33rd Annual INCOSE international symposium
hybrid event
Honolulu HI USA

H. Hick, S. Wartzack

Combining System Models and CAD for Change Scenario Management

Introduction

Presenters

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ime

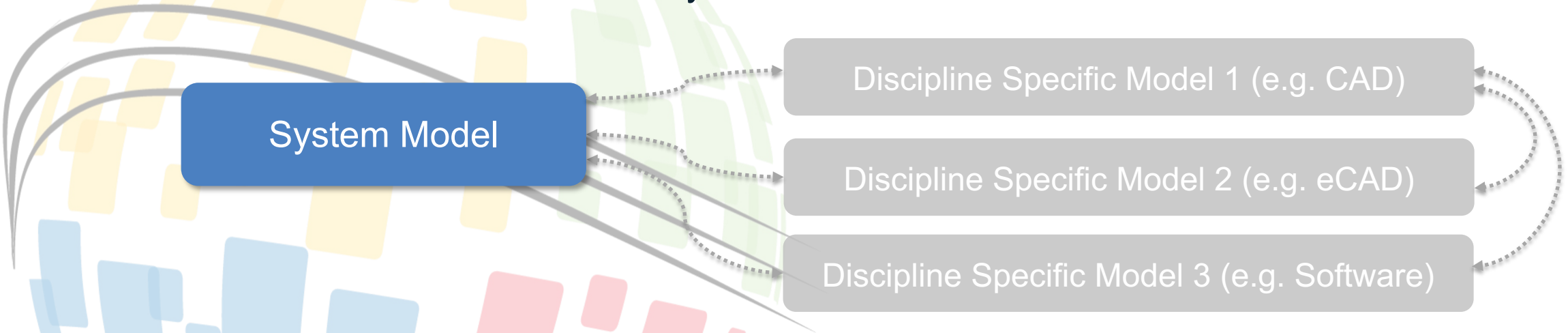
SIEMENS

The Challenge

Target: Traceability

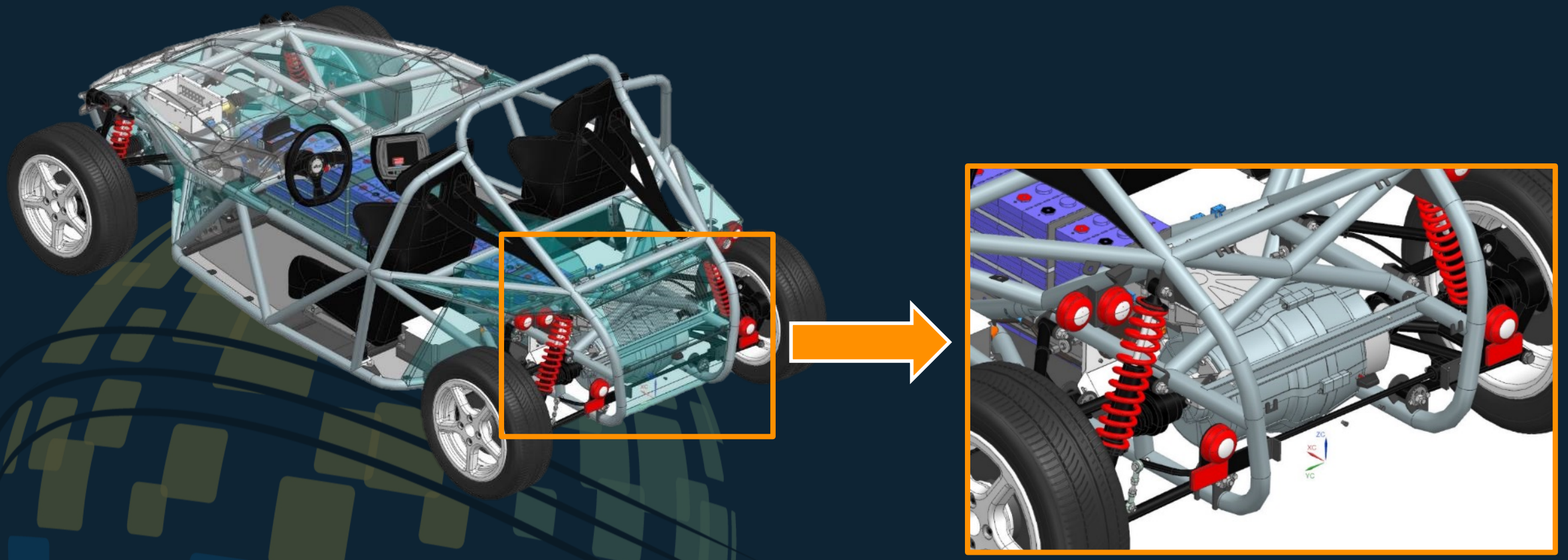
Challenge: Divergent types and forms of models generated and used by of different disciplines

- Which models are linked and in which way?
- Which system artifacts are linked?
- How can consistency be maintained?



Introduction

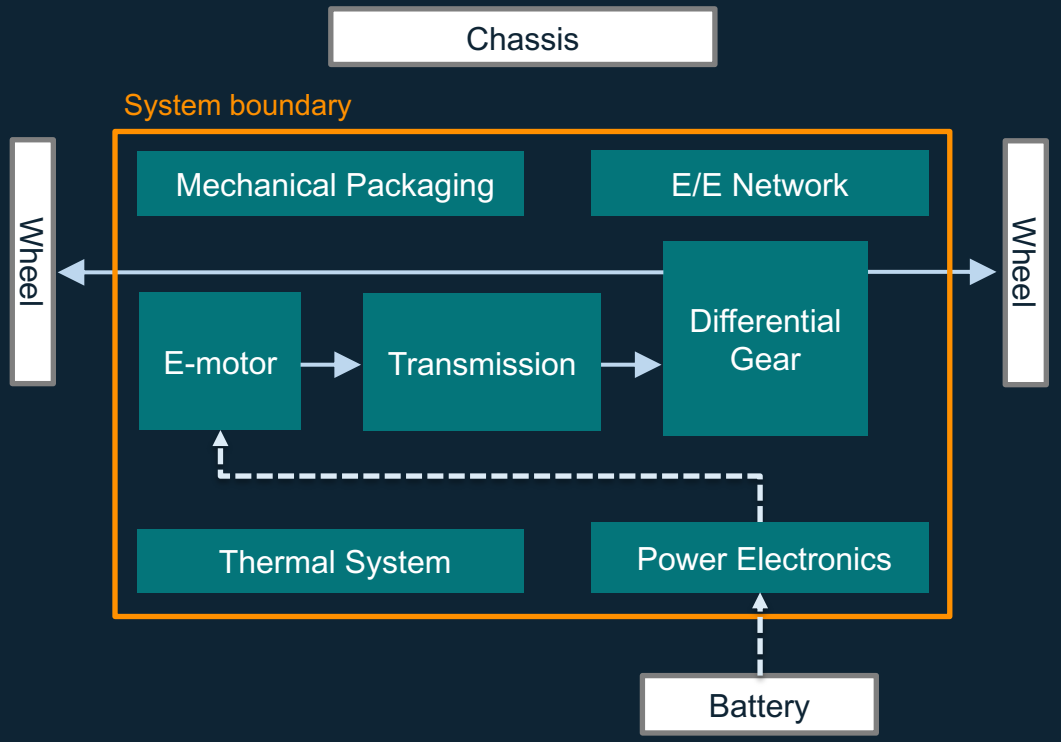
E-Axle Design as Result of Hybrid Modelling



