INCQUERY

Modellezéssel Budapestről a Marsig,

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

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.

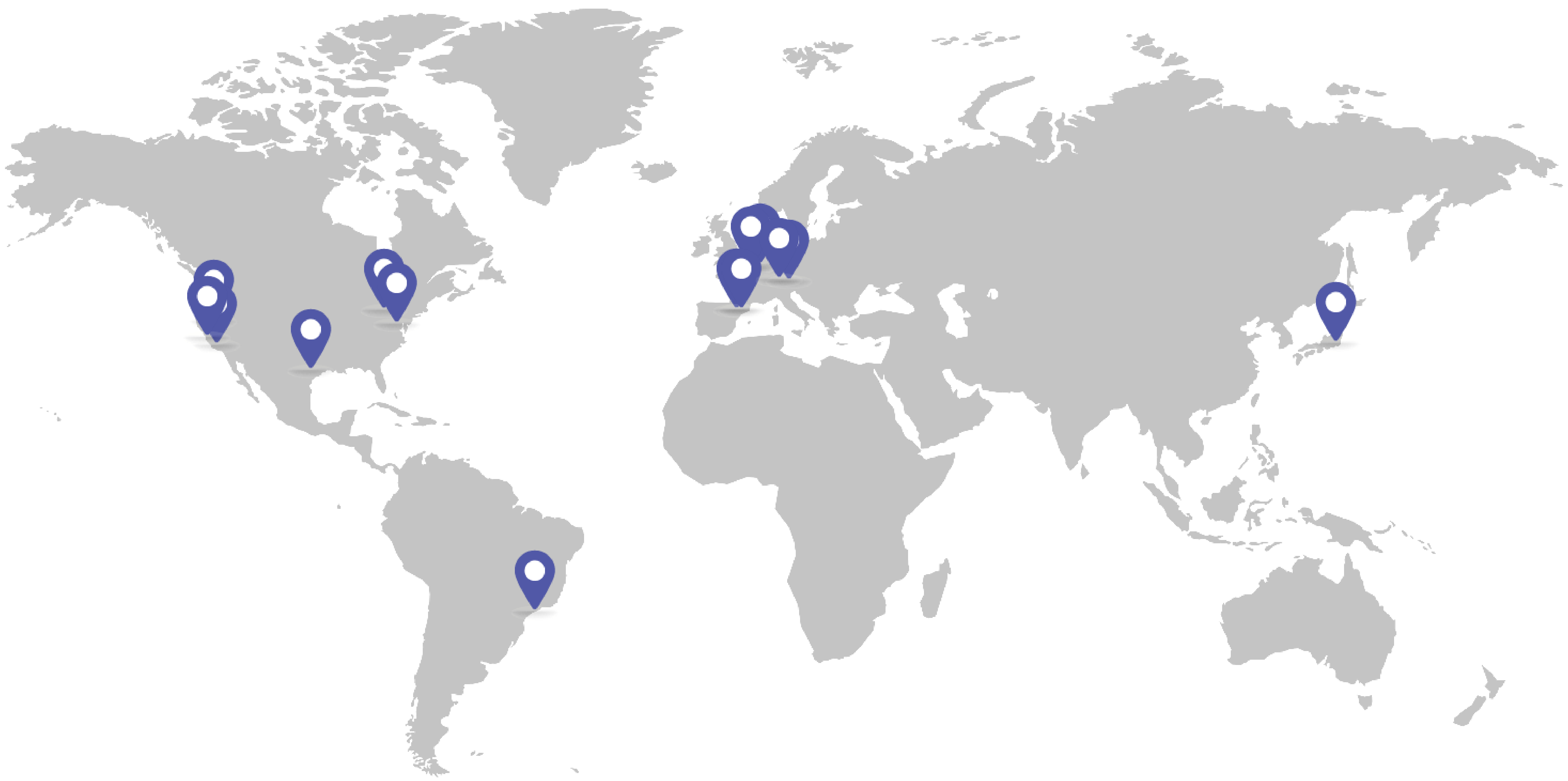
Future

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

In numbers

162+	10	10	40	8
Projects	Years	Countries	Engineers	Researchers

Our clients



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

Demonstrated history of successful collaboration with leading international organizations

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.

