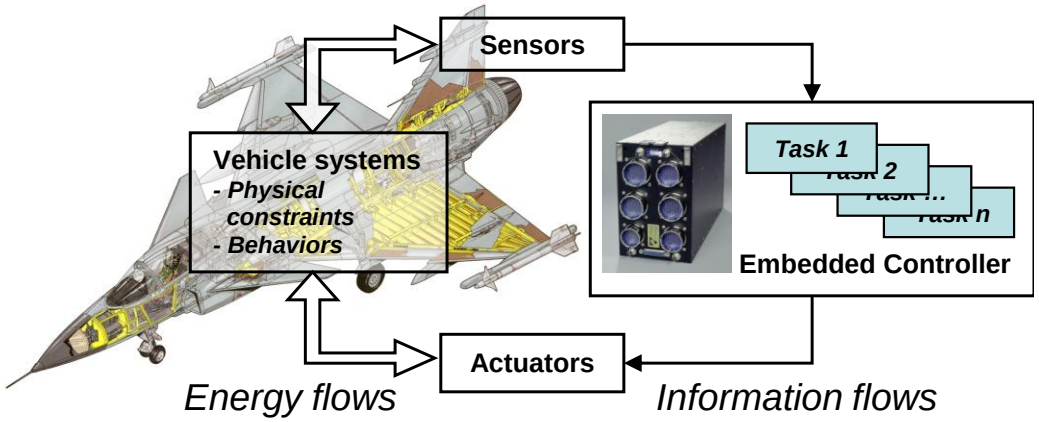
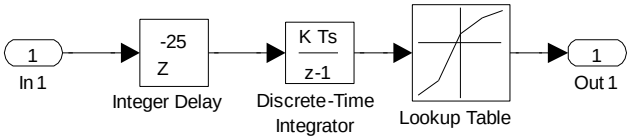
# Needs for performance of Large Scale Modeling & Simulation

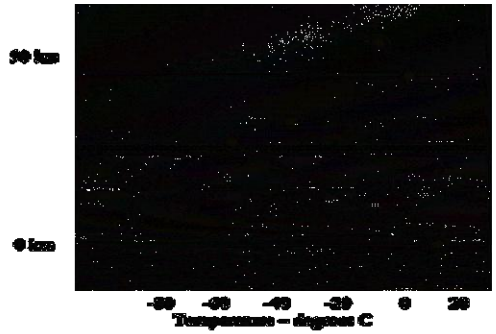
MODPROD 2010
Henric Andersson
Saab Aeronautics / IEI-LiU

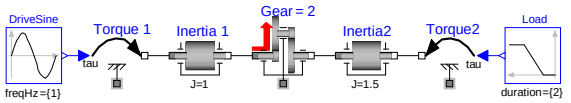
This work is related to the NFFP5 and Crescendo research programs

