COOPERATION

CORONA

Customer-Oriented Product Engineering of Micro and Nano Devices

Efficient Virtual Manufacturing for MNT

Gerold Schröpfer, Coventor

September 2010, 7th ESA Round-Table on MNT for Space Applications

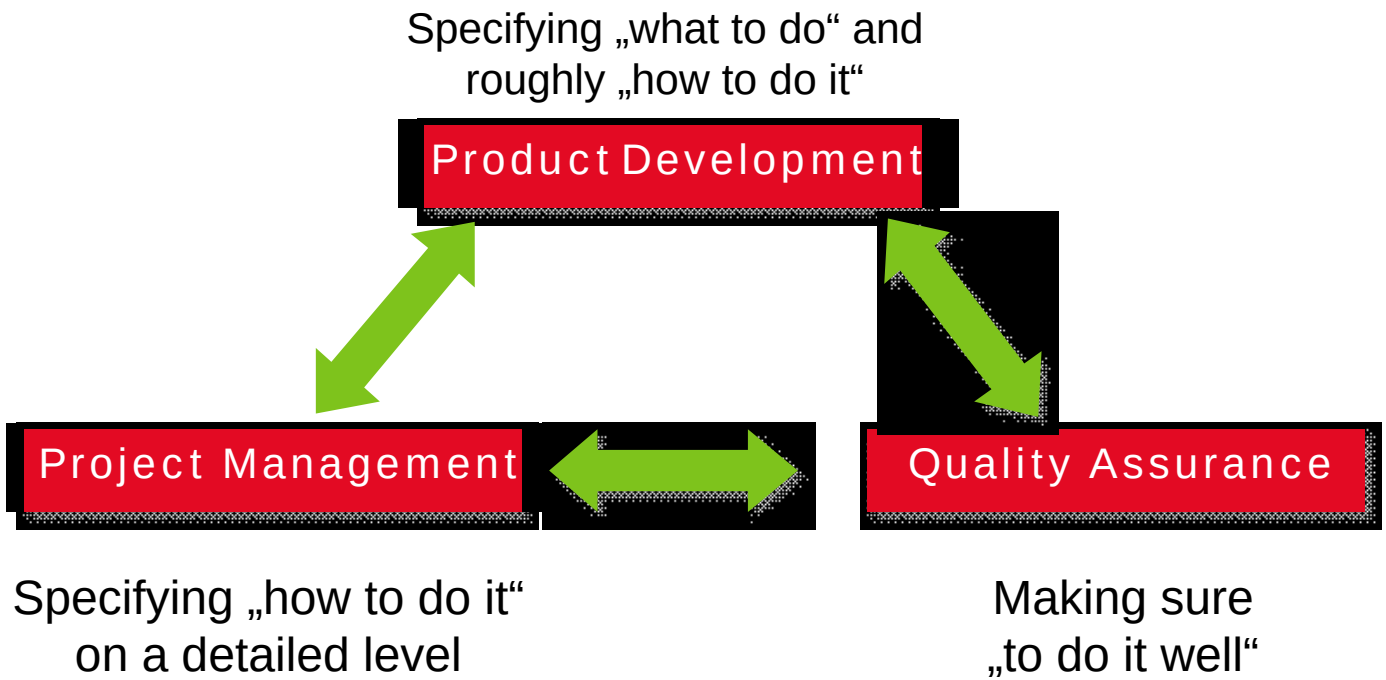
COVENTOR ELMOS ITE IVAM. Process Relations Streamlining Process Development Theon sensors UNIVERSITY OF CAMBRIDGE UNIVERSITÄT SIEGEN XFAB MIXED-SIGNAL FOUNDRY EXPERTS

Outline

- **CORONA project**
  - Vision and aims
- **CORONA software tools**
  - Process IP and know-how management
  - 3D MNT design
  - Virtual Manufacturing
  - Process design kits

Product Engineering ...

- **… is the process of gradually turning the idea of a technical device into a physical realisation.**
- **… includes both the design and the fabrication stages.**

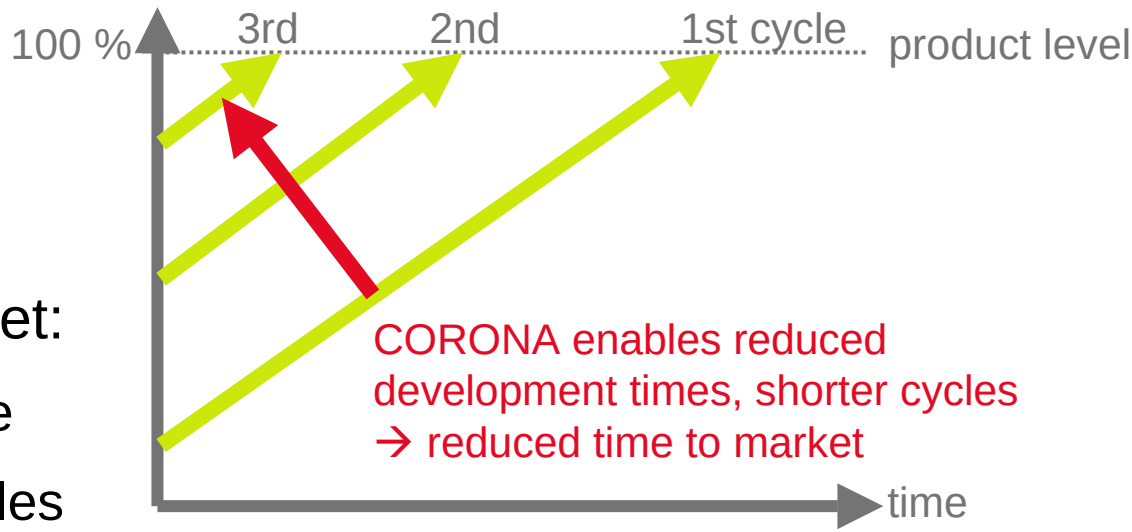


Challenges in MNT Product Engineering

- **A large variety of business models**
  - From large IDMs to specialised companies
- **Distributed development and manufacturing**
  - Different companies (or departments) at different locations
- **SME focus**
  - Frequently SMEs involved with small development budget
- **Customer orientation**
  - Only the customer knows product and constraints

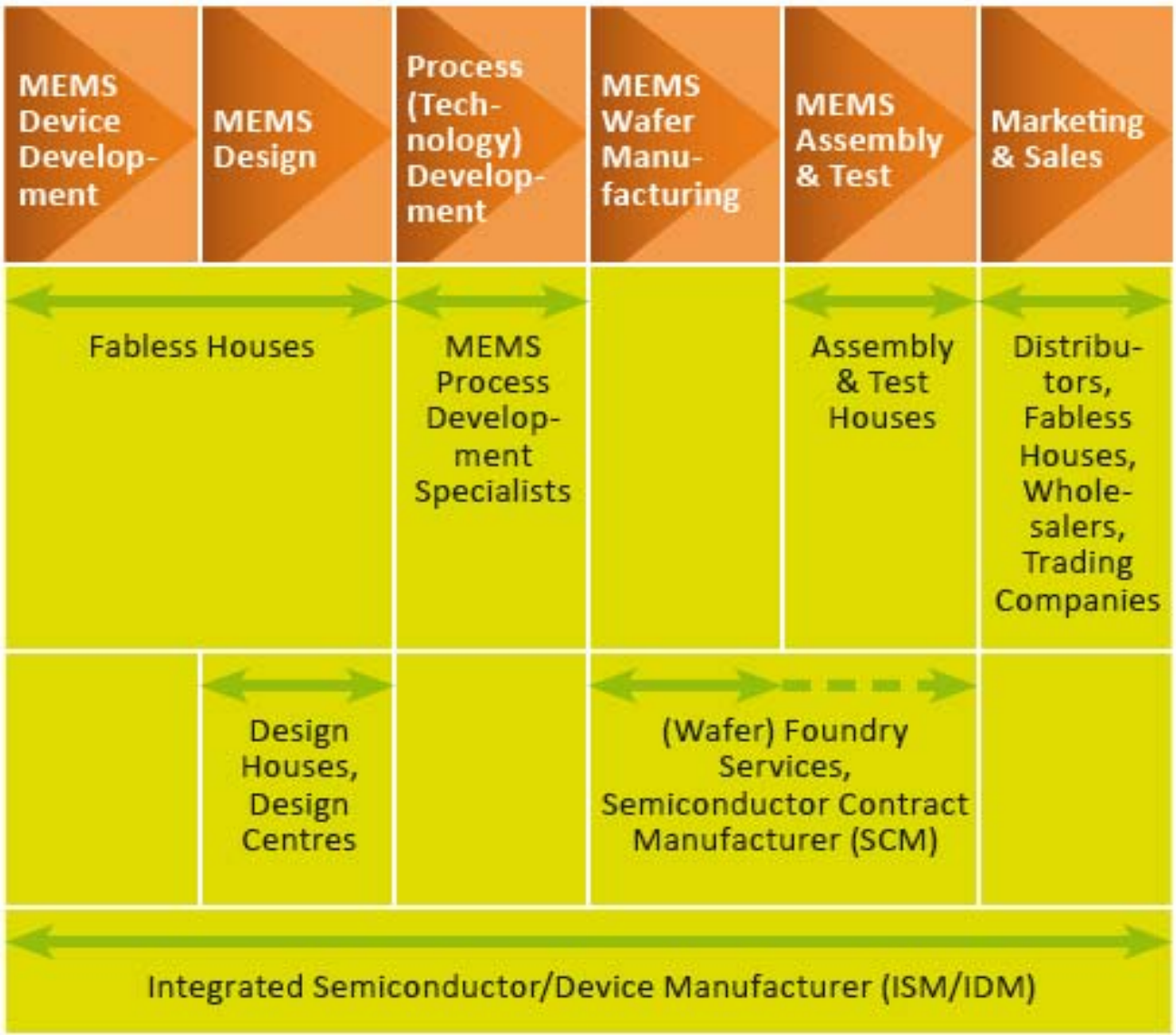
- **But…**
  - There is currently no appropriate product engineering methodology and tools available to support these aspects.

- **What can be expected from MNT product engineering?**



  - Shorter time-to-market:
    - Reduced cycle time
    - Fewer learning cycles
  - Access to knowledge-bases on design and fabrication
    - ICT based structure and tools
    - Improved transfer of knowledge from design to production
  - Customer-lead multi-site product development

Value chain in MNT



Partners

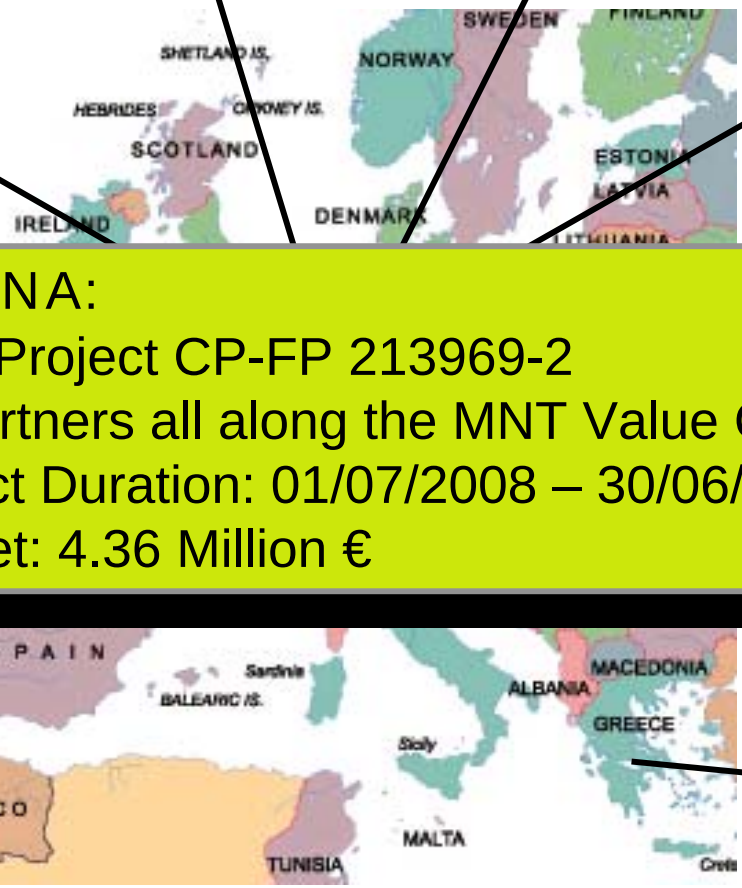
CORONA

driven by ELMOS

IVAM.

