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Syndeia for
Model-Based Engineering (MBE/MBSE)

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INCOSE SE Vision 2025

FOOD AND SHELTER

CLEAN WATER

HEALTHY (PHYSICAL) ENVIRONMENT

ACCESS TO HEALTH CARE

ACCESS TO INFORMATION, COMMUNICATION, EDUCATION

TRANSPORTATION AND MOBILITY

ECONOMIC SECURITY AND EQUITY

SECURITY AND SAFETY

Systems

Interconnected

Interdependent

Complex

INCOSE SE Vision 2025
http://goo.gl/uE5OS9
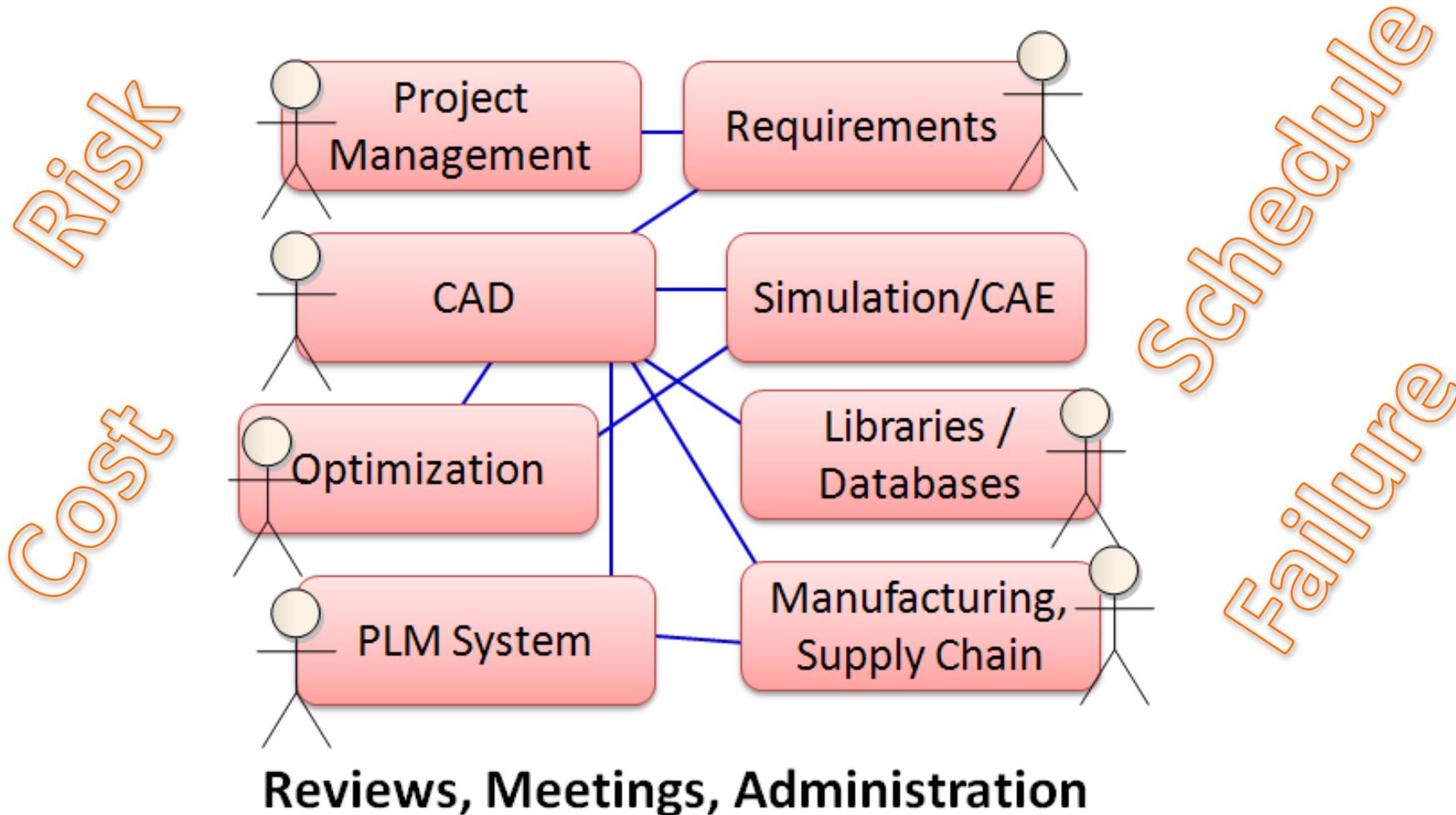
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About Intercax
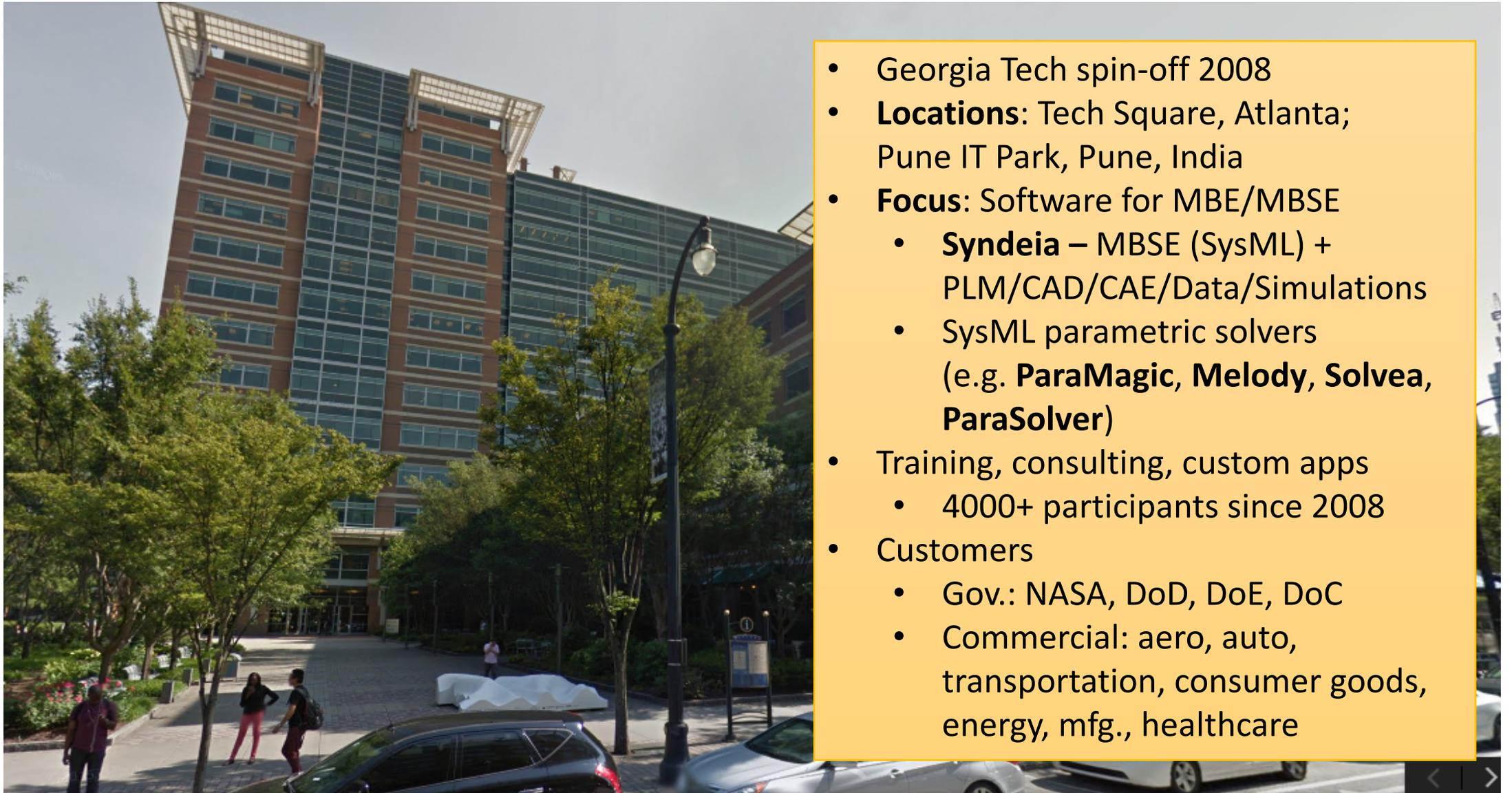
- Georgia Tech spin-off 2008
- **Locations**: Tech Square, Atlanta; Pune IT Park, Pune, India
- **Focus**: Software for MBE/MBSE
  - **Syndeia –** MBSE (SysML) + PLM/CAD/CAE/Data/Simulations
  - SysML parametric solvers (e.g. **ParaMagic**, **Melody**, **Solvea**, **ParaSolver**)
- Training, consulting, custom apps
  - 4000+ participants since 2008
- Customers
  - Gov.: NASA, DoD, DoE, DoC
  - Commercial: aero, auto, transportation, consumer goods, energy, mfg., healthcare

