Next Generation Embedded Systems: Design, Integration and Validation Challenges

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Technology drivers in modern ES

- Functionality vs. implementation
  - Dominated by programming over a platform
    - Hardware programming: e.g. FPGA
- Flexibility in functionality
  - Integrability
    - Capability based
    - Service oriented system composition
    - Semantic capability description- ontology styled modeling
  - Run-time deployment/reconfiguration
    - RT-virtualization
    - Numerous commercial and open-source systems
- Flexibility in system topology
  - Wireless/mobile communication
  - M2M
- Model based design
  - Run-time design/reconfigurability

Cyber-physical system (CPS)

- Computational and physical elements.
- Combination & coordination between

- Significant computational resources
  - processing capability, local storage + cloud
- Multiple sensory input/output devices
  - cameras, GPS chips, light sensors, proximity sensors
- Multiple communication mechanisms
  - WiFi, 3G, EDGE, Bluetooth, Zigbee
- High-level/MDD/DSL programming languages
  - enable rapid development of mobile CPS node SW

Internet of things – cyber physical systems

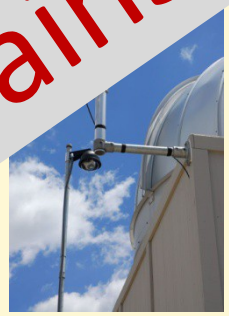
Problem

Service

Cyber world

Physical world

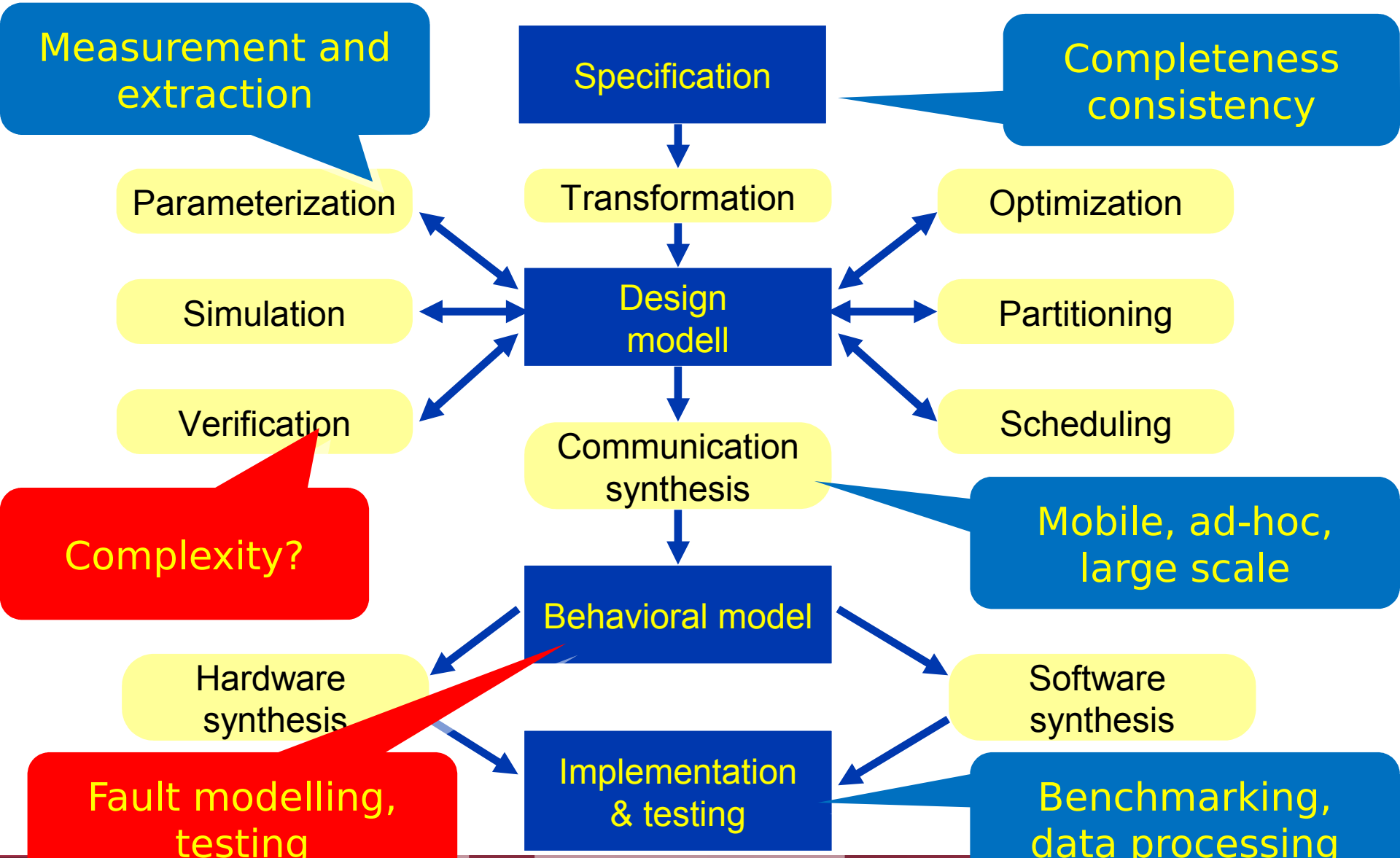
Distributed over multiple domains of control