# MODEL BASED DEVELOPMENT

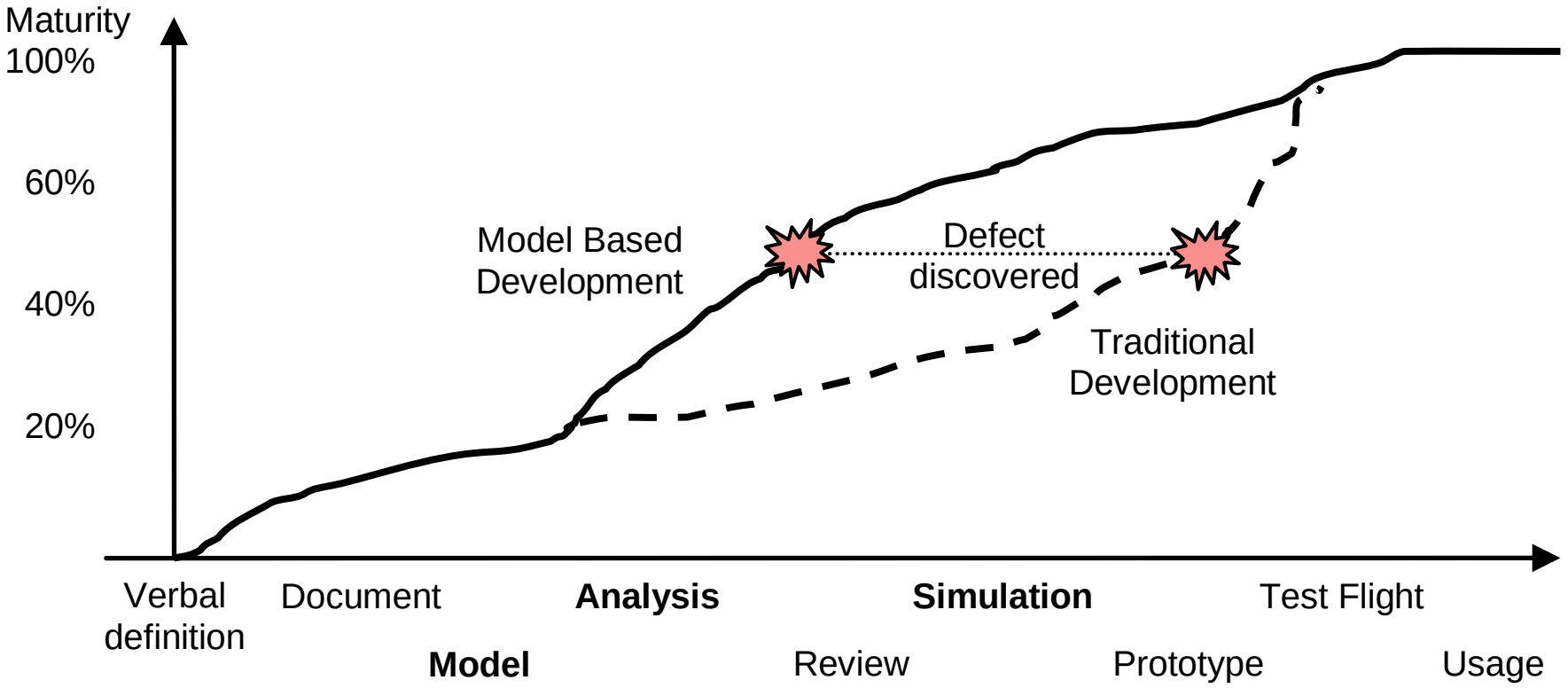




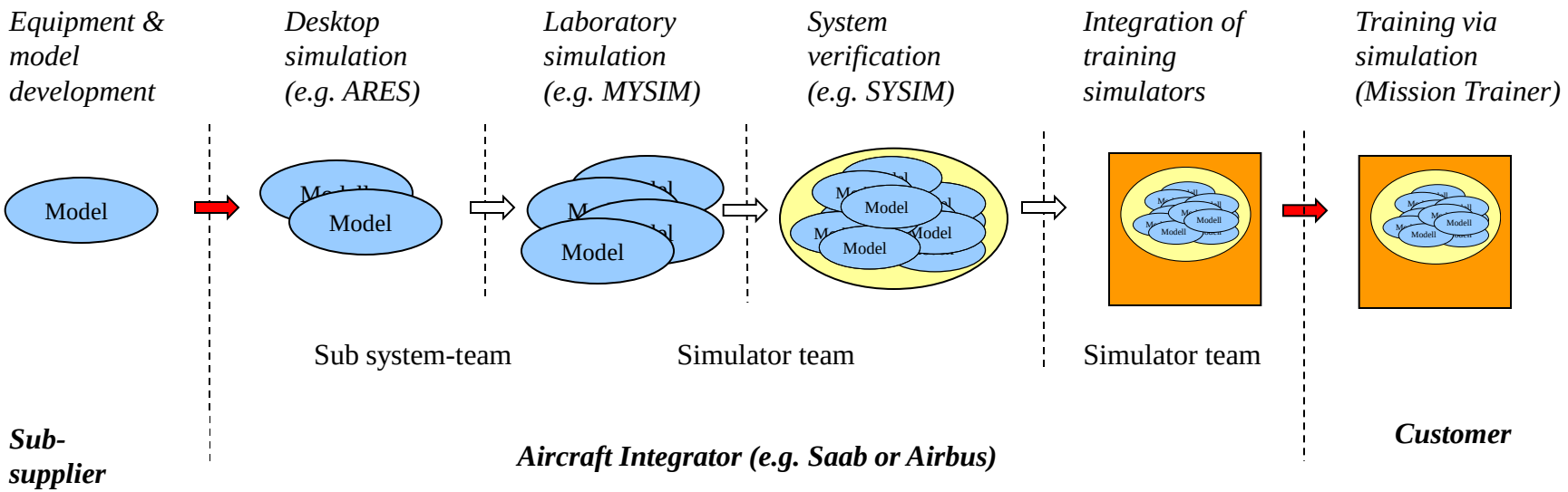
# THE VALUES OF MBD / MBSE




Modeling, simulation and analysis “get the function to mature” more rapidly compared to traditional document-centric methods