Introduction

E-Axle & eRod Demonstrator

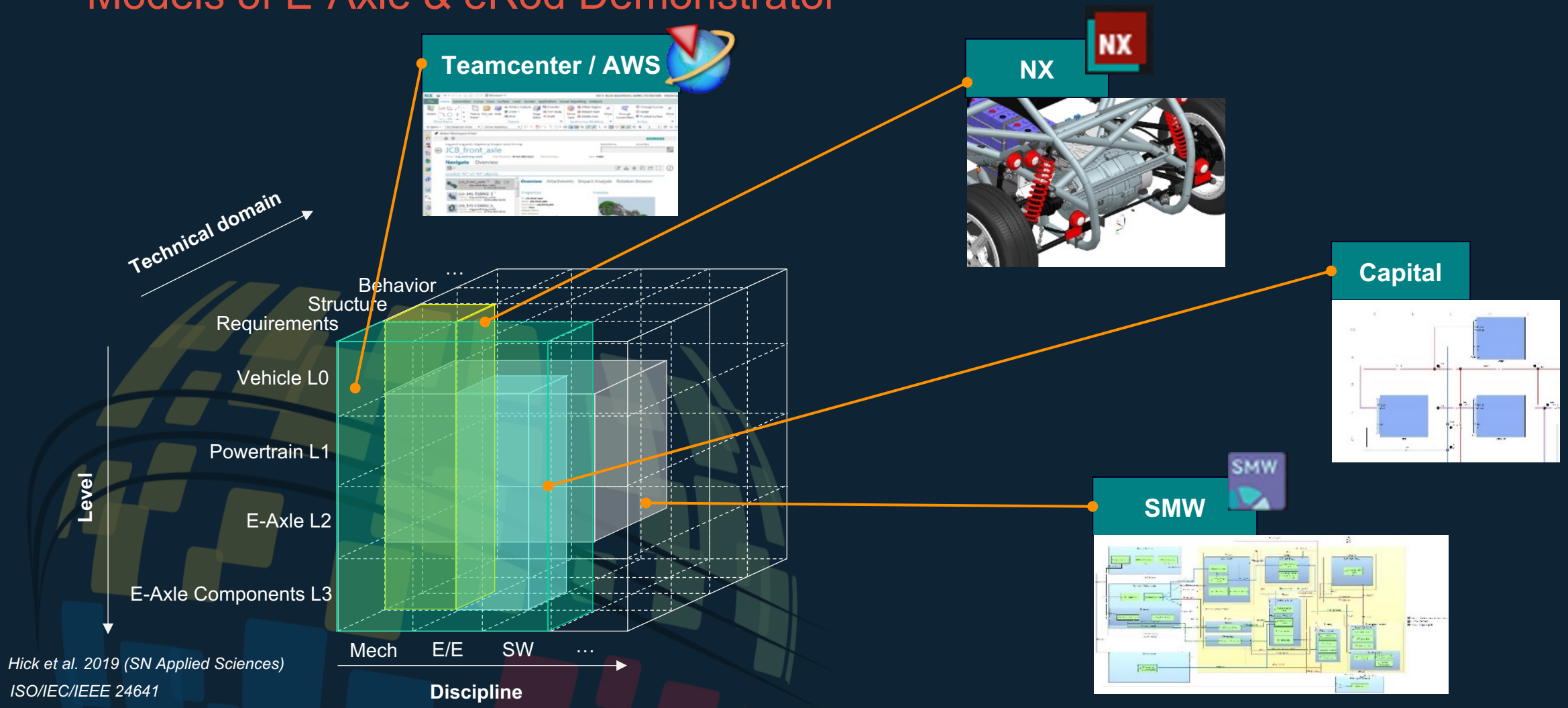
Starting point: **Siemens eRod**



Scope of modeling of a new eAxle

Introduction

Models of E-Axle & eRod Demonstrator



Hick et al. 2019 (SN Applied Sciences)

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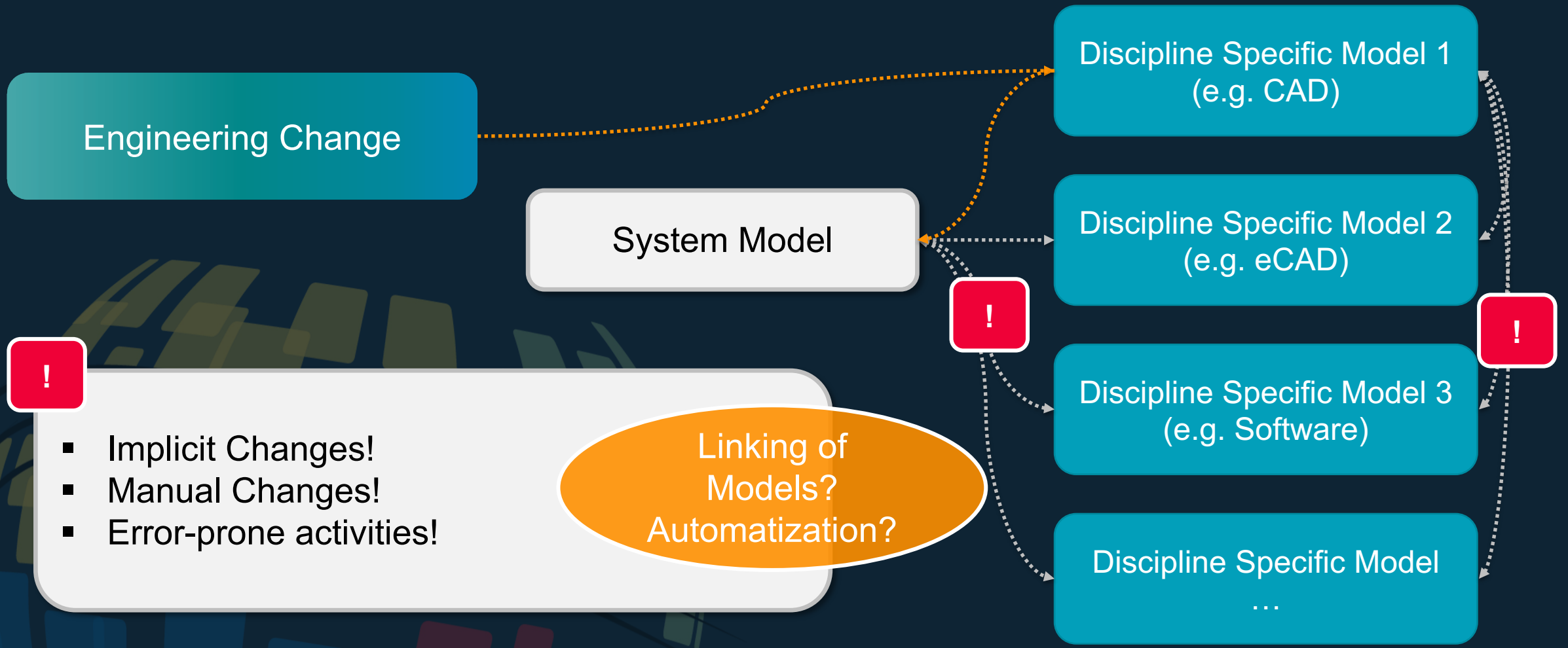
Engineering Change