UNIVERSITY OF CAMBRIDGE

Process Relations



ITE

UNIVERSITÄT SIEGEN

FAB

FOUNDRY EXPERTS

CORONA:
- NMP Project CP-FP 213969-2
- 11 Partners all along the MNT Value Chain
- Project Duration: 01/07/2008 – 30/06/2011
- Budget: 4.36 Million €

COVENTOR

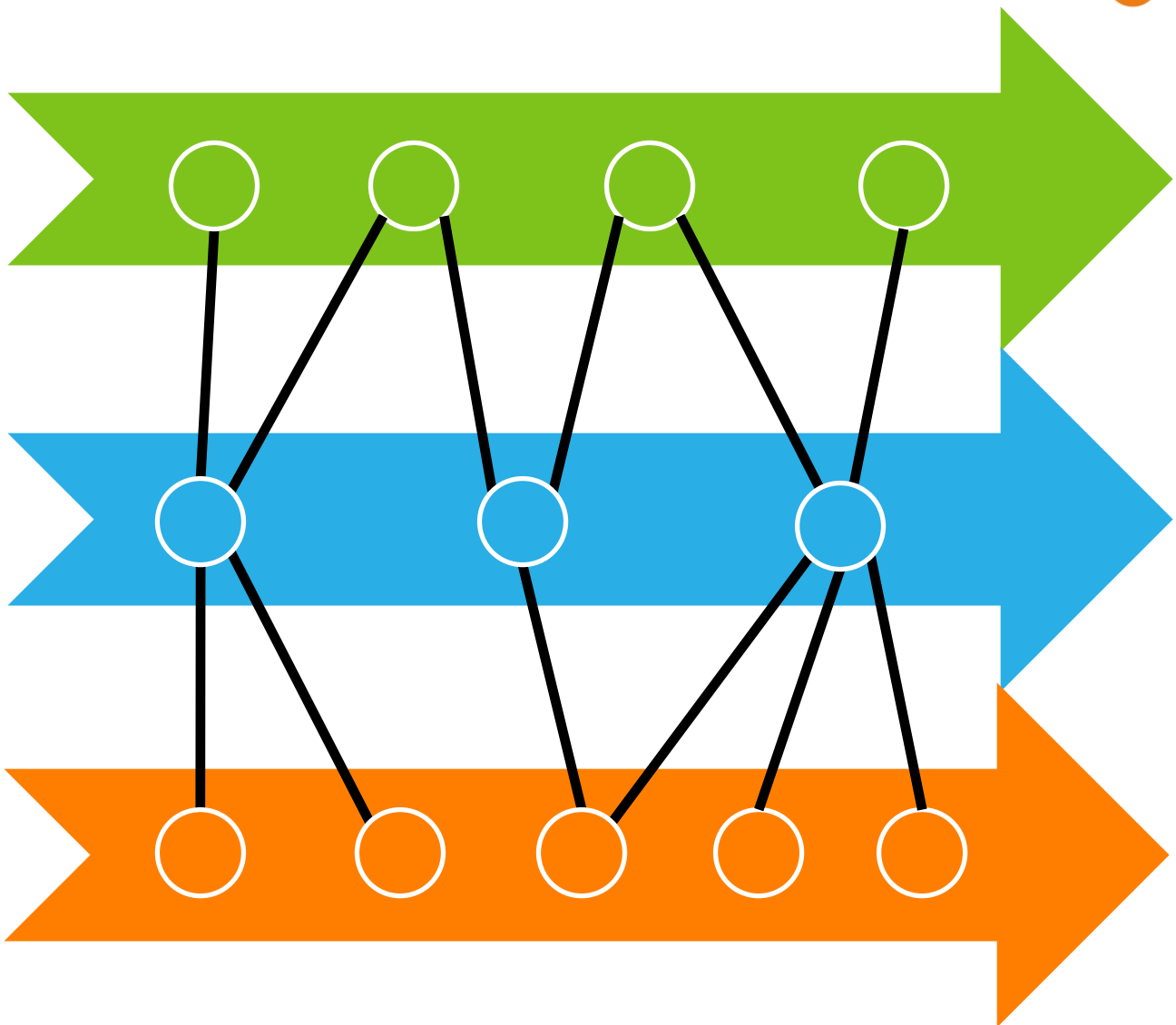
Theon sensors

Workflow in CORONA

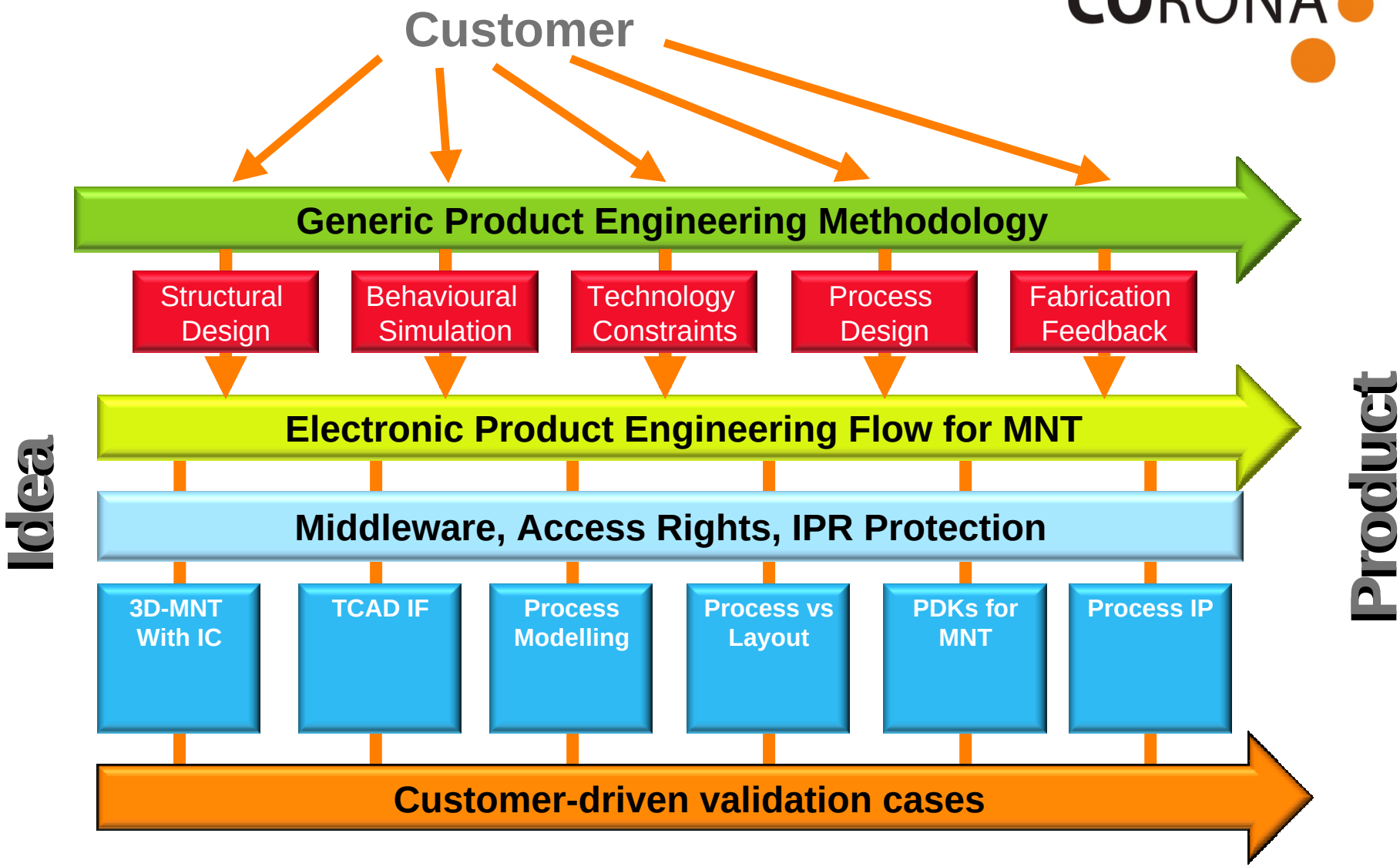
Methodology
Workflow Definition

Middle Ware & Tools
Workflow/Designflow Integration

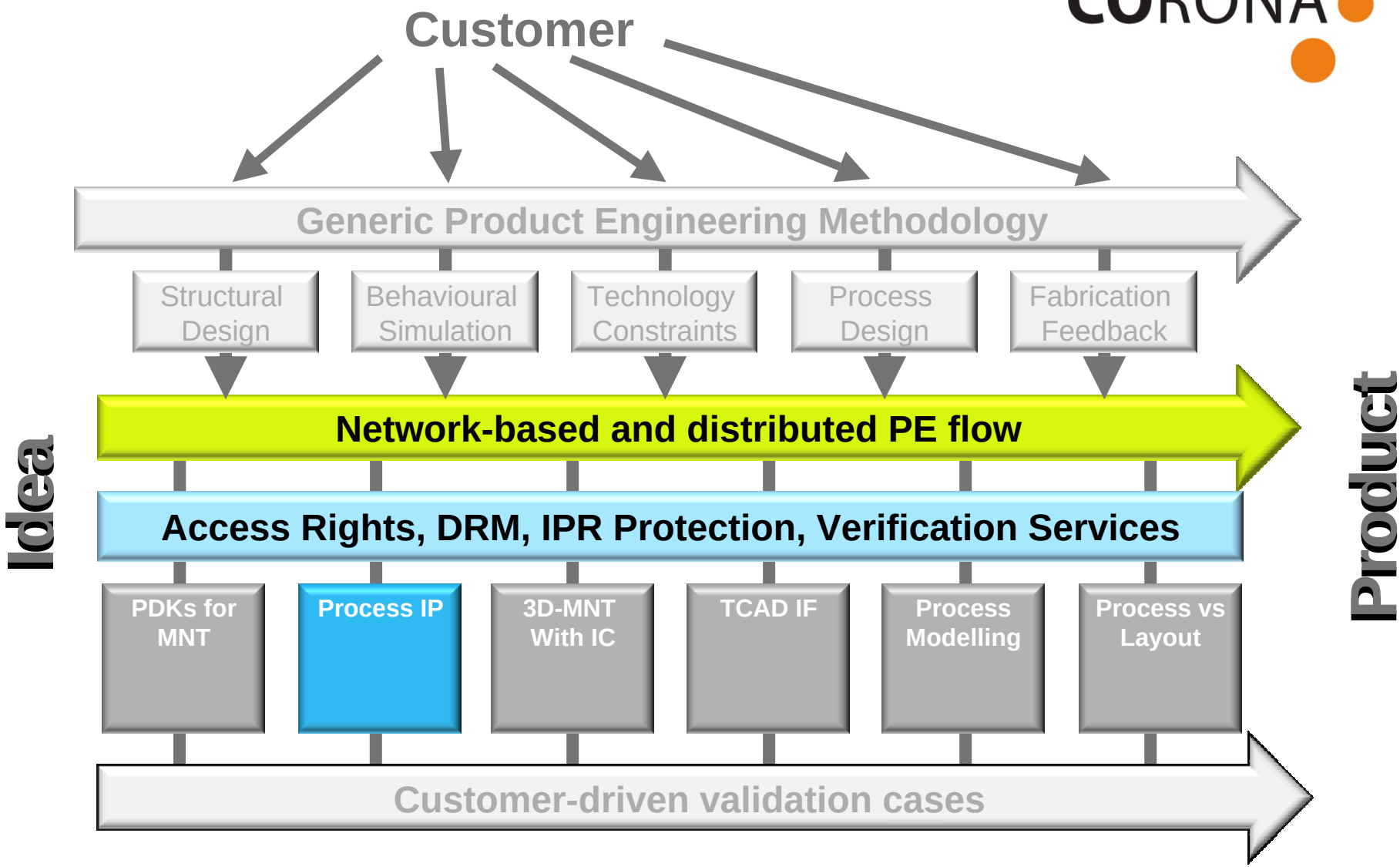
Validation
by real-life business cases



CORONA Product Engineering Vision



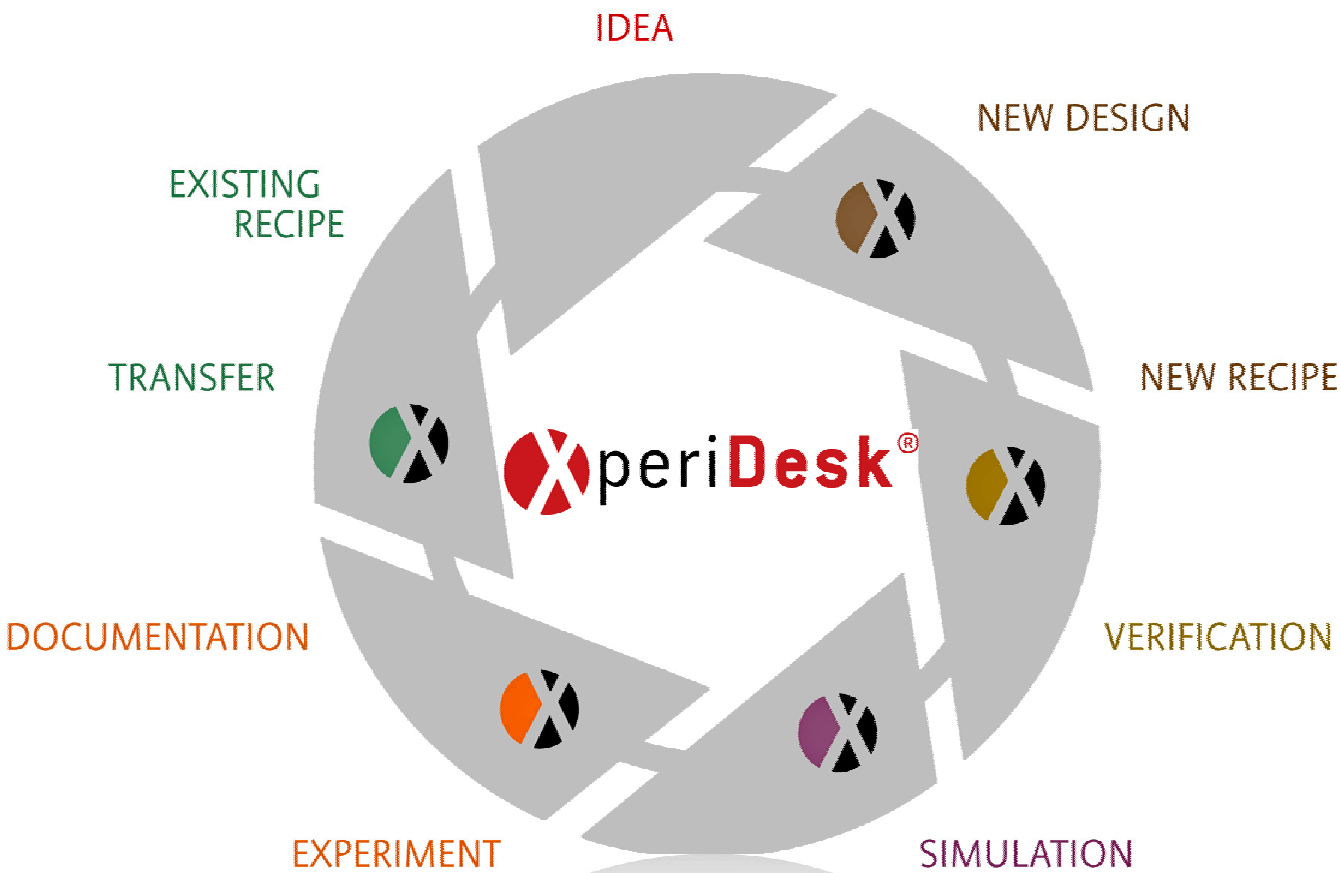
Process IP


Customer
Generic Product Engineering Methodology
Structural Design