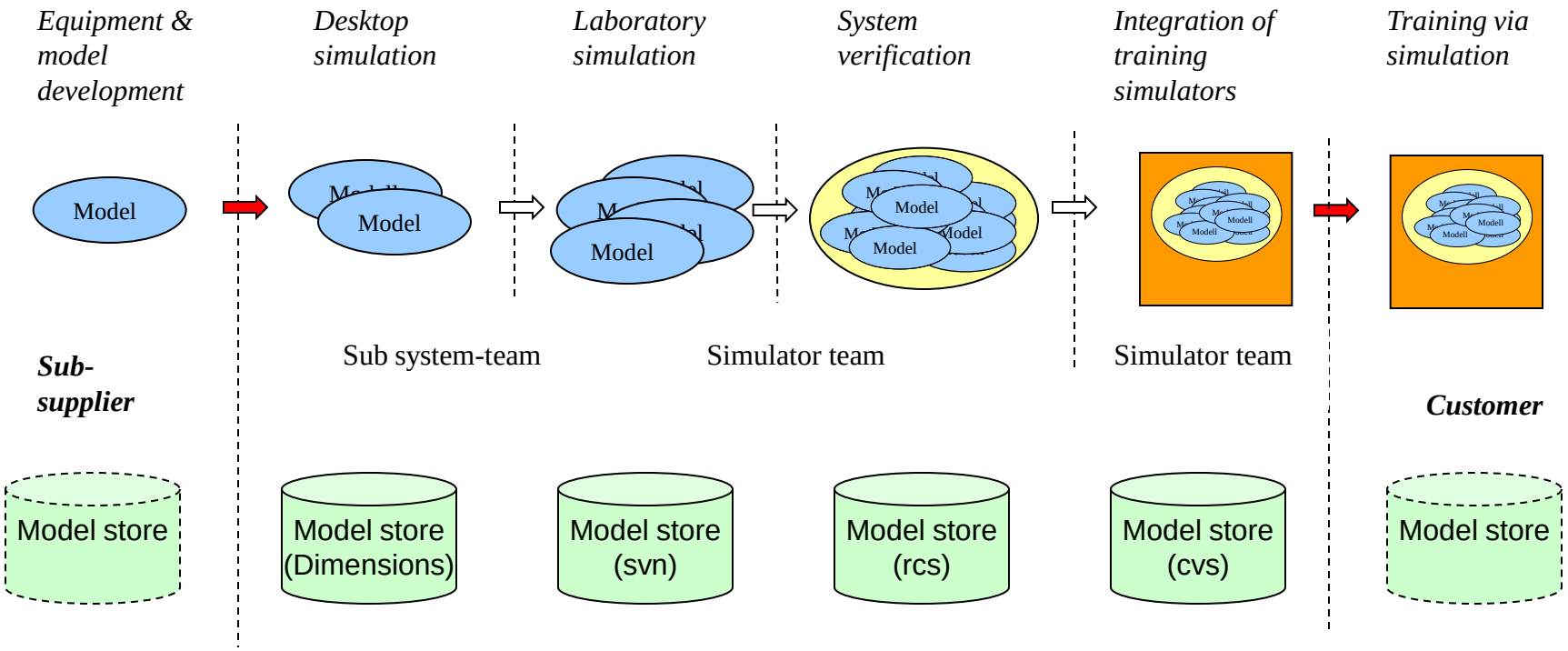
# FLOW OF SIMULATION MODELS

- Origin of models :
  - Deliverables from sub suppliers (e.g. Engine)
  - Development of  models of aircraft subsystems (e.g. Fuel system)
  - Development of simulator specific models (e.g. Servo)



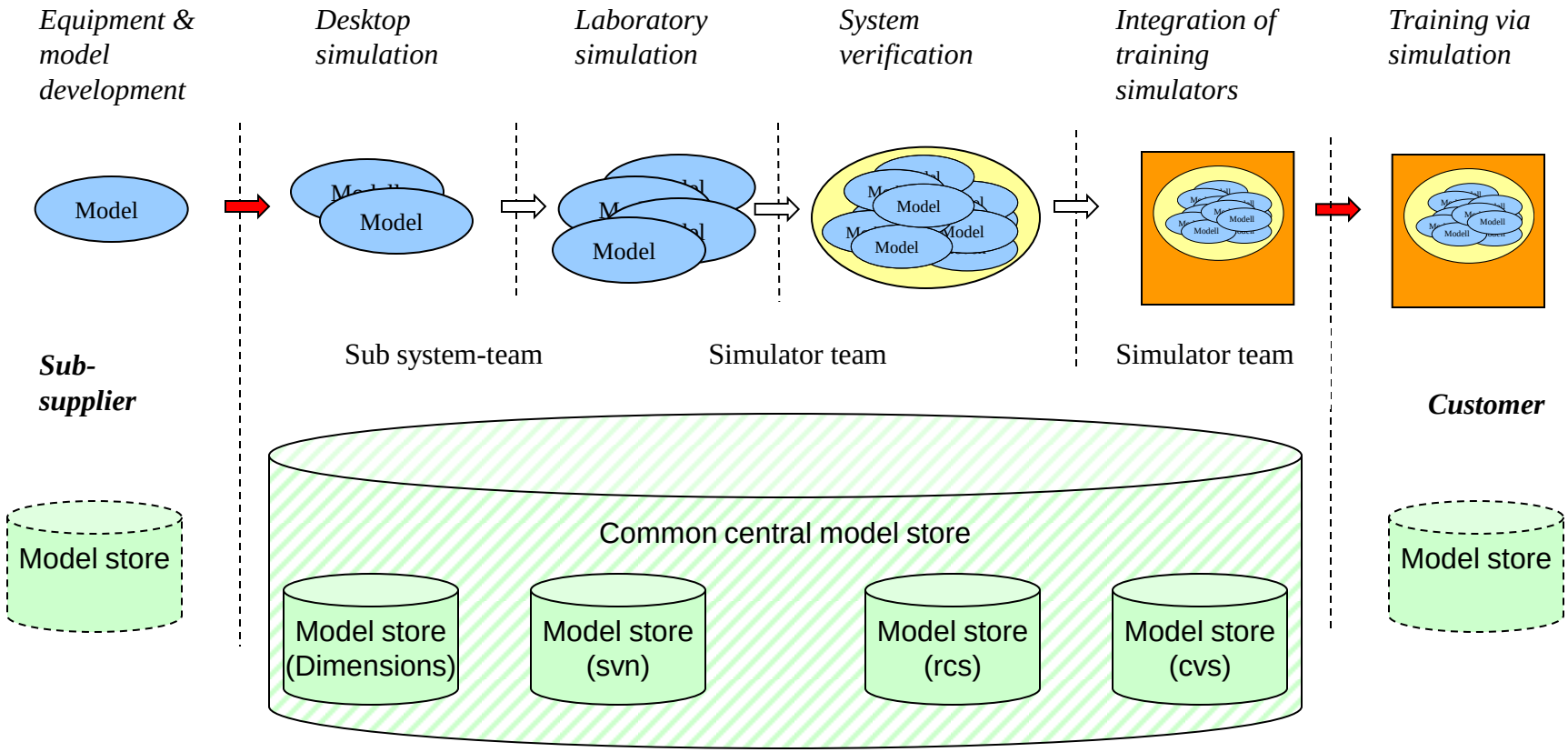
# FLOW OF SIMULATION MODELS

- Models storage – typical situation



# FLOW OF SIMULATION MODELS

- Models storage – in a common ”model store”



# CHALLENGES

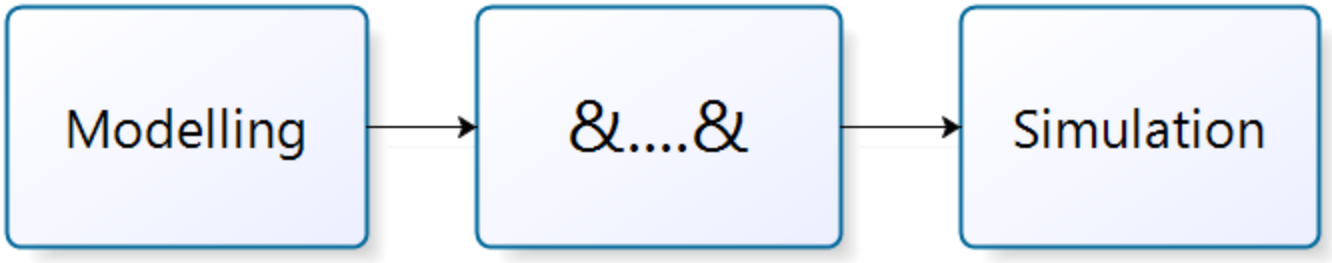
- Computer performance increases
  - enables simulation based approaches in product/systems **development**
  - simulation is used also for **verification/certification** and **training** activities