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Contents

- MBSE ++
- Introduction to Syndeia
- SysML 2.0 WG - System Modeling Environment (SME)
- Syndeia Demonstration
- Syndeia Latest Release
- Syndeia Future
- Questions and Comments

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Where is the system architecture / blueprint?

Point-to-point ad-hoc information flows without a common architecture model

Risk

Cost

Schedule

Failure

Project Management

Requirements

CAD

Simulation/CAE

Optimization

Libraries / Databases

PLM System

Manufacturing, Supply Chain

Reviews, Meetings, Administration

Use of models in systems engineering IS NOT model-based systems engineering (MBSE)

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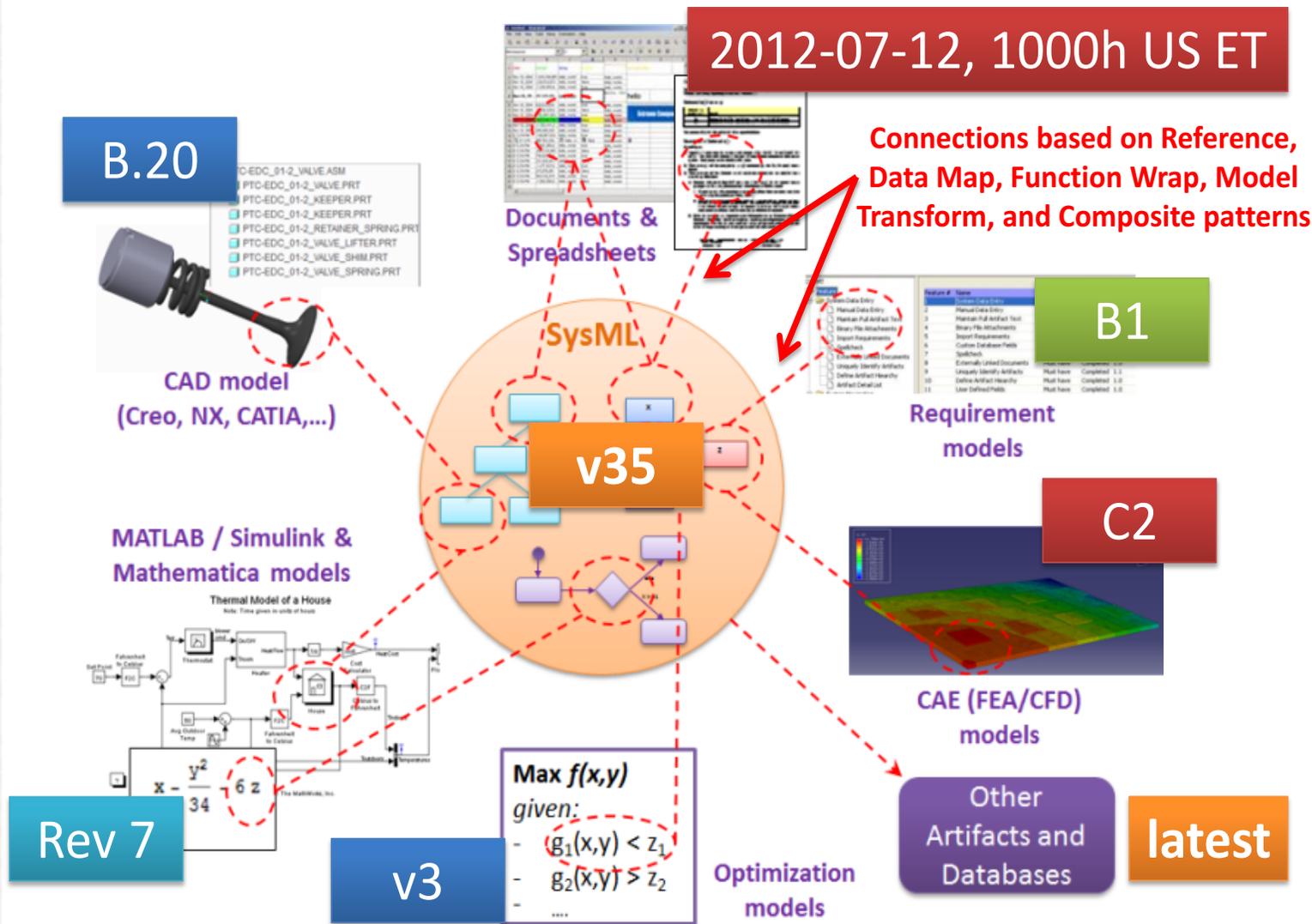# Transition from Document-Based to Model-Based Systems Engineering
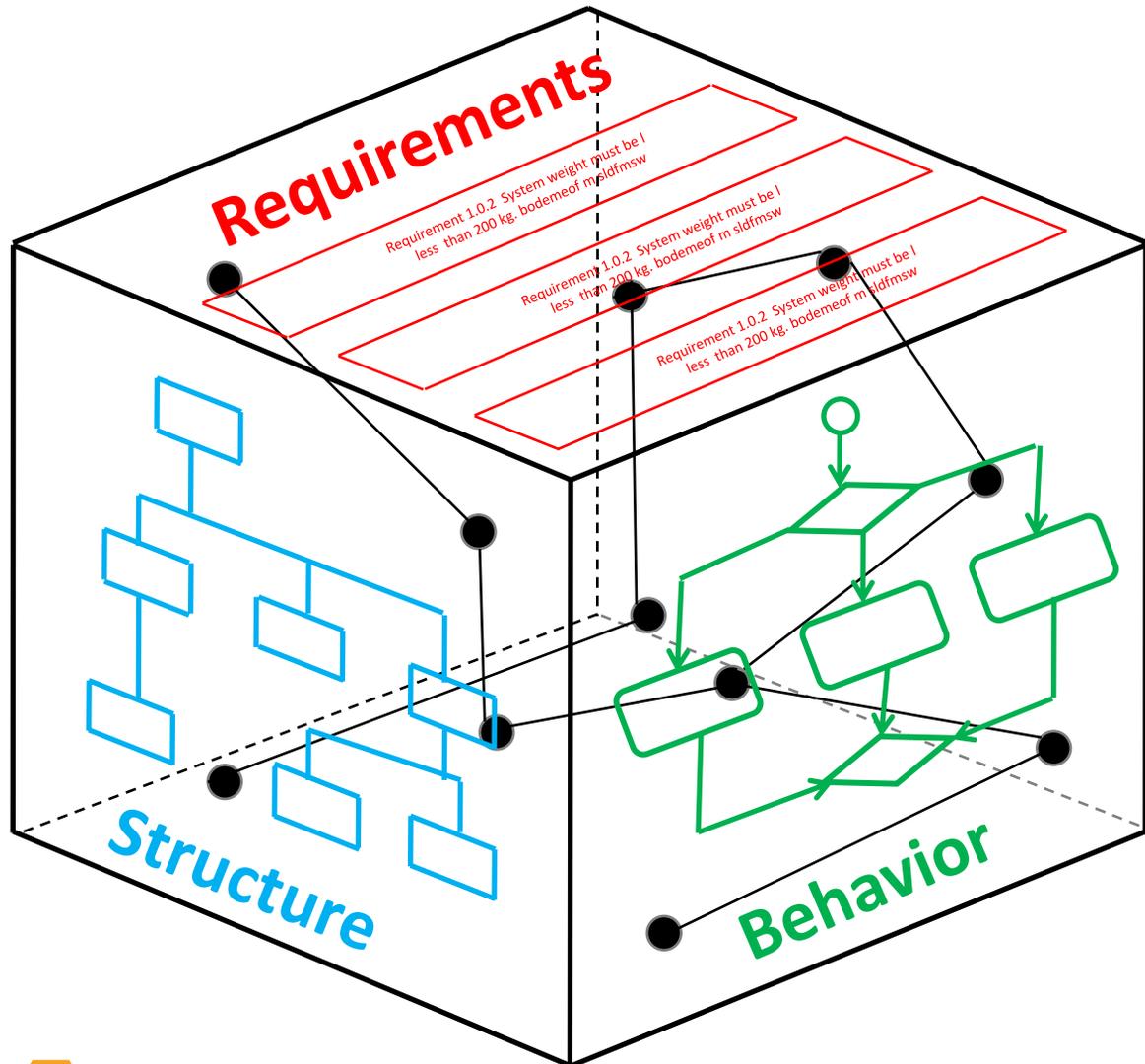
- MBSE = Unified model of the system versus series of disconnected documents or document-based flows between models (DBSE)

- System docs and views can be generated from this unified model

- DBSE > MBSE ⇔ 2D > 3D CAD

- Models in SE ≠ MBSE

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DBSE > MBSE > MBSE++

- OMG SysML – www.omgsysml.org
  - Widely adopted as a standard for modeling, analyzing, and developing system architecture

- However
  - Most of the detailed engineering carried out in domain-specific tools and repositories, such as in PLM, ALM, Req. Mgt., Databases, Simulation environments, Project Management, CAD, CAE, and other tools

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What is MBSE++

B.20

PTC-EDC-01-2_VALVE.ASM
PTC-EDC-01-2_VALVE.PRT
PTC-EDC-01-2_KEEPER.PRT
PTC-EDC-01-2_KEEPER.PRT
PTC-EDC-01-2_RETAINER_SPRING.PRT
PTC-EDC-01-2_VALVE_LIFTER.PRT
PTC-EDC-01-2_VALVE_SHIM.PRT
PTC-EDC-01-2_VALVE_SPRING.PRT

CAD model
(Creo, NX, CATIA,...)