Motivation



Motivation

Theoretical approach

Activities

Requirements Engineering

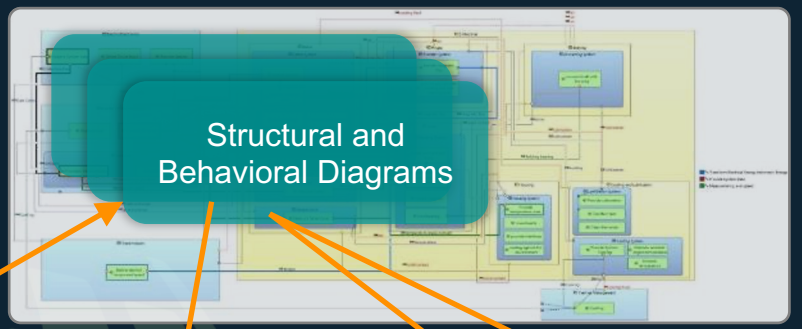
System Design

Models are linked to each other to ensure **consistency** and **traceability**

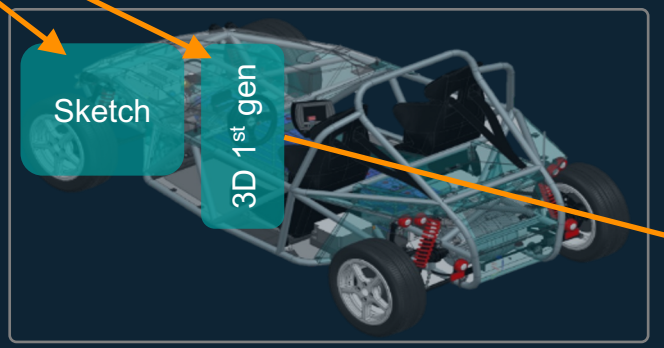
Should-be situation

Models

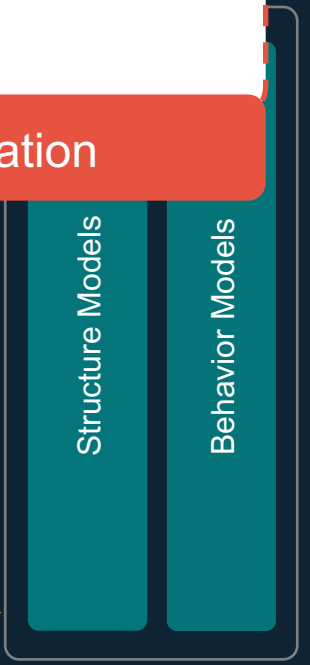
Requirements Models



eCAD Models



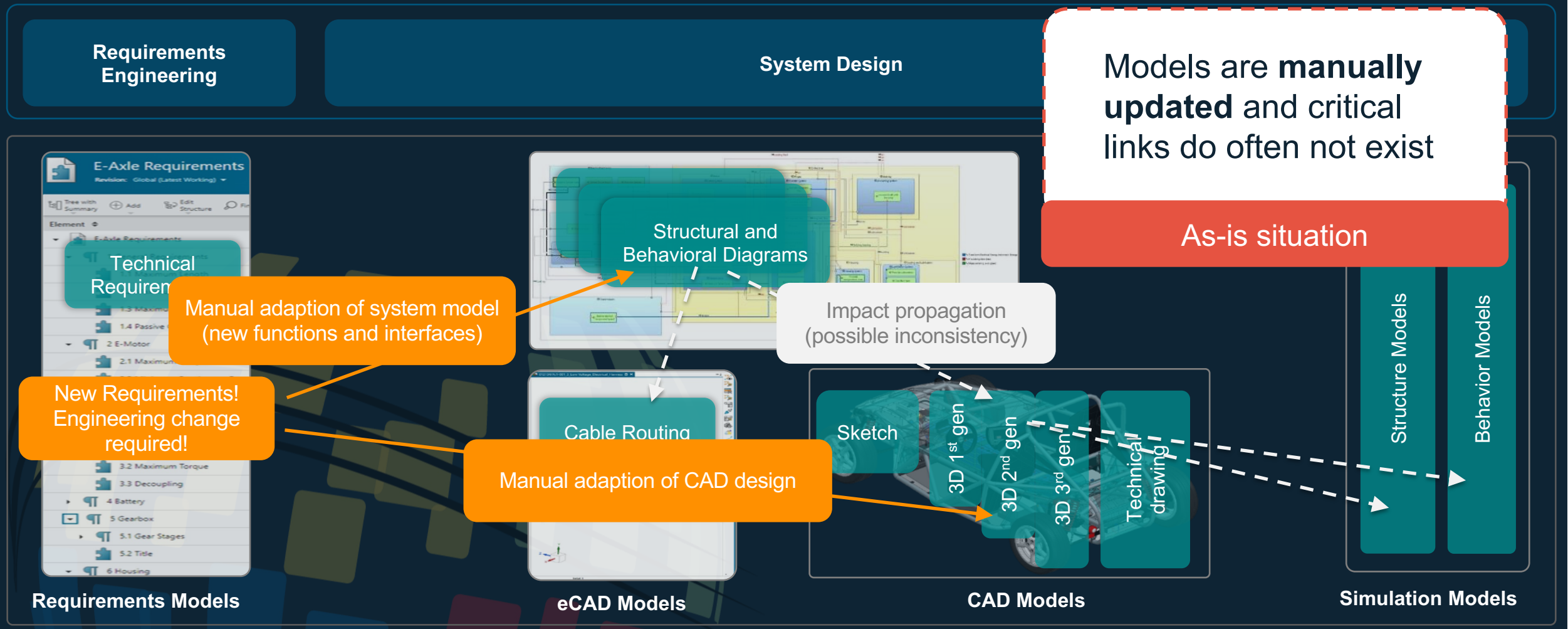
CAD Models



Simulation Models

Motivation

As-is situation

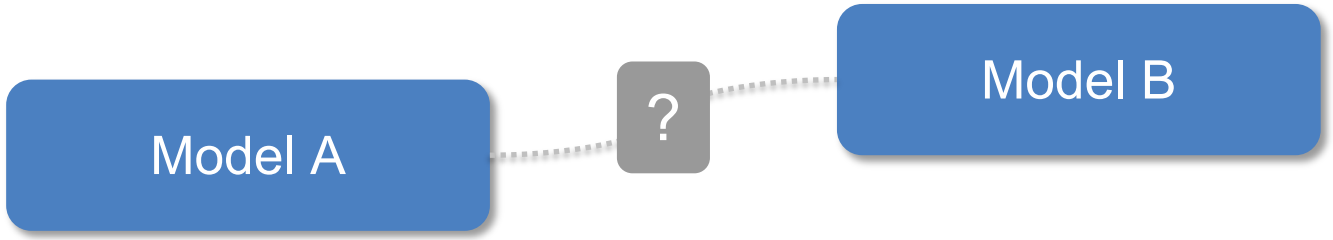


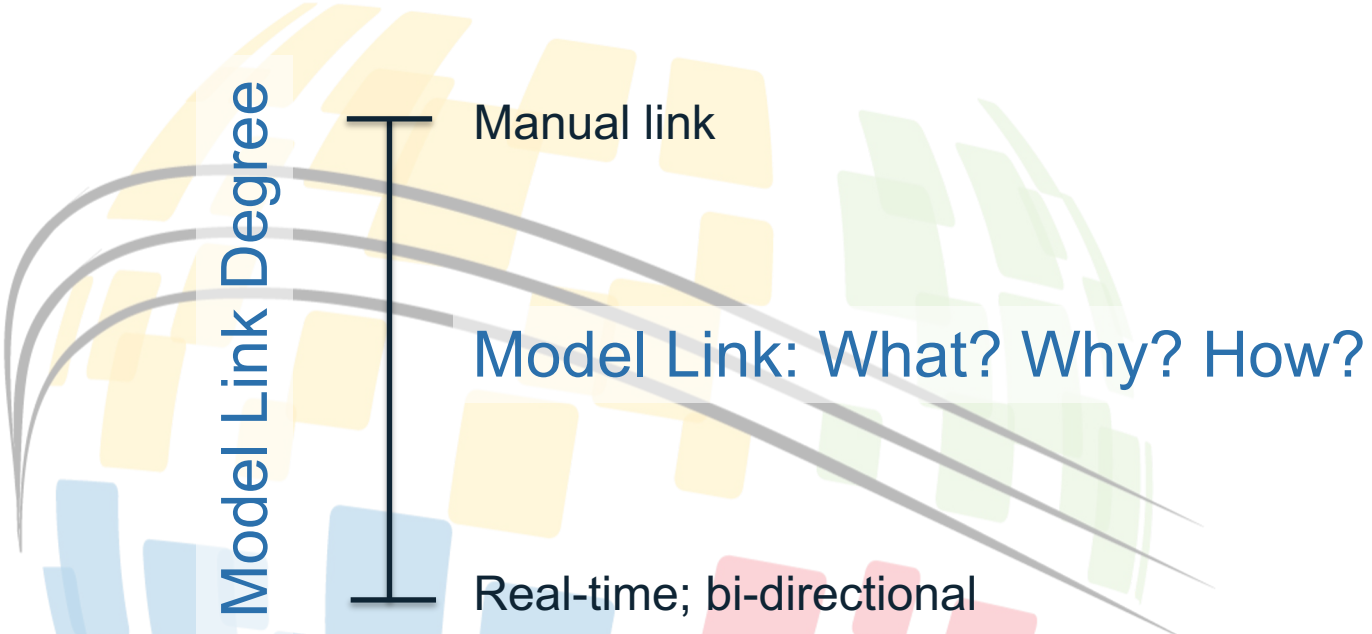
Models are **manually updated** and critical links do often not exist

As-is situation

Model Linking

Fundamentals





Model Link: What? Why? How?