Challenges in set-up and support of large-scale simulation of a/c systems:

- Many models ~100
- Different kinds of models, e.g. environment, mechanics, electronics, software
- Variants of the systems that the models represent
- Variants of the models, e.g. different levels of fidelity
- Versions of models
- Different sets of System Parameters for parametric models
- Reuse of models between simulator types, e.g. desktop, training, verification
- Different operating systems/computer platforms for simulation execution
- Different modeling notations, languages & tools/techniques
  e.g. continuous, discrete, event-based, steady-state, dynamic

# LARGE SCALE MODELING & SIMULATION

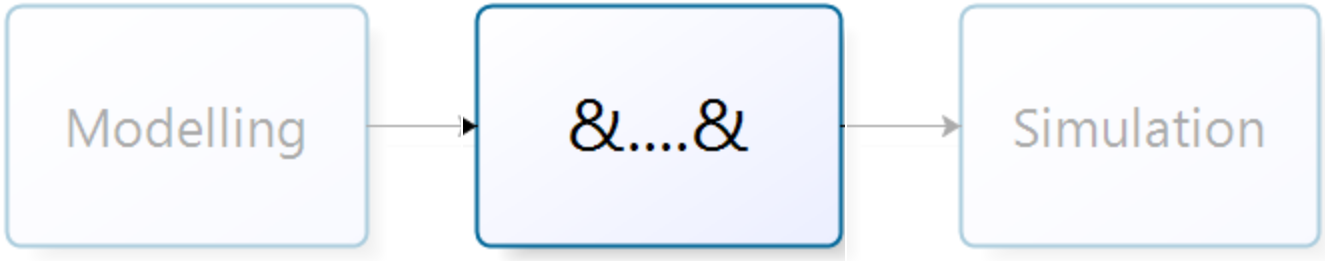
- In large scale M&S there is a need to support the activities between M and S – the &…& activities




- The process of creating simulations of the whole aircraft  from a set of subsystem models

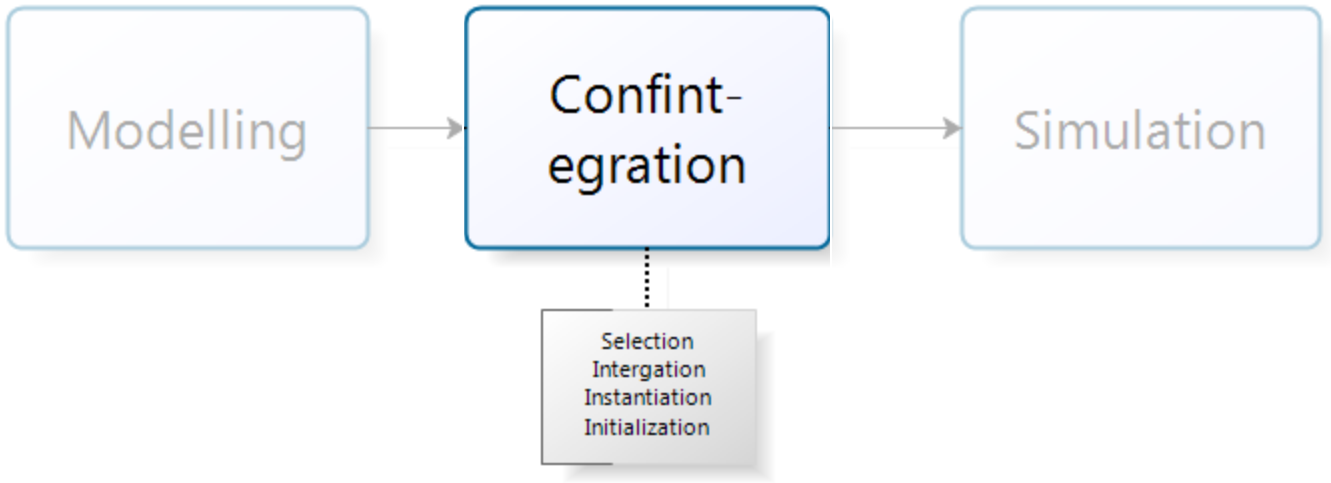
# LARGE SCALE MODELING & SIMULATION

- What are the &….& activities?




- Model characterization/declaration
- Choice of models from model store
- Configuration of models integration
- Verification of models consistency
- Build integrated model (compilation & linking)
- Instantiation and Initialization