Behavioural Simulation
Technology Constraints
Process Design
Fabrication Feedback
Network-based and distributed PE flow
Access Rights, DRM, IPR Protection, Verification Services
PDKs for MNT
Process IP
3D-MNT With IC
TCAD IF
Process Modelling
Process vs Layout
Customer-driven validation cases
Idea
Product

Process development cycle

XperiDesk®

CORONA

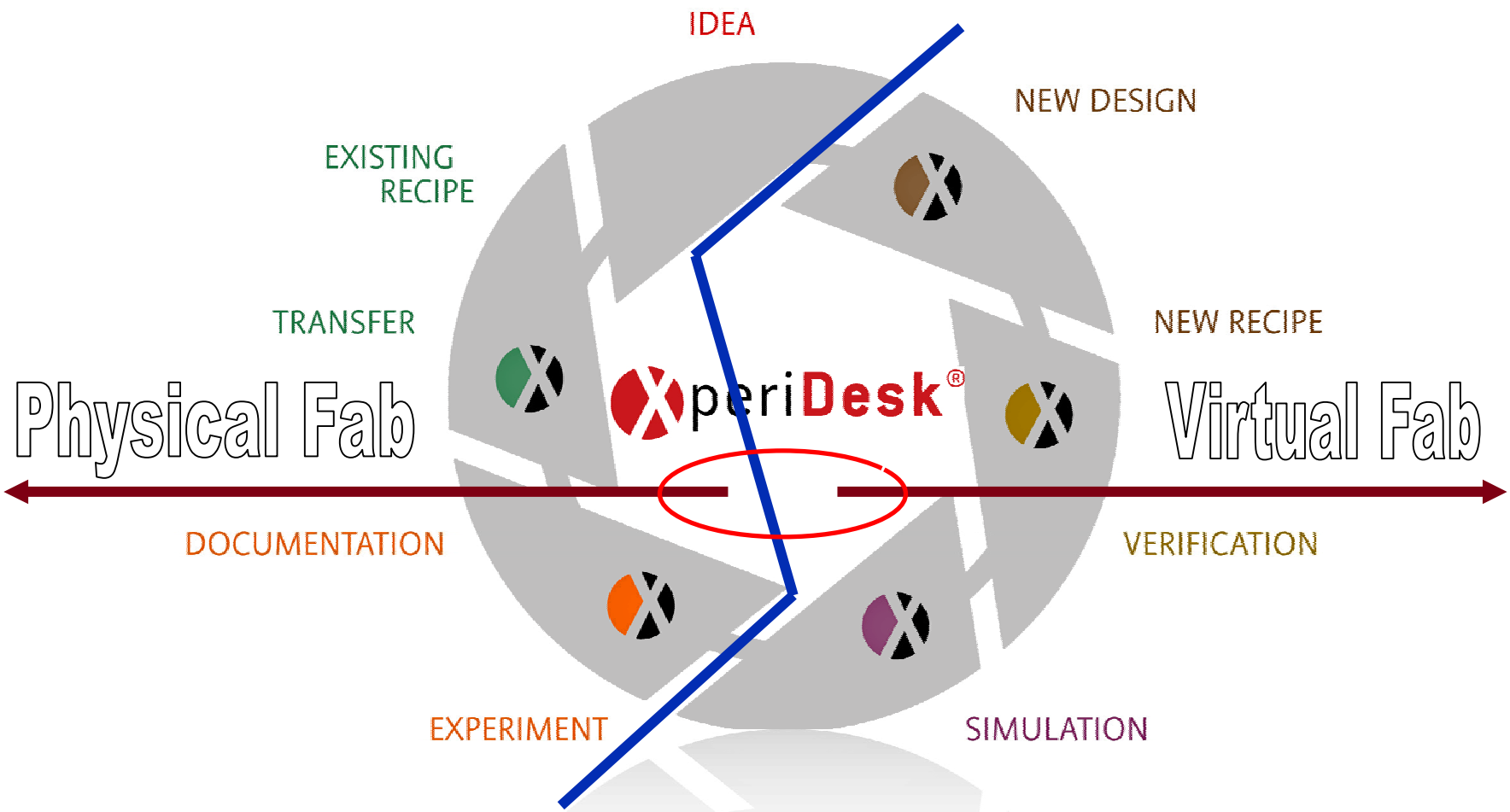


XperiDesign XperiFication XperiSim XperiLink XperiShare

Physical and Virtual Fab

XperiDesk®

CORONA



XperiDesign XperiFication XperiSim XperiLink XperiShare

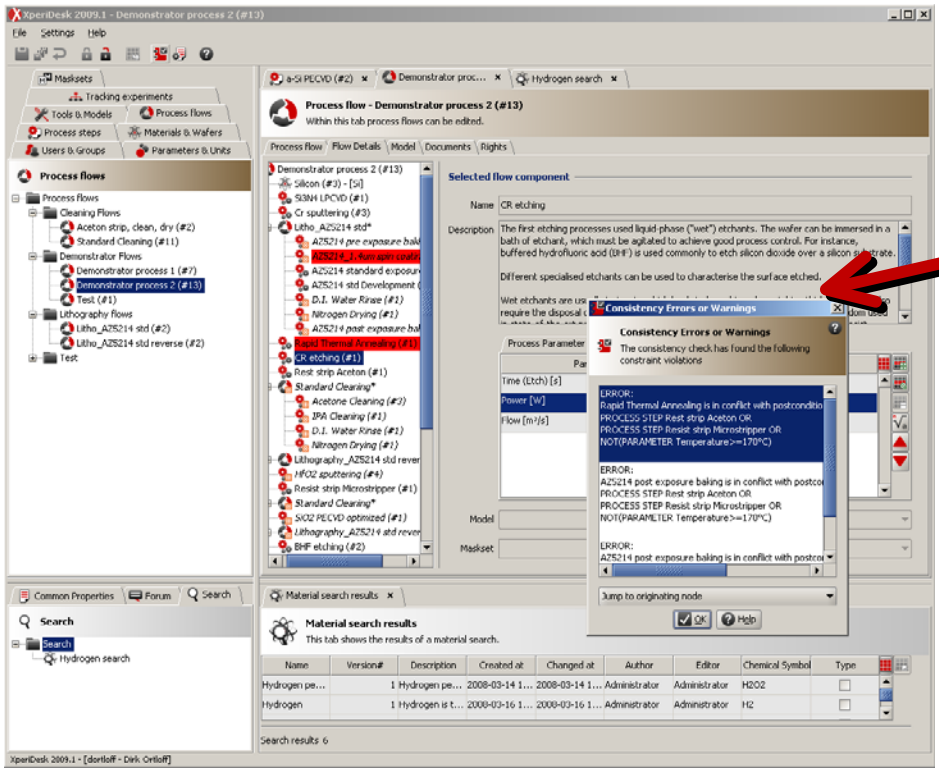
Process Tools

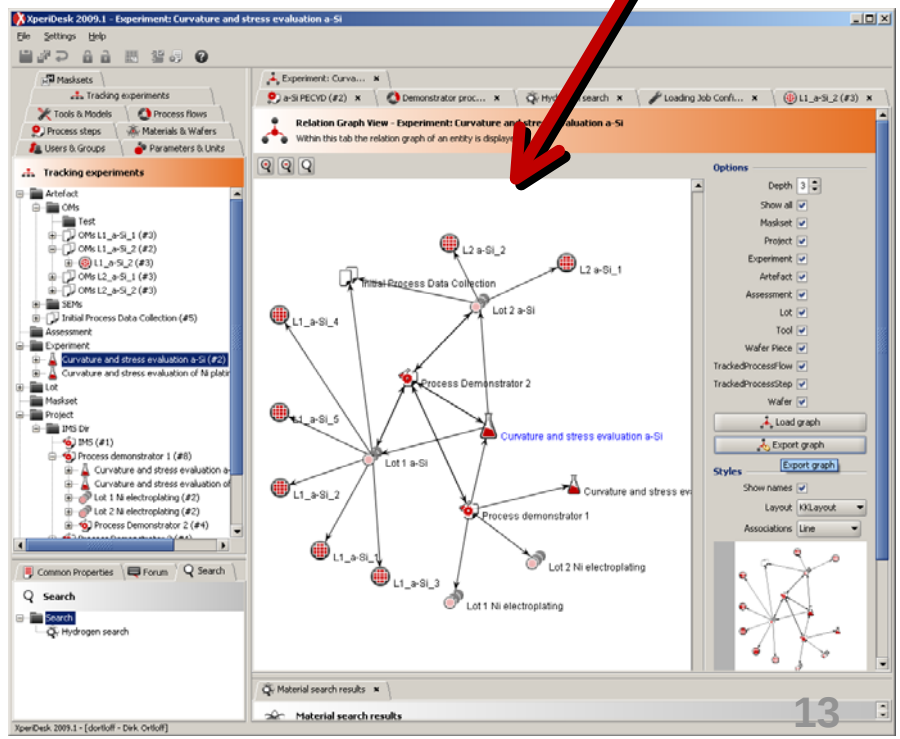
- **A framework for process design verification and tracking**