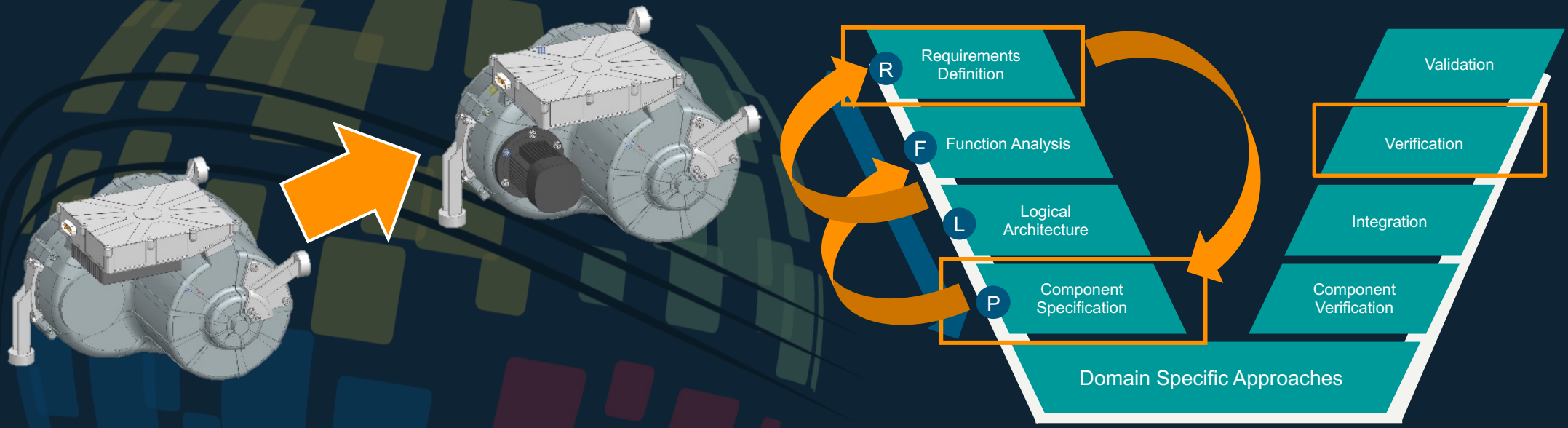
Link artifacts that have to be linked in order to serve the engineering purpose
not those that could be linked

Chosen approach

Analysis of Model Links

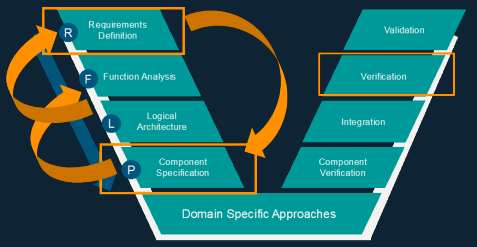
Change scenario to evaluate traceability & consistency

Requirements	Functions	Logical	Physical
Change of required eAxle cooling power	New functions required due to change of cooling	Additional logical system required to fulfill functions	New physical components and adaption of existing components



MBSE Tool Landscape

Implications & Exchanges I/II



Product Lifecycle Management Tool | **System Modeling Tool** | **eCAD Tool** | **CAD Tool**