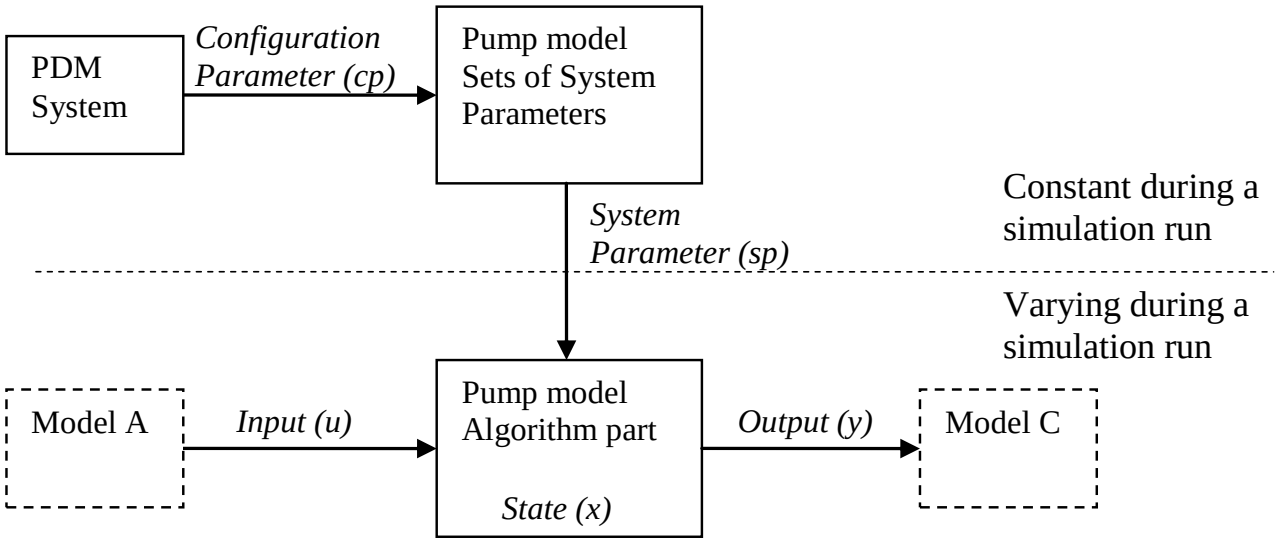
# LARGE SCALE MODELING & SIMULATION




- For simplicity we call the &…& activities the *confintegration* process

  selection, integration, instantiation & initialization during full configuration control

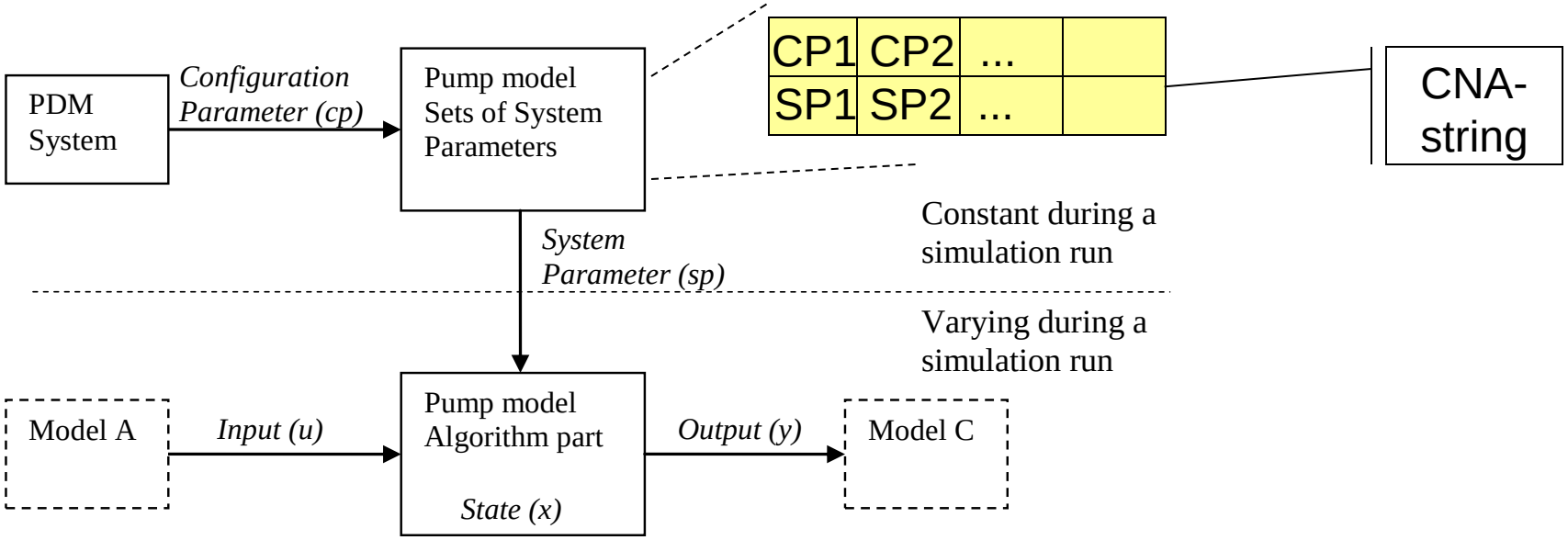
# PARAMETRIC CONFIGURABLE MODELS




Model interactions: Input (u), Output (y), State (x), System Parameter (SP) and Configuration Parameter (CP) used for parametric models.