2012-07-12, 1000h US ET

Documents &
Spreadsheets

Connections based on Reference,
Data Map, Function Wrap, Model
Transform, and Composite patterns

SysML

v35

B1

Requirement
models

C2

CAE (FEA/CFD)
models

MATLAB / Simulink &
Mathematica models

Thermal Model of a House

$$x - \frac{y^2}{34} \quad 6\ z$$

Rev 7

Max $f(x,y)$
given:
- $g_1(x,y) < z_1$
- $g_2(x,y) > z_2$
- ....

v3

Optimization
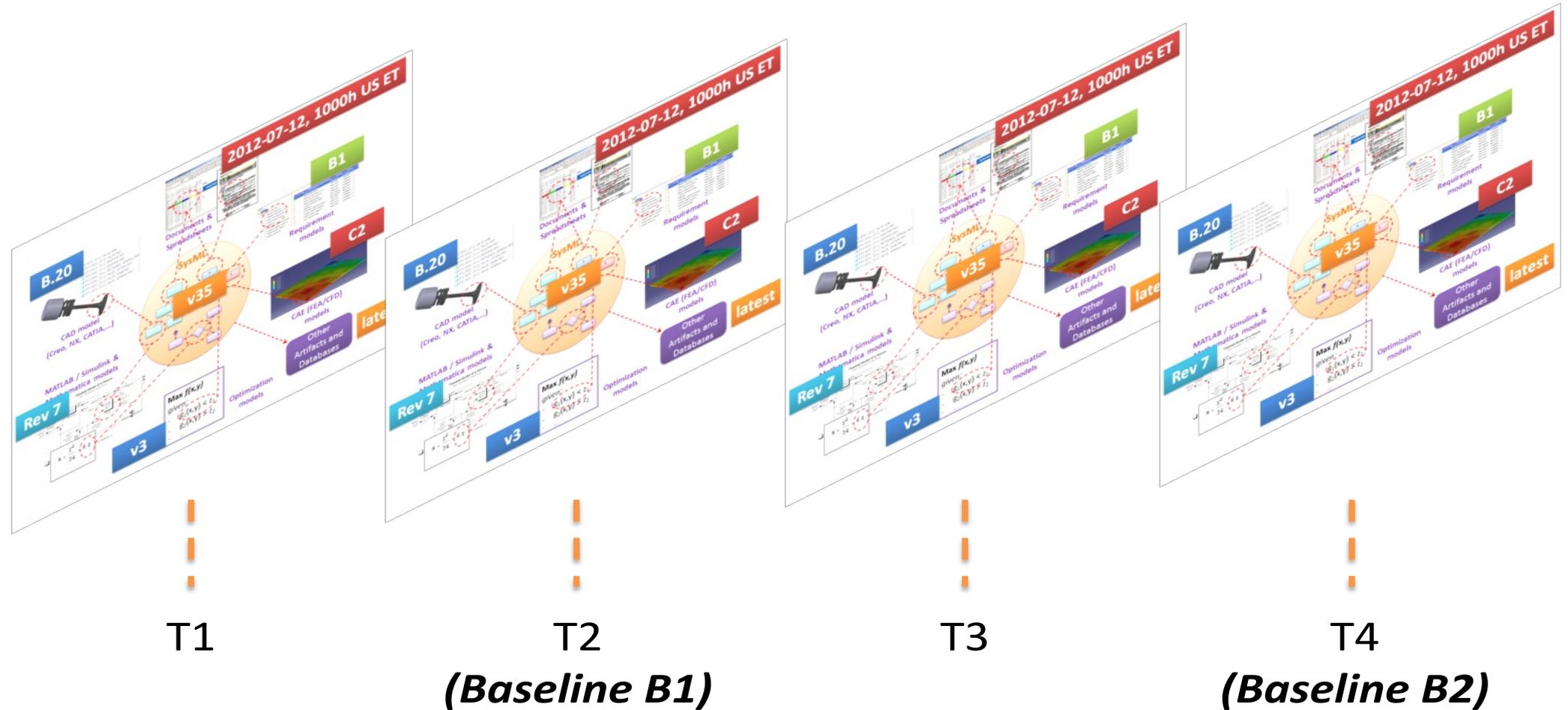**models**

Other
Artifacts and
Databases

latest

Connect architecture model (SysML) with domain-specific models

Total System Model (TSM) as a digital blueprint of the system connecting models across disciplines, tools, and version-management systems

Goal: Seamless traceability between disciplines across the system lifecycle

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Total System Model (TSM)
TSM evolves as each of the version-managed models evolve

T1

T2
(Baseline B1)

T3

T4
(Baseline B2)

Timeline

6 Principles of MBSE++

Bajaj, M., Zwemer, D., Yntema, R., Phung, A., Kumar, A., Dwivedi, A., Waikar, M. "MBSE++ — Foundations for Extended Model-Based Systems Engineering Across System Lifecycle". 26th Annual INCOSE International Symposium (IS 2016) Edinburgh, Scotland, UK, July 18-21, 2016

1. Heterogeneous and Decentralized Data
2. Capturing and Maintaining High-Level System Architecture
3. Spectrum of Model-Based Connections
4. Unified Framework for Model-Based Connections
5. From Traceability to Impact
6. Many Users, Many Views

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Model-Based Connection Patterns

- What is the purpose of model-based connections?

