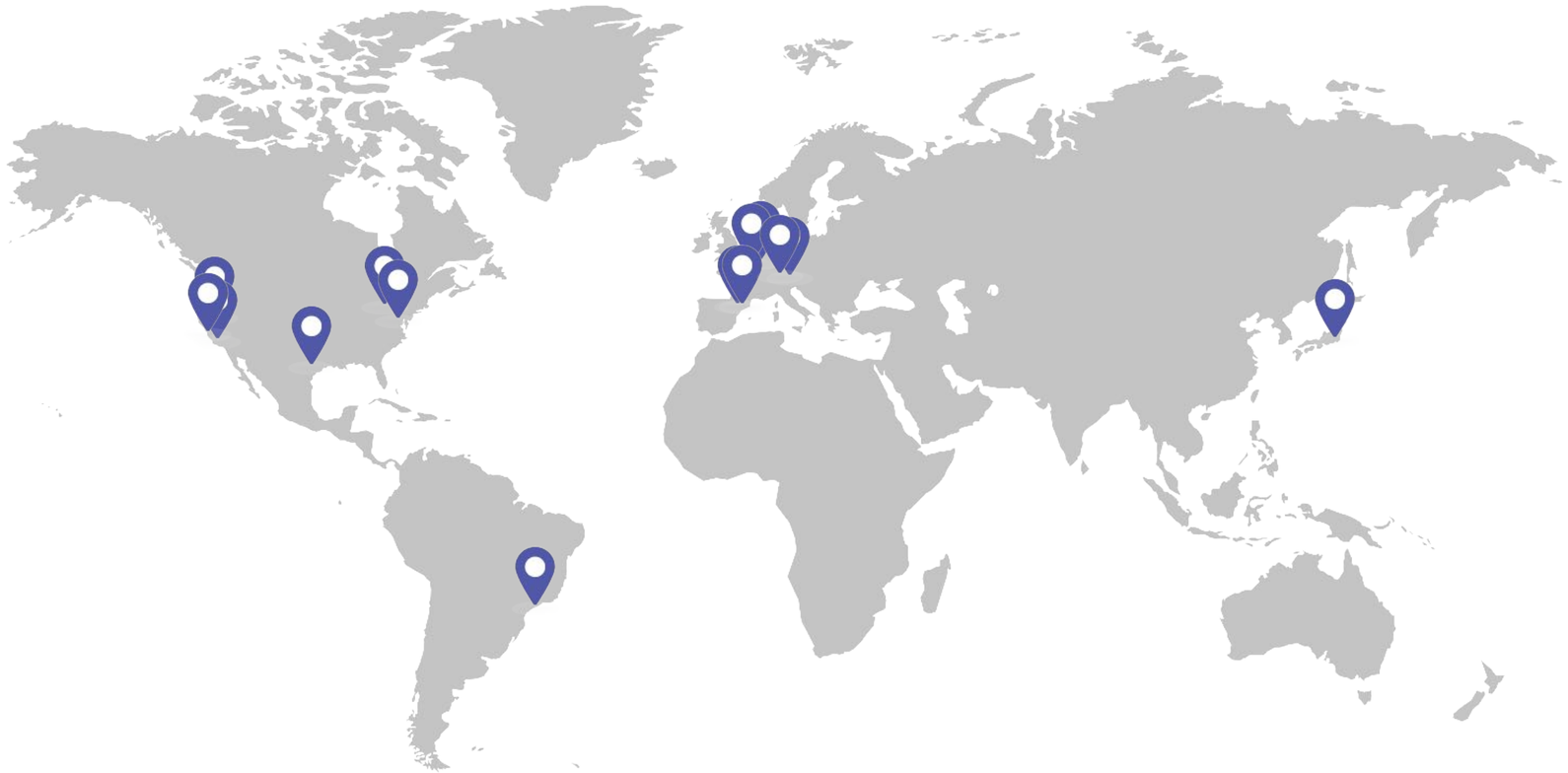
10 Years

10 Countries

40 Engineers

8 Researchers

Our clients



Demonstrated history of successful collaboration
with leading international organizations

THALES
ERICSSON
Vincotech
B/S/H/
UK SPACE AGENCY
Wabtec CORPORATION
NATIONAL INSTRUMENTS
EMBRAER
BOMBARDIER
Mercedes-Benz
RIMAC AUTOMOBILI
PORSCHE
Leica LEICA
MAGNA
AUTOMOTIVE LIGHTING
MARELLI
LieberLieber
logi.cals
Airmatic
eclipse
OMG OBJECT MANAGEMENT GROUP
AUTOSAR

Our footprints

Industries:

- Aerospace & Defense
- Automotive (ADAS)
- Industrial Automation
- Biomedical

Cameo - Modeling, Simulation & Analysis Excellence 2018

MAJOR RECENT REFERENCES

DASSAULT SYSTÈMES A trusted Development Partnership with No Magic / Dassault proving excellence in customer and product development.

NASA JPL The IncQuery Suite serves as a central component in the Computer Aided Engineering toolchain, integrating with Open MBEE and various other engineering tools.

AIRBUS Integrated tools and complex engineering platforms through a high-impact R&D project, involving MATLAB Simulink and Cameo.

FORD Developed various MBSE solutions: model composition, report automation, verification and validation.

SIEMENS Helped Mentor Graphics to develop its Capital VSTAR product family.

THYSSENKRUPP Participated in internal product development around AUTOSAR toolchains.

DASSAULT SYSTEMES · NASA · JPL Jet Propulsion Laboratory California Institute of Technology · AIRBUS · Ford · SIEMENS · thyssenkrupp

Taming Monsters with Dragons:

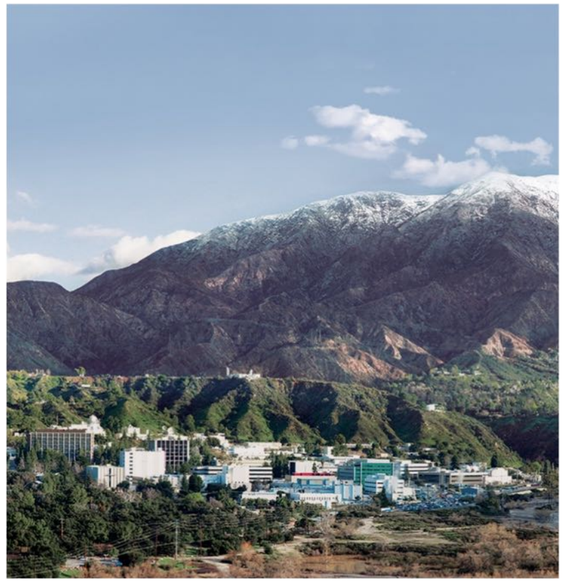
A systematic fractal oriented approach to digital twin pipelines

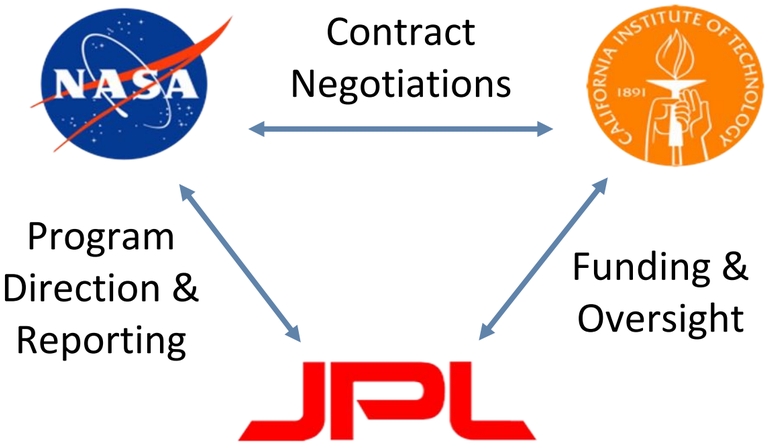
Robert Karban
Jet Propulsion Laboratory, California Institute of Technology

MESConf, June 2022, Munich, Germany

JPL is Part of NASA and Caltech

Federally-funded (NASA-owned) Research and Development Center (FFRDC)
University Operated (Caltech)
$2.7B Business Base
6,000 Employees





167 Acres (includes 12 acres leased for parking)
139 Buildings; 36 Trailers
673,000 Net Square Feet of Office Space
906,000 Net Square Feet of
Non-Office Space (e.g., Labs)