XperiDesk®

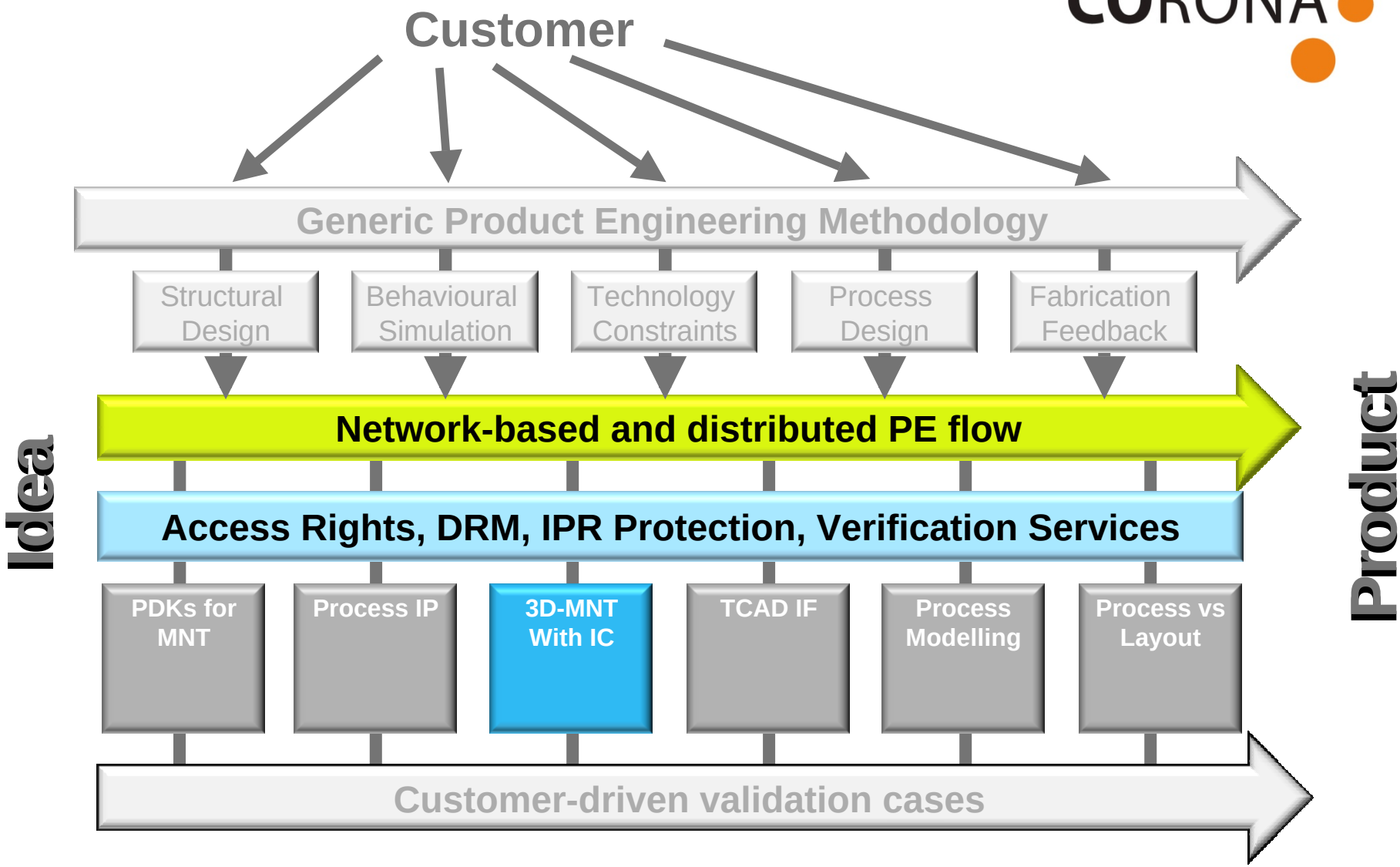
Process Flow Editor

Process Tracking



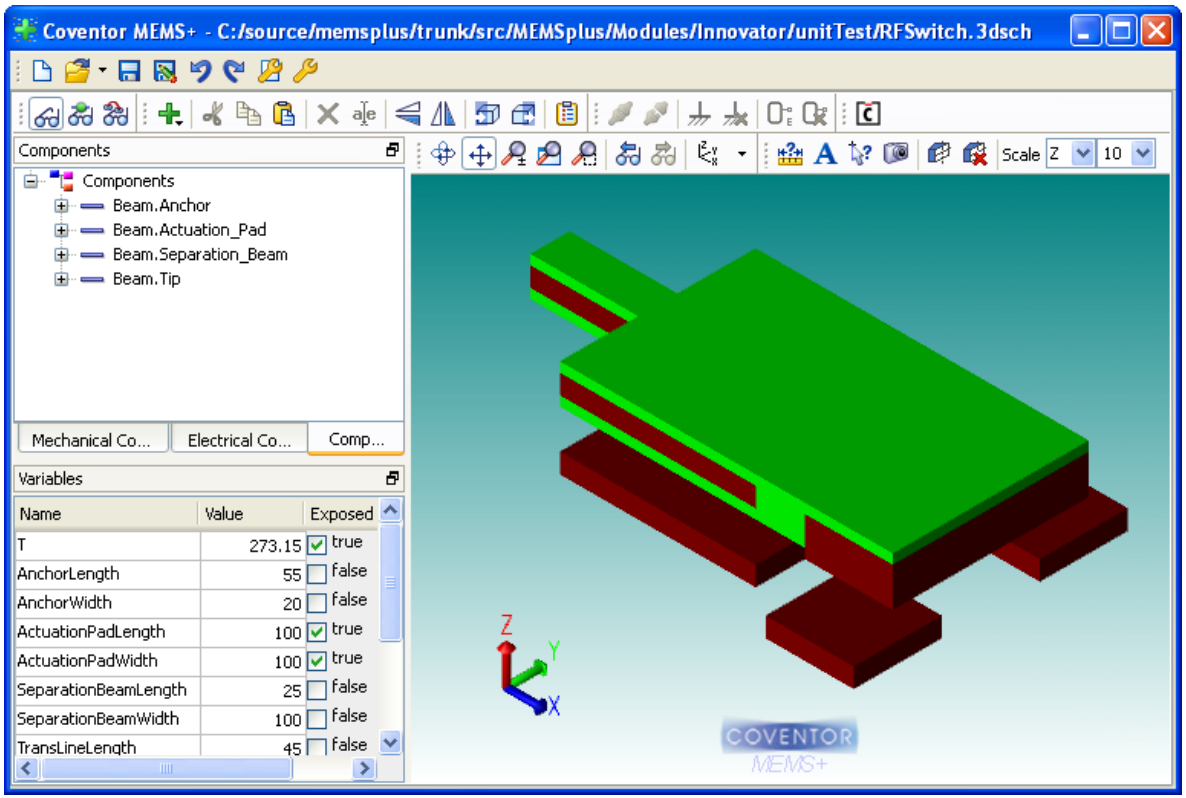


3D-MNT With IC

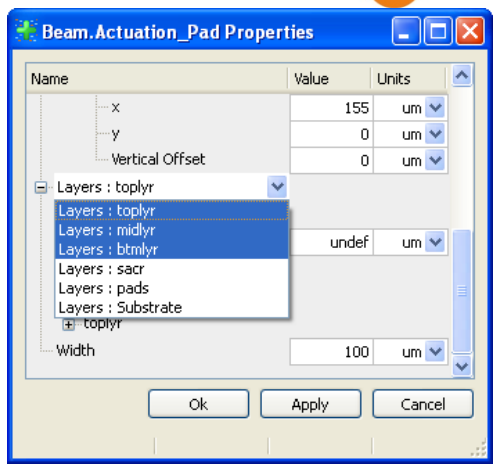


3D Schematic Editor for MEMS

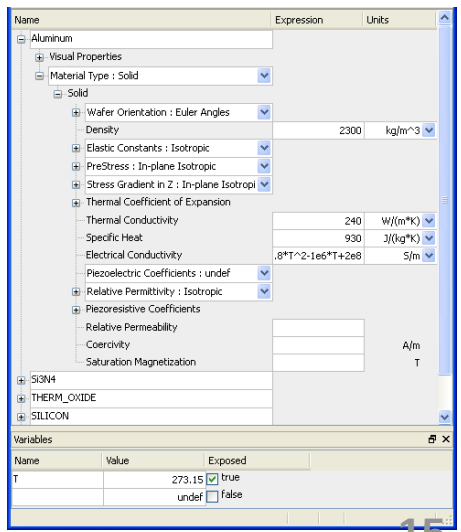
- **MEMS Design in 3D**
  - Intuitive 3D environment for device creation
  - Based on validated MEMS component library
  - Parameterization of material, process and design



3-D view of RF switch in new 3D schematic Editor GUI (Graphical User Interface)

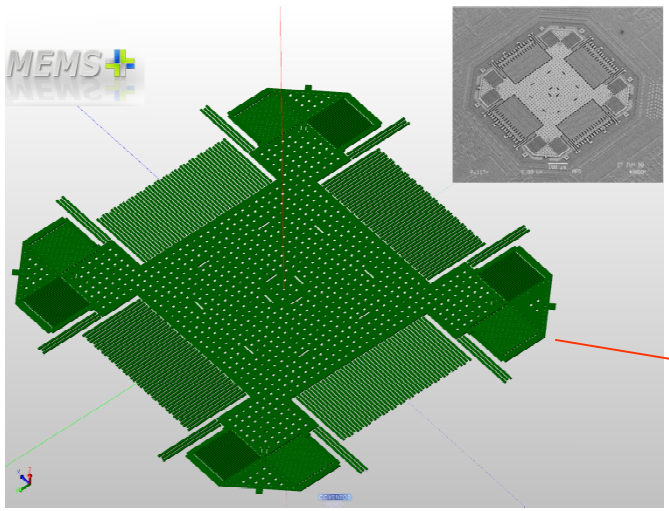


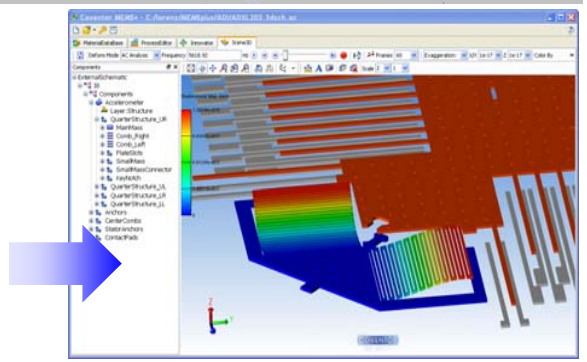
Layer Browser in a Property Window of a Straight Beam Component