Jet Propulsion Laboratory
California Institute of Technology

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

Contract Negotiations

Program Direction & Reporting

Funding & Oversight

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

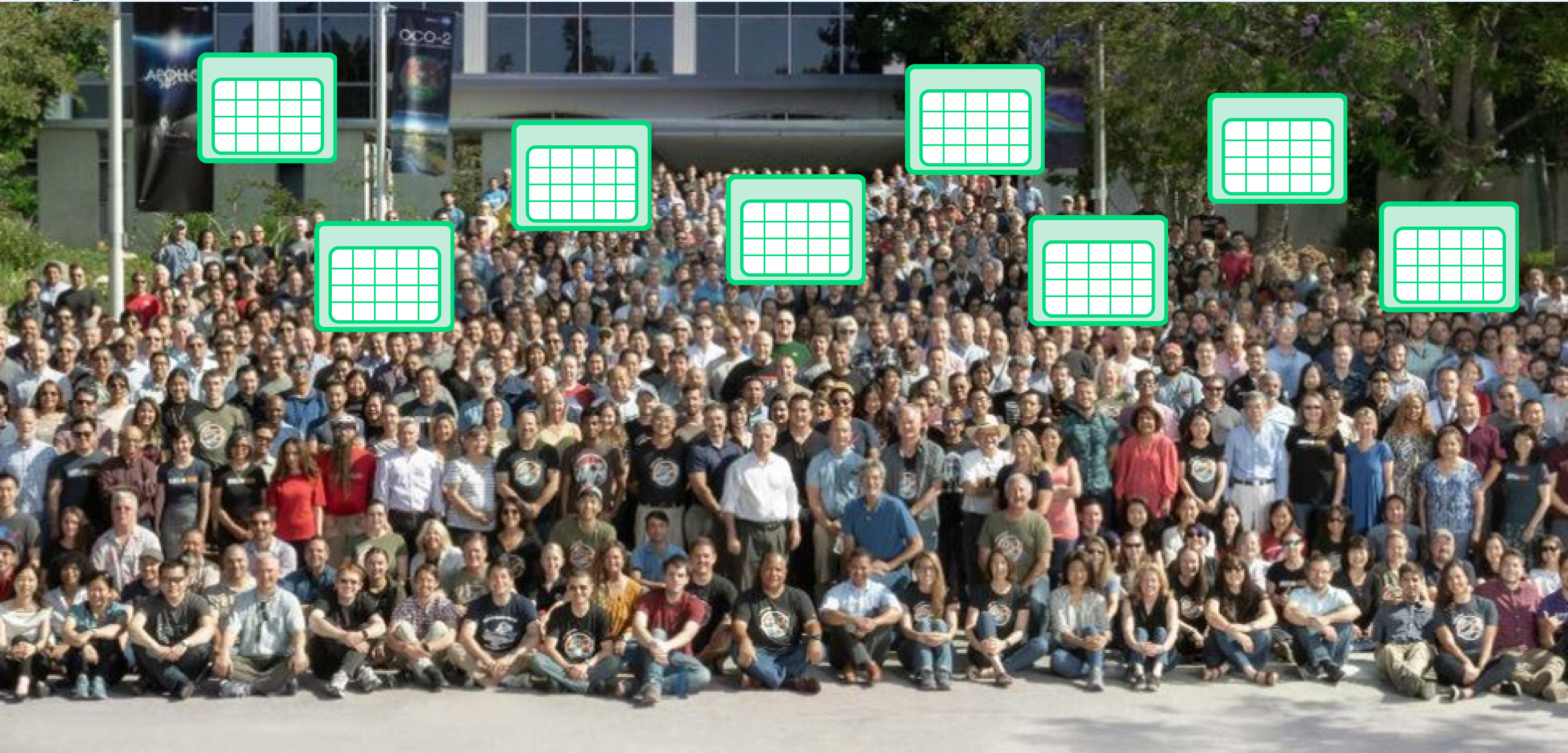
Viking, first landing on another planet

Continuous presence on Mars since 1997

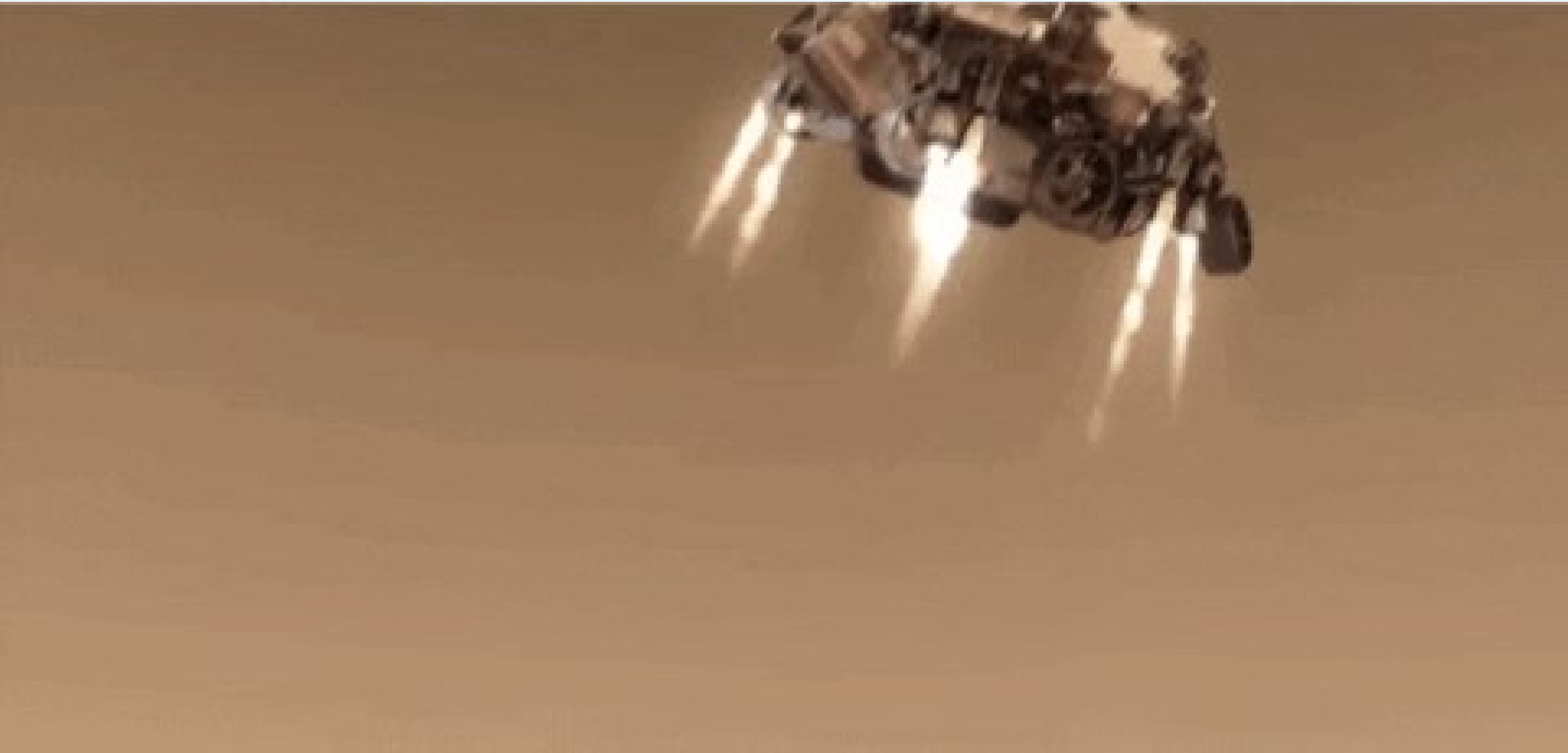
Voyager 1, First interstellar traveler

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

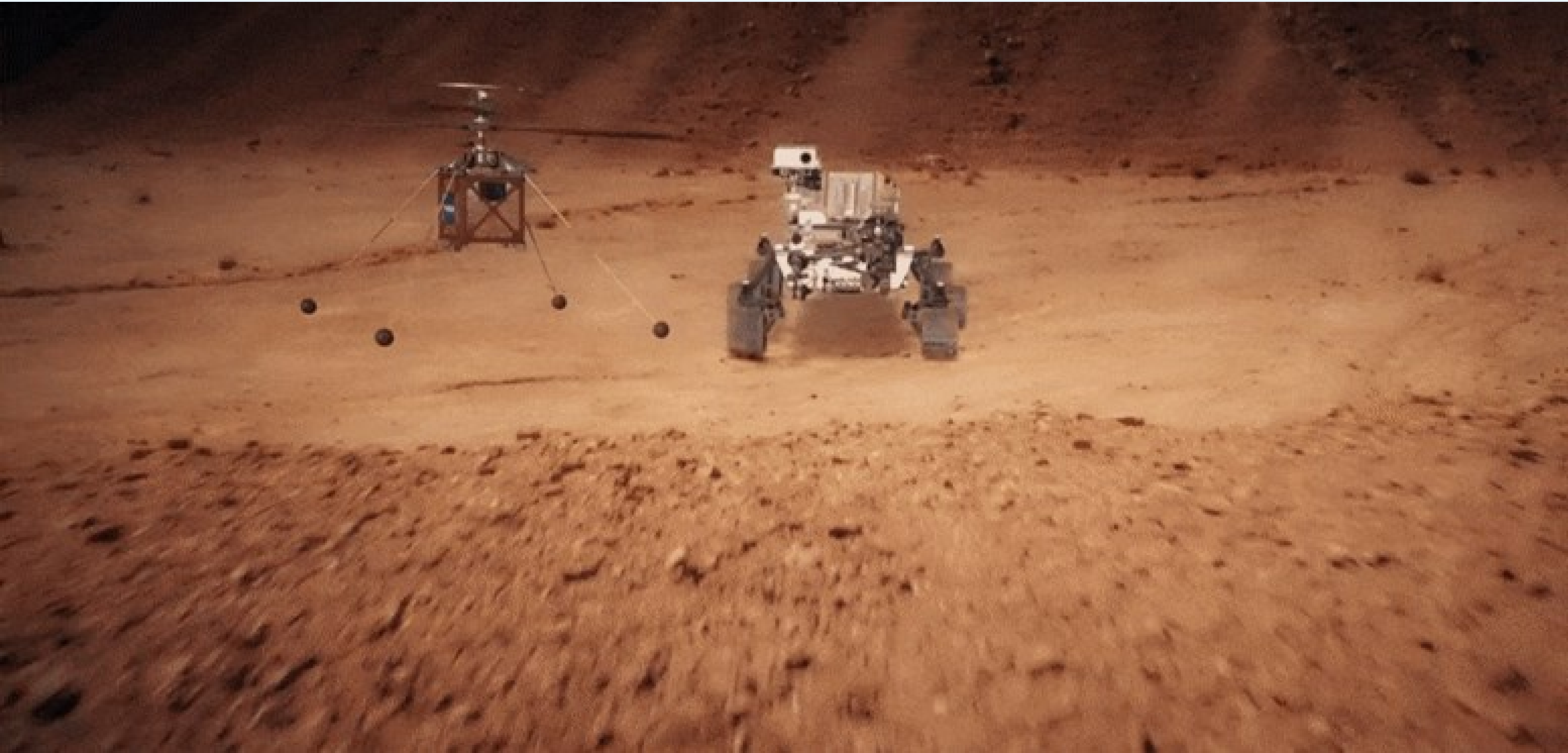
...and they communicate their project needs often through spreadsheets.



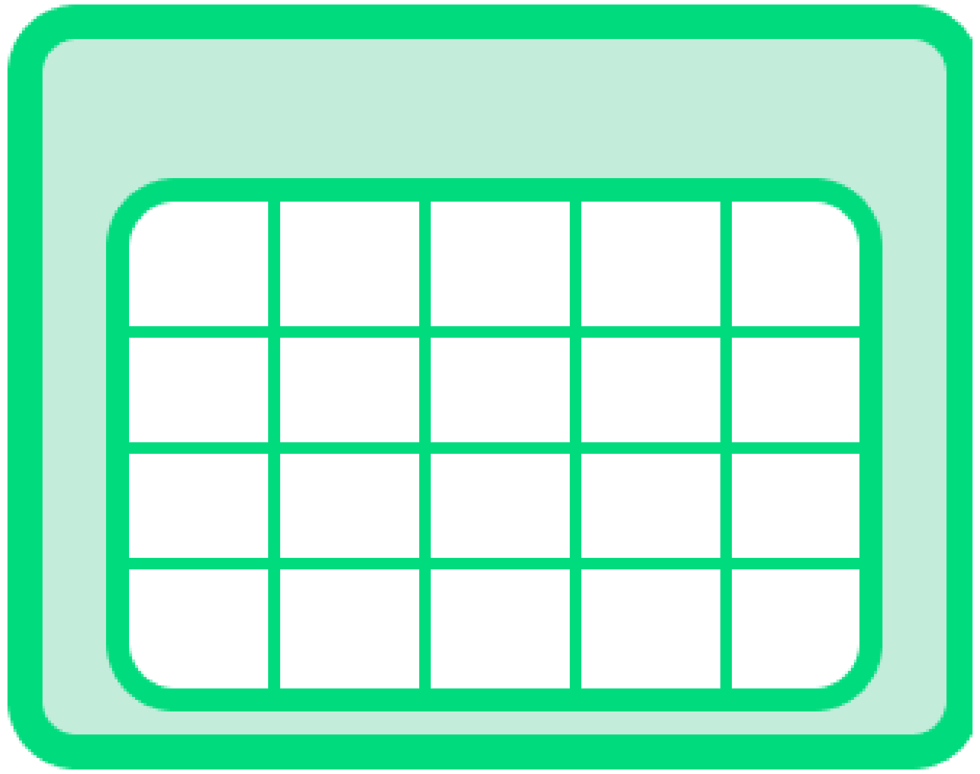
To eventually do this...



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

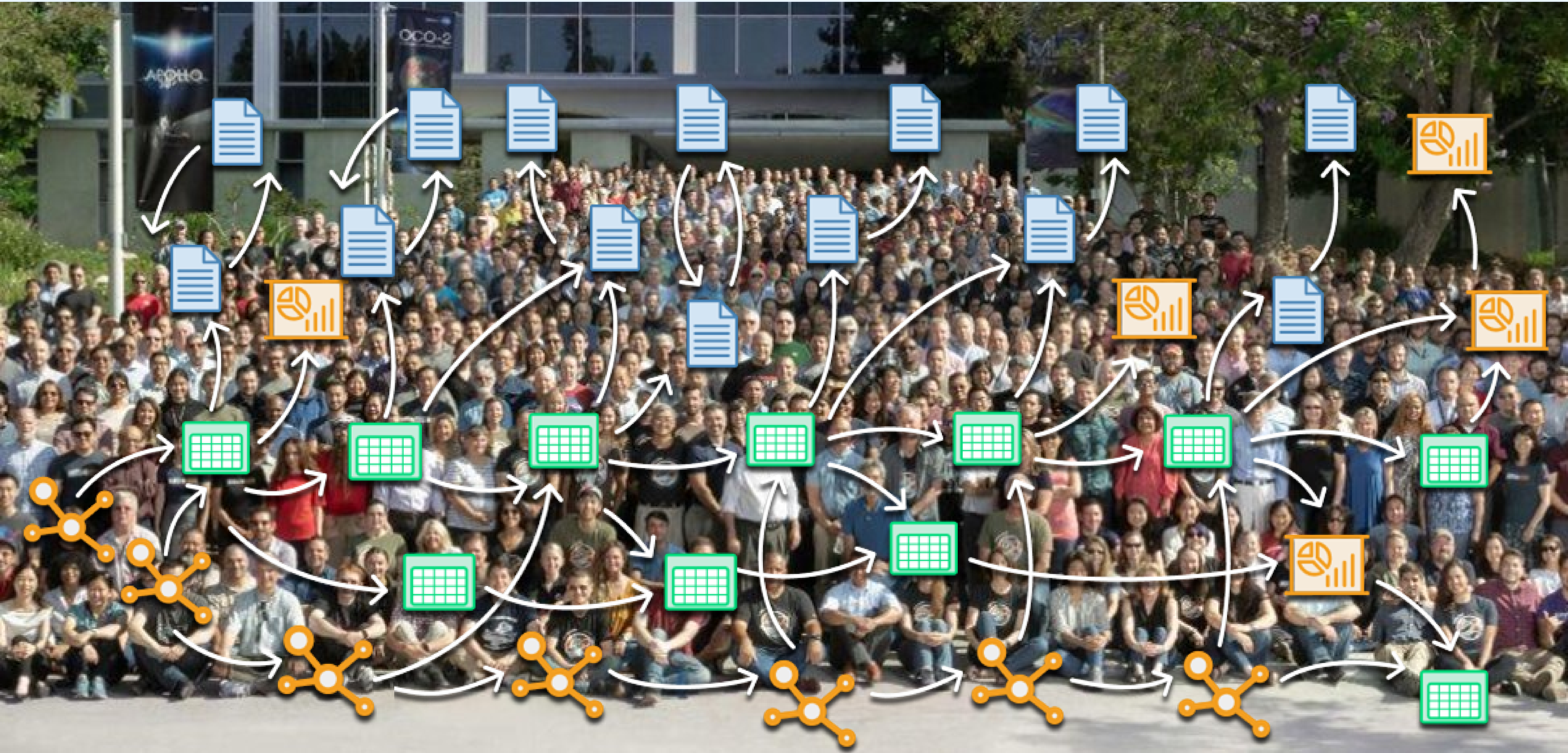


So how do we get from this...

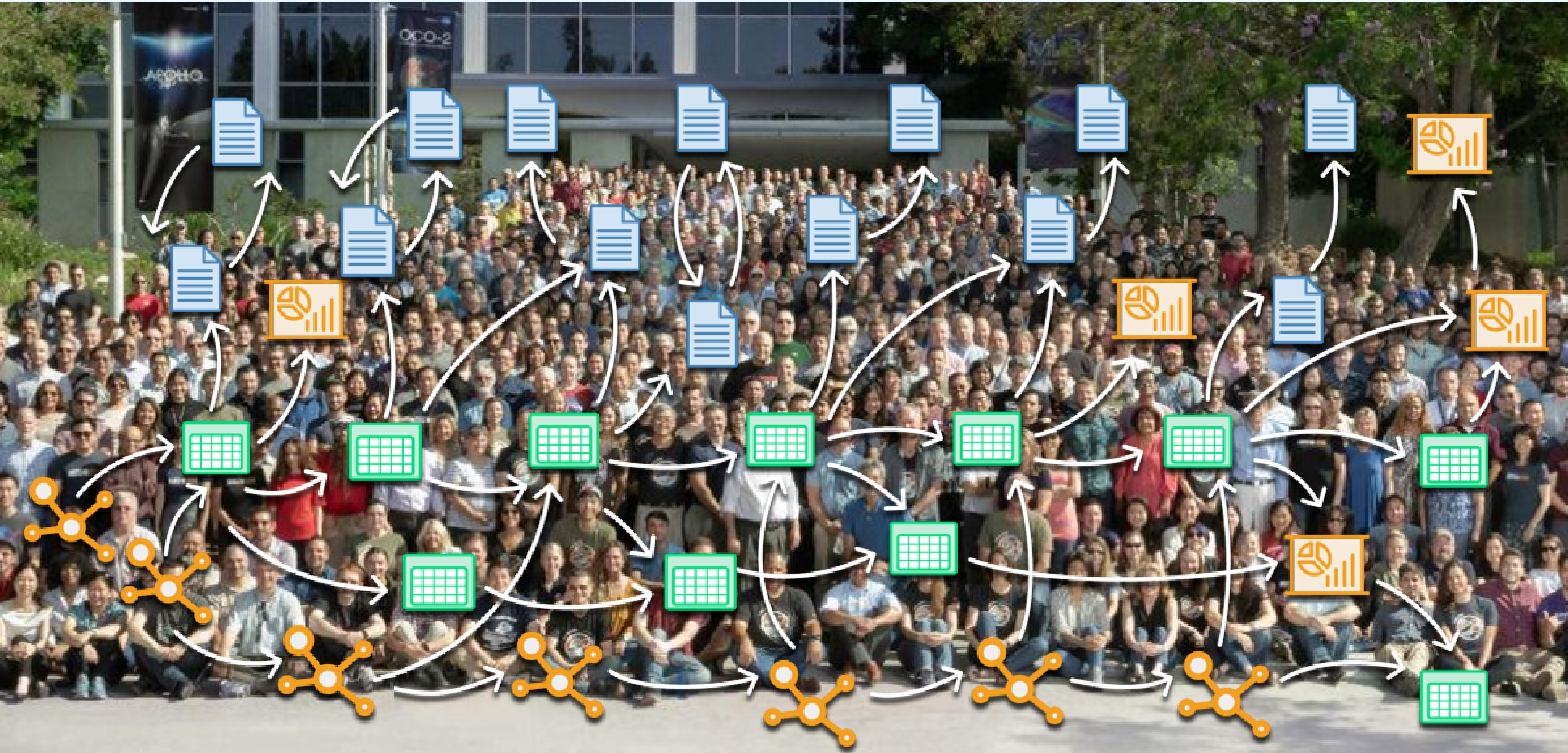


to this?