Some Notable Firsts

Surveyor 1, First soft landing on the moon

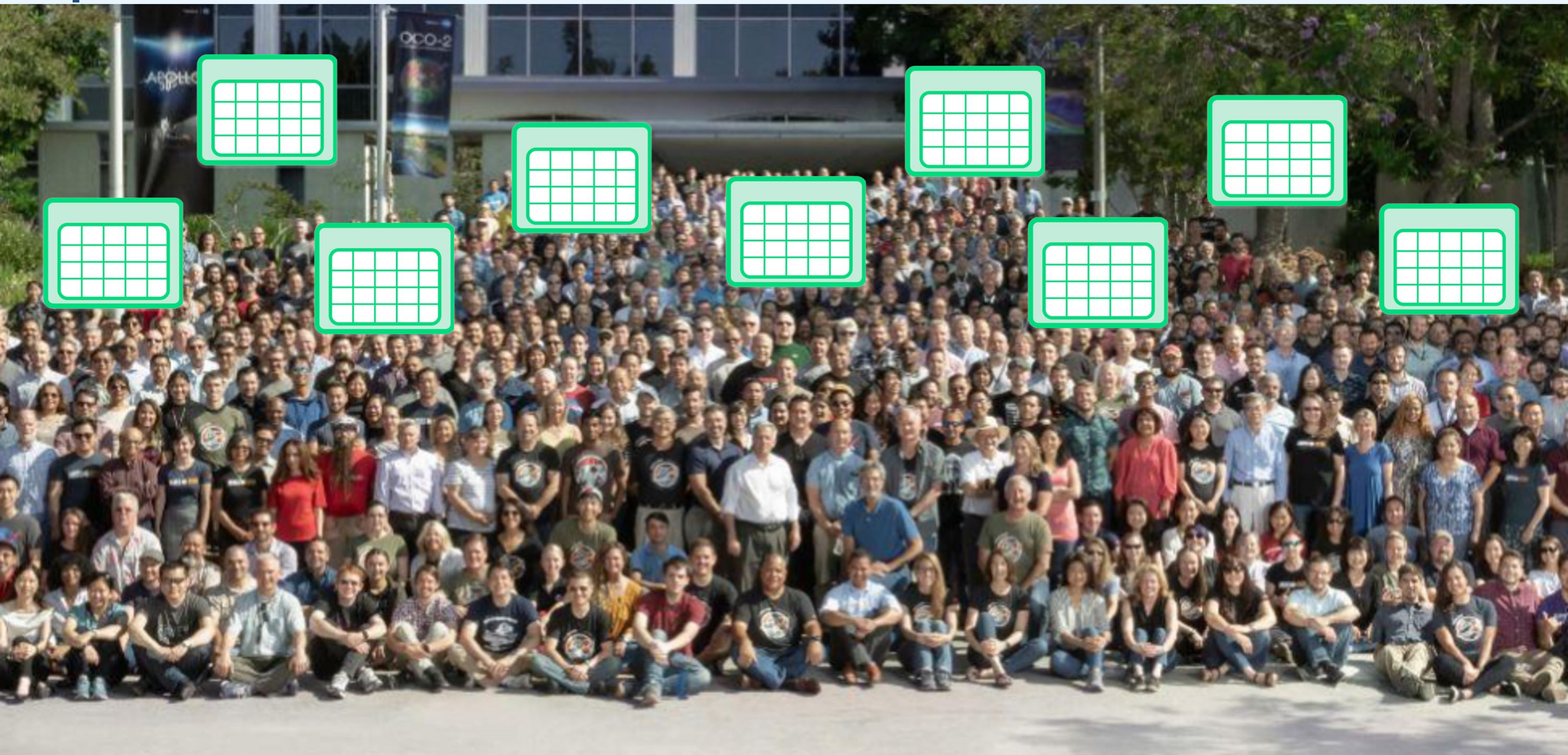
Viking, first landing on another planet

Continuous presence on Mars since 1997

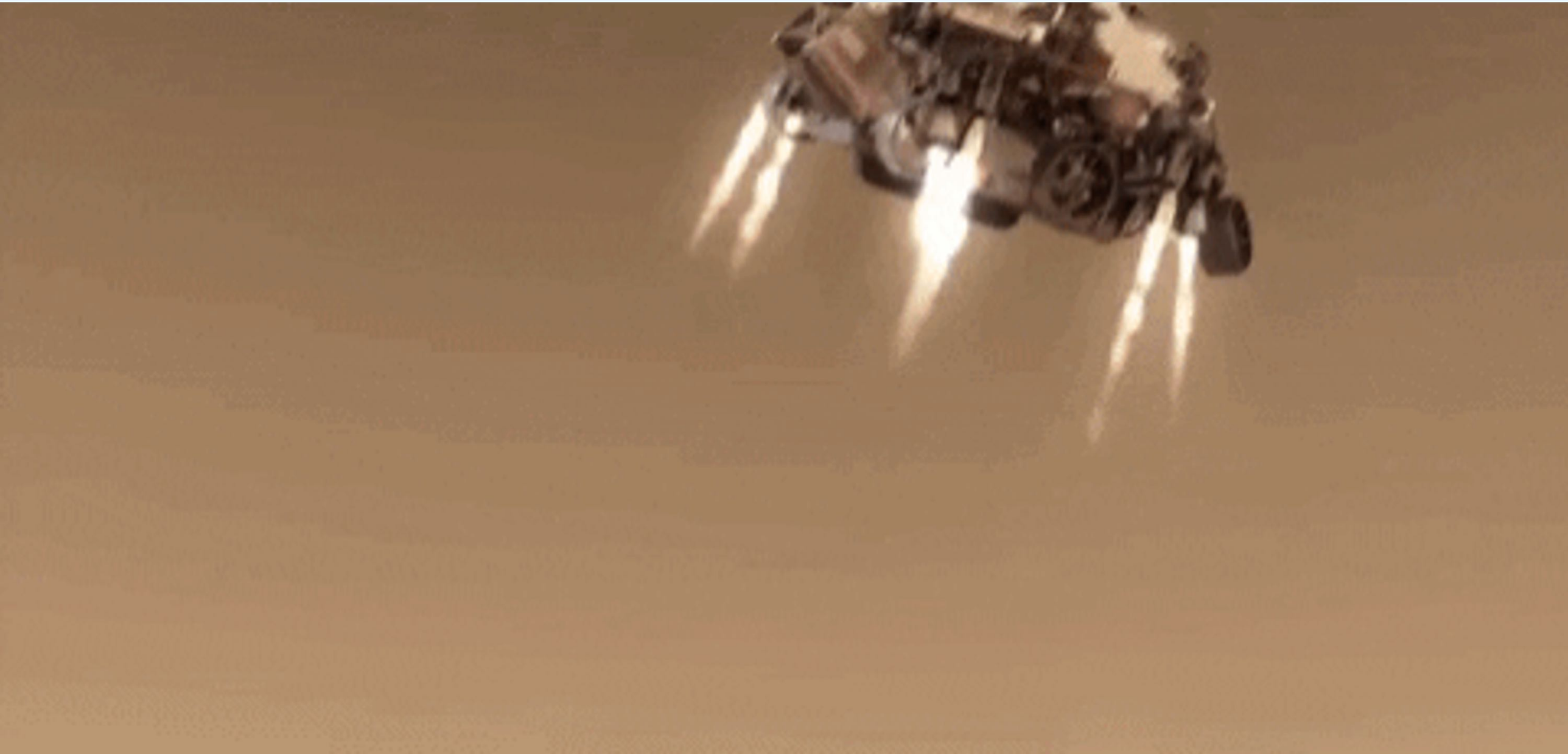
Voyager 1, First interstellar traveler

Project teams are large. Lots of people work on one project...

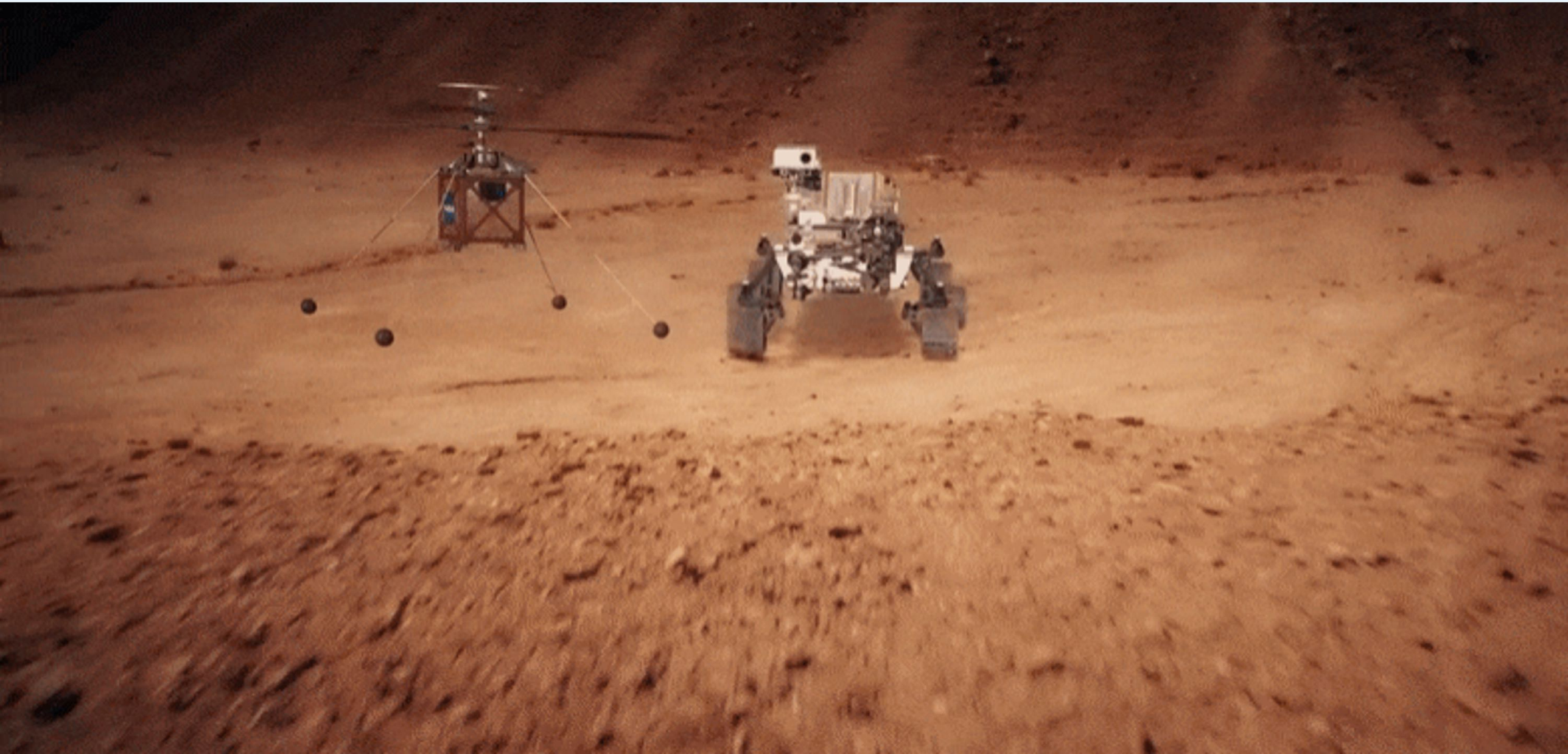
...and they communicate their project needs often through spreadsheets.



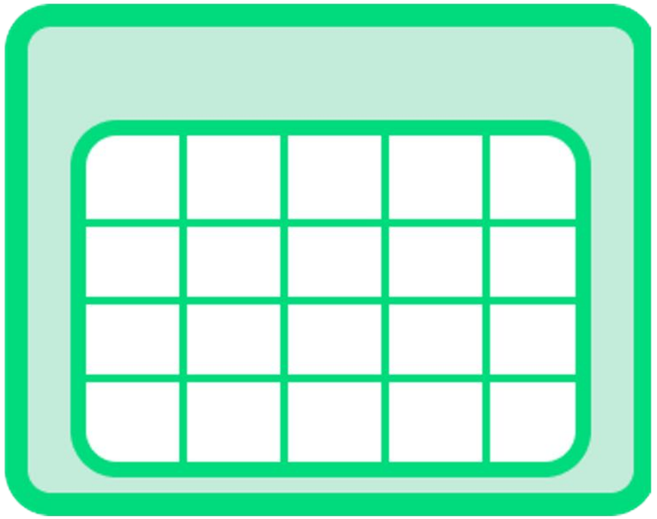
To eventually do this...