Reference Connections
Track/compare/sync versions of connected elements

Data Map Connections
+ Track/compare/sync element attributes

Function Wrap Connections
+ Track/execute connection elements
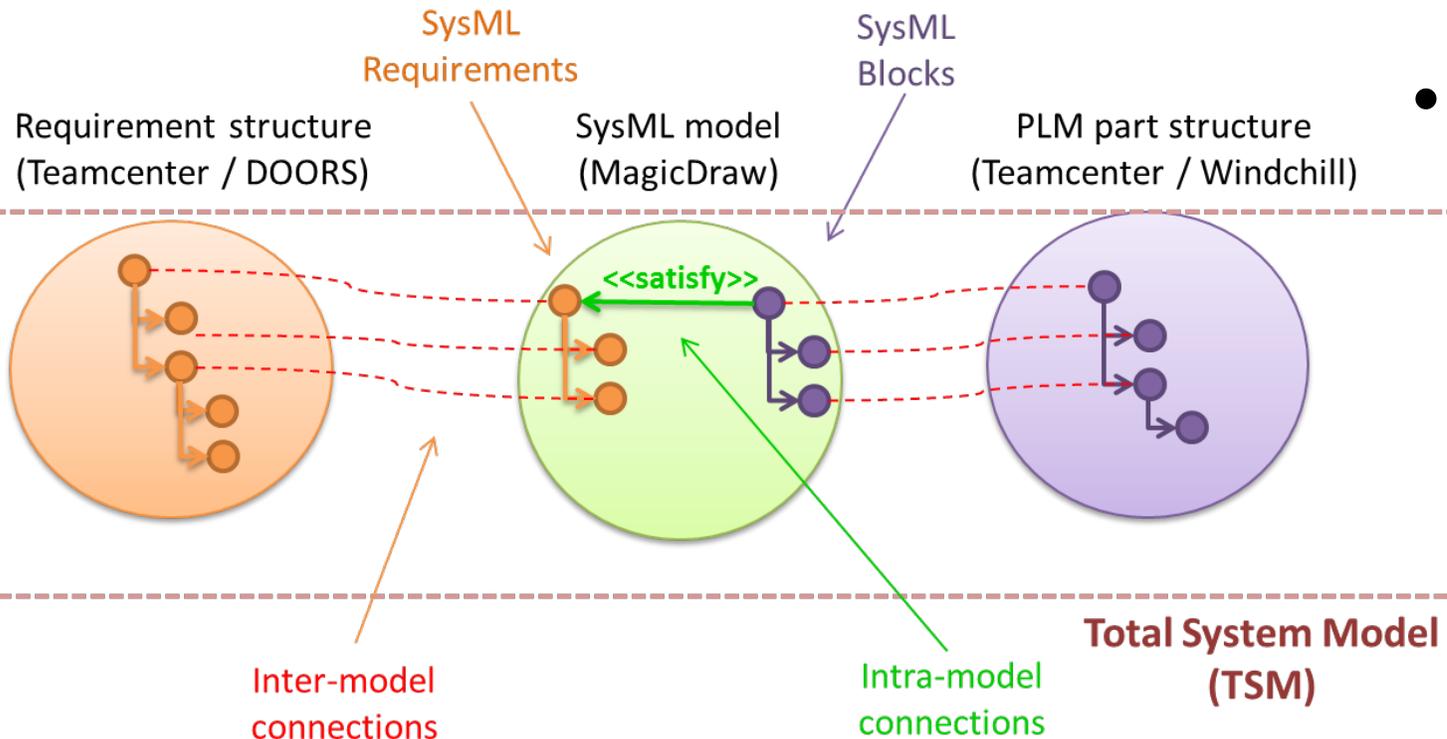
Model Transform Connections
+ Track/compare/sync element structure (multi-level)

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Intra-Model and Inter-Model Connections

- Model-based connections are building blocks of interoperability

- Types of connections
  - **Inter-model** connections are between elements in different models / tools e.g. SysML block – PLM part
  - **Intra-model** connections are between elements in same model / tool, e.g. SysML block – SysML requirement