R — Capabilities & Use Cases

F — System Functions

L — Logical Functions

P — Physical Architecture

Ensure consistency between different layers of the system model

Indirect Linking

More detailled tool landscape in publication

MBSE Tool Landscape

Implications & Exchanges II/II

Product Lifecycle Management Tool

System Modeling Tool

eCAD Tool

CAD Tool

Transfer of functions

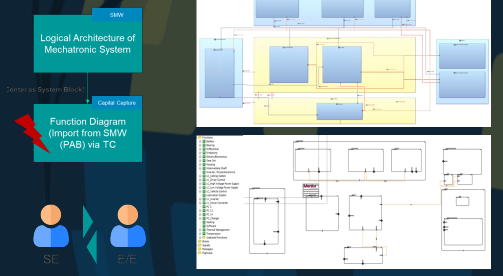
Unidirectional Model Linking

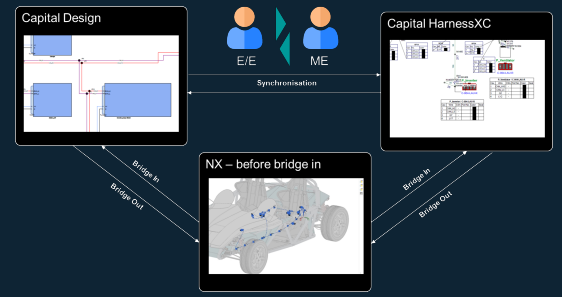
L Logical Functions

P Physical Architecture

Twinning of information in different domain specific models

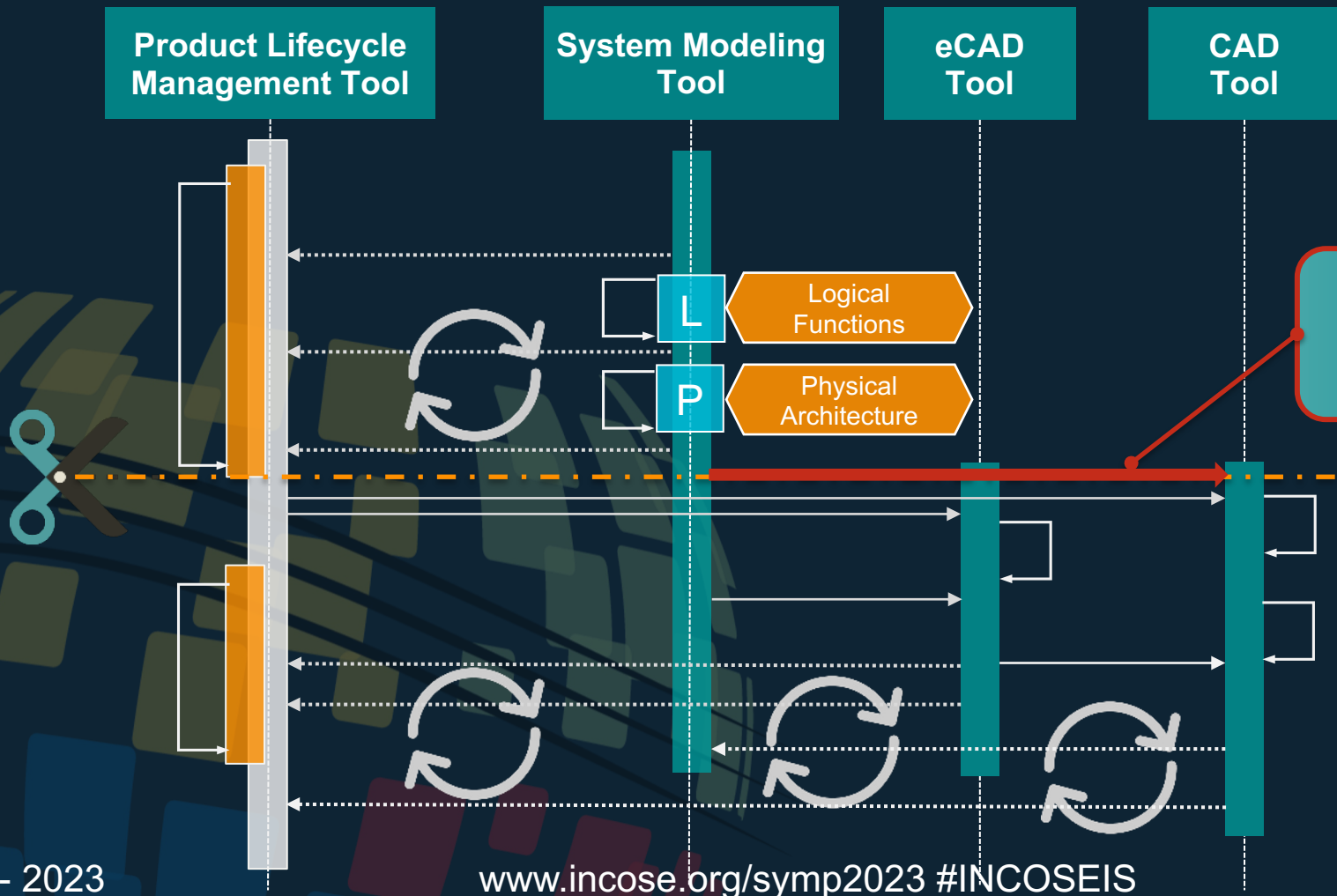
Partial Bidirectional Model Linking





MBSE Tool Landscape

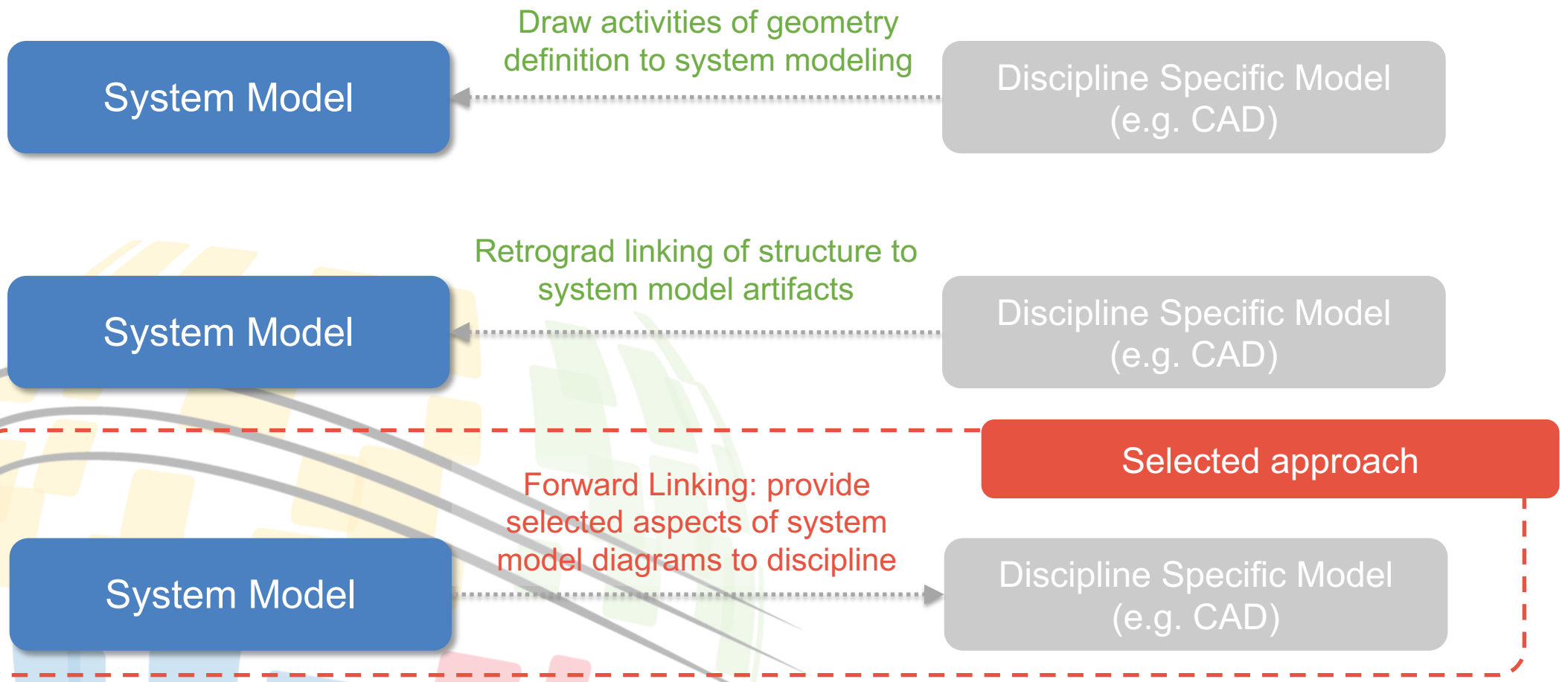
Implications & Exchanges II/II



Challenge

Traceability between System Model and CAD

Methods for Model Linking



Proposed Method

Descriptive System Model

To bridge the gap between system model and CAD, a methodical approach is defined

CAD Model(s)

Step 1:
System Model based on Process Definition

Step 2:
Filter relevant Information from System Model for CAD Design

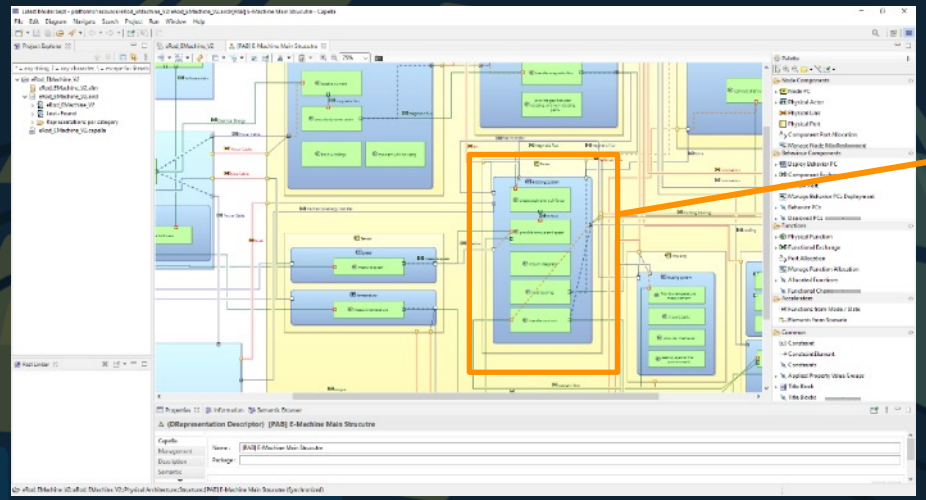
Step 3:
Provide Information for CAD Engineer

Step 4:
Exchange Information between System Model and CAD Model

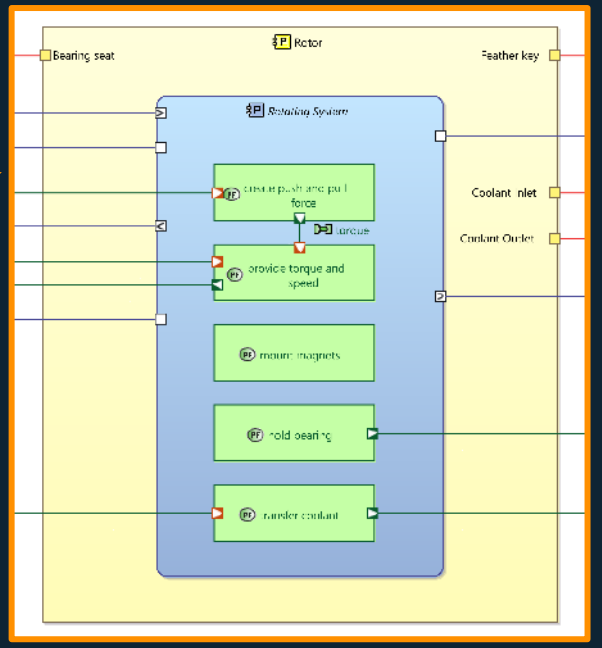
Proposed Method

Step 1: System Model Structure = f(Engineering Process)

- Engineering Process Definition?
- Which diagram provides relevant information?
- Which artifacts are relevant for the CAD engineer‘s task?

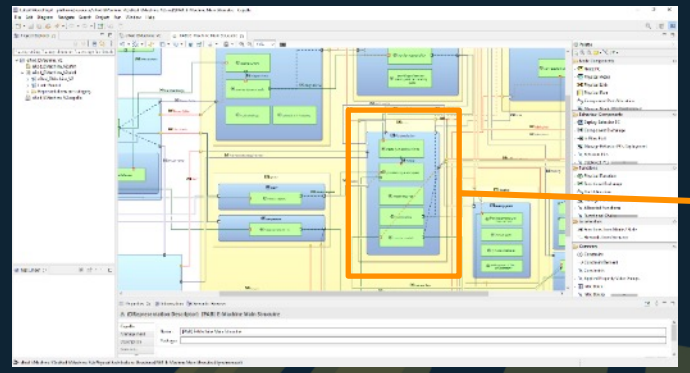


PAB diagram of SMW/Capella system model

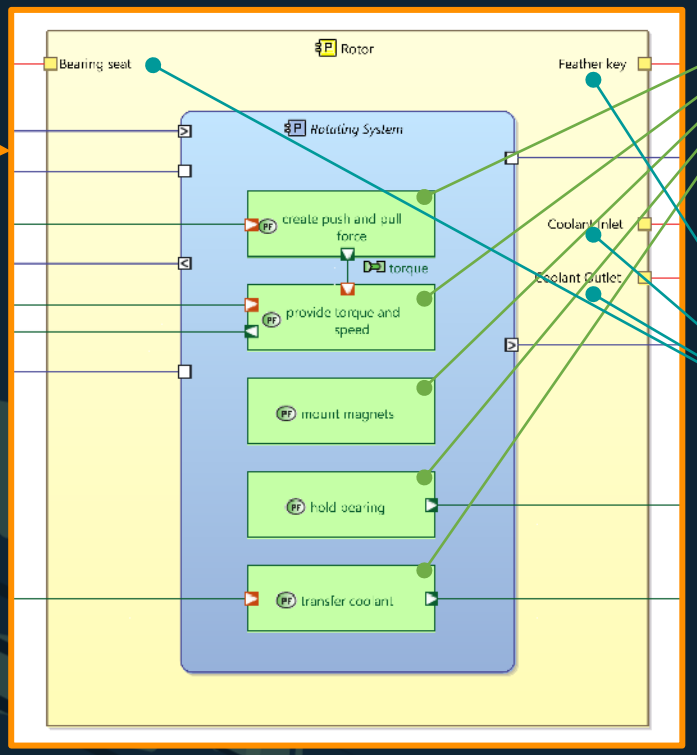


Proposed Method

Step 2: Filter Relevant Information



PAB diagram of SMW/Capella system model



Functions

- Provide torque and speed
- Mount magnets
- Hold bearing
- Create push/pull force
- Transfer coolant