And this. But it takes a lot to get here.

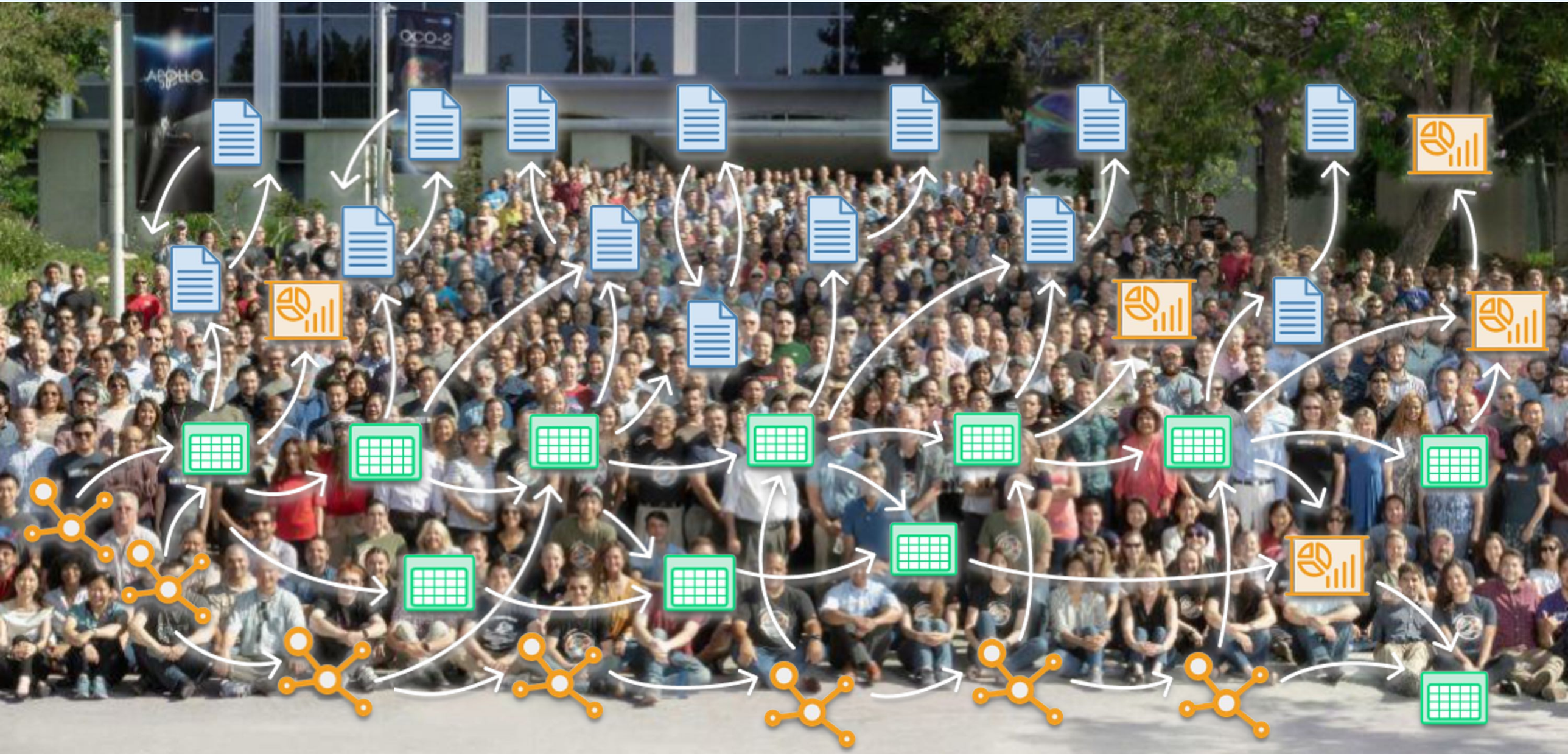


So how do we get from this...

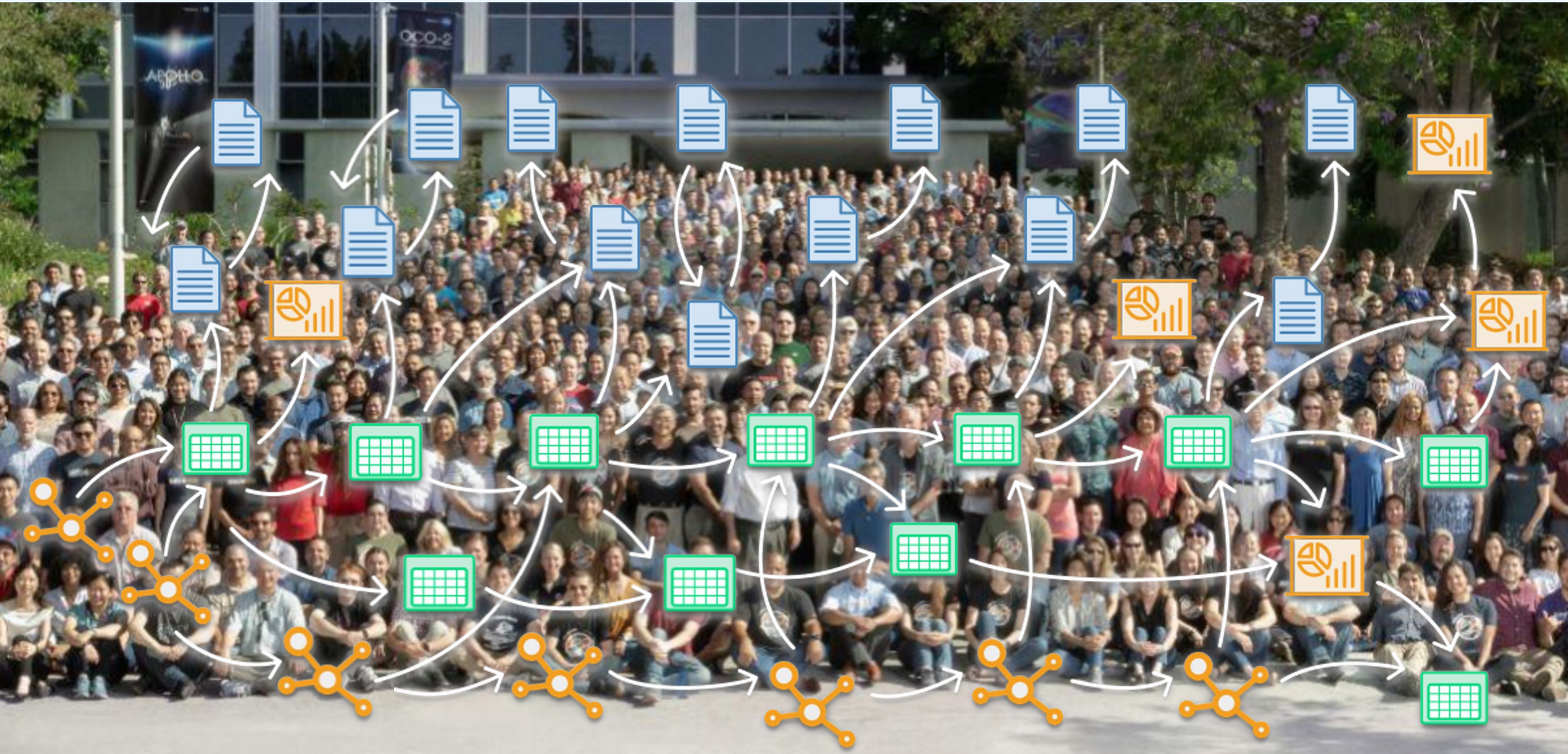


to this?

It takes people, and requirements, and spreadsheets, and documents, and processes, and workflows, and tests...



Unfortunately, all of these things create silos of information that lead to miscommunication and duplicate work.



A project starts simple.

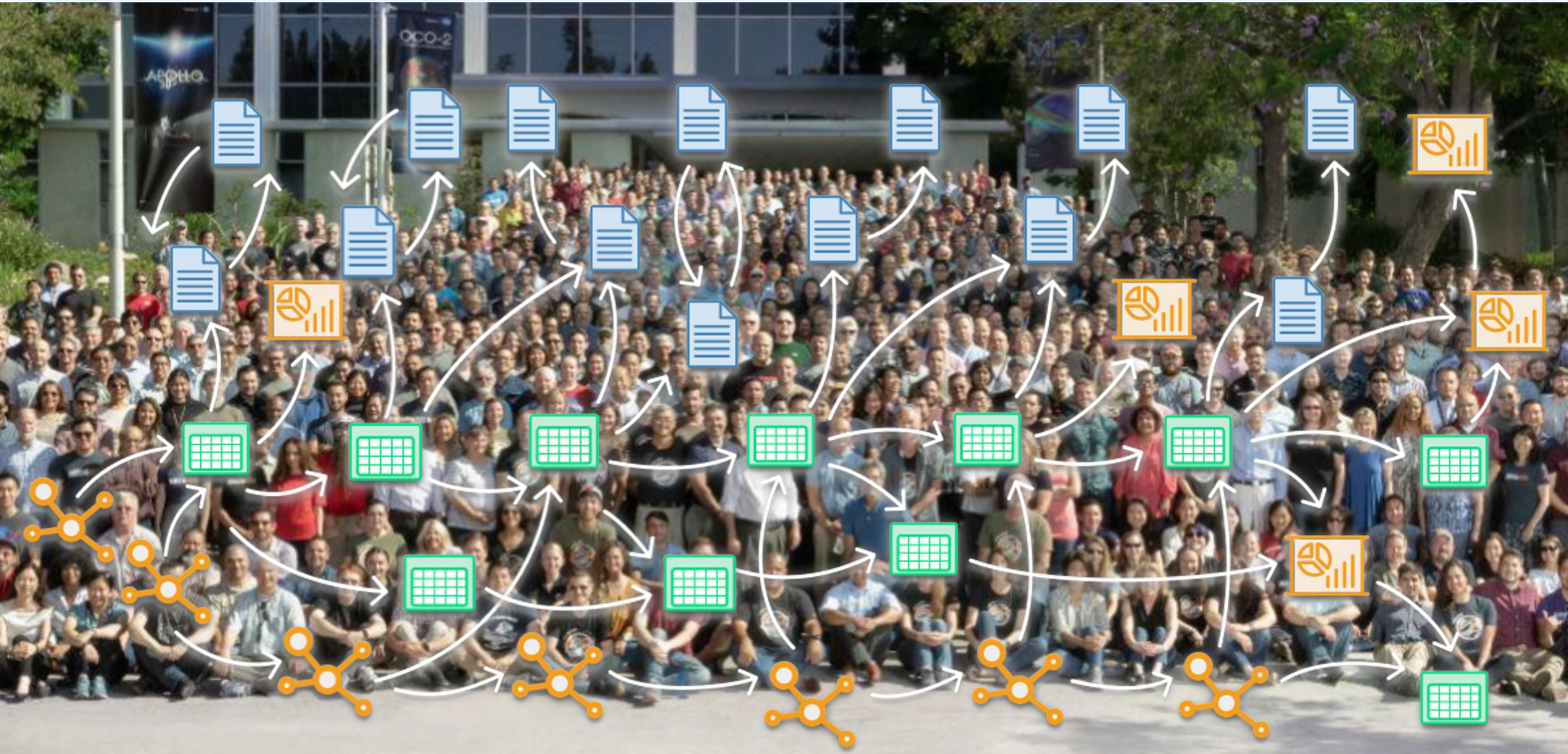
Engineers iterate on their models.