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.



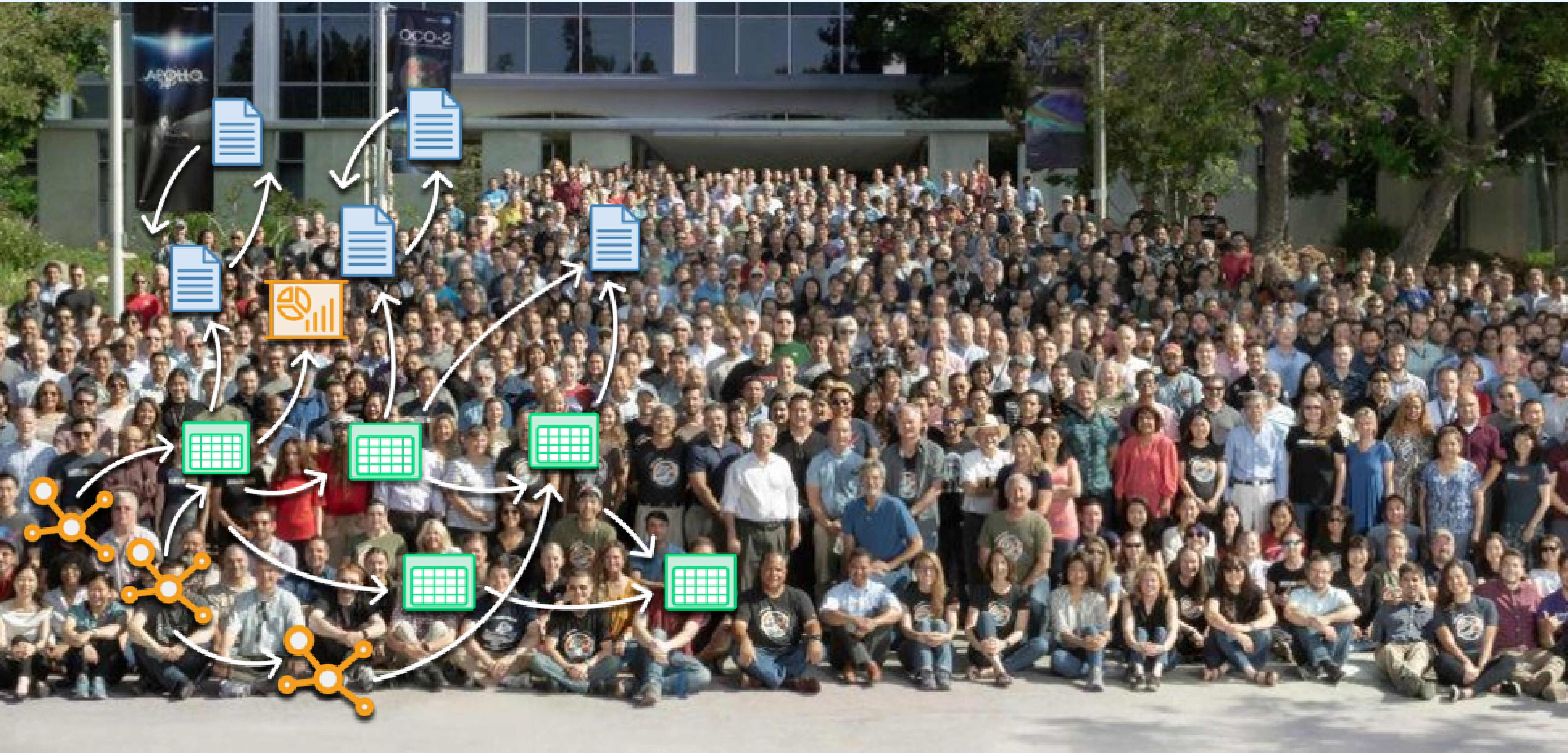
A project starts simple.

Engineers iterate on their models.

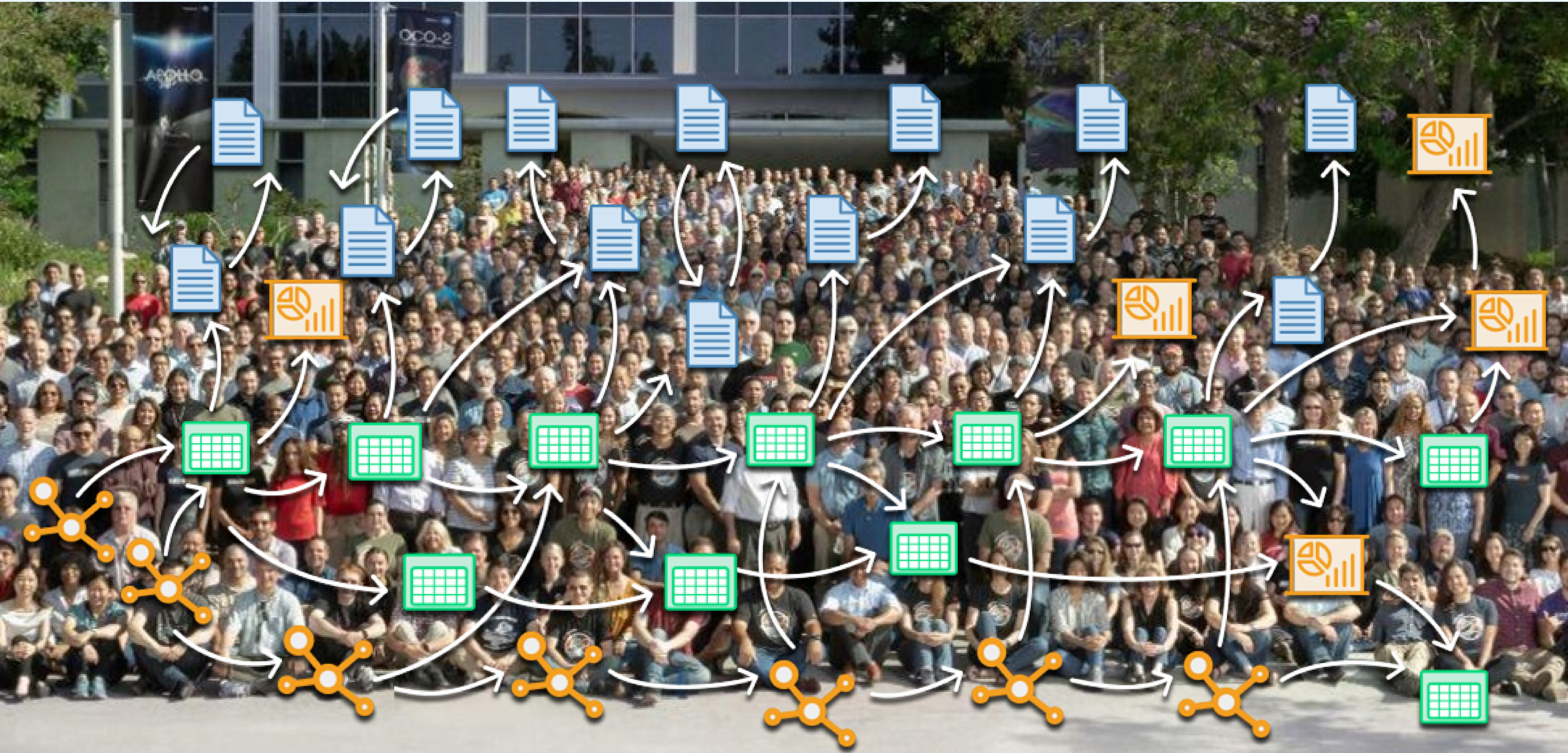
They add it to a spreadsheet to track it over time.

They add it to a document.

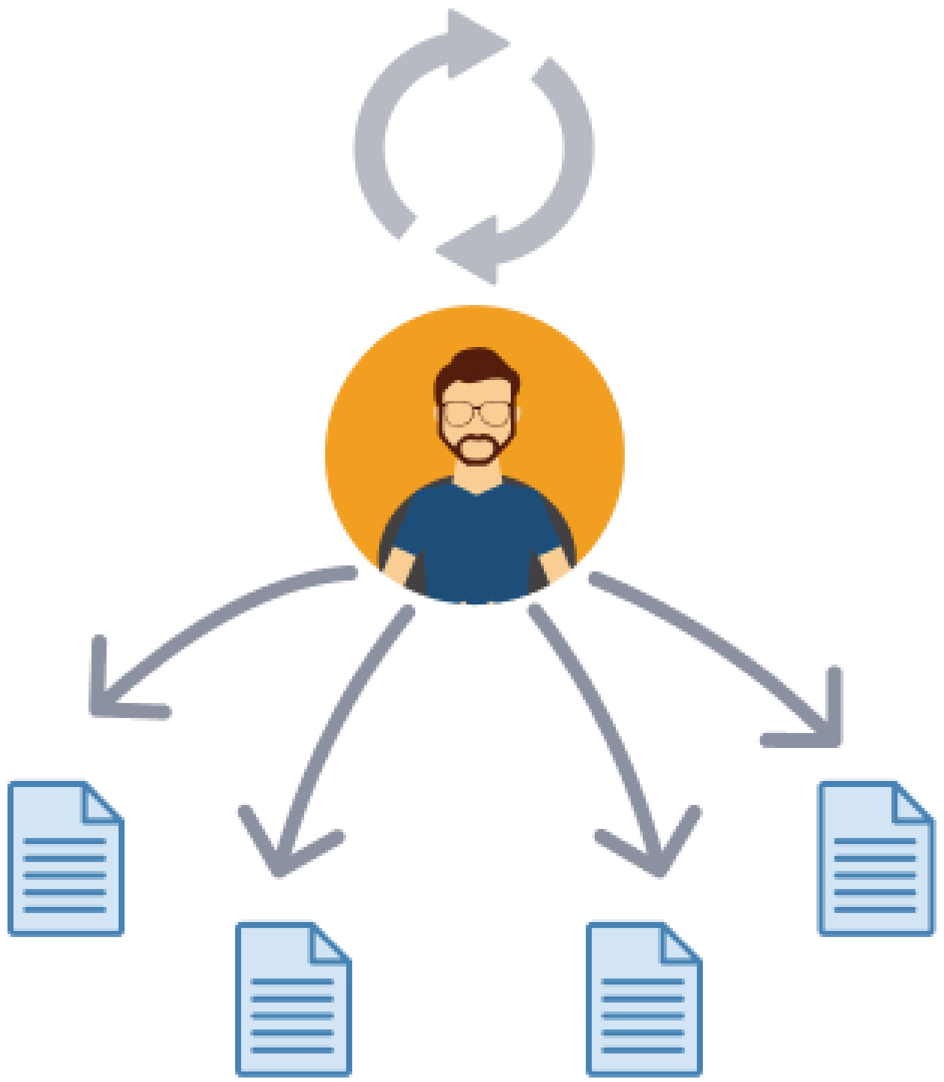
And get input from others.



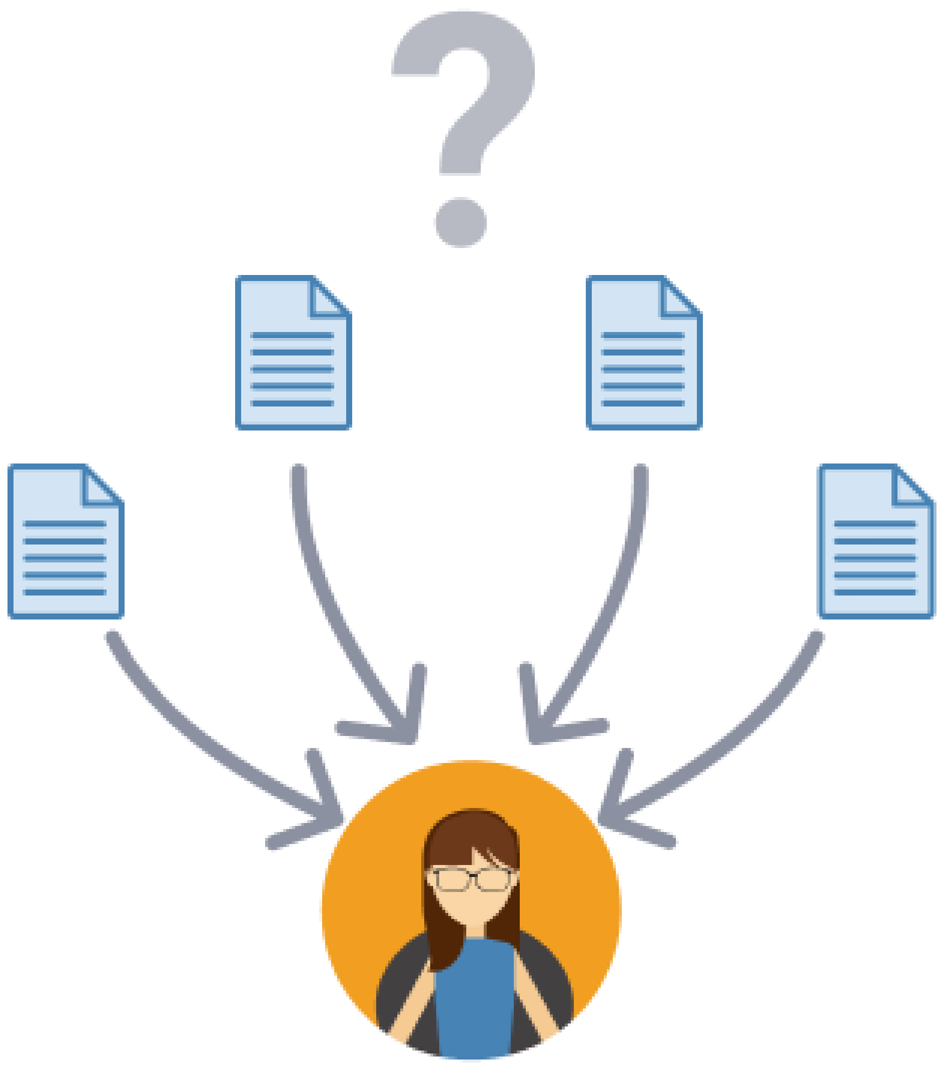
And it gets complicated pretty quickly...