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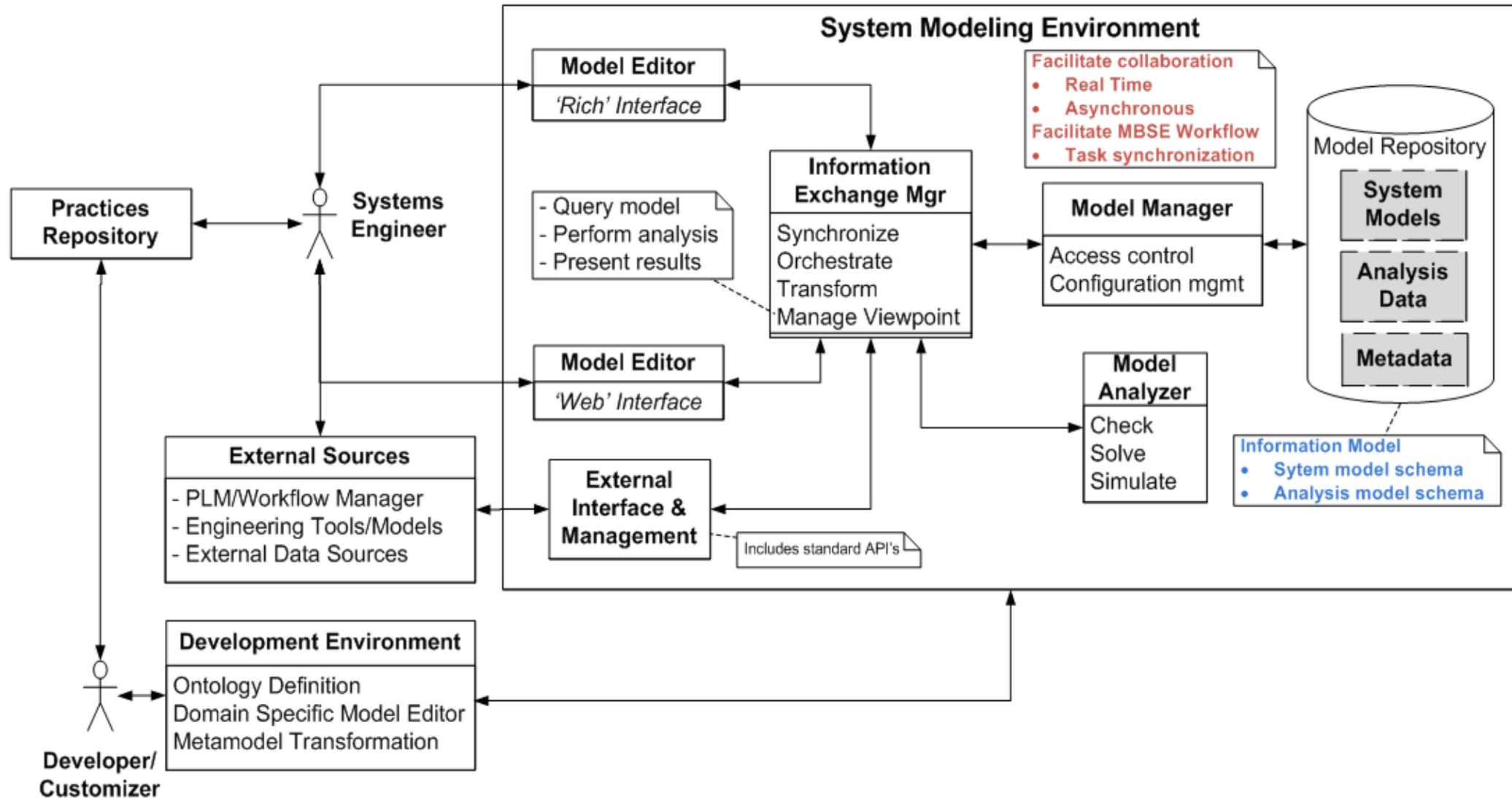# Syndeia = Software Platform for MBSE++
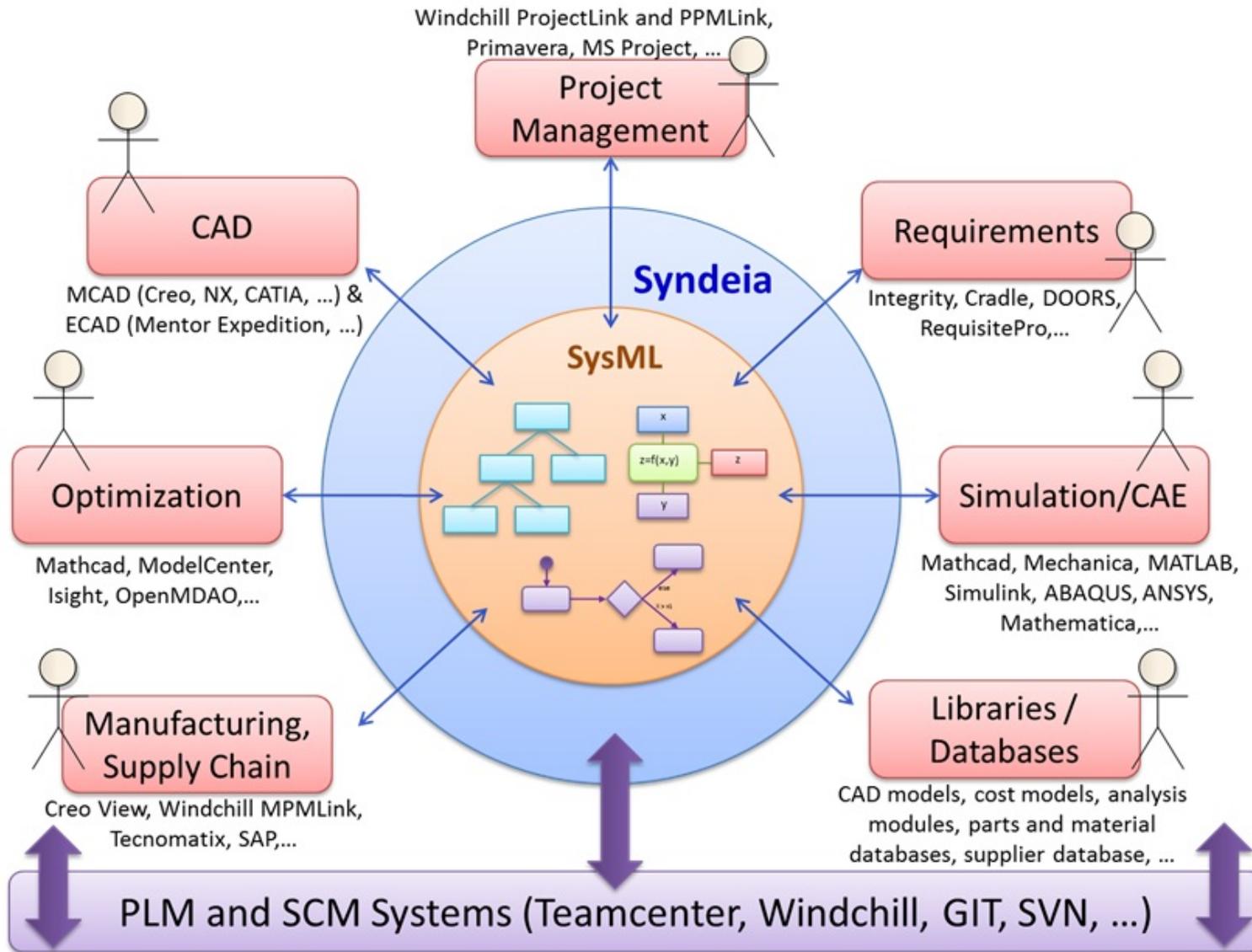
Search, Connect, Access, Transform, Compare, Sync, Visualize models in the TSM

We will Illustrate 6 principles of MBSE++ using Syndeia

Syndeia 3.0 released July 2016 – www.syndeia.com

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System Modeling Environment (SME) - SysML 2.0 WG

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Syndeia Demonstration

In this demonstration, you will see clear examples of:

1. Total System Model Interfaces, Repositories, APIs
2. Total System Model Construction
3. Total System Model Management & Config. Control
4. Total System Model Visualization
5. Total System Model Analysis