They add it to a spreadsheet to track it over time.

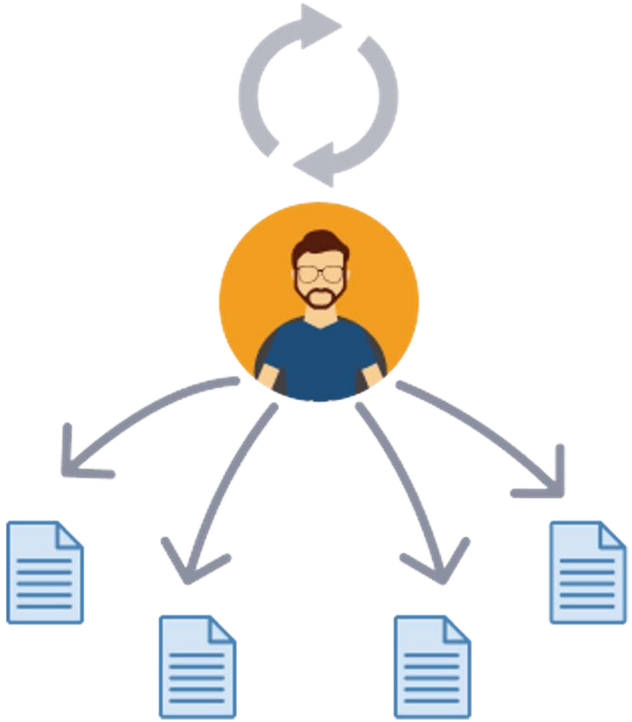
They add it to a document.

And get input from others.

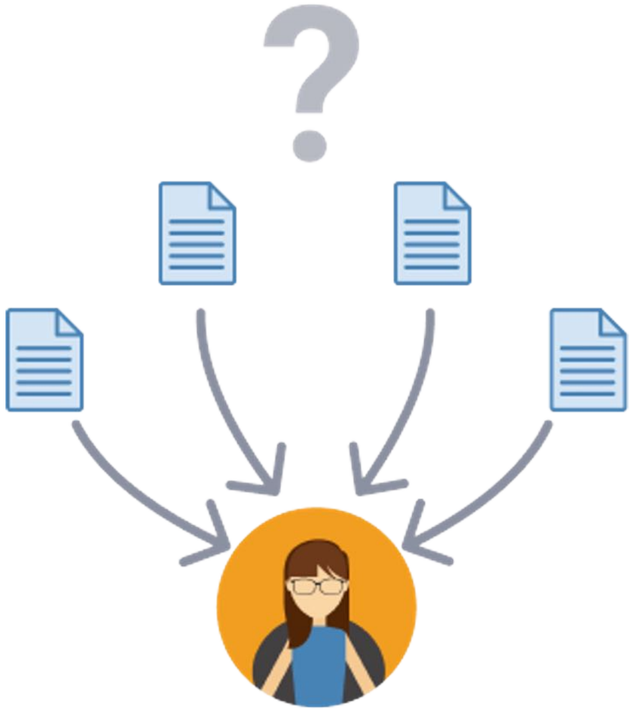
And it gets complicated pretty quickly...



Bad Ratio of Real engineering vs. overhead



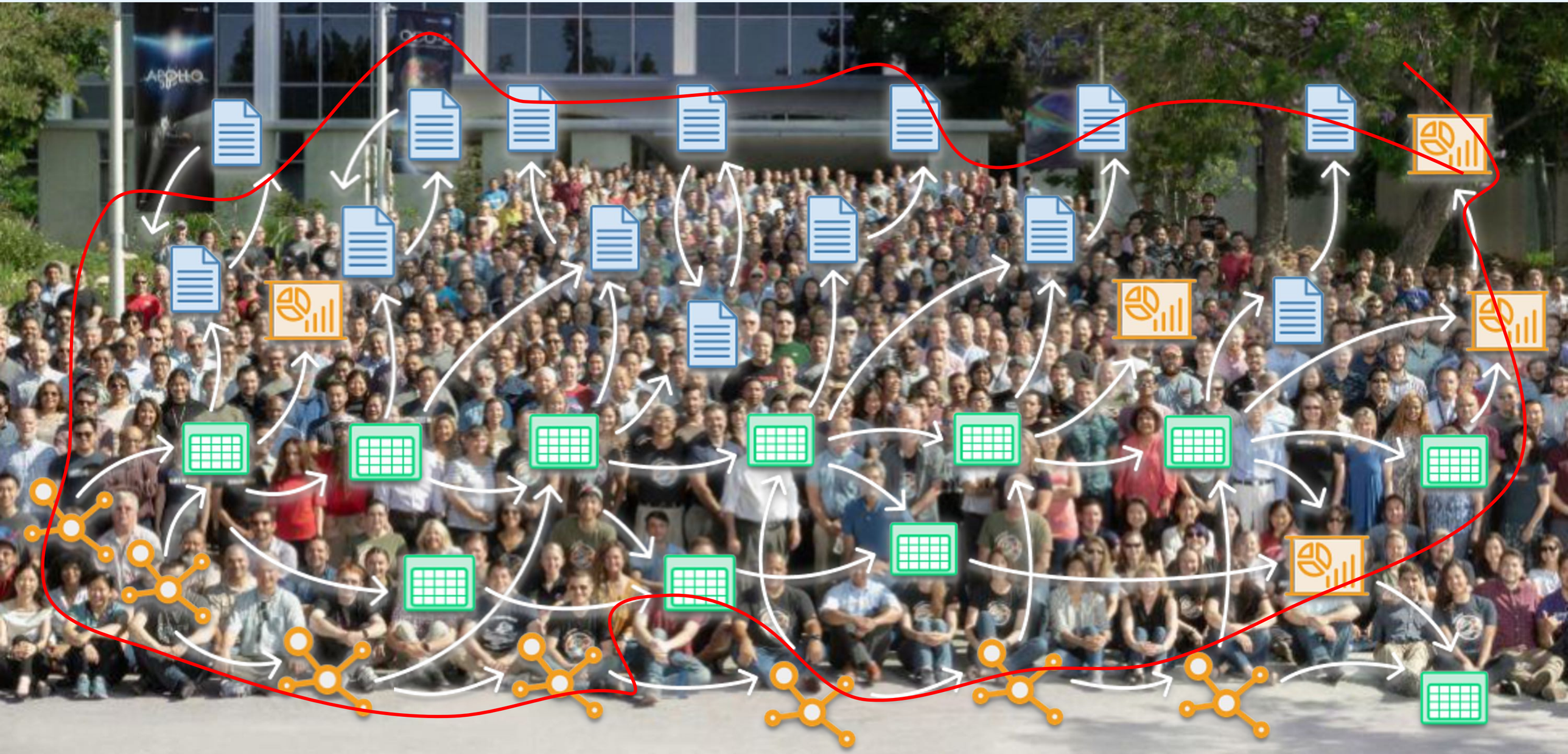
Repetitive Data Entry



Version Confusion

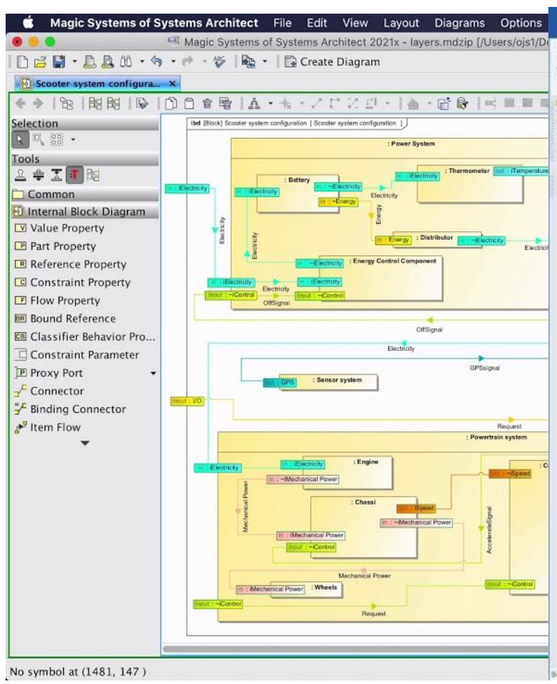
Constant Searching

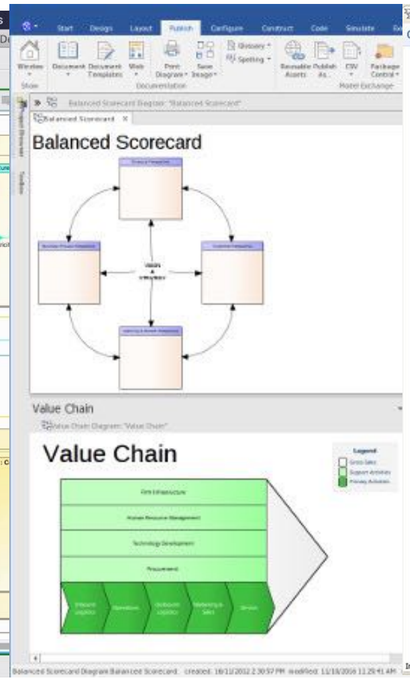
How do we connect all of these things together?