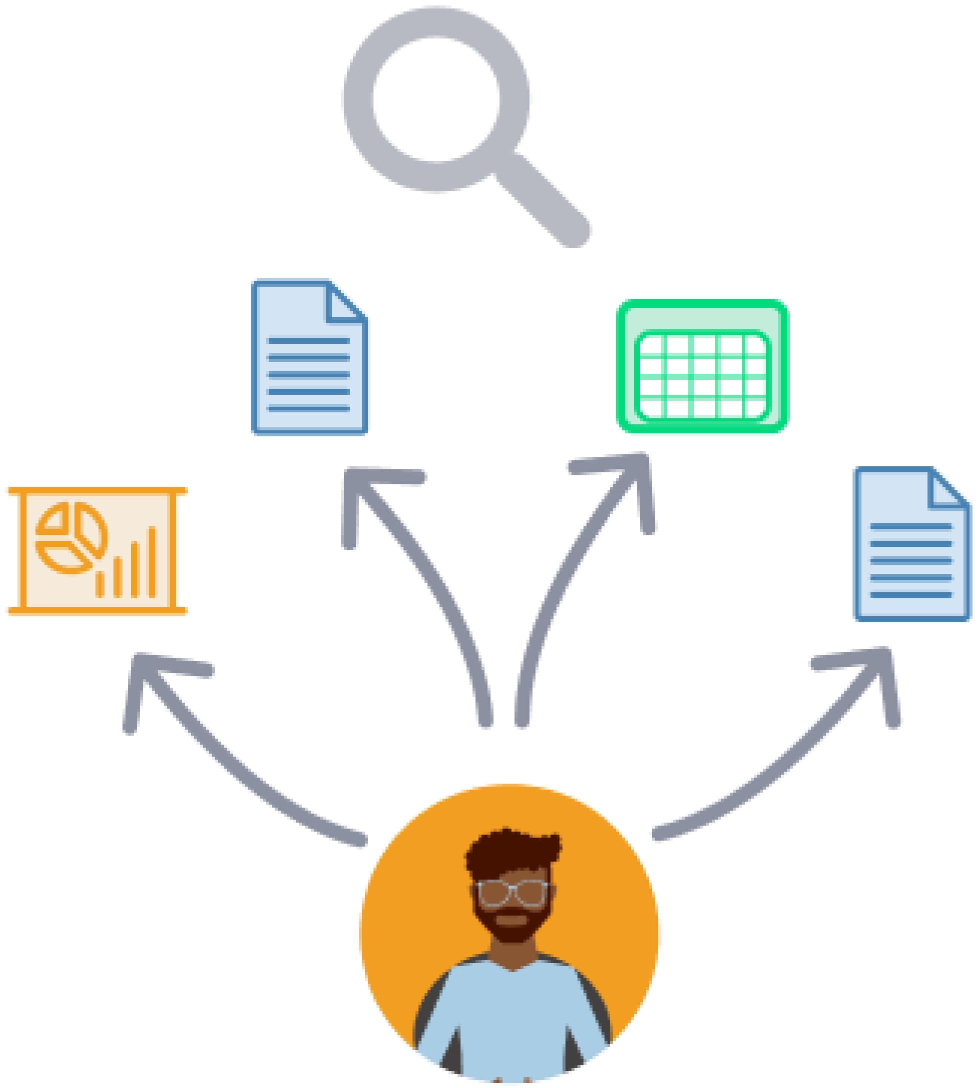
Bad Ratio of Real engineering vs. overhead



Repetitive Data Entry

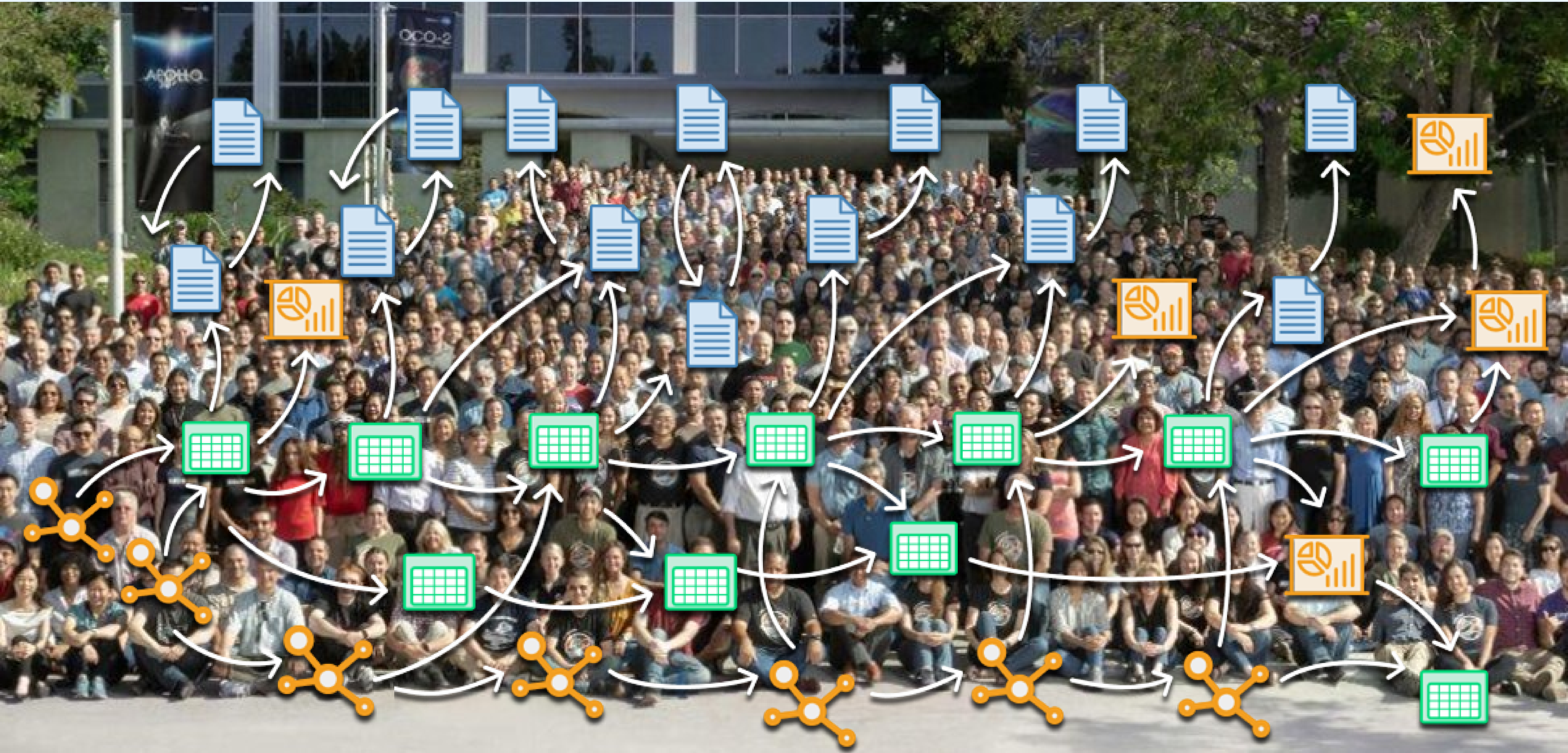


Version Confusion



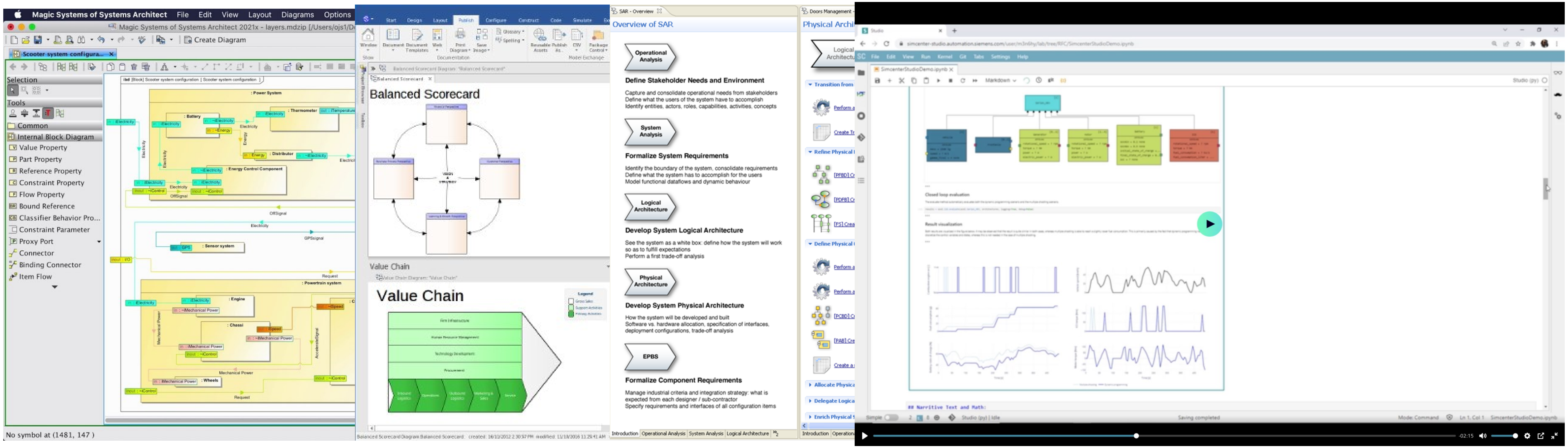
Constant Searching

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)