Sam's Challenge
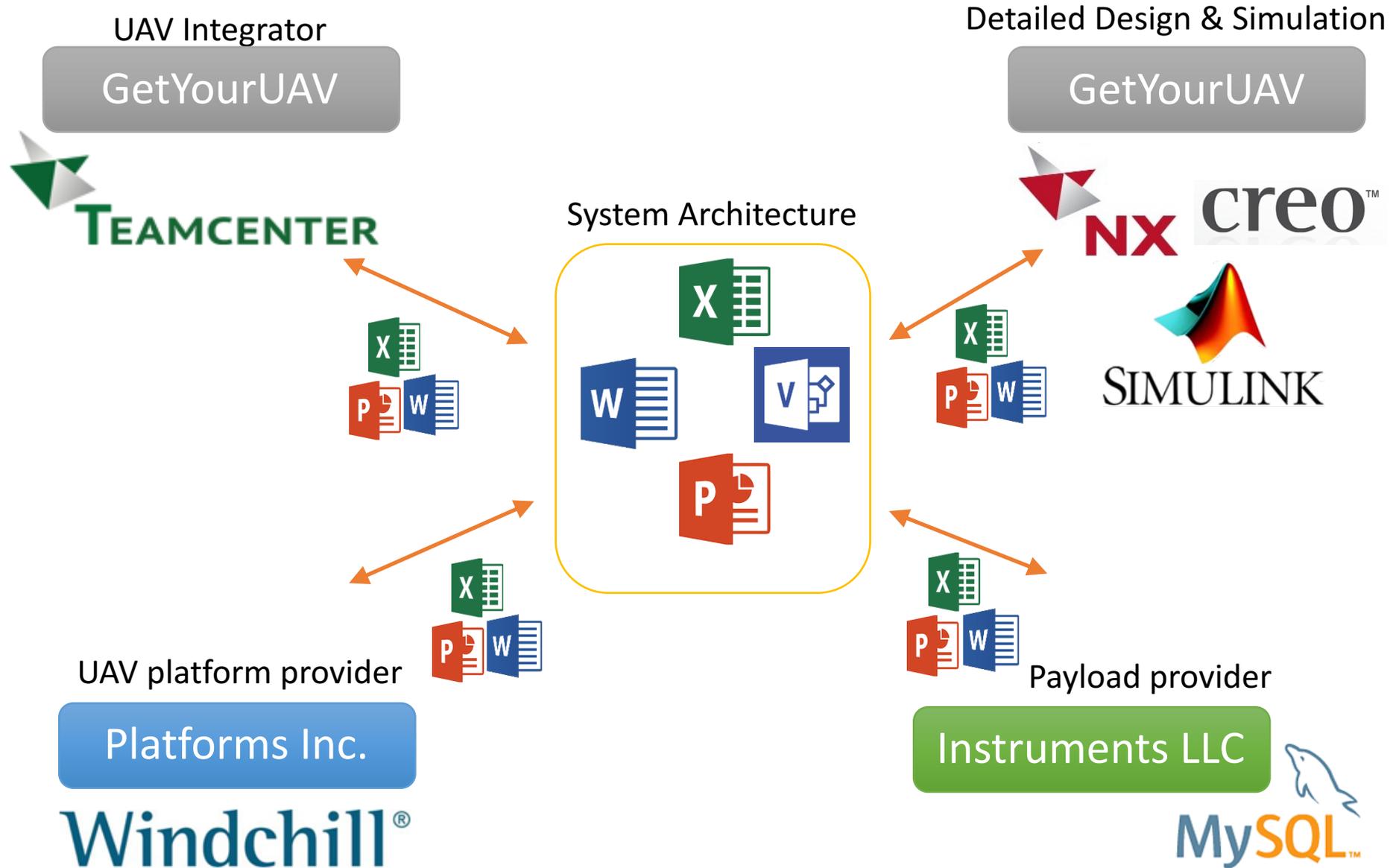## Diverse set of modeling & simulation software, databases, & repositories
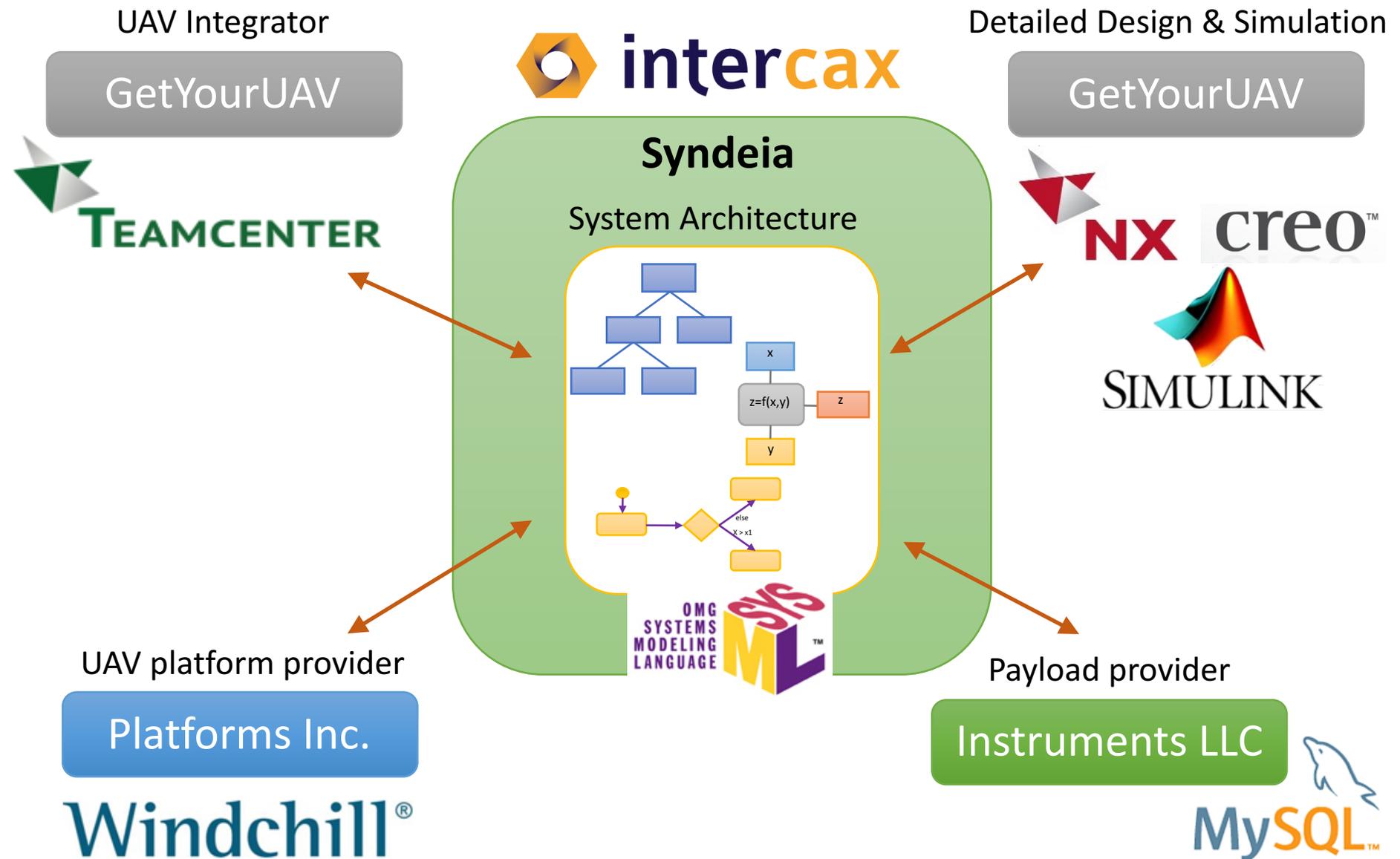