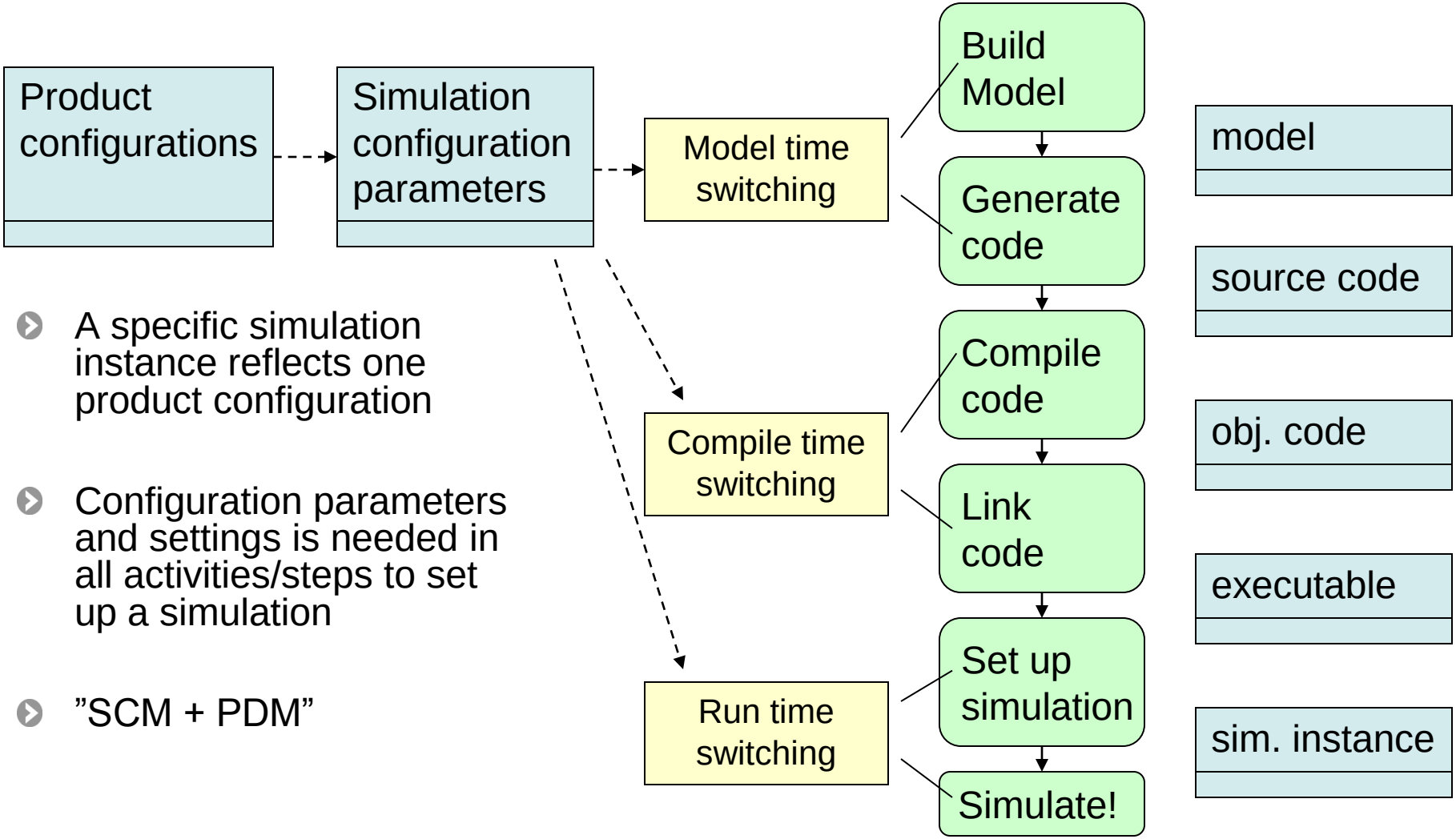
Configuration Parameters (CP) are created in the Product Data Management (PDM) system and used in the simulator prior to a simulation run to instantiate the models with a consistent set of System Parameters (SP).