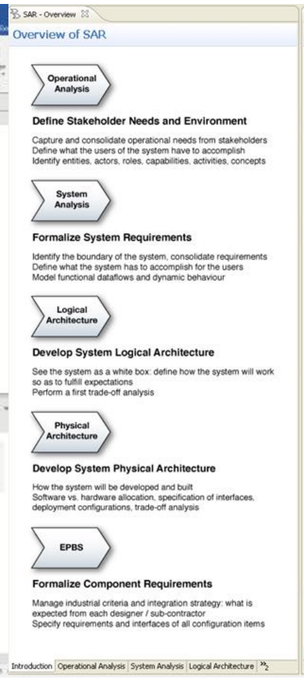


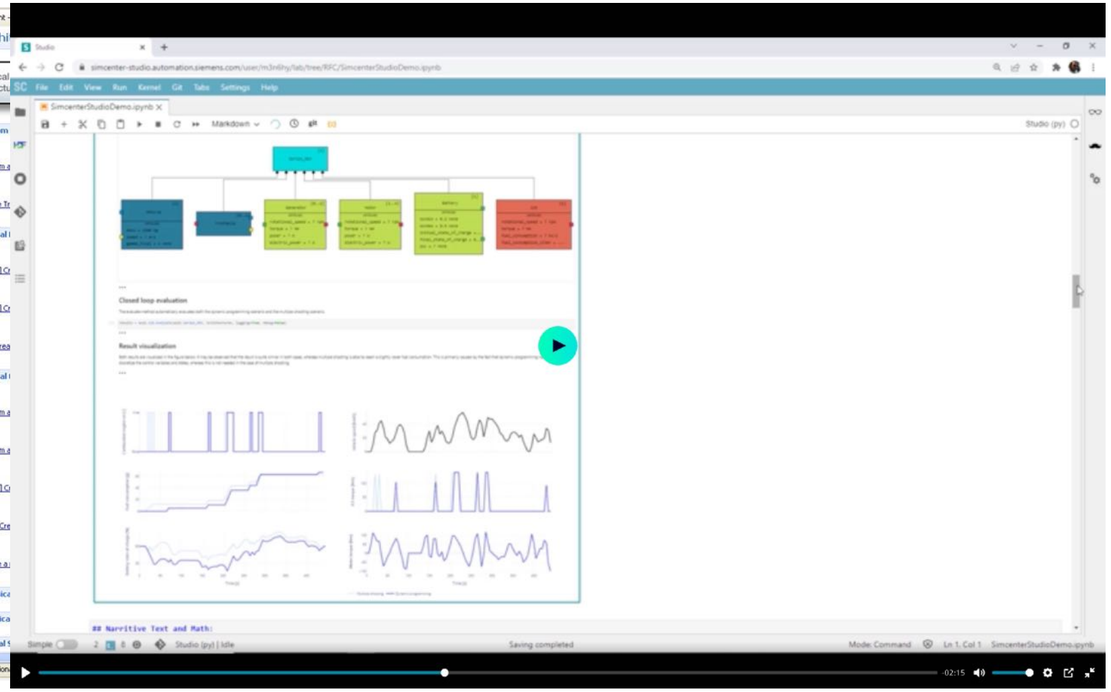
Model Based Systems Engineering (MBSE)

- MBSE is the formalized application of modeling techniques to support system requirements, design, analysis, verification, validation and documentation activities
- MBSE expresses a system using a Systems Modeling Language (e.g. SysML, Modelica)
- MBSE is often applied with a method like Object Oriented System Engineering Method (OOSEM)









Iterative

Workflow across product lifecycle

Collaboration & Capture

Set up Architecture topology

Deconfliction

Discovery

Design & Constraint Capture

Architecture & Design

(Generative) Architecture exploration

System level & multi-physics Co-simulation

Behavioral Specifications

Variants & Configurations

(Quantitative) Analysis

Multi-attribute comparison & constraint evaluation

Visualizations (e.g. telemetry)

Behavioral Analysis

Functional & physical trade

Publication

Products

Documents

Issue Management

Continuous Integration

Process Orchestration

Process (Traceable, Auditable, Repeatable)

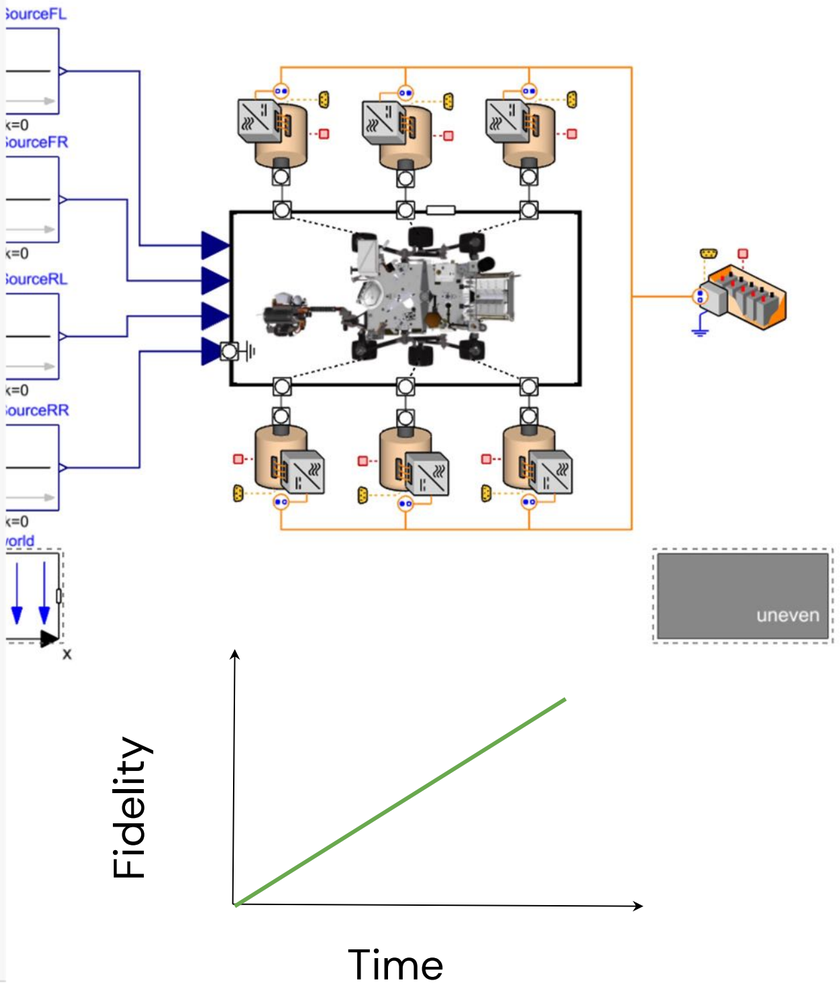
OpenCAE

Iterative

Collaboration & Capture

```
system simple_rover:
    owns:
        Chassis
        Wheel
        PowerSupply
        Terrain

component Chassis:
    ports::group wheels:
        out::wheel_structure w1
        out::wheel_structure w2
        out::wheel_structure w3
        out::wheel_structure w4
        (out)::wheel_structure w5
        (out)::wheel_structure w6
    ports:
        out::power_structure p1
component Wheel:
    properties:
        multiplicity = 4..6
    ports:
        in::wheel_structure w1
        out::terrain t1
component PowerSupply:
    ports:
        in::power_structure p1
component Terrain:
    ports::group terrains:
        in::terrain t1
        in::terrain t2
        in::terrain t3
        in::terrain t4
        (in)::terrain t5
        (in)::terrain t6
```



Pages / ... / CAE Systems Environment Wiki and Discussion

Engineering Document

Created by Robert Karban just a moment ago

This document captures the design and analysis of a rover.