Sam wishes to do

- System engineering
- Modeling & simulation
- Model reconciliation
- Model communication
- Document exchange

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Sam's Current SE Environment

UAV Integrator

GetYourUAV

Detailed Design & Simulation

GetYourUAV

System Architecture

UAV platform provider

Platforms Inc.

Payload provider

Instruments LLC

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Sam's New SE Environment

UAV Integrator

GetYourUAV

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Detailed Design & Simulation

GetYourUAV

Syndeia

System Architecture

UAV platform provider

Platforms Inc.

Payload provider

Instruments LLC

Watch Demonstration Video

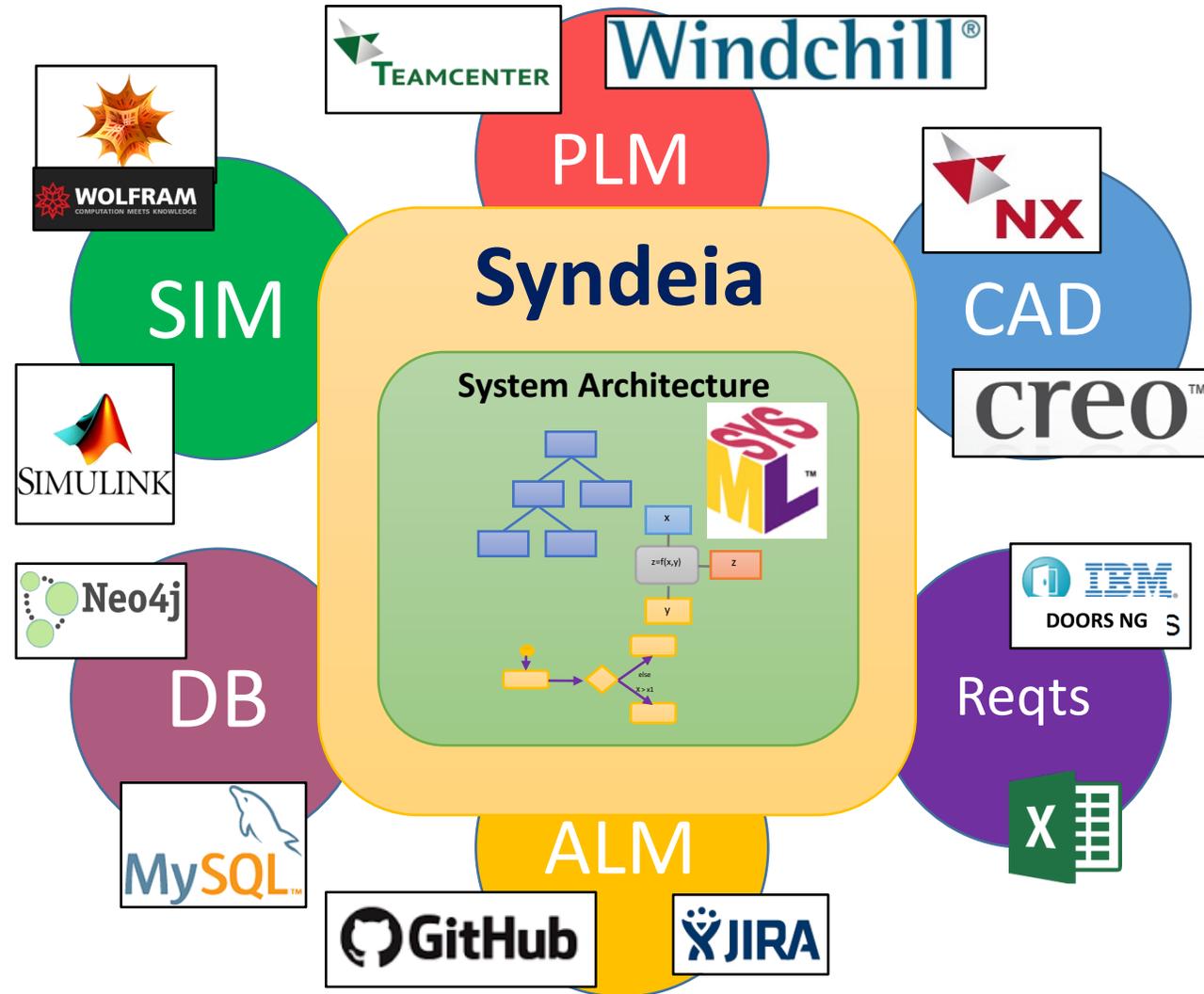- **YouTube - https://youtu.be/Fu1w6sQviko**

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Syndeia leverages open standards, open frameworks, and open APIs

- Systems Modeling Language
  - MagicDraw, Rhapsody, Enterprise Architect, Integrity Modeler
- REST Web Services
- JSON
- JDBC
- ISO STEP 10303
- Apache projects (multiple)
- OSLC
- FMI
- … and others

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Syndeia Roadmap

- **Syndeia started as a MBSE-centric tool**, deployed as a plugin for SysML Modeling tools (MagicDraw, Rhapsody,...)
  - Stores inter-model connections in the SysML model
  - Operates primarily from the SysML tool
- **Syndeia is an enterprise MBE application**
  - REST web services with a backend graph database
  - Advanced query & visualization capabilities
  - Accessible from anywhere in the tool chain (SysML, PLM, ALM,...)
  - Incorporates parametric execution and analysis
  - API for extensible end user applications
- **Syndeia 3.1 (Backend Graph Database, Fall 2016)**

Questions / Comments

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