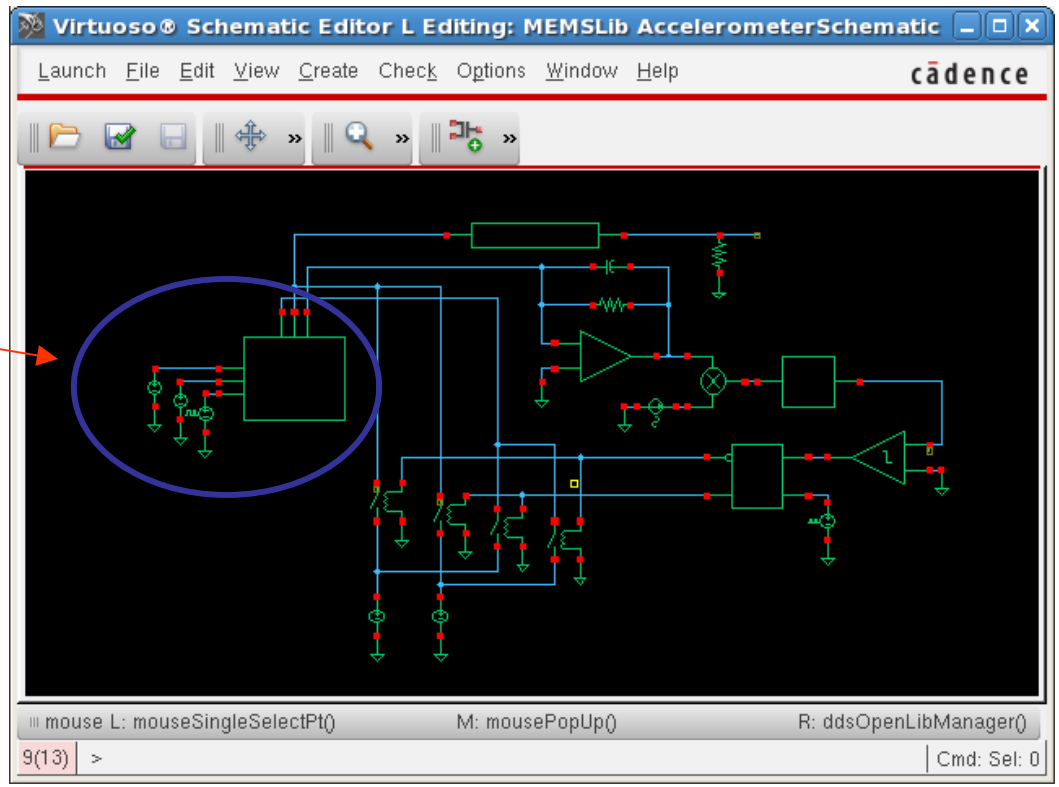


Material Property Editor

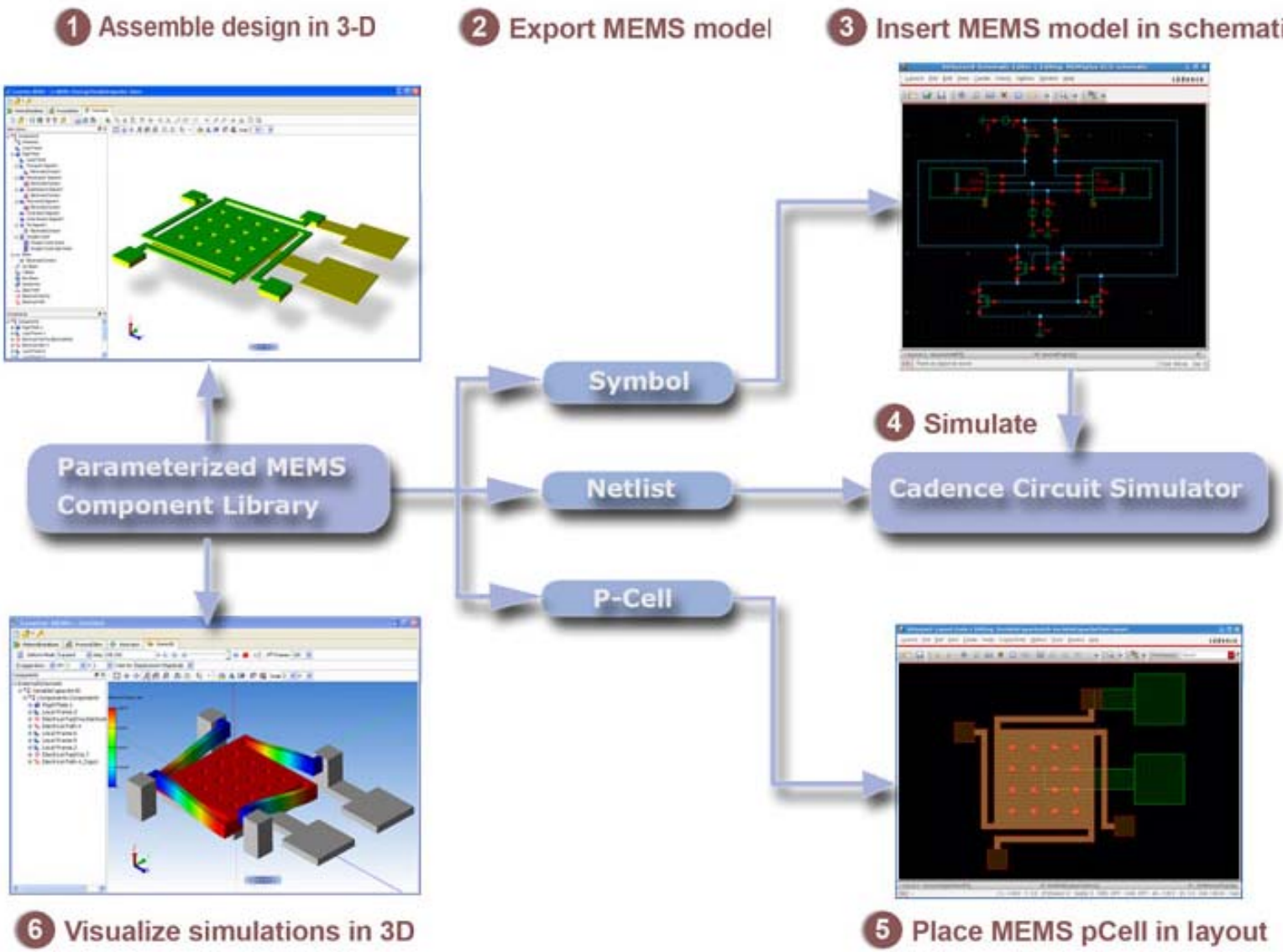
- **Seamless Connection to IC Design**
  - The MEMS designer transfers the model to the IC-designer
  - The IC designer does electronic system design



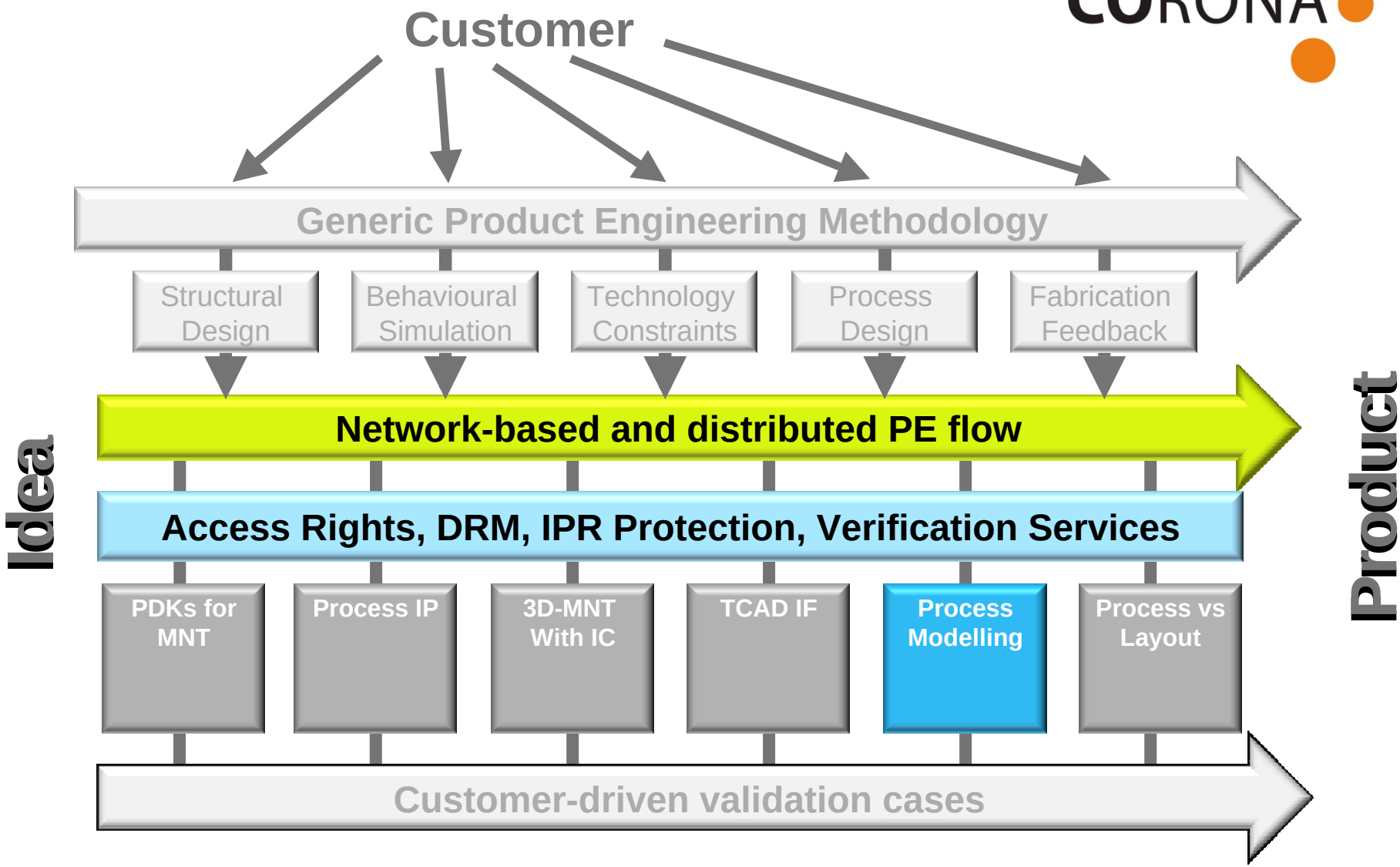




Design of 3D MEMS with IC



Process Modelling



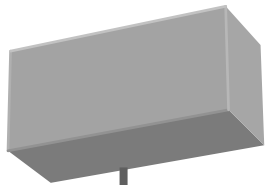
Virtual Fabrication

Actual Fab

Virtual Fab software

Blank wafer

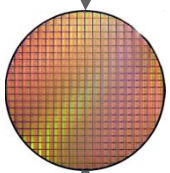
2-D layout



Rectangular area of interest

Move wafer thru line, following recipe *(partial or full sequence)*

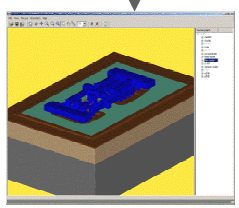
Mimic equipment to build 3-D model *(partial or full sequence)*