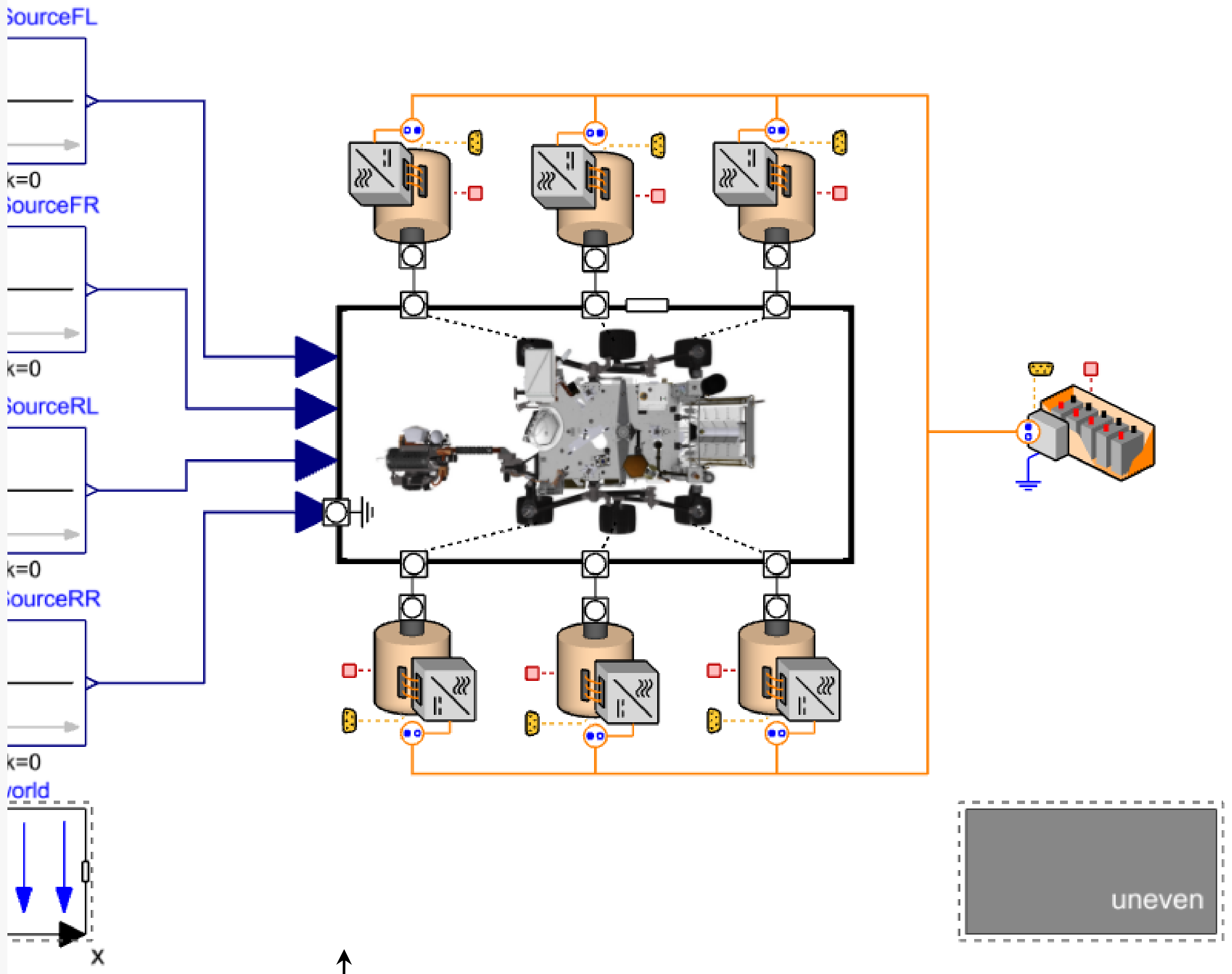
OpenCAE

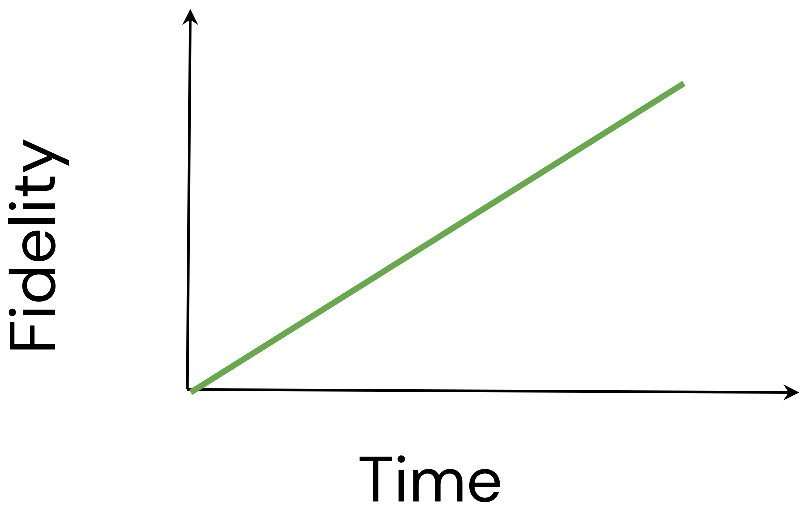
Iterative

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

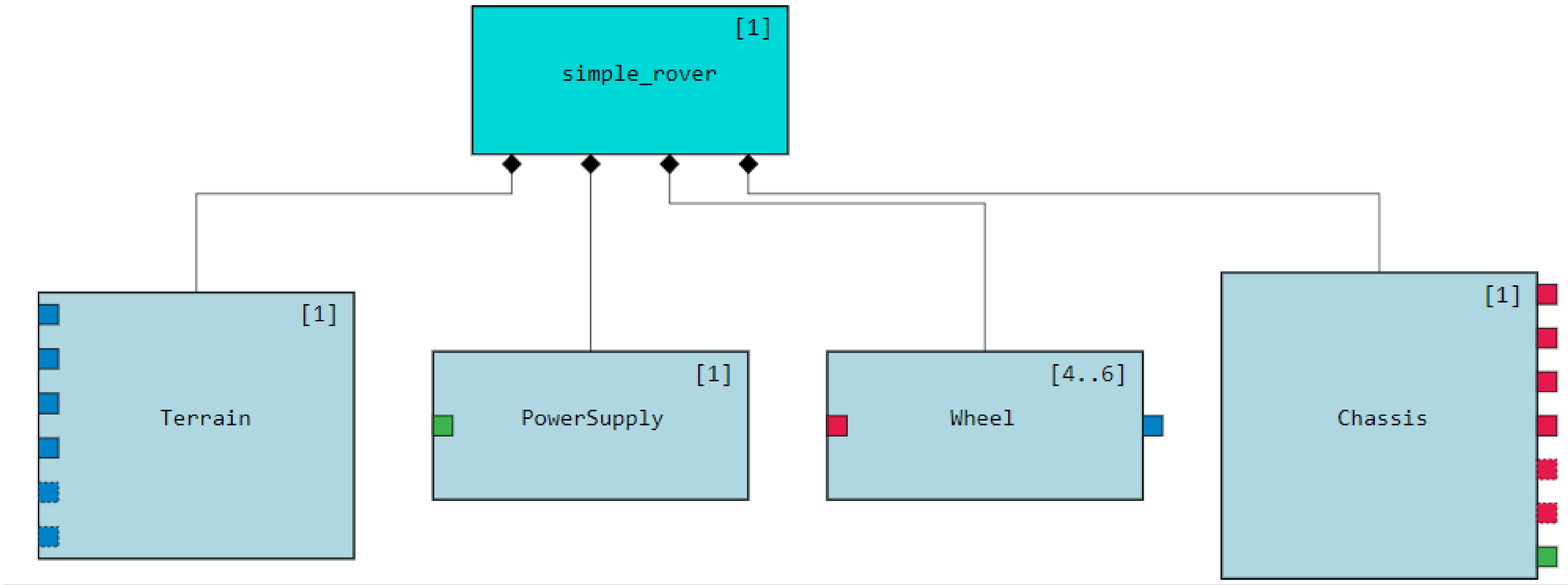
Design & Constraint Capture

System model **Multi-physics model** **Wiki**

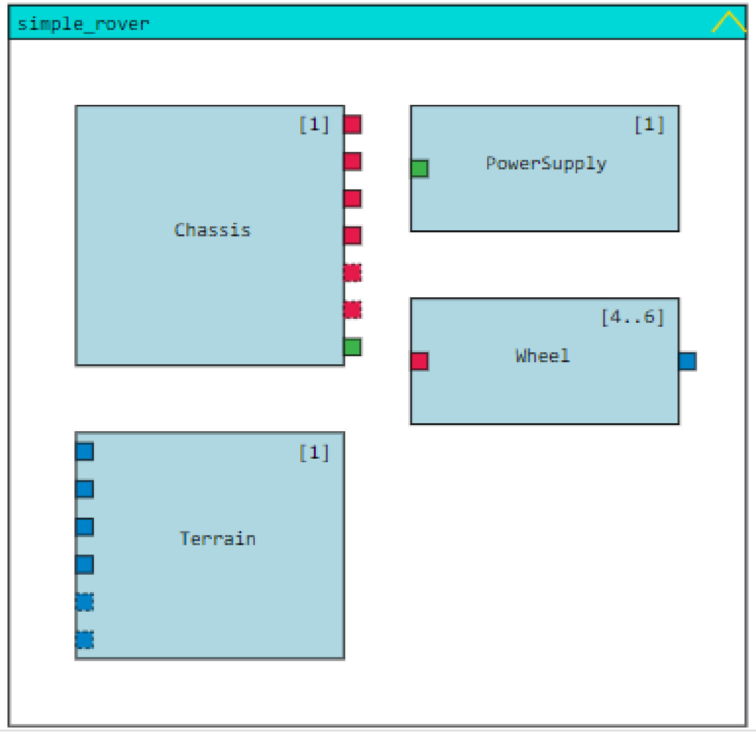
OpenCAE

Iterative

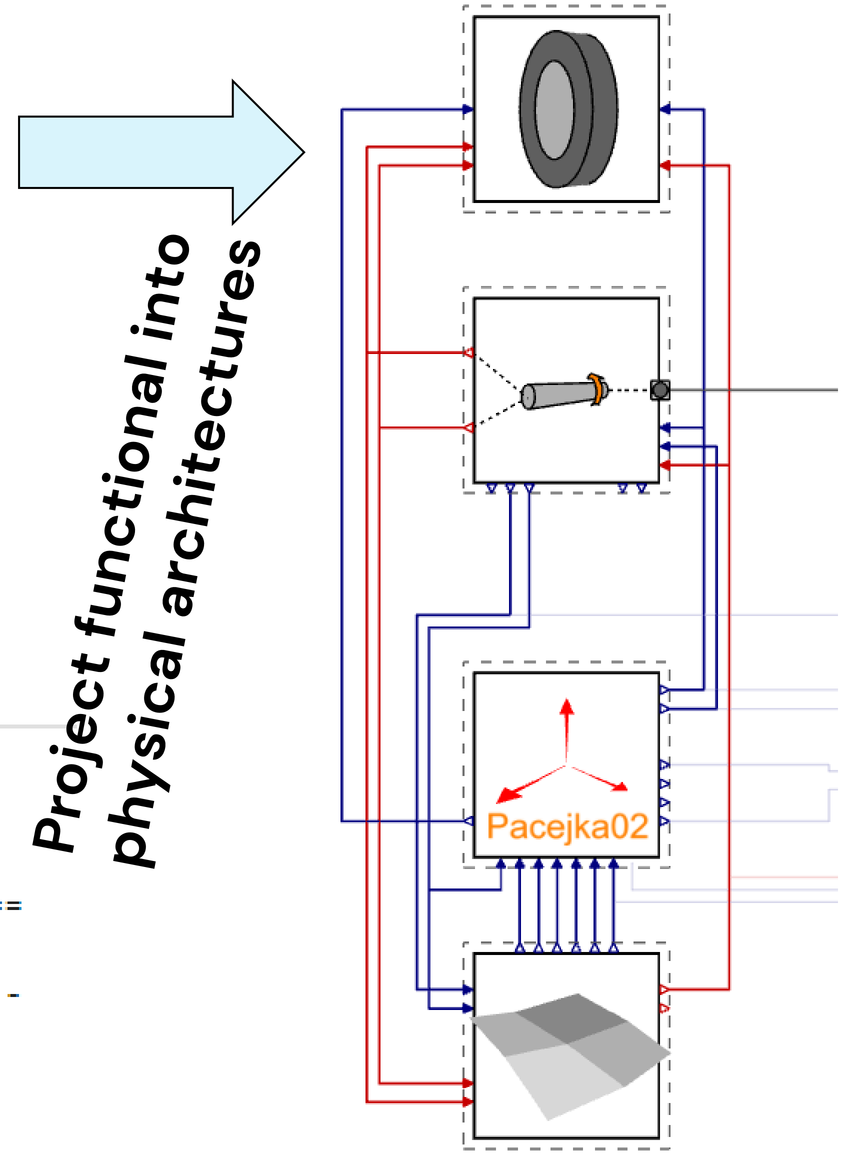
Architecture and Design




```
    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
```




```
==============================
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

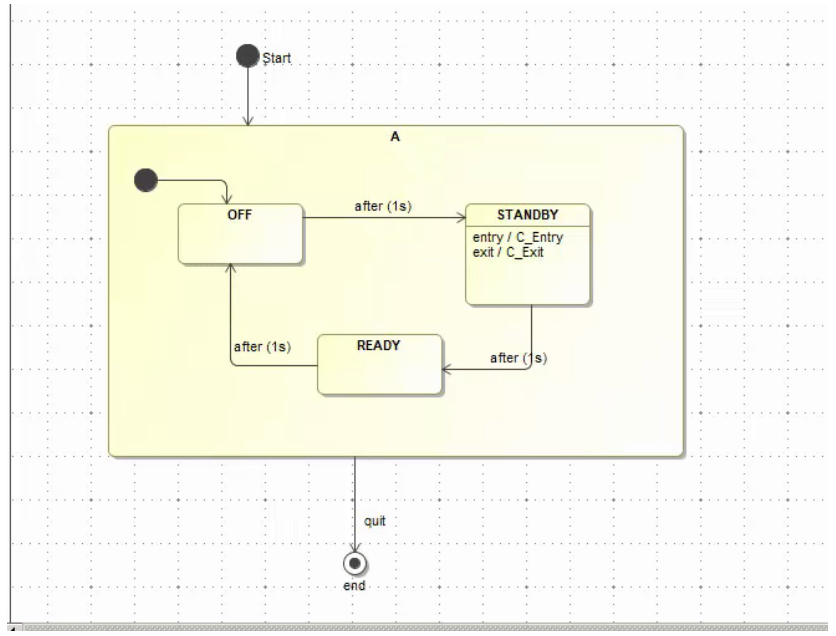
- Articulation of Design Space
- Determine required connectivity constraints

OpenCAE

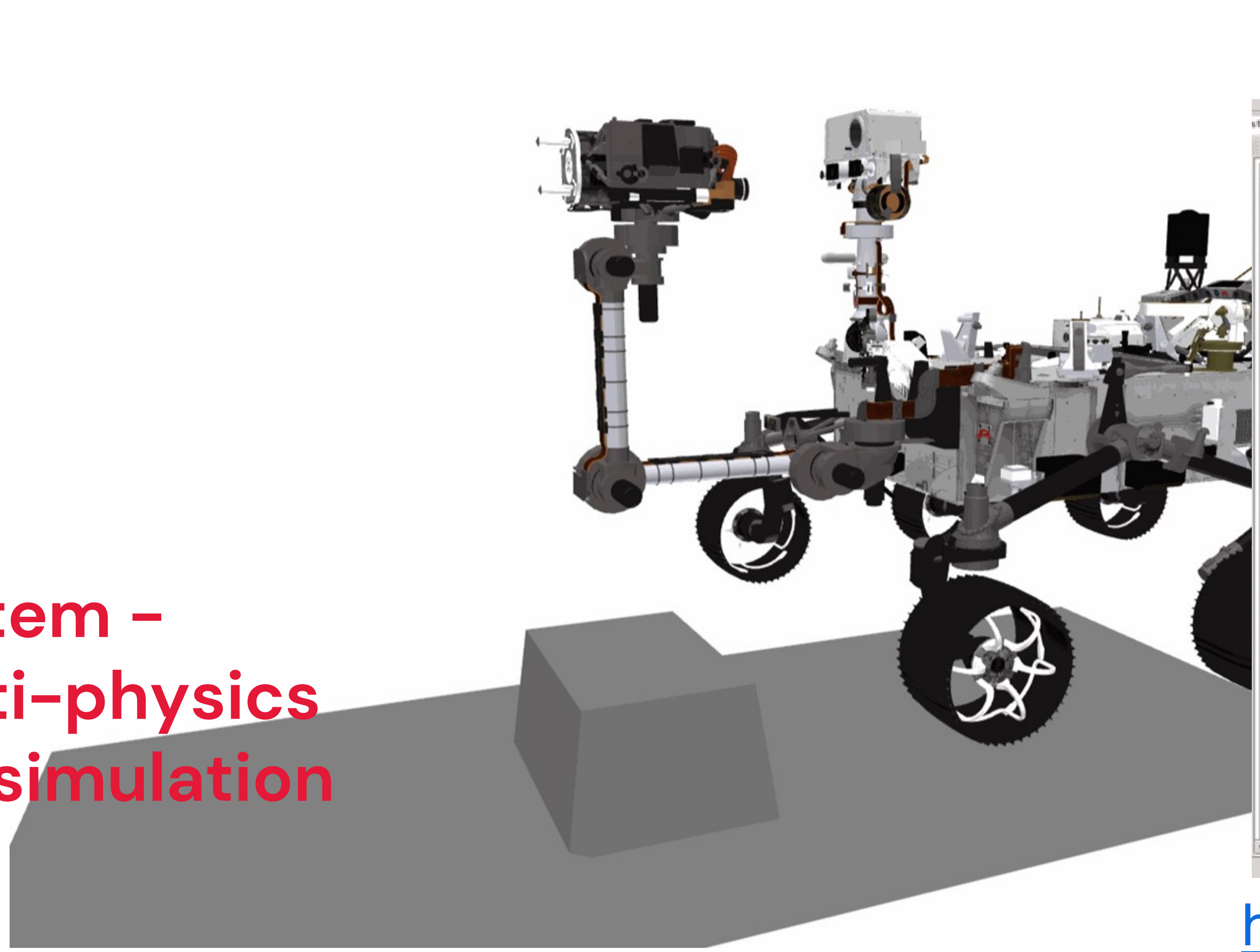
Quantitative Analysis

- Baseline Analysis
- Adding new Components
- Swapping Components

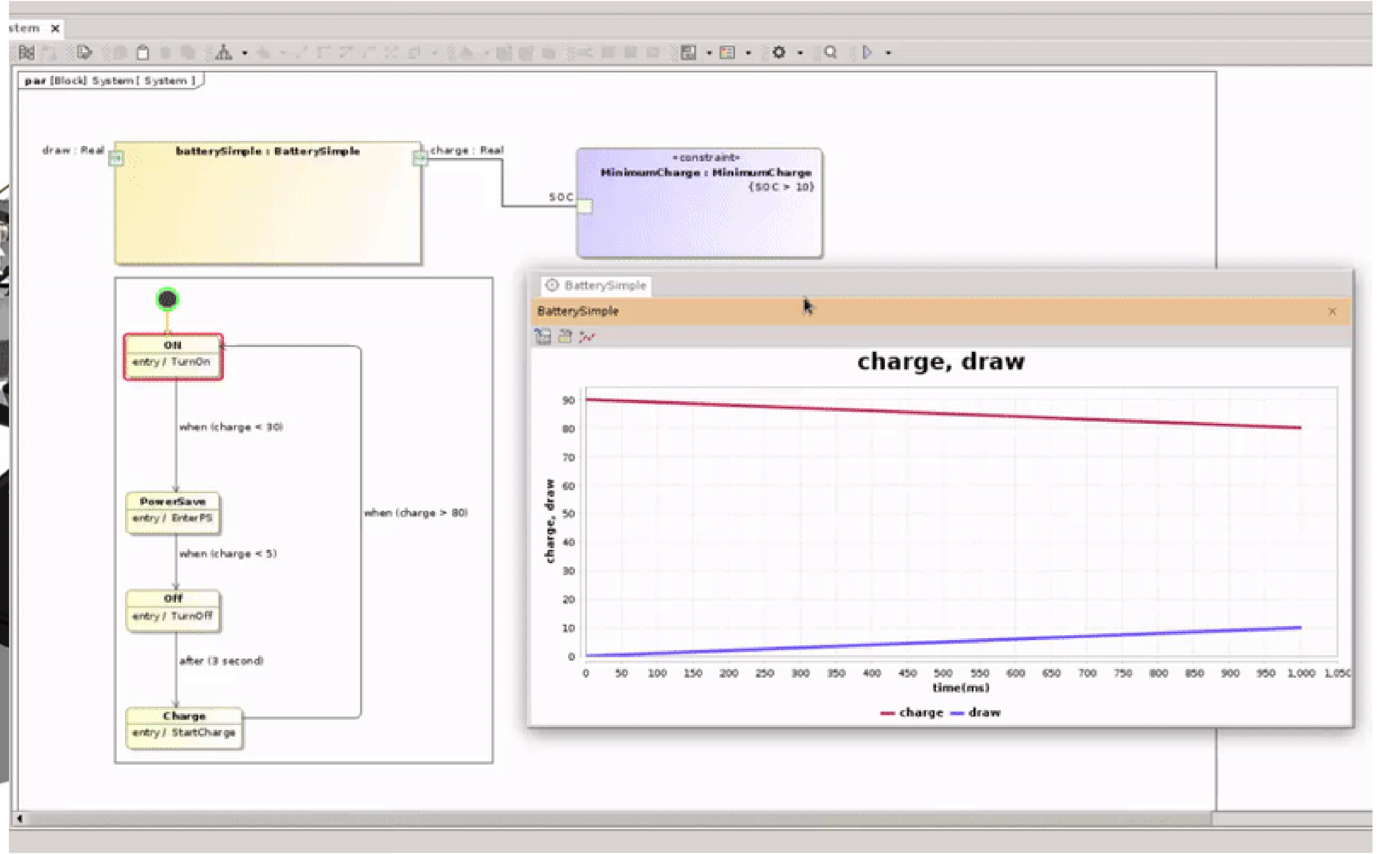