MEL

Component	Mass
Chassis	500 kg
Wheel	10 kg
PowerSupply	50 kg

Architectures

Analysis of attributes

Collaboration & Capture

Set up Architecture topology

Deconfliction

Discovery

Design & Constraint Capture

System model

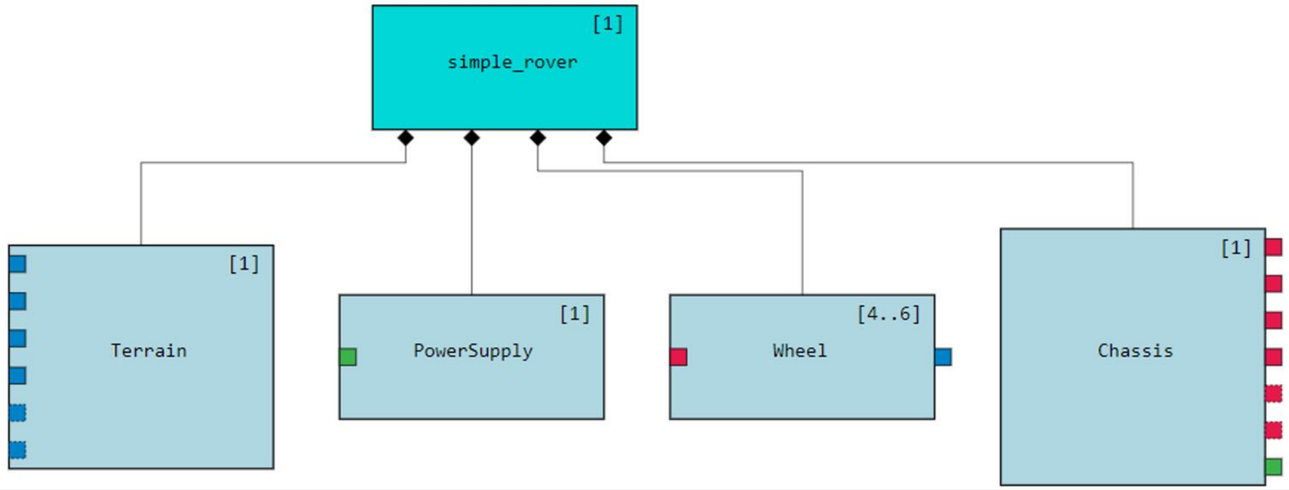
Multi-physics model

Wiki

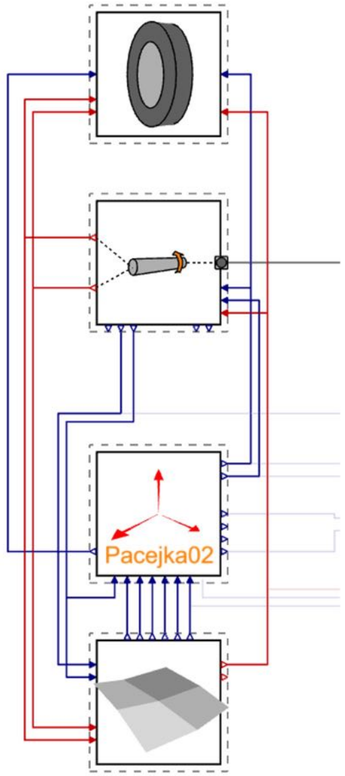
OpenCAE

Iterative

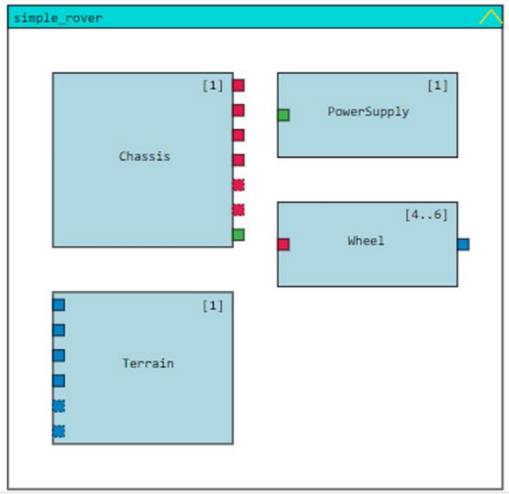
Architecture and Design



Project functional into physical architectures




```
component PowerSupply:
    ports:
        in::power_structure p1
component Terrain:
    ports::group terrains:
        in::terrain t1
        in::terrain t2
        in::terrain t3
        in::terrain t4
        (in)::terrain t5
        (in)::terrain t6
```




```
==============================
Run: simple_rover -
 - - - - - - - - - - - - - - -
Creating ensembles...
... done in 0.136seconds.
 - 3 total ensembles
... Instantiating ensembles...
 ... 100.00% instantiated in 0.024 seconds
 - 3 ensembles
... done in 0.170 seconds, maximum tree width = 0, maximum multiplicity = 6.
 - - - - - - - - - - - - - - -
Creating architectures...
 - 3 unique architectures in 3.560 seconds
... done in 3.561 seconds.
```

Architecture & Design

(Generative) Architecture exploration

System level & multi-physics Co-simulation Behavioral Specifications

Variants & Configurations

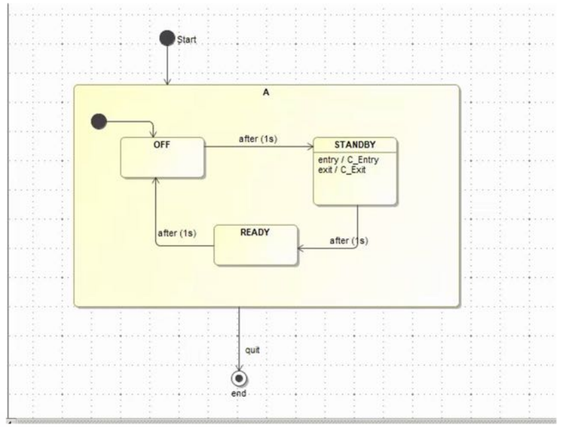
- Articulation of Design Space
- Determine required connectivity constraints

OpenCAE

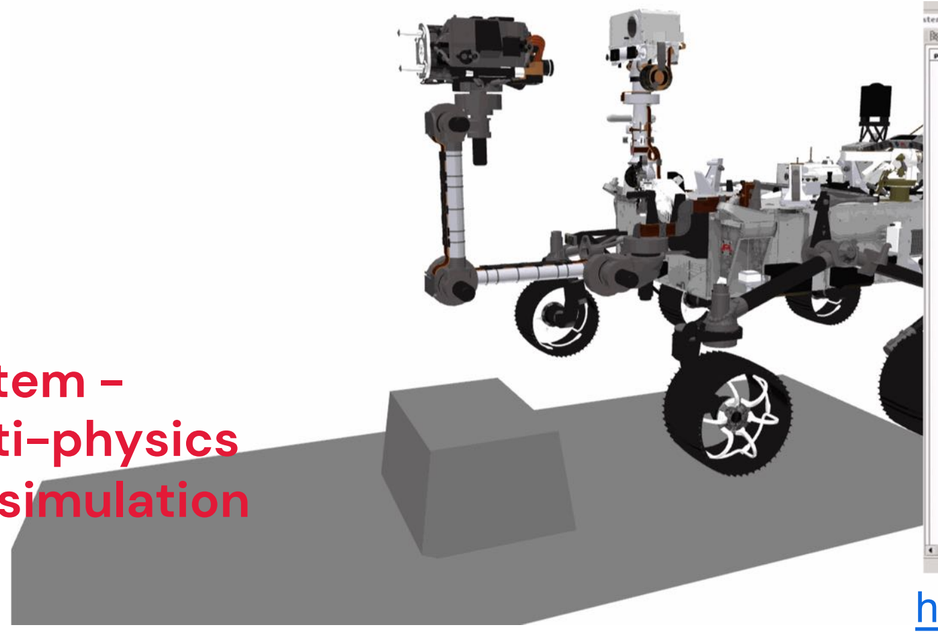
Quantitative Analysis

- Baseline Analysis
- Adding new Components
- Swapping Components

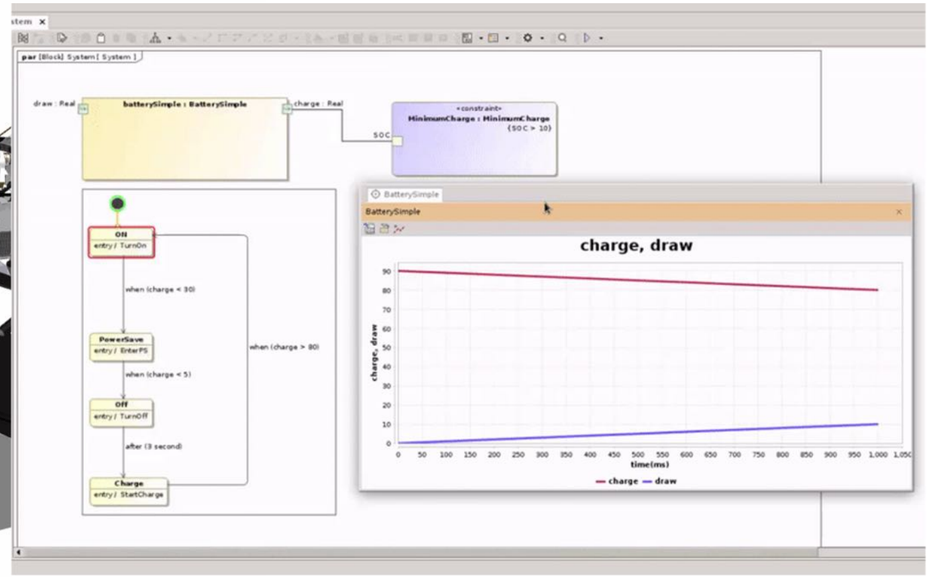
Guided Architecture Selection in an integrated engineering environment



FSW simulation



System - Multi-physics Co-simulation



Constraint evaluation

https://github.com/Open-MBEE/perseverance-modelica

Quantitative Analysis

Multi-attribute comparison & constraint evaluation

Visualizations (e.g. telemetry)

Behavioral Analysis

Functional & physical trade

OpenCAE

Publication

People Calendars Create ··· Search

Pages /... / CAE Systems Environment Wiki and Discussion Edit Save for later Watching Share ···