# PARAMETRIC CONFIGURABLE MODELS



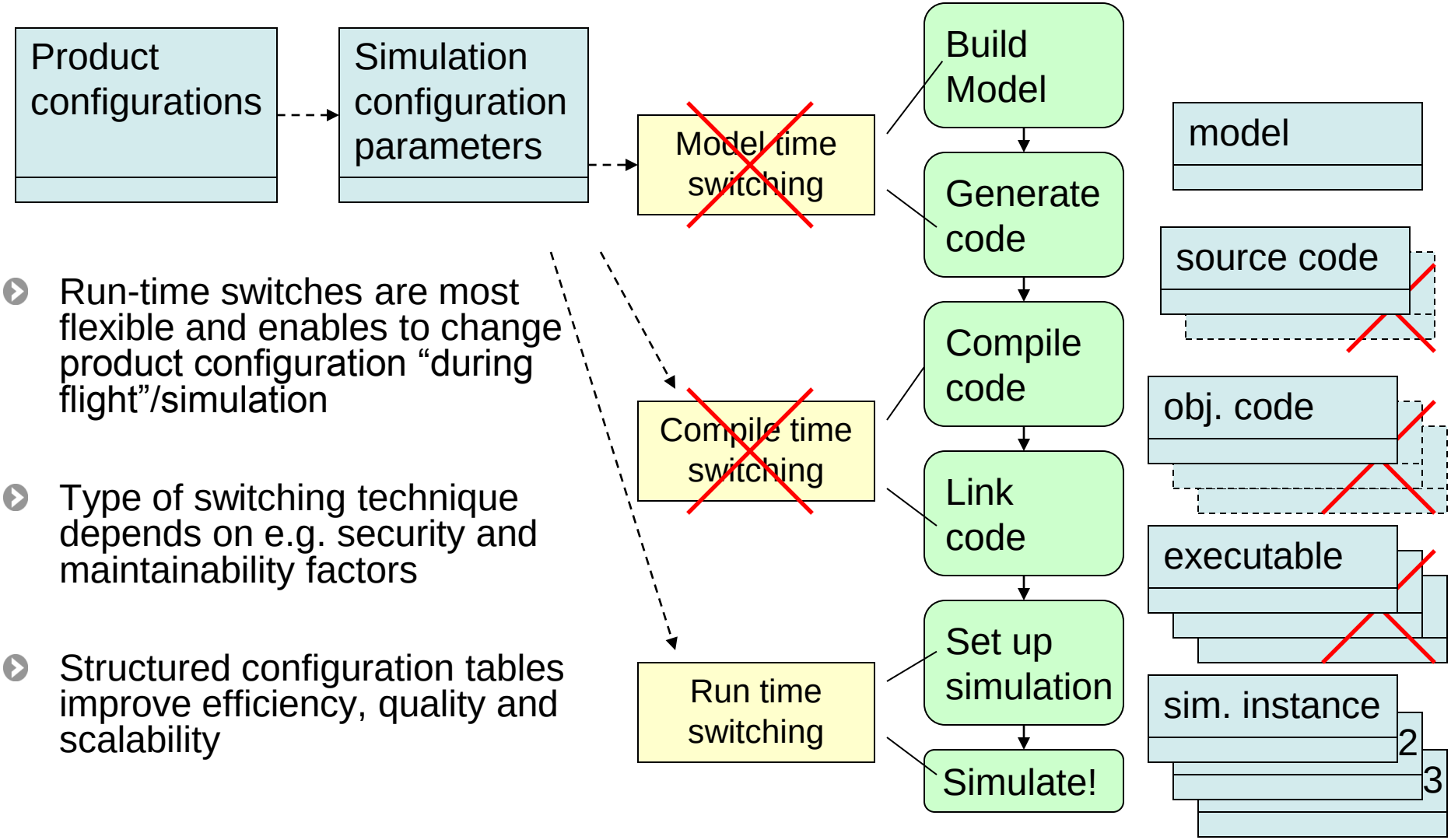

Typically, the CP are stored in PDM while SP are handled in a Software Configuration Management (SCM) tool, and in this work a proposal of connection between CP and SP on the conceptual level are suggested. A structured data storage object “CNA-string” (ConfiguratioN datA string) for cross-referencing or mapping of CP onto SP is introduced. The various validated CNA-strings containing consistent configurations can be stored in the simulation environment in e.g. XML format for easy access.

# SIMULATION CONFINTEGRATION PROCESS



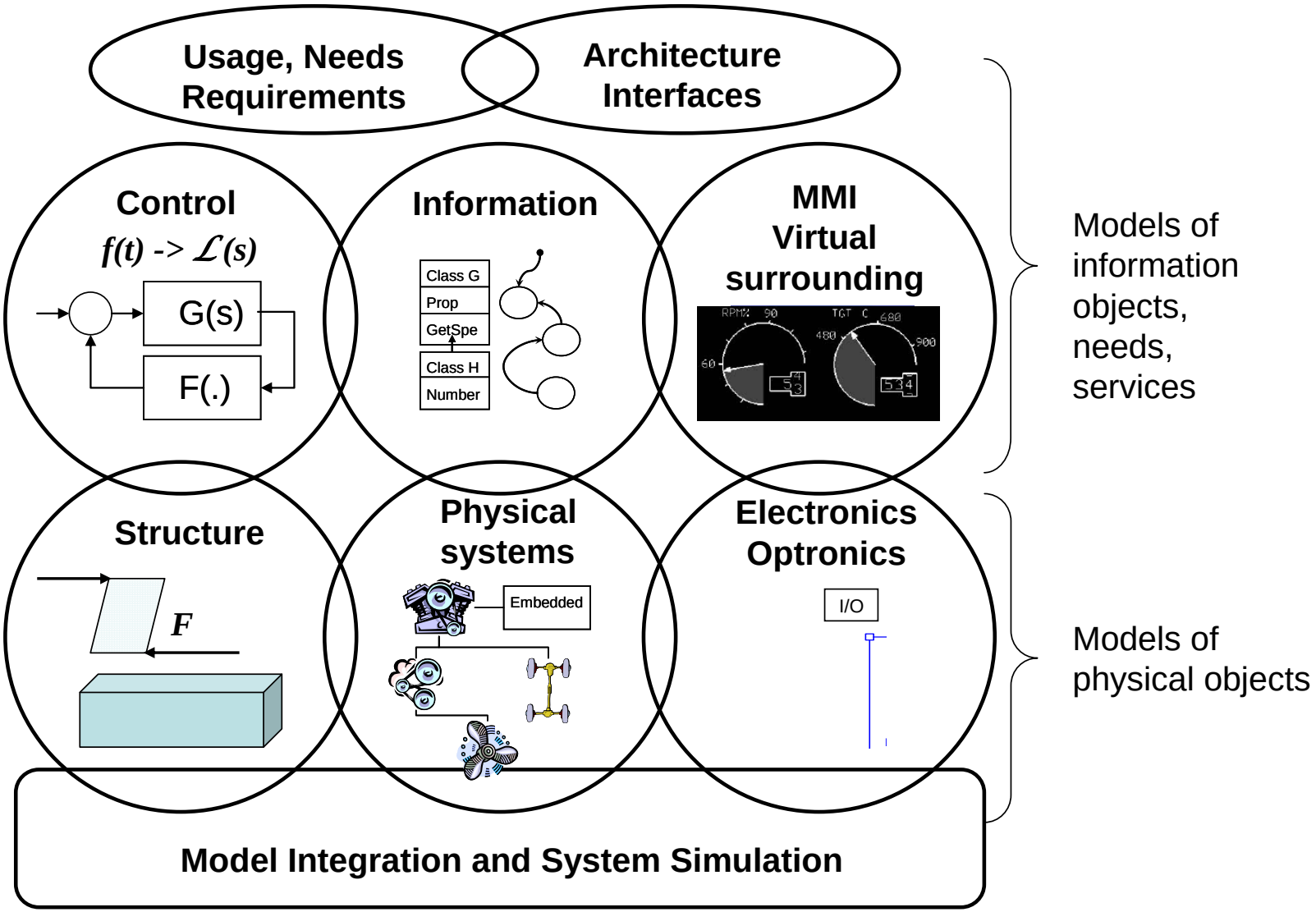

- A specific simulation instance reflects one product configuration
- Configuration parameters and settings is needed in all activities/steps to set up a simulation
- ”SCM + PDM”