Guided Architecture Selection in an integrated engineering environment



FSW simulation



System – Multi-physics Co-simulation



Constraint evaluation

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

Quantitative Analysis

Multi-attribute comparison & constraint evaluation

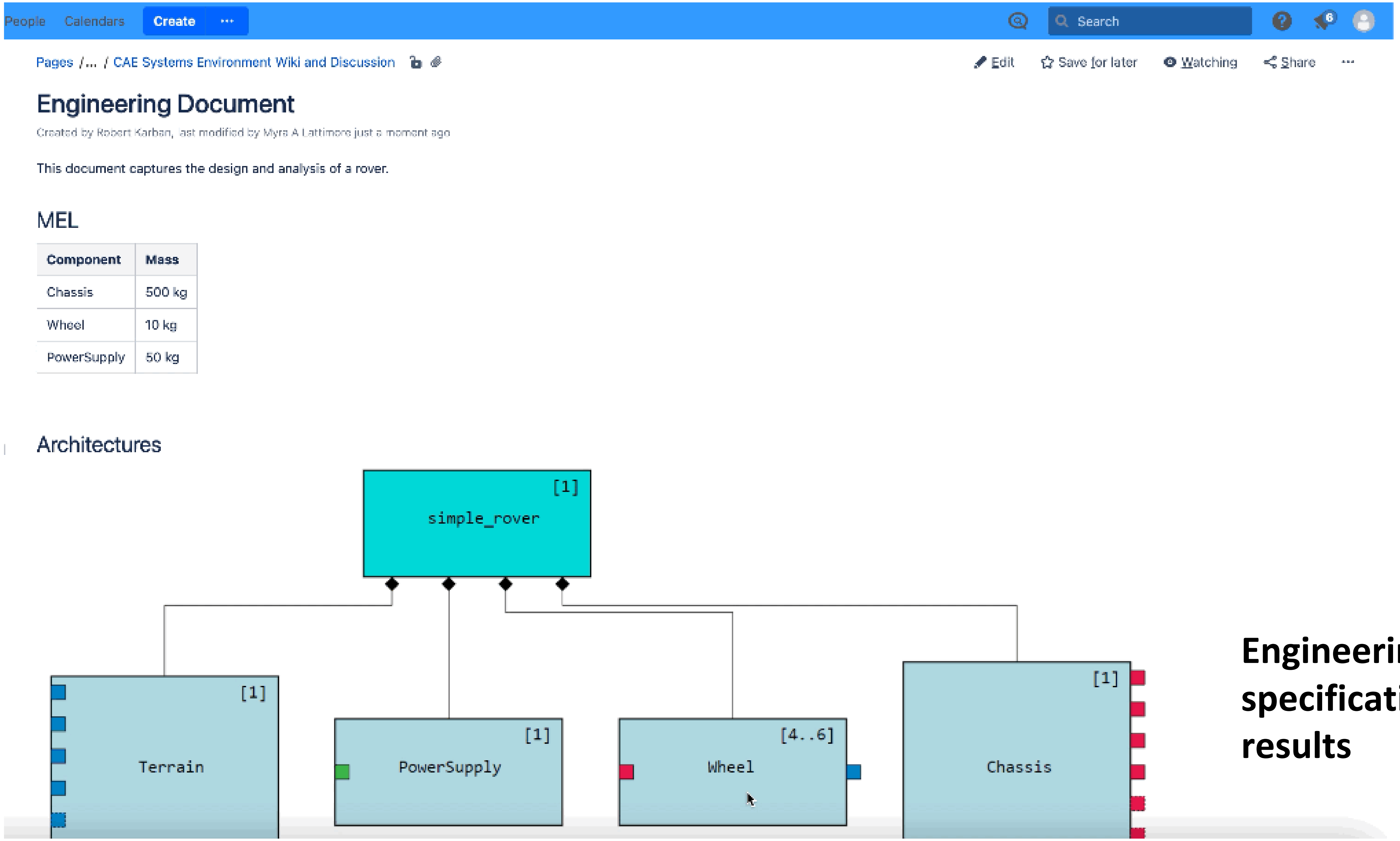
Visualizations (e.g. telemetry)

Behavioral Analysis

Functional & physical trade

OpenCAE

Publication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Engineering Document

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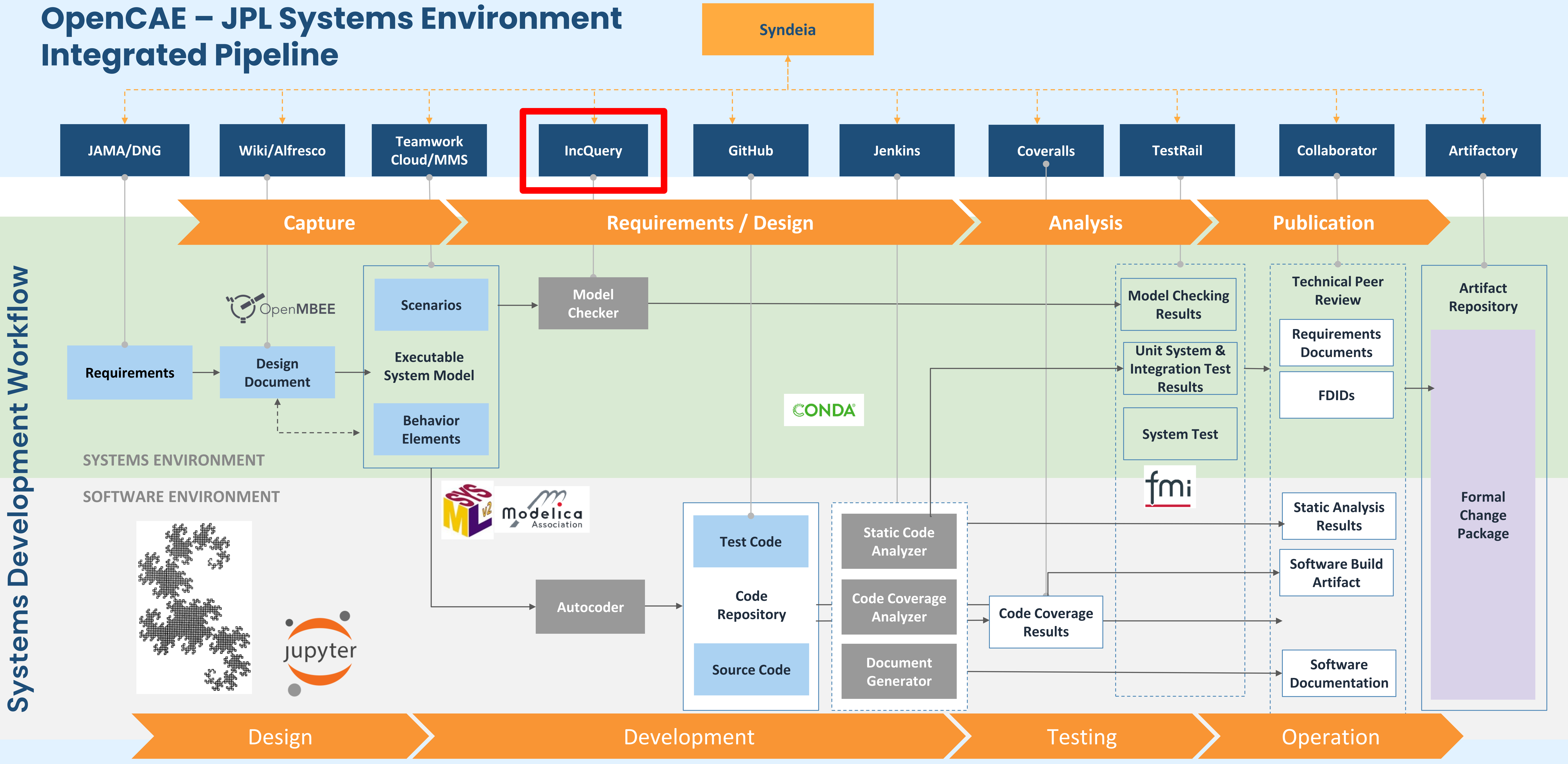
MEL

Component	Mass
Chassis	500 kg
Wheel	10 kg
PowerSupply	50 kg

Architectures

Engineering documents aggregate design specification, definition, and analysis results

OpenCAE – JPL Systems Environment Integrated Pipeline



DevOps - Continuous Integration - Simulation

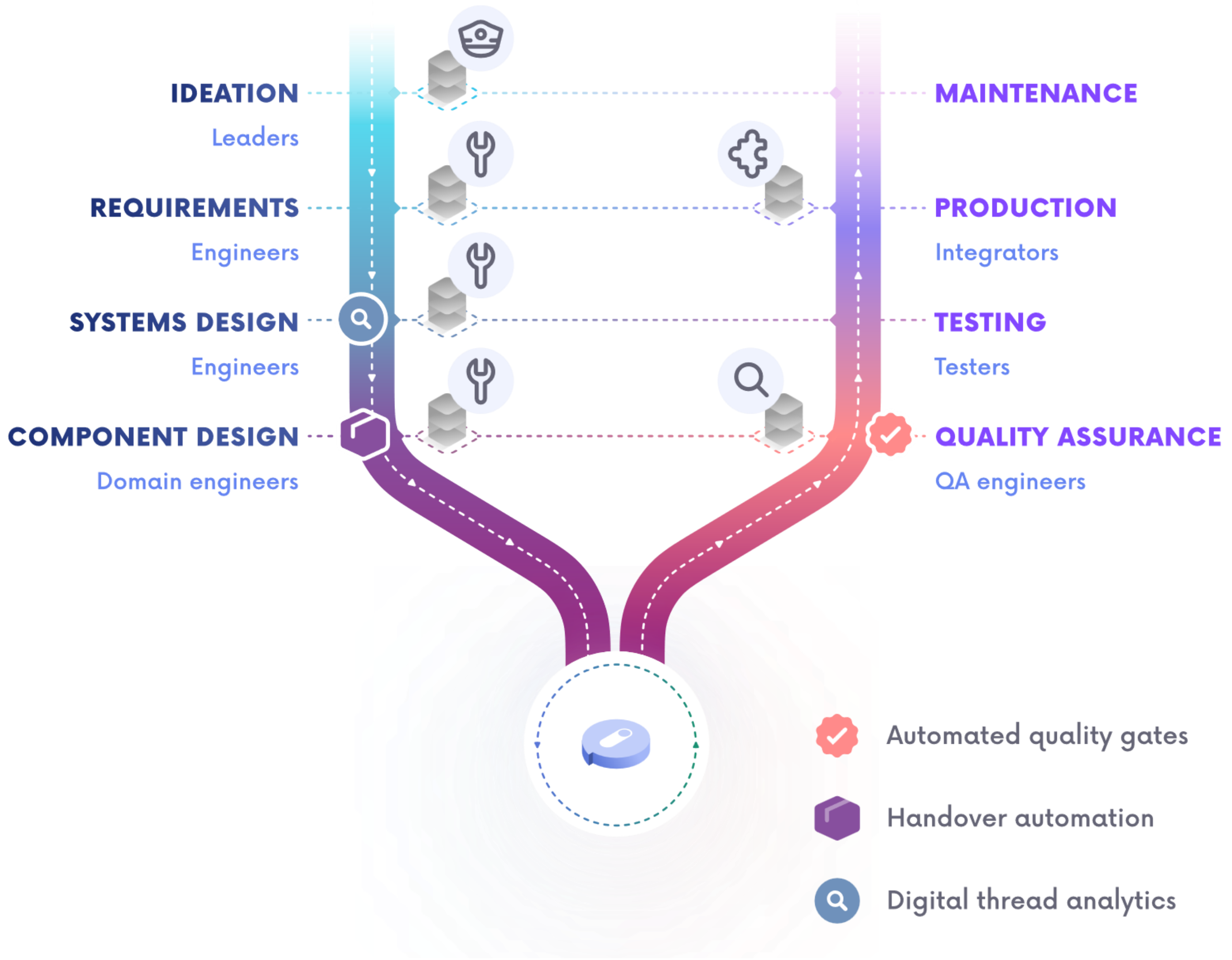