External Interfaces

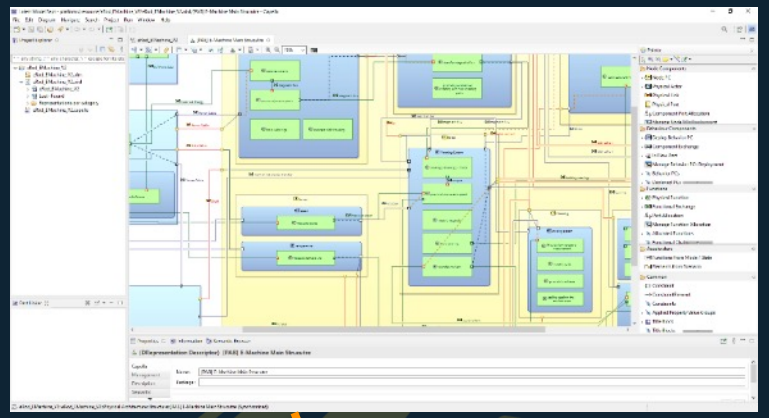
- Feather key
- Coolant Inlet
- Coolant Outlet

Internal Interfaces

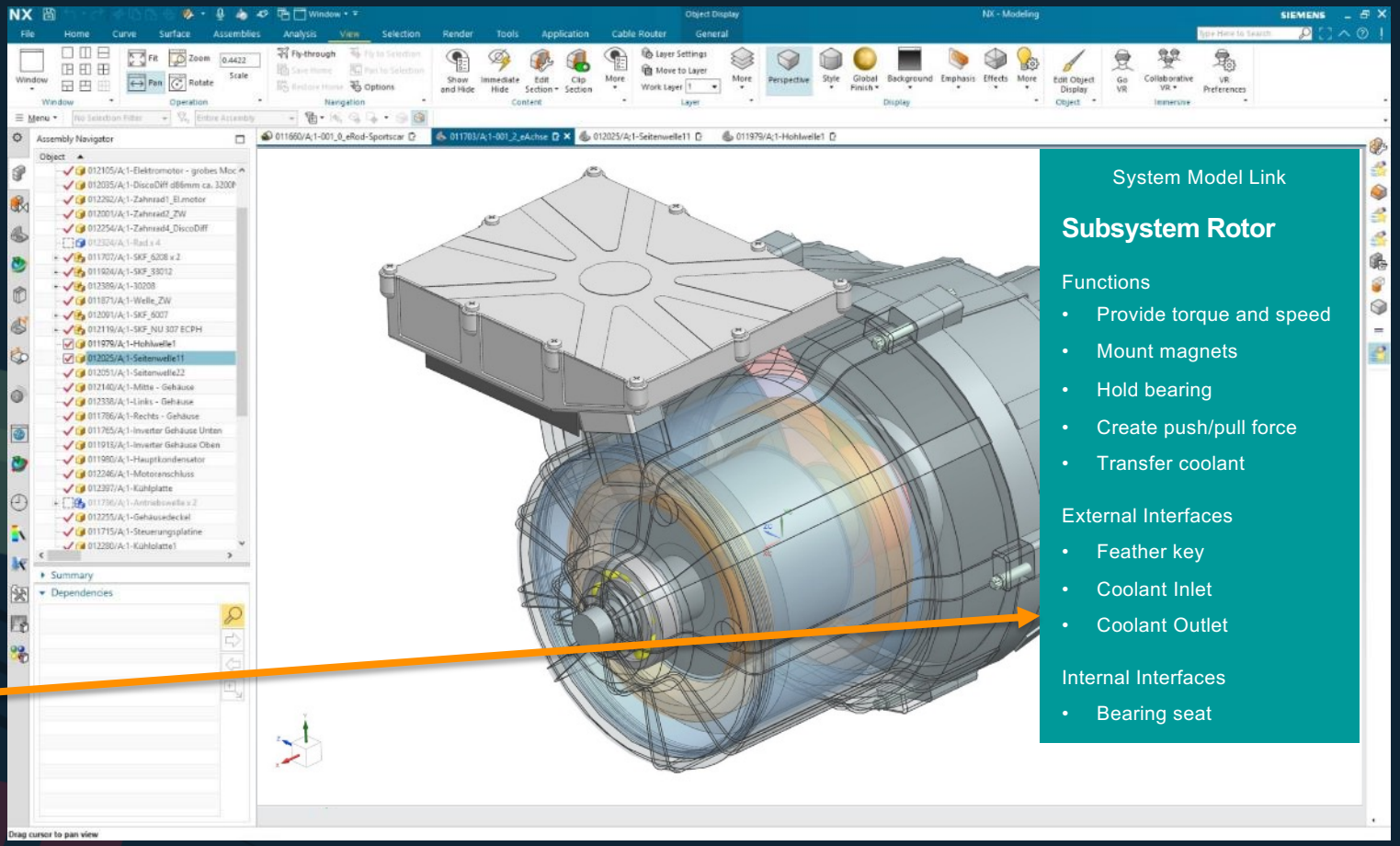
- Bearing seat

Proposed Method

Step 3: Provide Information for CAD



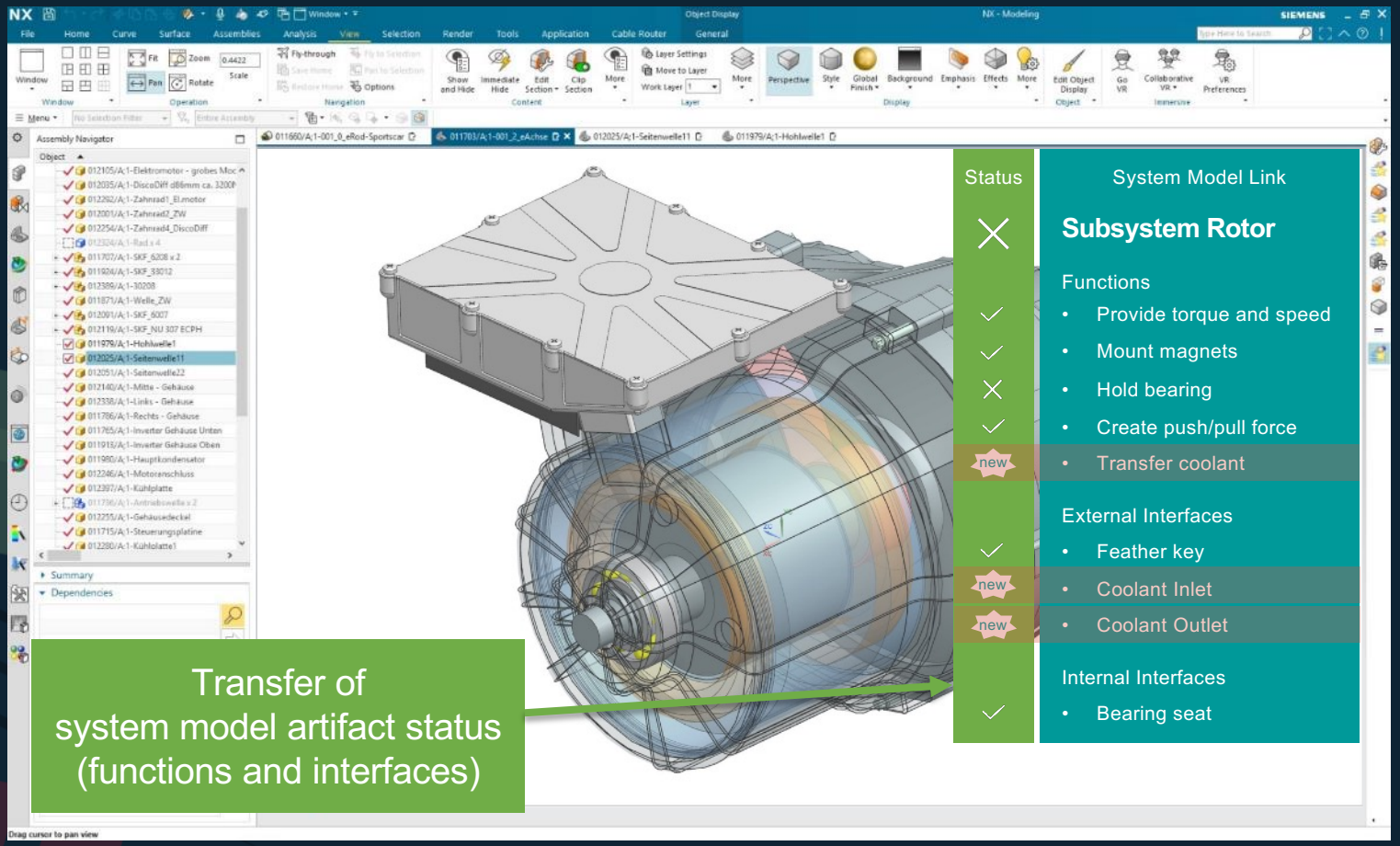
Transfer of
system model artifacts
(functions and interfaces)