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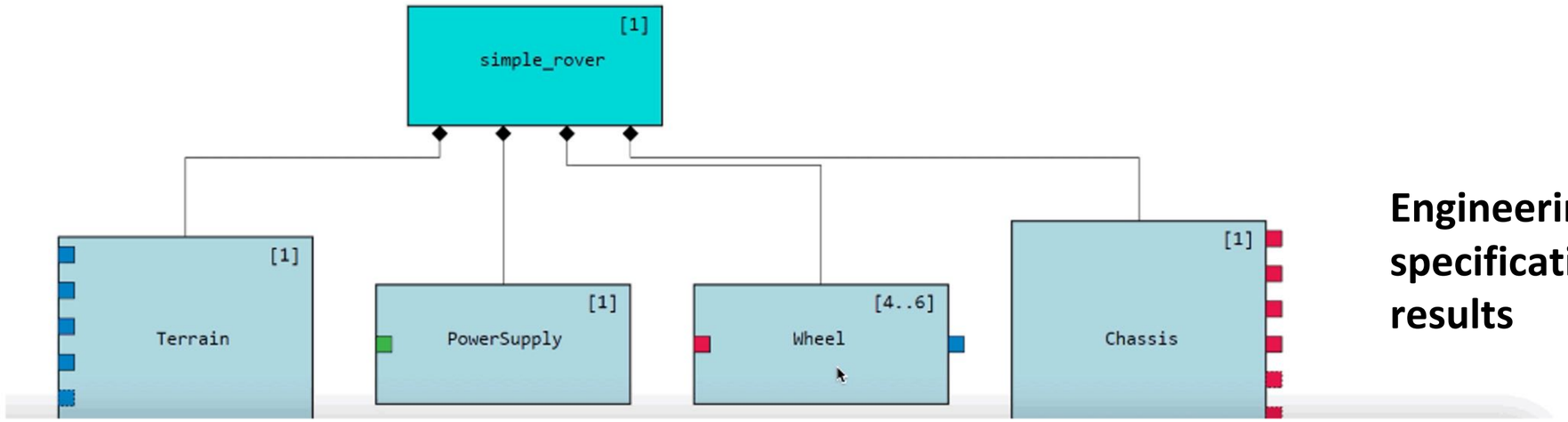
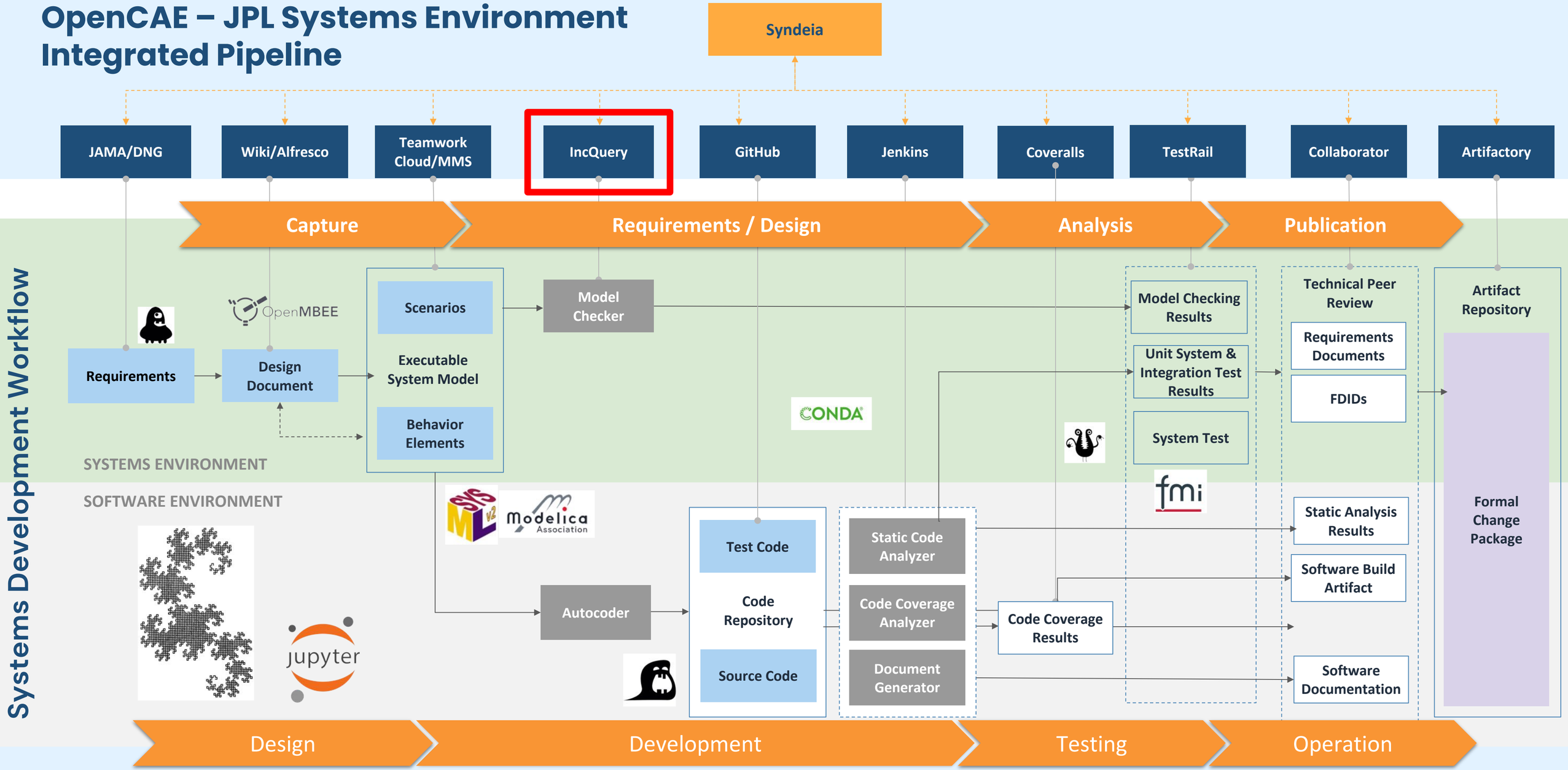


Engineering documents aggregate design specification, definition, and analysis results

OpenCAE

OpenCAE – JPL Systems Environment Integrated Pipeline



DevOps - Continuous Integration - Simulation

Process: Issue Management • Continuous Integration • Process Orchestration

JIRA | Jenkins | XLRelease

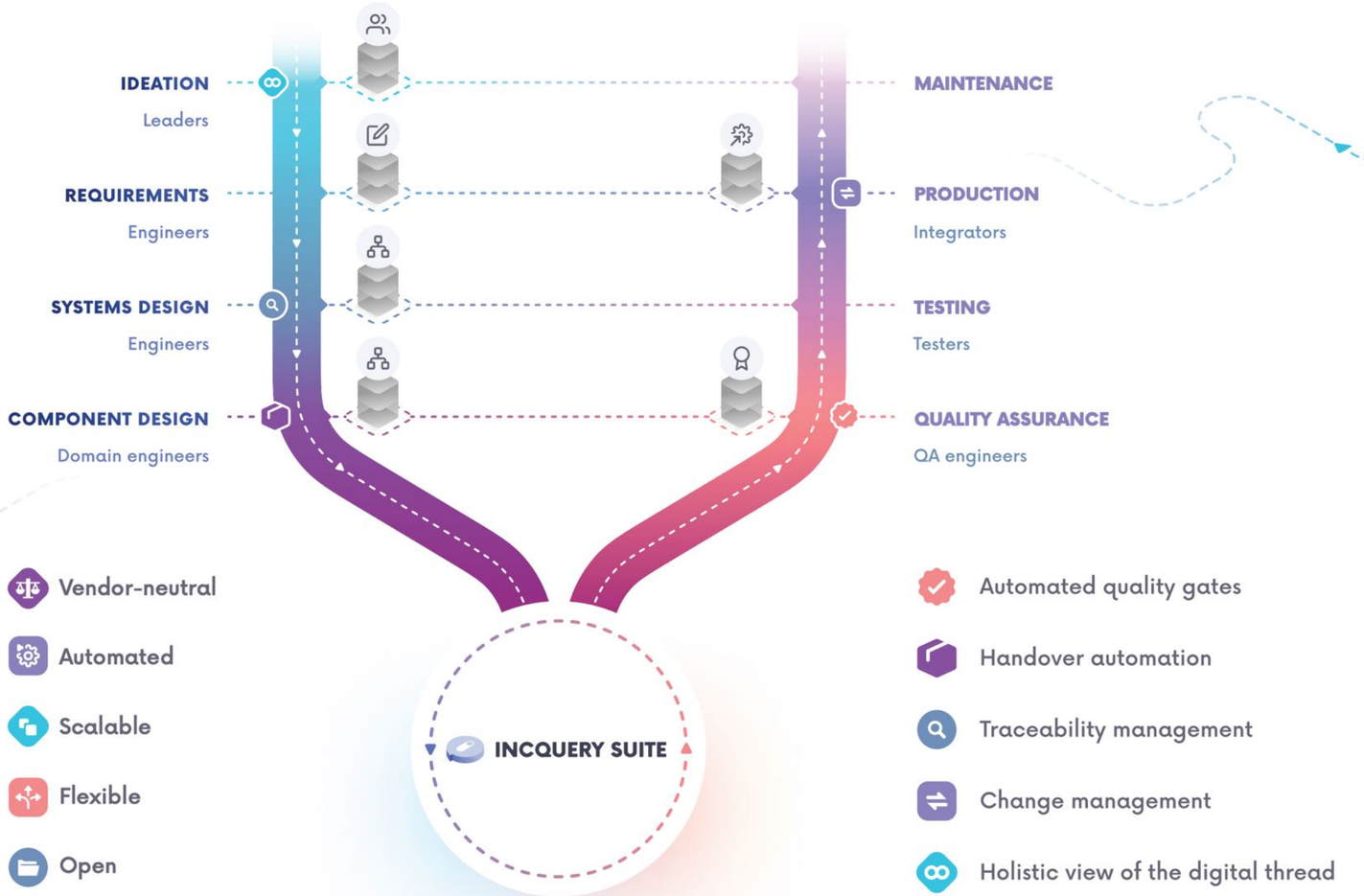
The IncQuery Vision

By 2035, we will live in a world where digital engineering permeates every aspect of life.

IncQuery Labs aims to be an **enabler** and a **catalyst** to realize this vision.

We provide a **new platform** for **digital engineering automation.**

- Automated, scalable, flexible, and open,
- New generation quality assurance with **digital thread analytics**



INCQUERY CLOUD

An enterprise-class, scalable application that extracts data from silos and maintains the **knowledge graph as representation of all digital threads.**

Use cases

- Digital Engineering analyst can build advanced digital threads to carry out in-depth analytics across engineering silos.
- Digital Engineering Manager can see dashboards that provide a holistic overview of the entire digital engineering process.