Process: Issue Management • Continuous Integration • Process Orchestration

JIRA | Jenkins | XLRelease

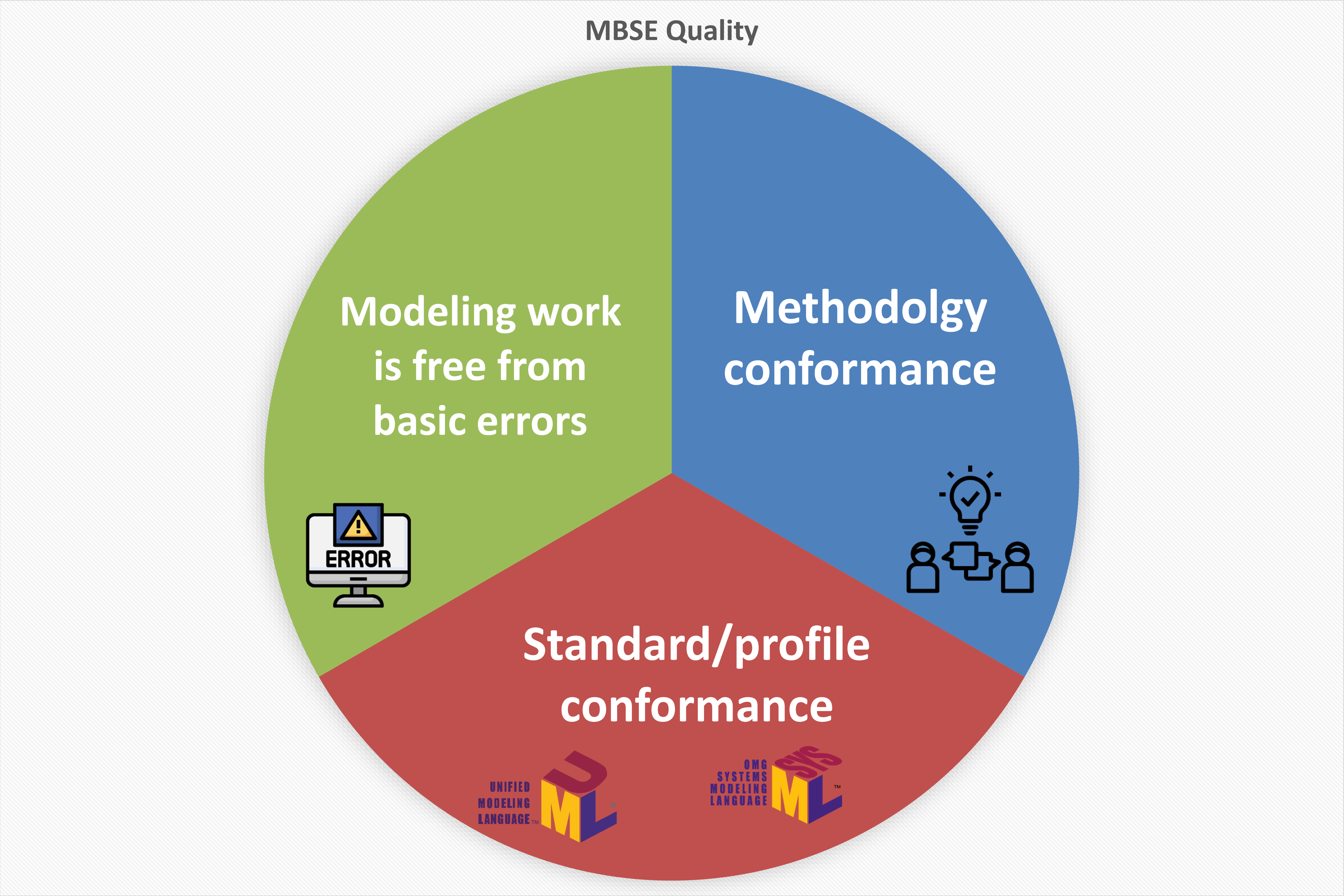
The IncQuery Vision

IncQuery provides a new platform for digital engineering automation.

- Automated Quality Gates to ensure engineering work free of design errors;
- Handover Automation to boost productivity and eliminate document-centric workflows;
- Digital Thread Analytics to break the vendor and data lock-in so you can get the maximum value of your engineering data.



What is model quality?

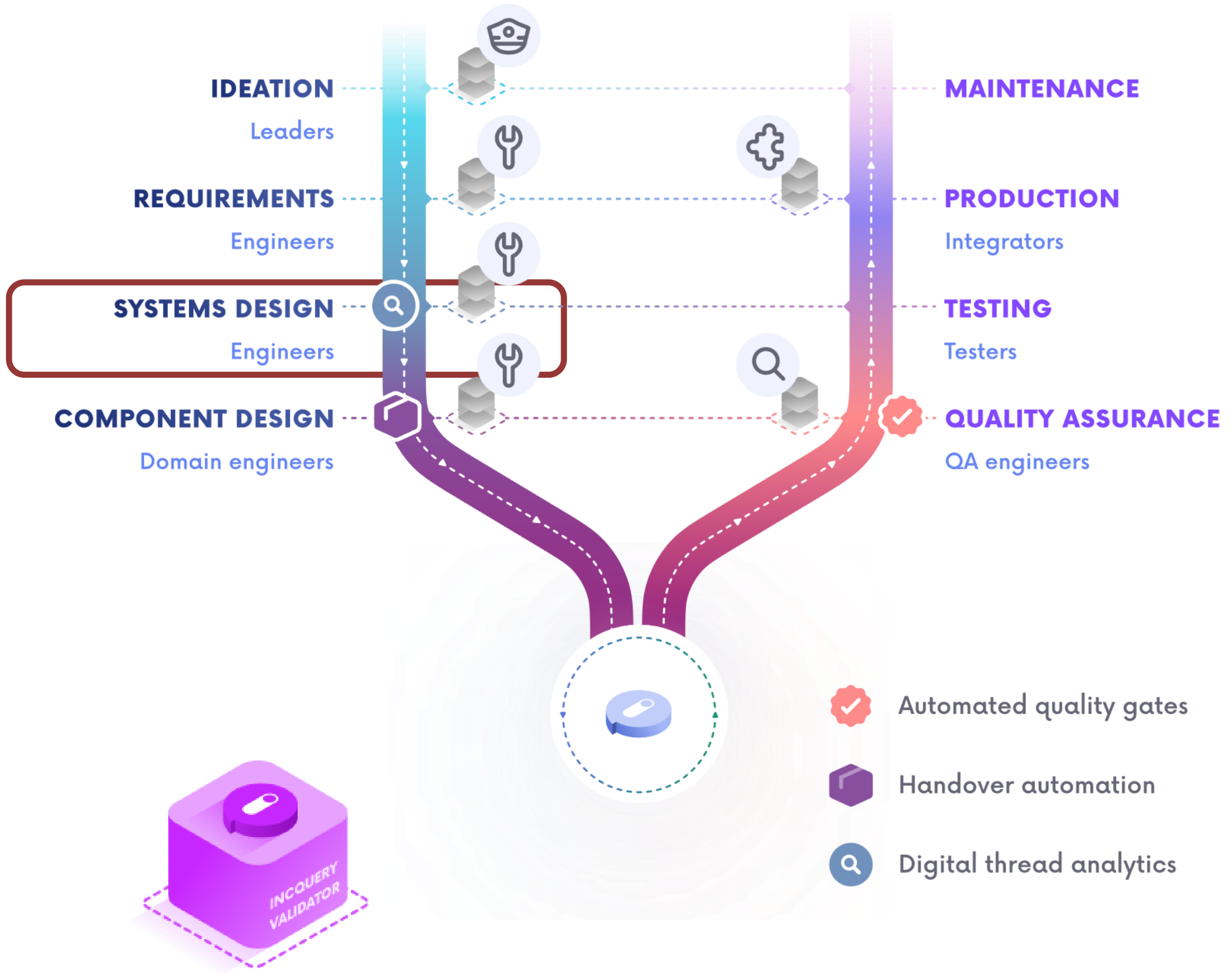


IncQuery Validator

Model Validation

Quality criteria that define well-formedness conditions to ensure authoring success.

- Goal: make errors visible and fixable inside the modelling tool



INCQUERY VALIDATOR

IncQuery Validator

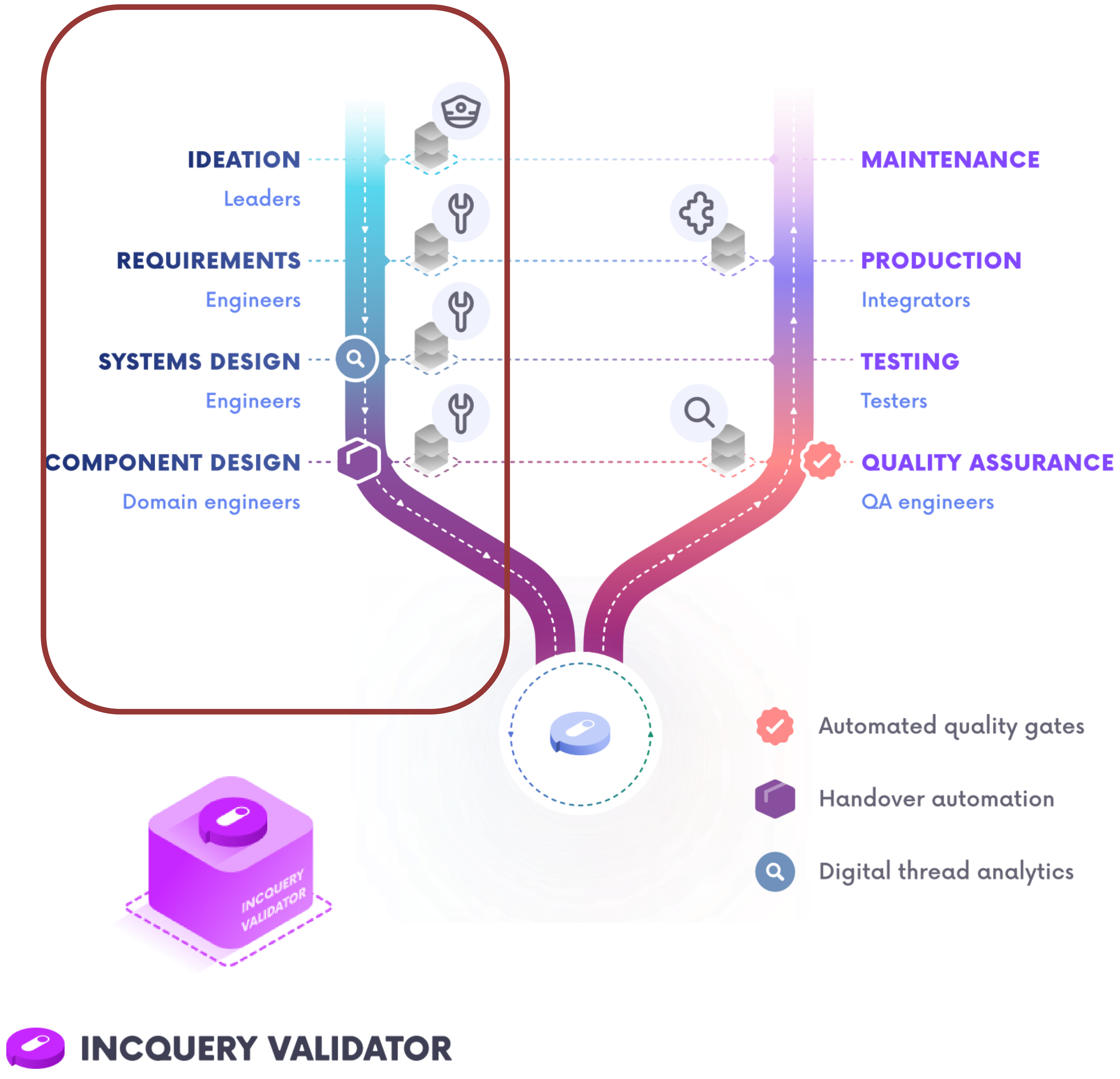
Model Governance