Proposed Method

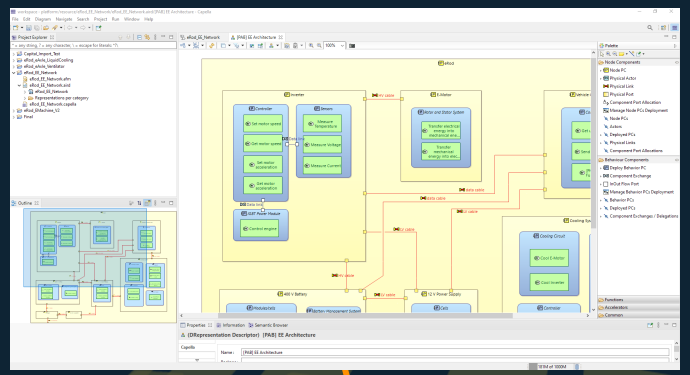
Step 4: Information Exchange (between System Model and CAD)

- System Model Update
- Cross check system model for NEW artifacts
- Design Analysis such as functional verification,....
- Provide possibility to MONITOR status



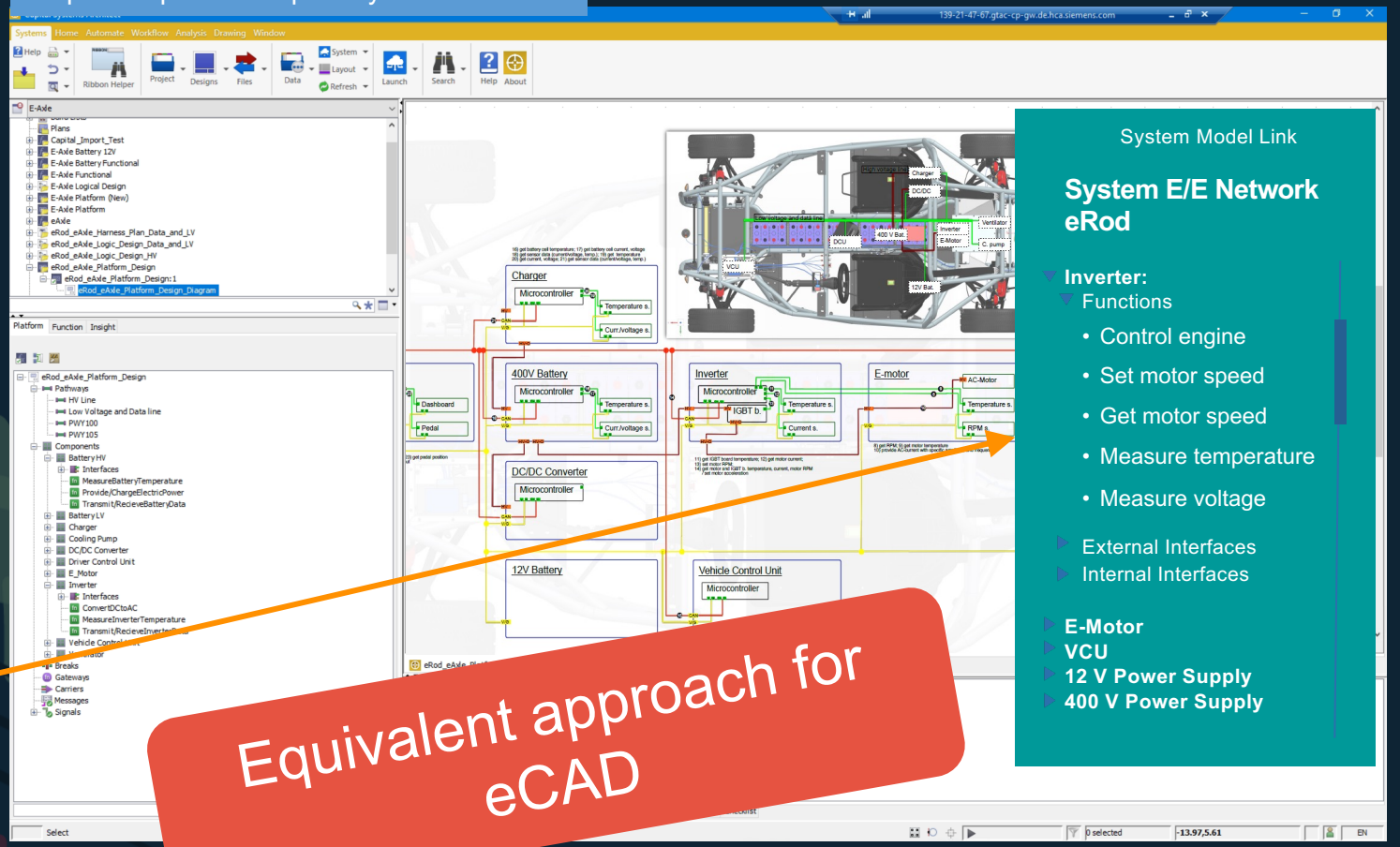
Proposed Method

Solution for Exchange between System Model and eCAD



Transfer of system model artifacts (functions and interfaces)

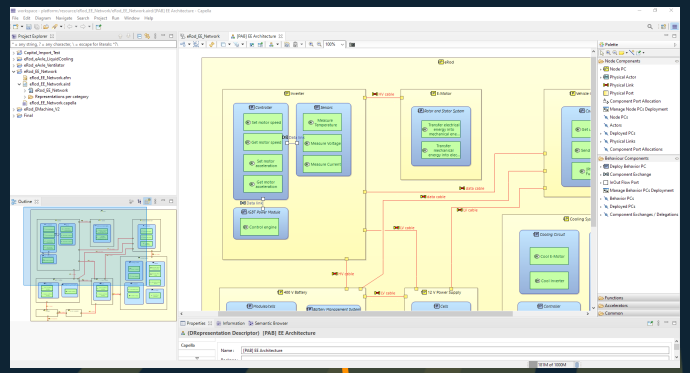
Capital Capture & Capital System Architect