# SIMULATION CONFINTEGRATION PROCESS




- Run-time switches are most flexible and enables to change product configuration “during flight”/simulation
- Type of switching technique depends on e.g. security and maintainability factors
- Structured configuration tables improve efficiency, quality and scalability

# MODELING DOMAINS



# THE INTEGRATION OF MODELING DOMAINS

**Modelica**

**UML**

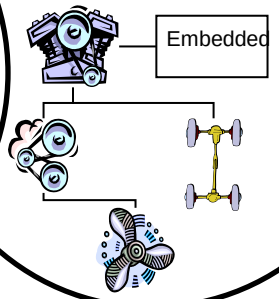
**CATIA**

**Simulink / Stateflow**

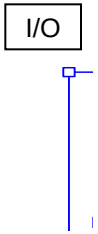
**VAPS**

**Struc-ture**

**Physical systems**

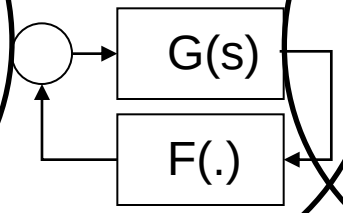



**Electronics Optronics**

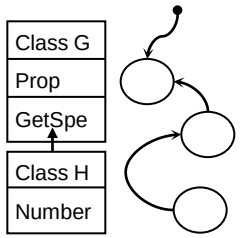



**Control**

$f(t) \rightarrow \mathcal{L}(s)$




**Information**

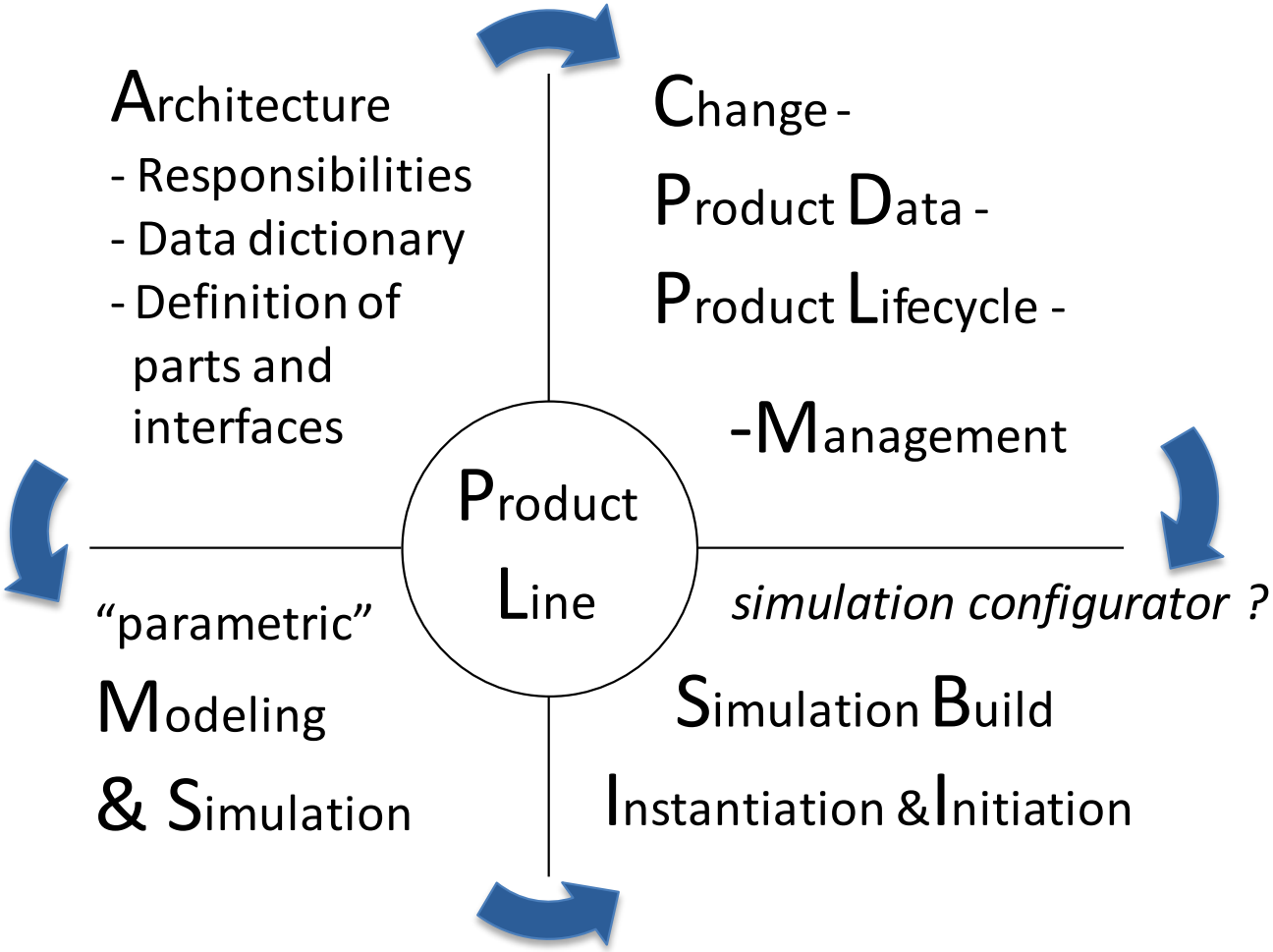



**MMI Virtual surr.**


Models of physical objects

Models of information objects, needs, services

# PRODUCT M&S DISCIPLINES



# CONCLUSIONS

- Need for configuration and integration support when building large-scale simulations (“*confintegration”*)

- Development of method to integrate PDM/PLM and simulation environment based on CNA-string approach

# Thanks!

This work is performed in scope of the Swedish National Aeronautics Research Programme, NFFP5, the Crescendo EC research project, and with application in Process and Systems Implementation for Aerospace products at Saab Aeronautics.