Processed wafer

3-D model

Sample, image, measure

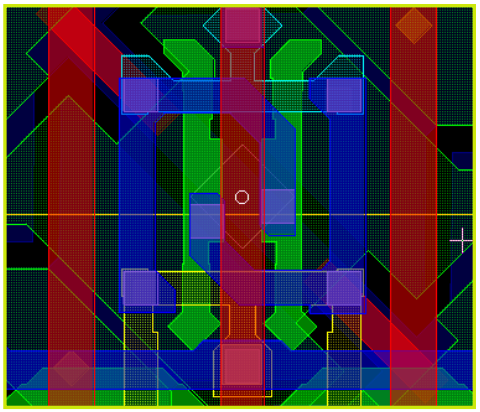


Visualize, image, measure

How it works

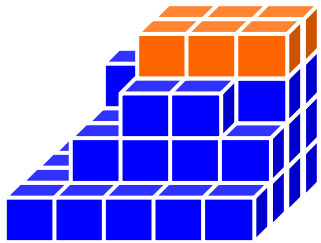
CORONA

GDSII Layout



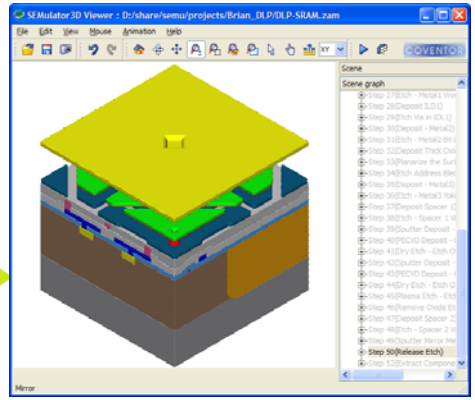
3D Modeling Engine

builds voxel models by applying a sequence of primitive operations

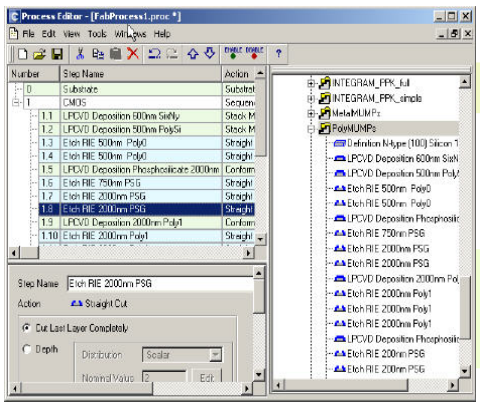


Voxels are 3D pixels

Visualization

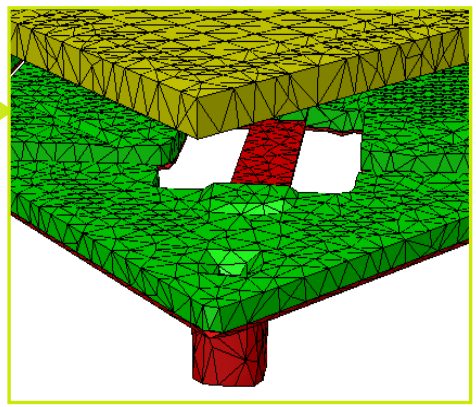


Process Description

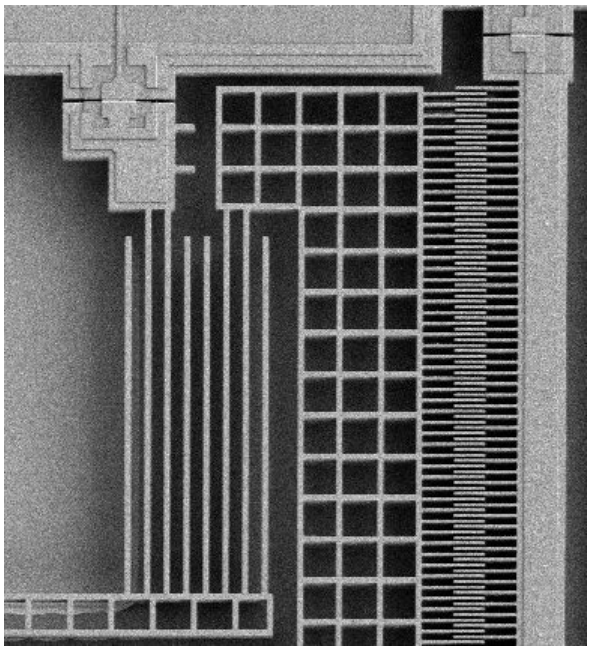


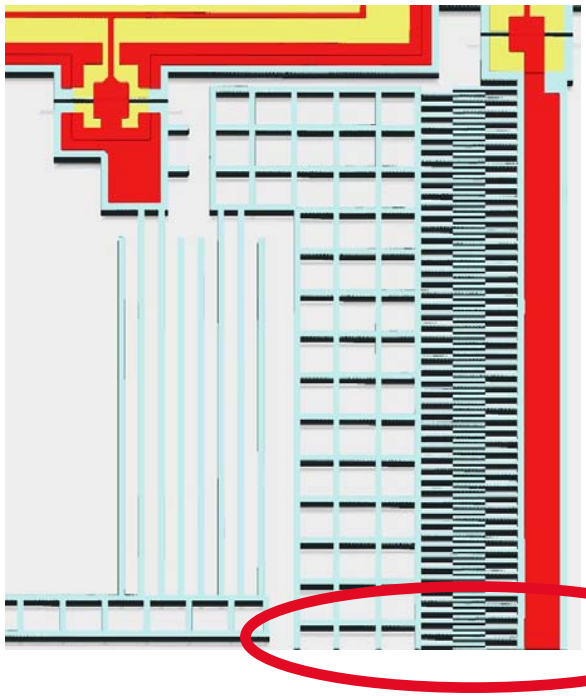
Customizable to <u>any</u> process technology

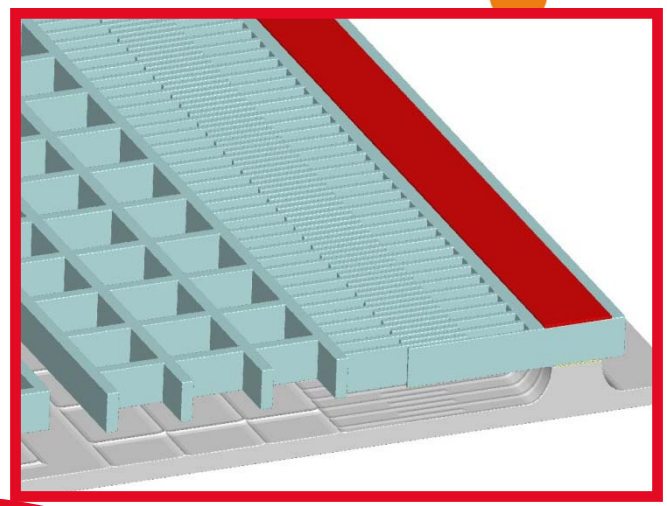
Simulation Mesh



Use case example: X-FAB SOI







SEM image

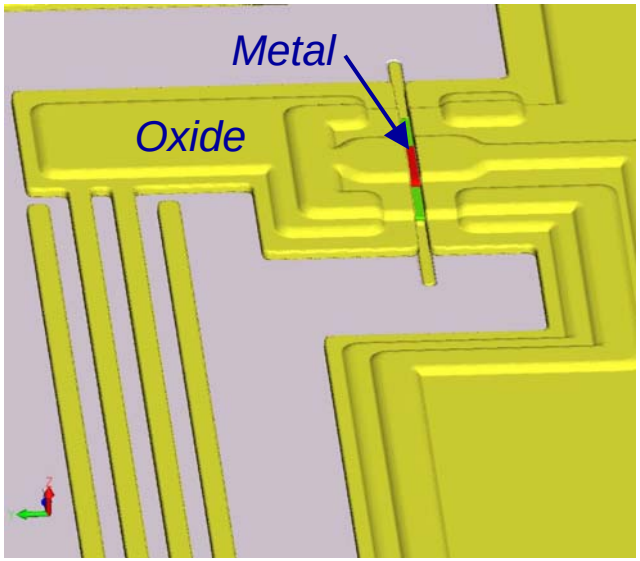
images created with SEMulator3D

X-FAB uses virtual fab runs for…

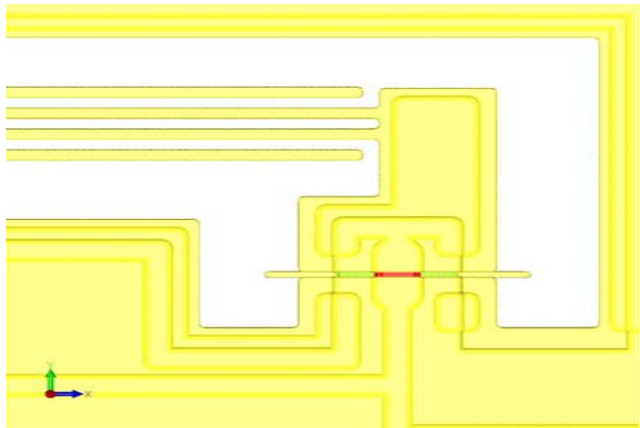
- Customer support, marketing of MEMS foundry technologies
- Checking new designs prior to actual fabrication
- Process development
- Failure analysis

Example: Design Check

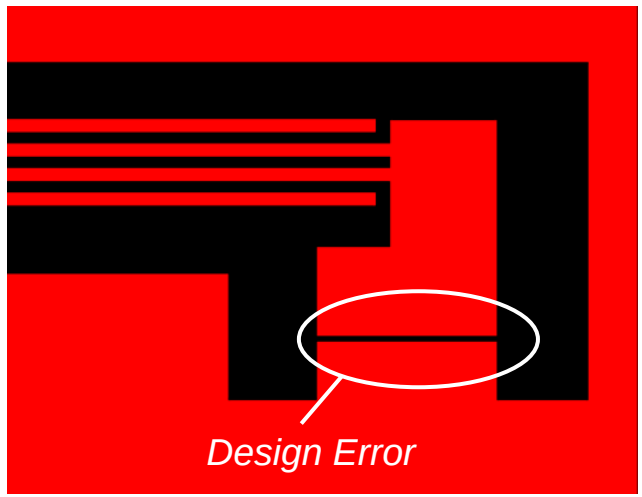
Example: A design error that was caught before mask tape-out



Visual inspection of SEMulator3D model showed isolation trench structure would have been improperly exposed to subsequent DRIE



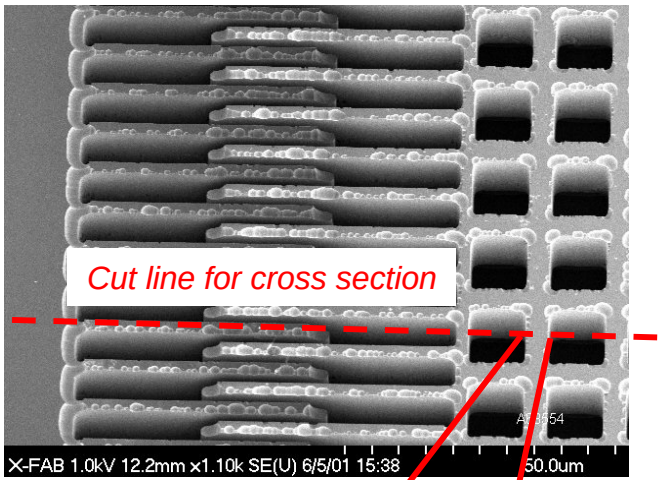
Top view of SEMulator3D model

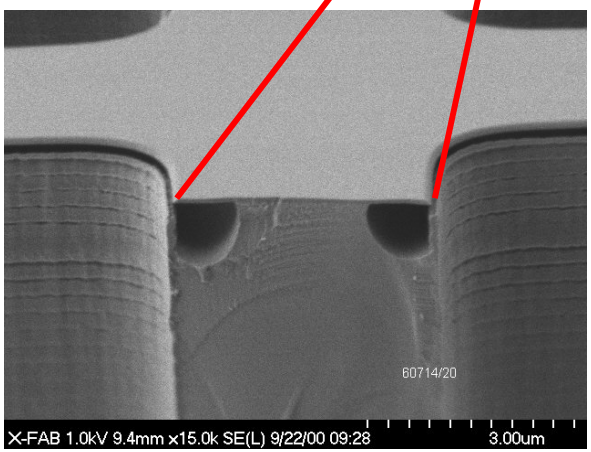


DRIE Oxide Mask

Example: Failure Analysis

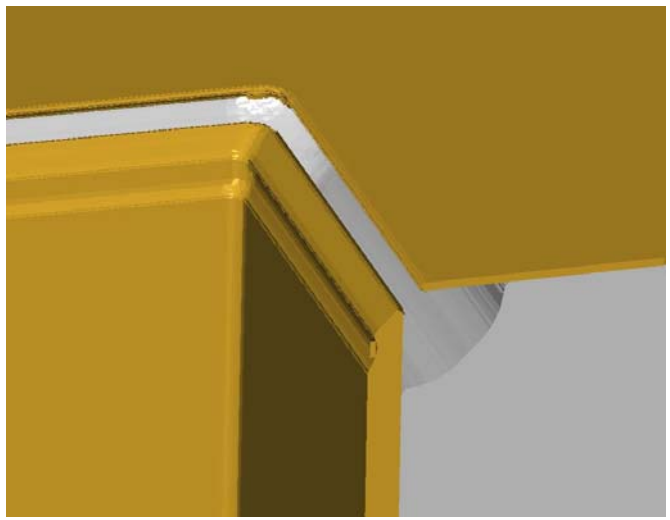
During development of X-FAB's technology, undesired pockets formed in mechanical layer during release etch





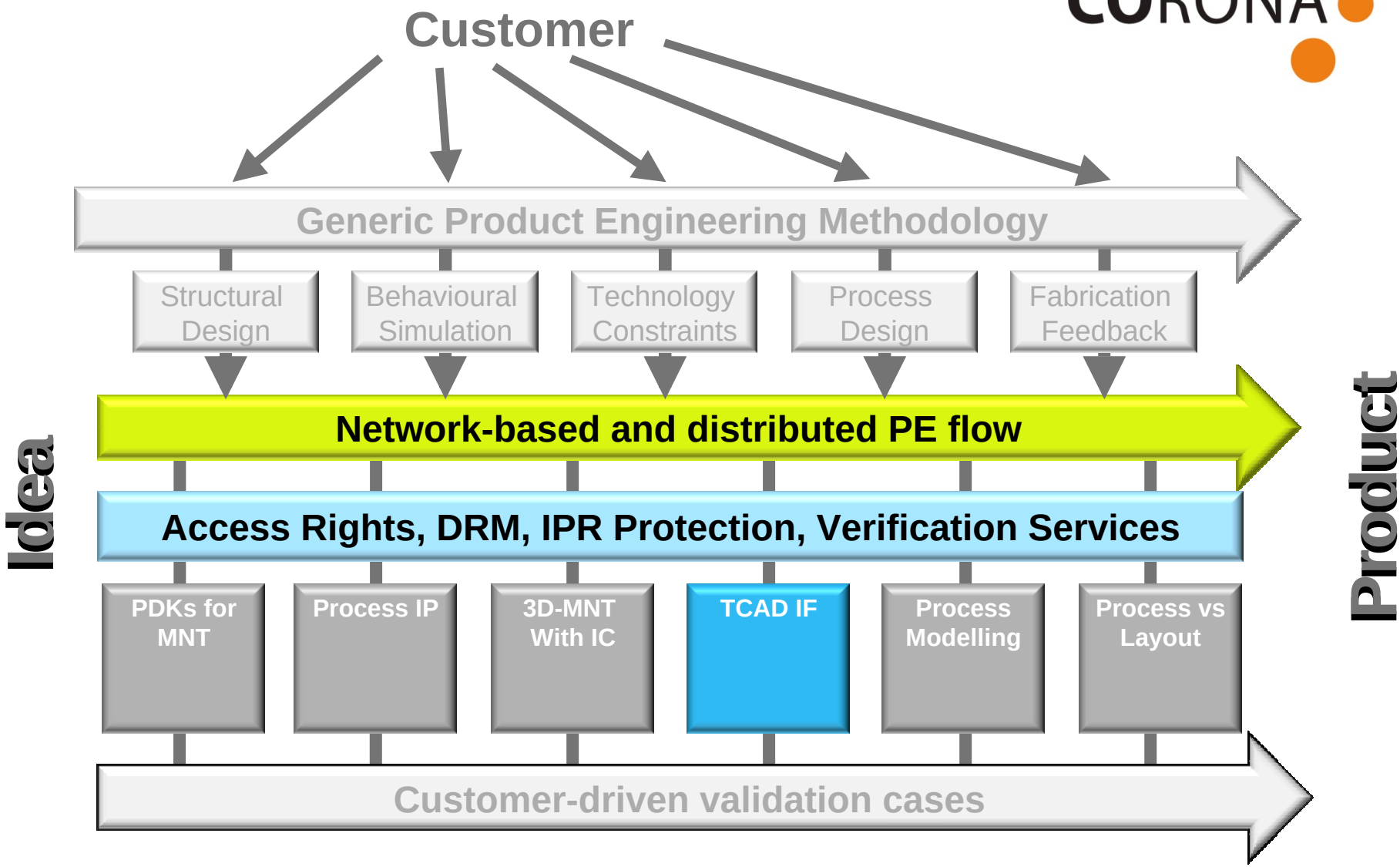
Detailed 3-D process model of the protective oxide layer confirmed the hypothesis about the process failure:

The release etch for the movable parts was etching through thin spots in the protective oxide layer

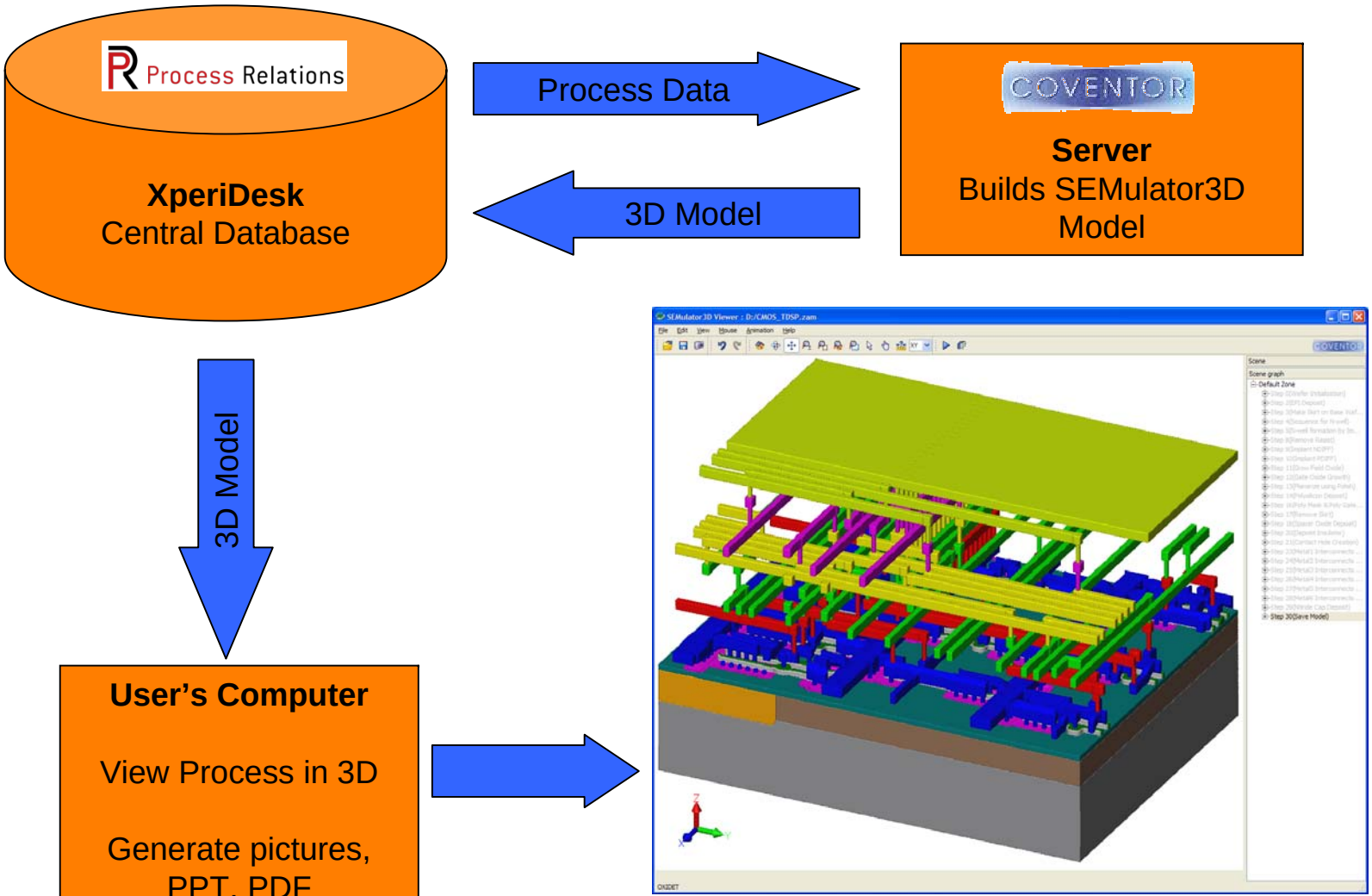


3-D Model

TCAD Interface

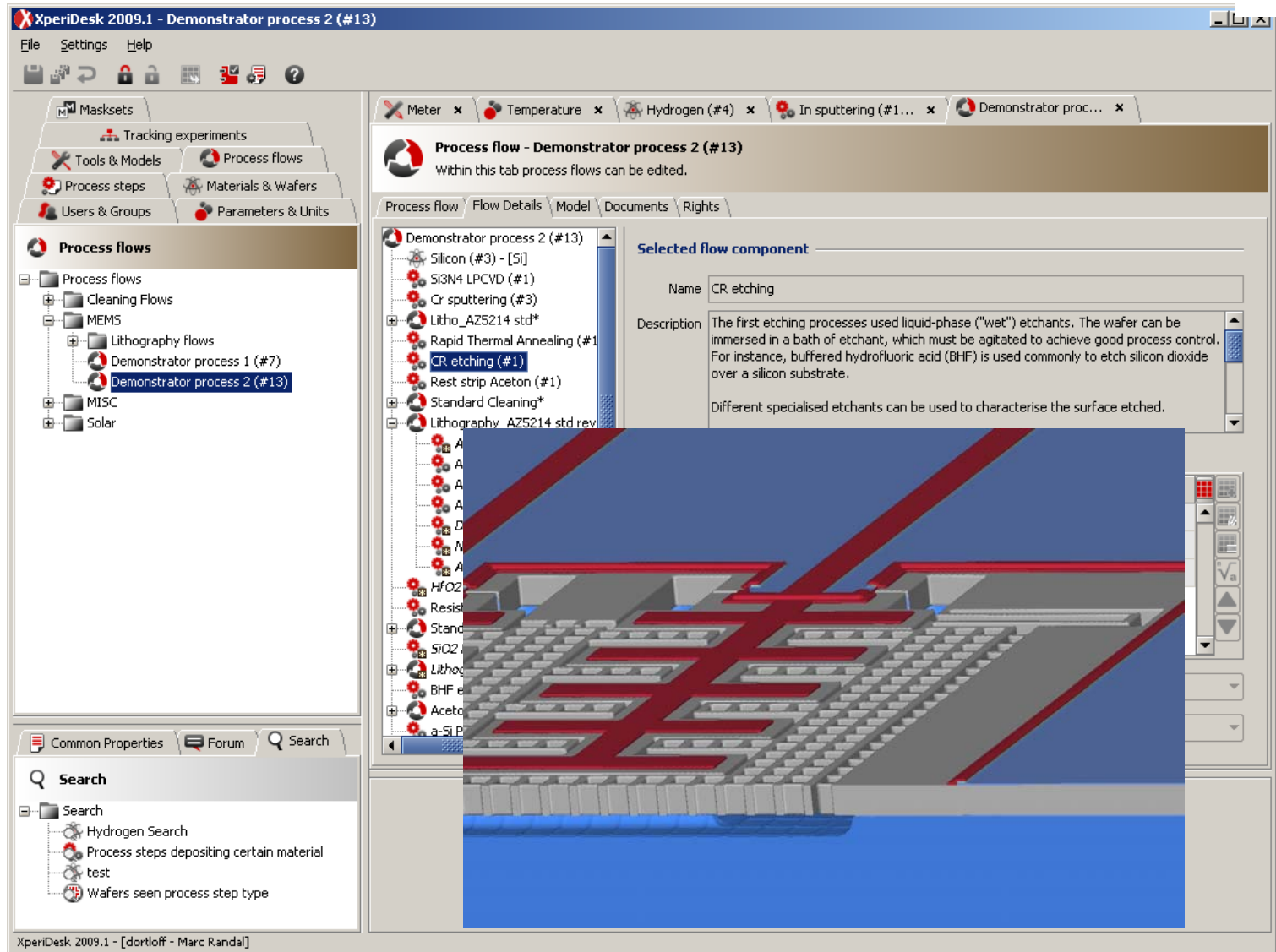


SEMulator3D and XperiDesk
Bi-Directional Integration

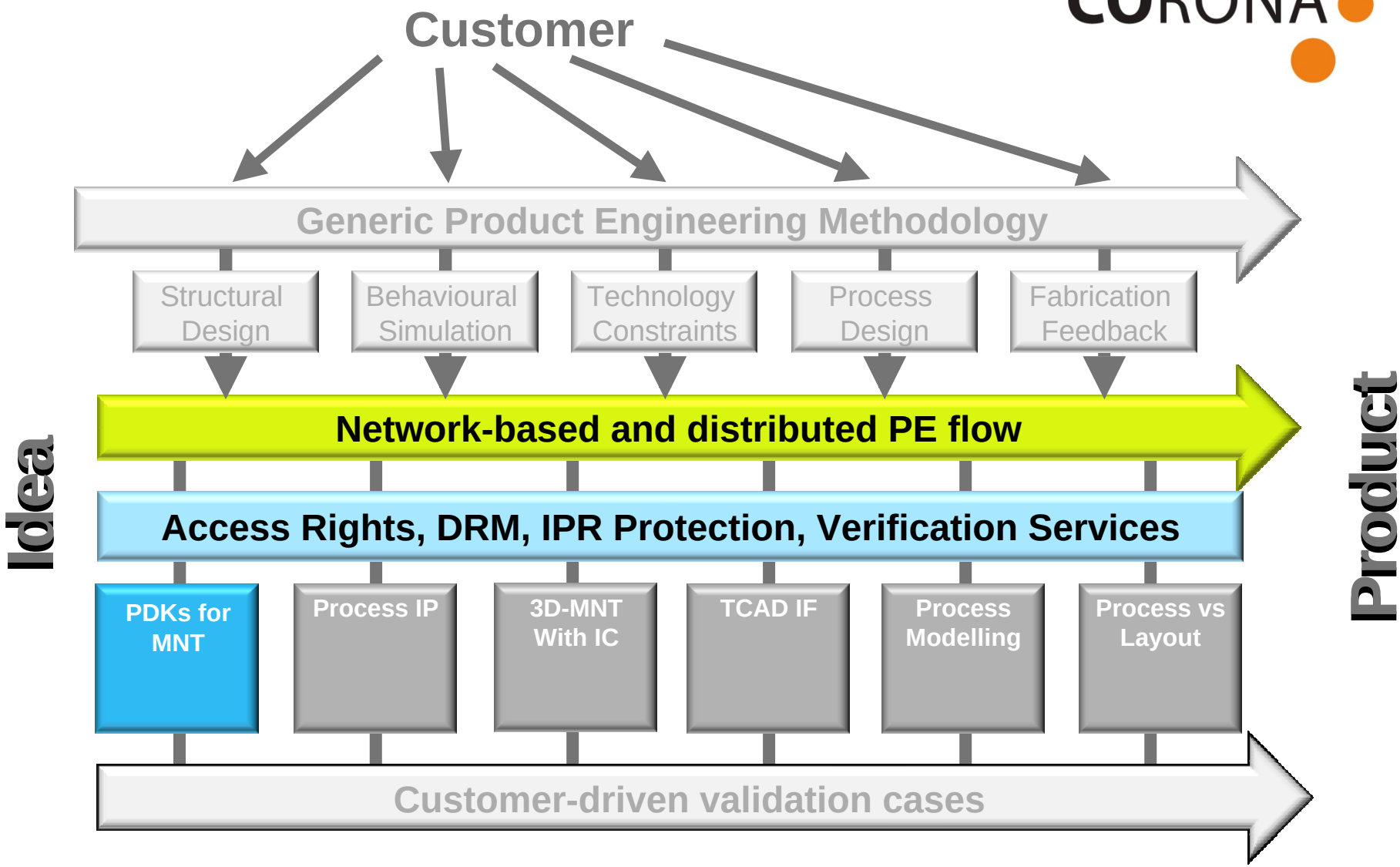


Virtual manufacturing via simulation

XperiSim



PDKs for MNT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Customer-driven validation cases
Idea
Product