Equivalent approach for eCAD

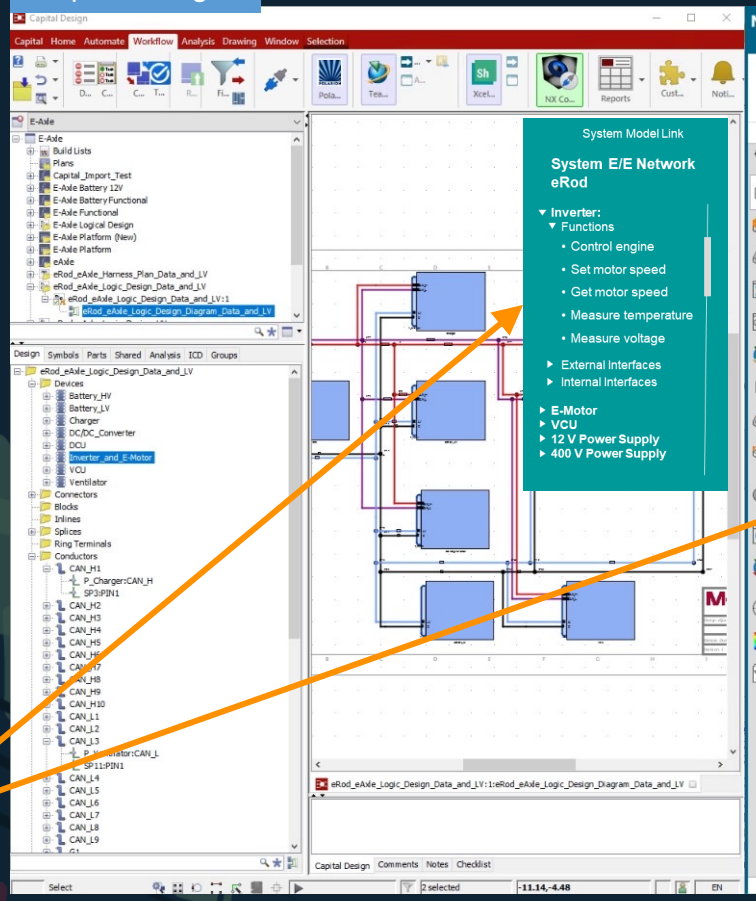
Proposed Method

Solution for Exchange between System Model, CAD and eCAD

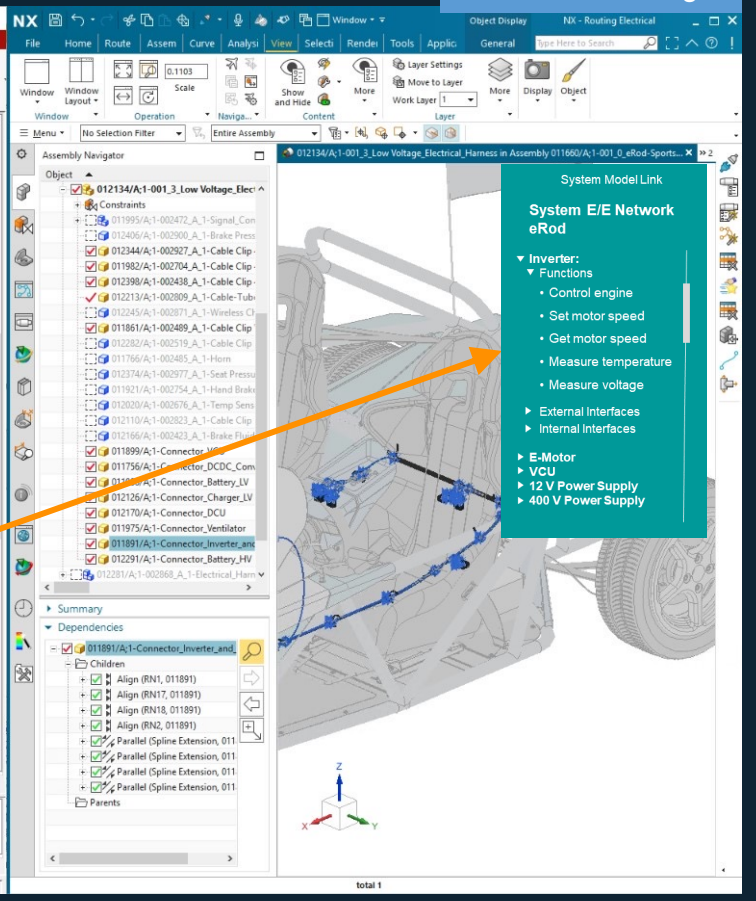


Transfer of
system model artifacts
(functions and interfaces)

Capital Design



NX Cable Routing



Summary

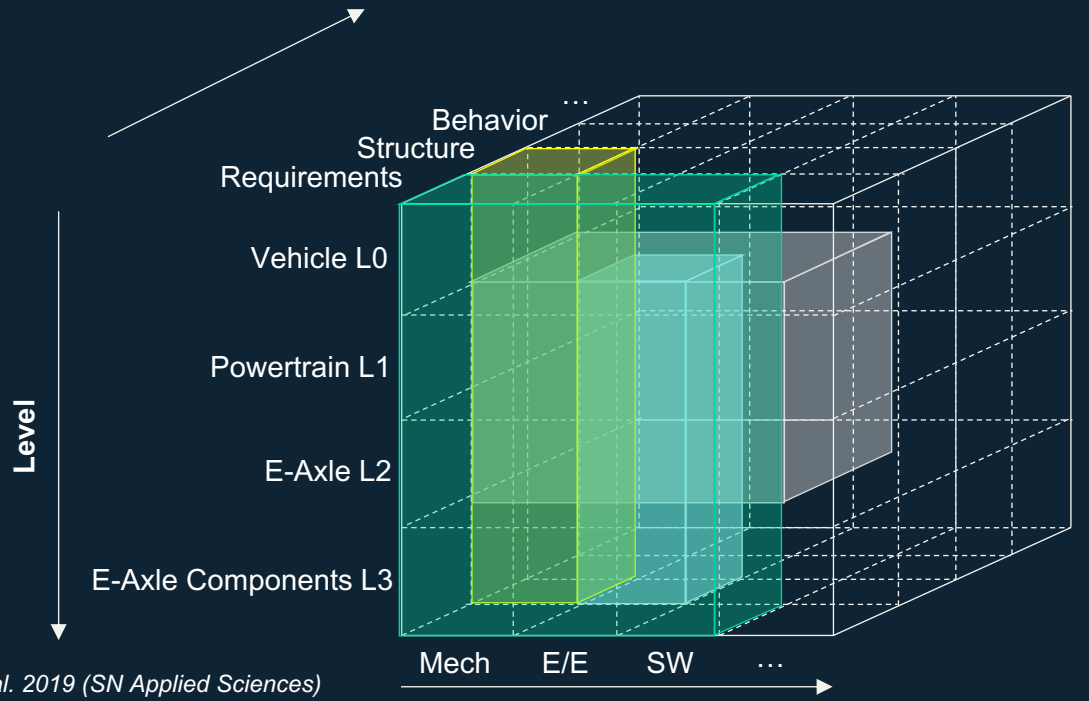
System Model Linking Method = f (Engineering Process)

- Link System Model to CAD or eCAD
- Link of System Model to PLM

Summary

Model Linking Fundamentals

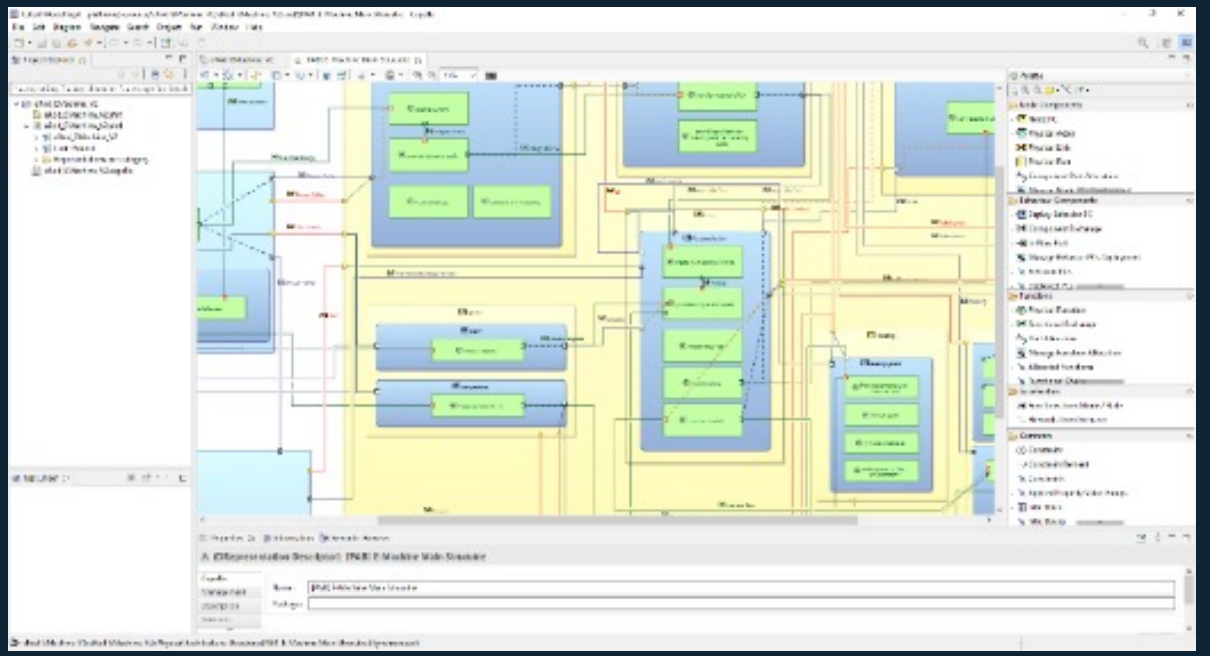
Ongoing research for a tool landscape with linked models



Hick et al. 2019 (SN Applied Sciences)

ISO/IEC/IEEE 24641

Summary



System Model Evolution

Advanced function and system modeling in general

Summary

- System Model Linking Method
- Model Linking Fundamentals
- System Model Evolution

Summary

- System Model Linking Method
- Model Linking Fundamentals
- System Model Evolution

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