Main features

- Allows to access all engineering data in a uniform, searchable and analyzable way.
- **E**nterprise-grade **access control.**
- Extensible industry standard OpenAPI interface.
- **Provides** graph and full-text based query and search **capabilities.**
- **Integrates with** reporting, visualization and integration capabilities of **Jupyter framework.**

OpenMBEE · jupyter · magicdraw · Modelon · jama · Teamwork Cloud · Capella · AUTOSAR · MATLAB Simulink · Jira · Confluence · Excel · Enterprise Architect · git · Polarion

Ford · Honda · JPL Jet Propulsion Laboratory California Institute of Technology

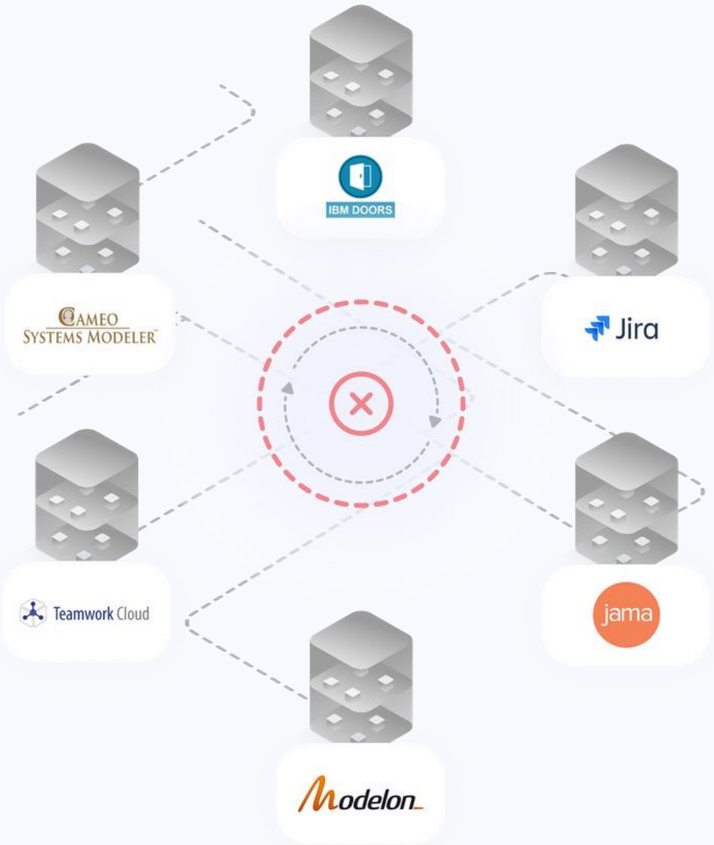
JPL
Jet Propulsion Laboratory

A well-known and pioneering engineering research organization, NASA JPL's main profile is designing and manufacturing robotic spacecraft to explore the Solar System. IncQuery Labs is proud to help them on their engineering journey to dare mighty things.

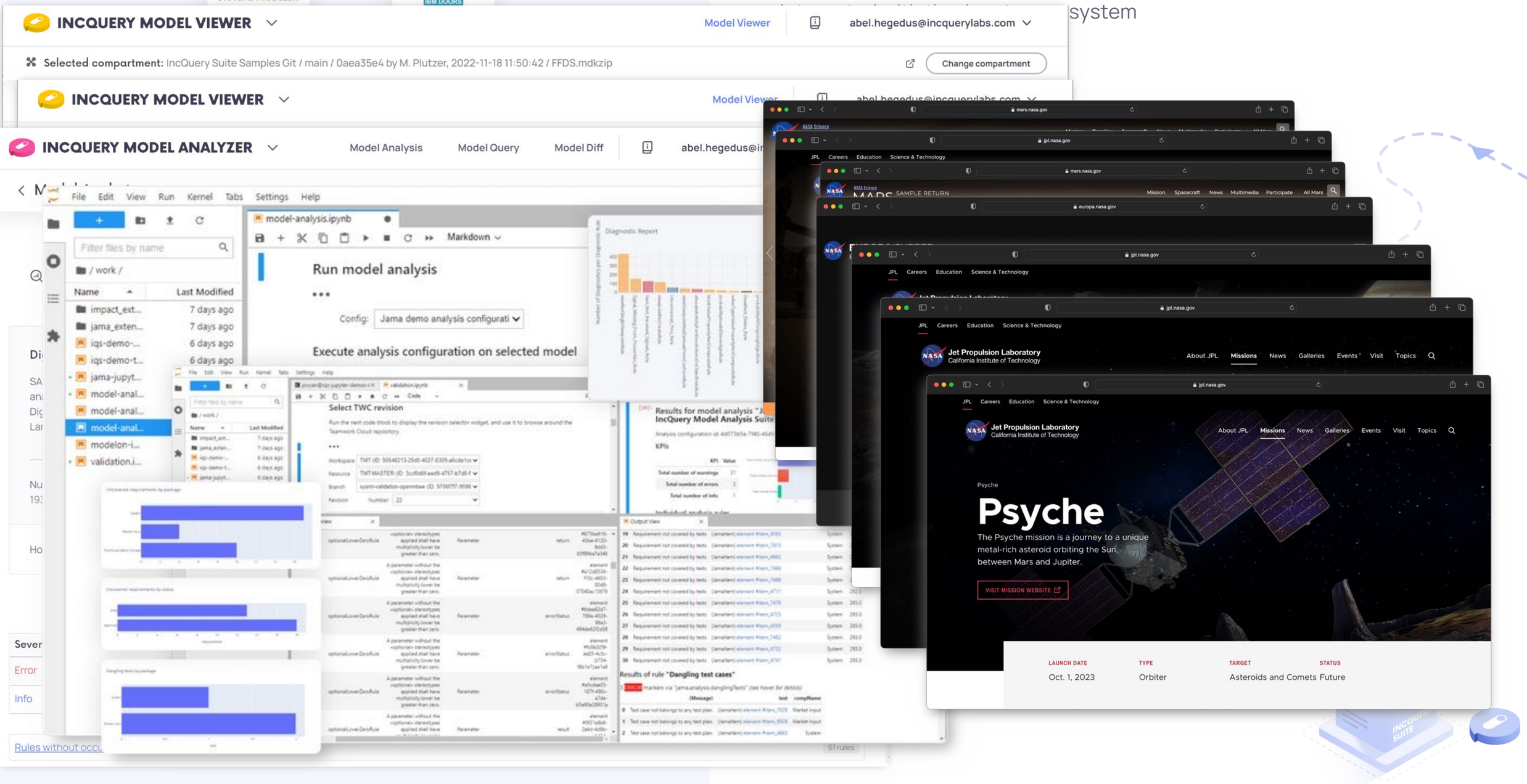
Computer Aided Engineering

The Computer Aided Engineering (CAE) division of NASA JPL is one of the leading groups of experts with the vision to connect systems engineers with other domain experts to develop missions and systems using an open portfolio of tools in a shared environment.

The CAE Systems Environment



- Automated validation of SysML models, graph-like visualization of engineering data
- Requirements analysis using OSLC and SPARQL
- system



Research collaboration: Pragmatic Verification of SysML

- Simulation, testing may not find every error
- ”Holy grail” of hidden formal methods
  - Systematically checks the model by traversing state space
  - Automated bidirectional translation between engineering domain (SysML) and formal domain (timed automata)

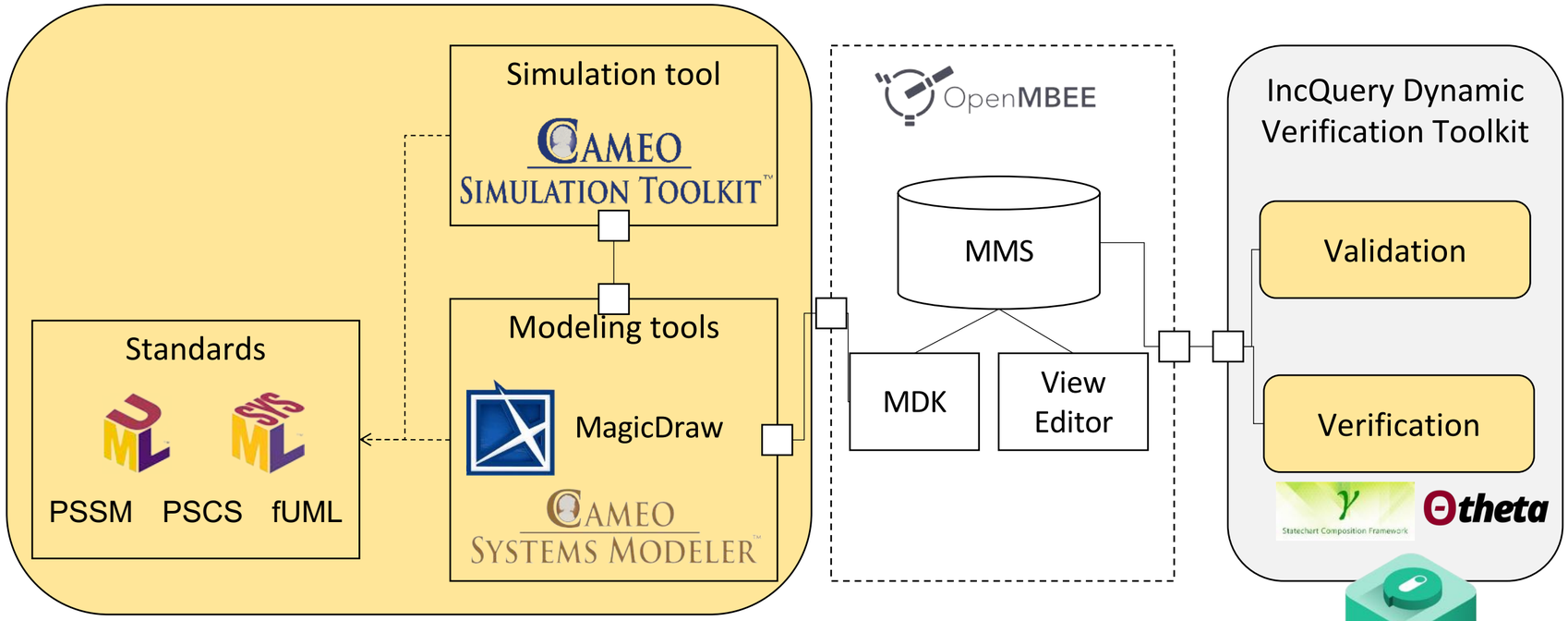
JOHANNES KEPLER UNIVERSITÄT LINZ

ftsrg

AIRBUS

ESO

Jet Propulsion Laboratory
California Institute of Technology



Model Checking as a Service: Towards Pragmatic Hidden Formal Methods

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ABSTRACT

1 INTRODUCTION

B. Horváth, B. Graics, Á. Hajdu, Z. Micskei, V. Molnár, I. Ráth, L. Andolfato, I. Gomes, R. Karban: Model checking as a service: towards pragmatic hidden formal methods. MoDELS 2020: 37:1-37:5.

https://doi.org/10.1145/3417990.3421407

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Thank YOU

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