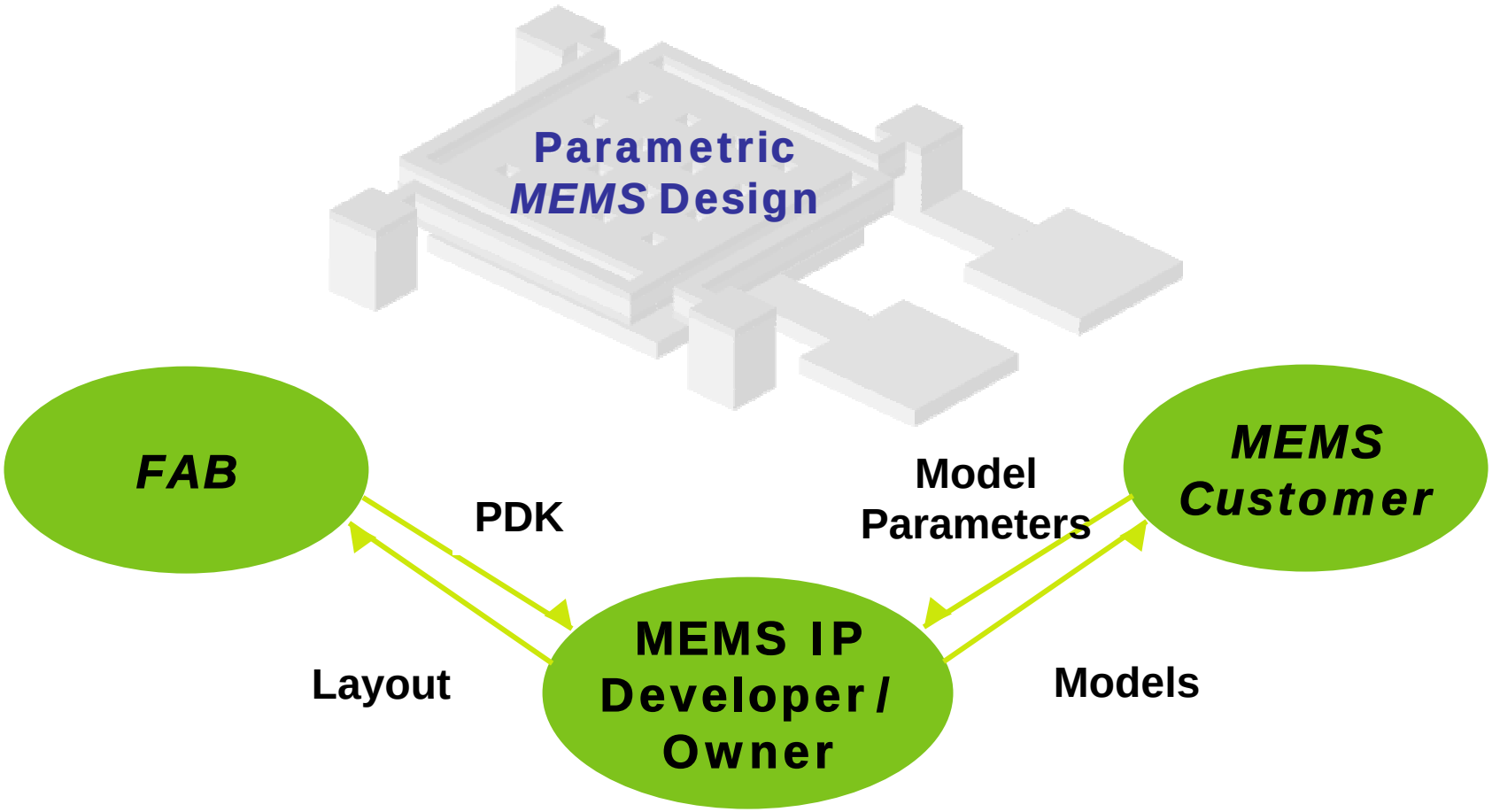
Design Kit Motivation

Designer

… use tools to build a bridge

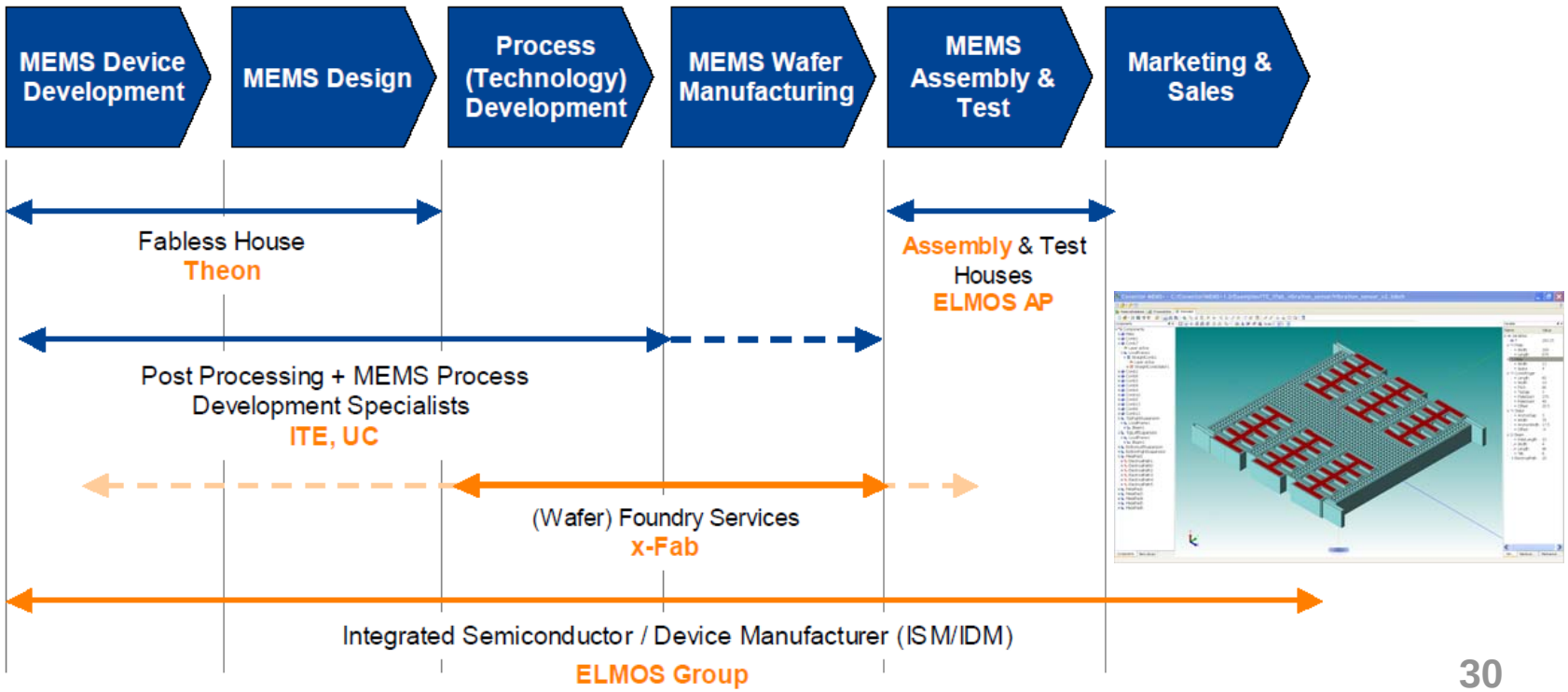
Enable MEMS Eco-System

- Facilitate communication between the distributed partners of the MEMS eco-system

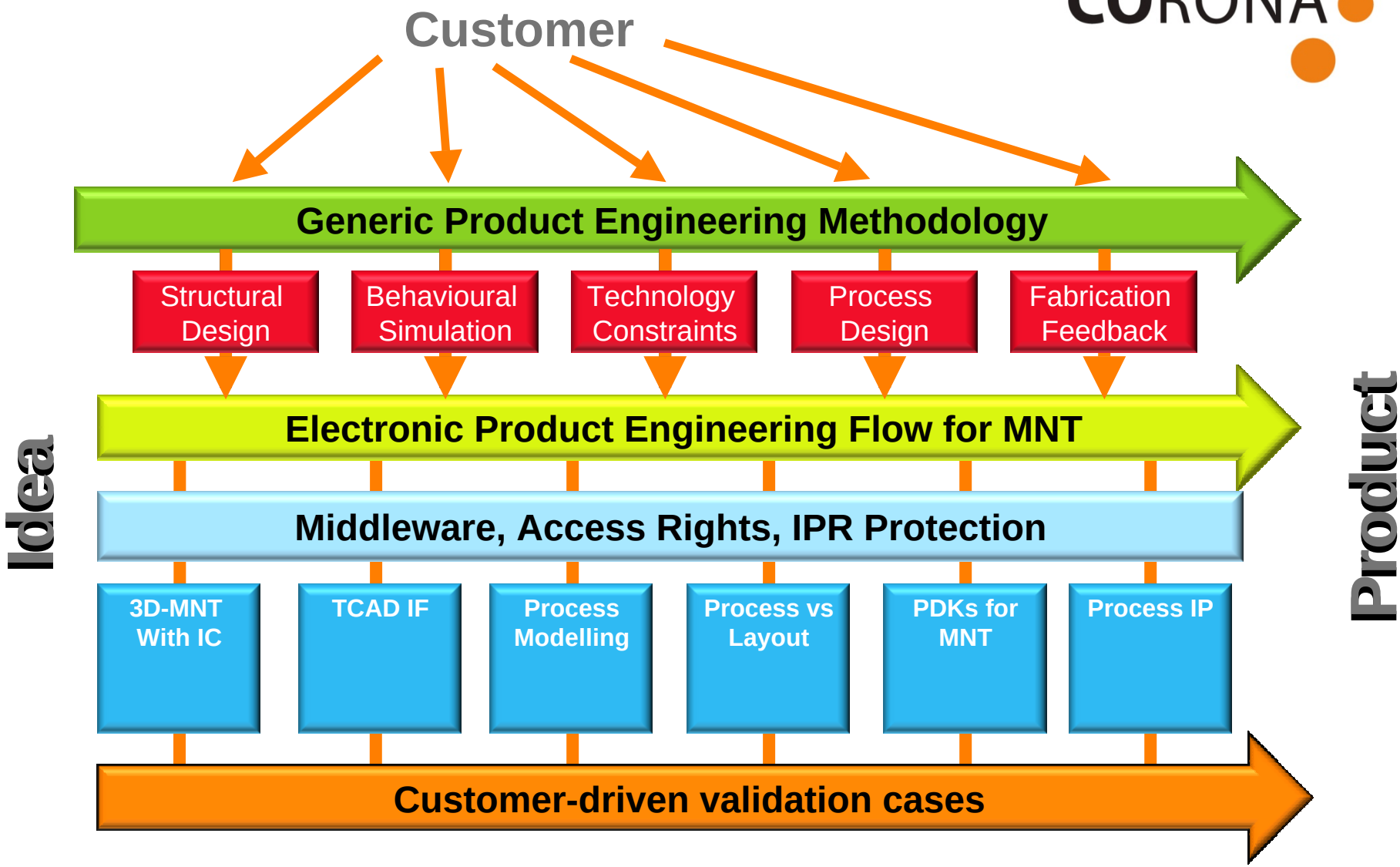


Validation via Business Cases

- **Fab Less -> Theon -> Capacitive Accelerometer**
- **Combination XFAB / ITE -> Technology design / Post Processing -> Smart vibration detector**
- **University Cambridge -> post processing -> Life Science**
- **Integrated Manufacturer -> ELMOS -> Pressure Sensor System**



CORONA Product Engineering Vision



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