Quality criteria that define the preconditions for data exchange.

Enforce policies (style guidelines) across several stakeholders (organizations).

Make sure that models are

- Consistent in style;
- Understandable across several teams;
- Free of common mistakes & anti-patterns;
- Complete.



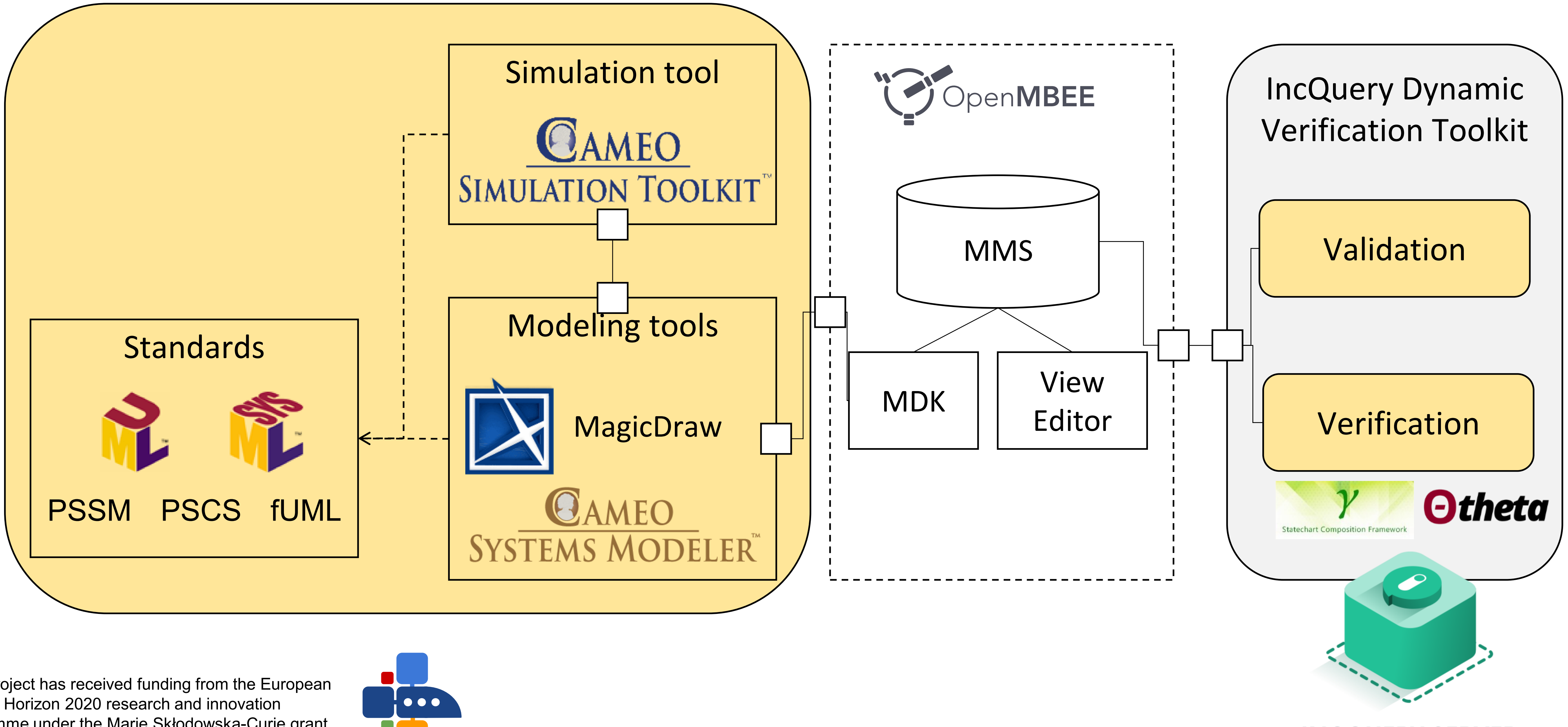

Simonyi
Konferencia
Magyarország legnagyobb egyetemi
hallgatók által szervezett éves technológiai
konferenciája.
24. 03. 19.

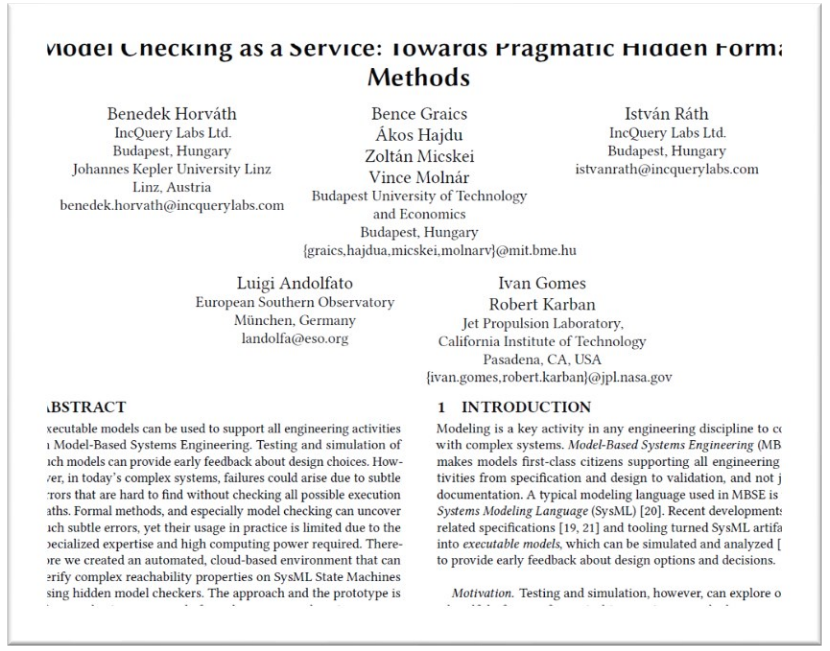
Research collaboration: Pragmatic Verification of SysML

- 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

Jet Propulsion Laboratory
California Institute of Technology




Model Checking as a Service: Towards Pragmatic Hidden Formal Methods

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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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