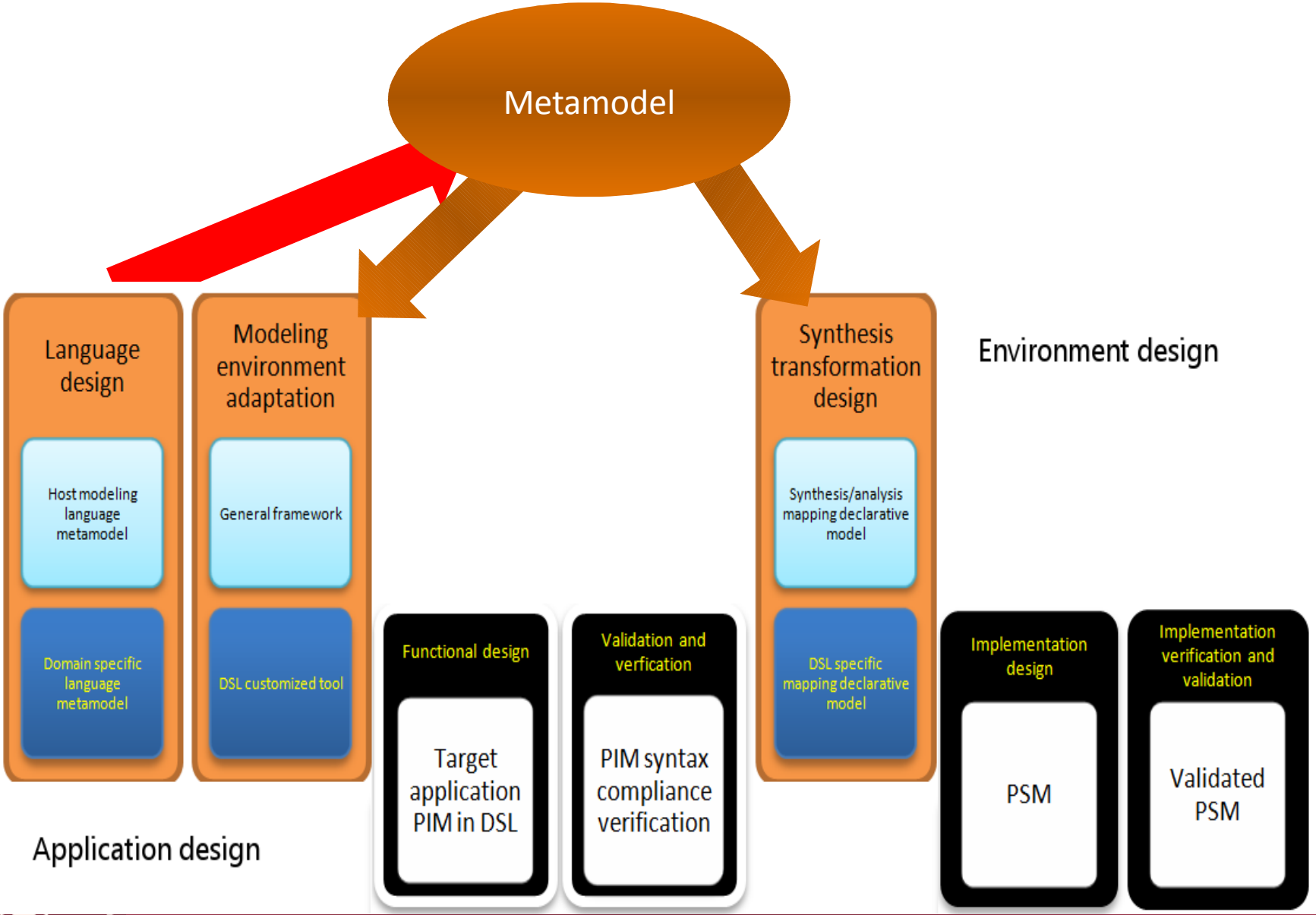
MDA in embedded systems design

ARTEMIS SRA: ruling over complexity needs MDA

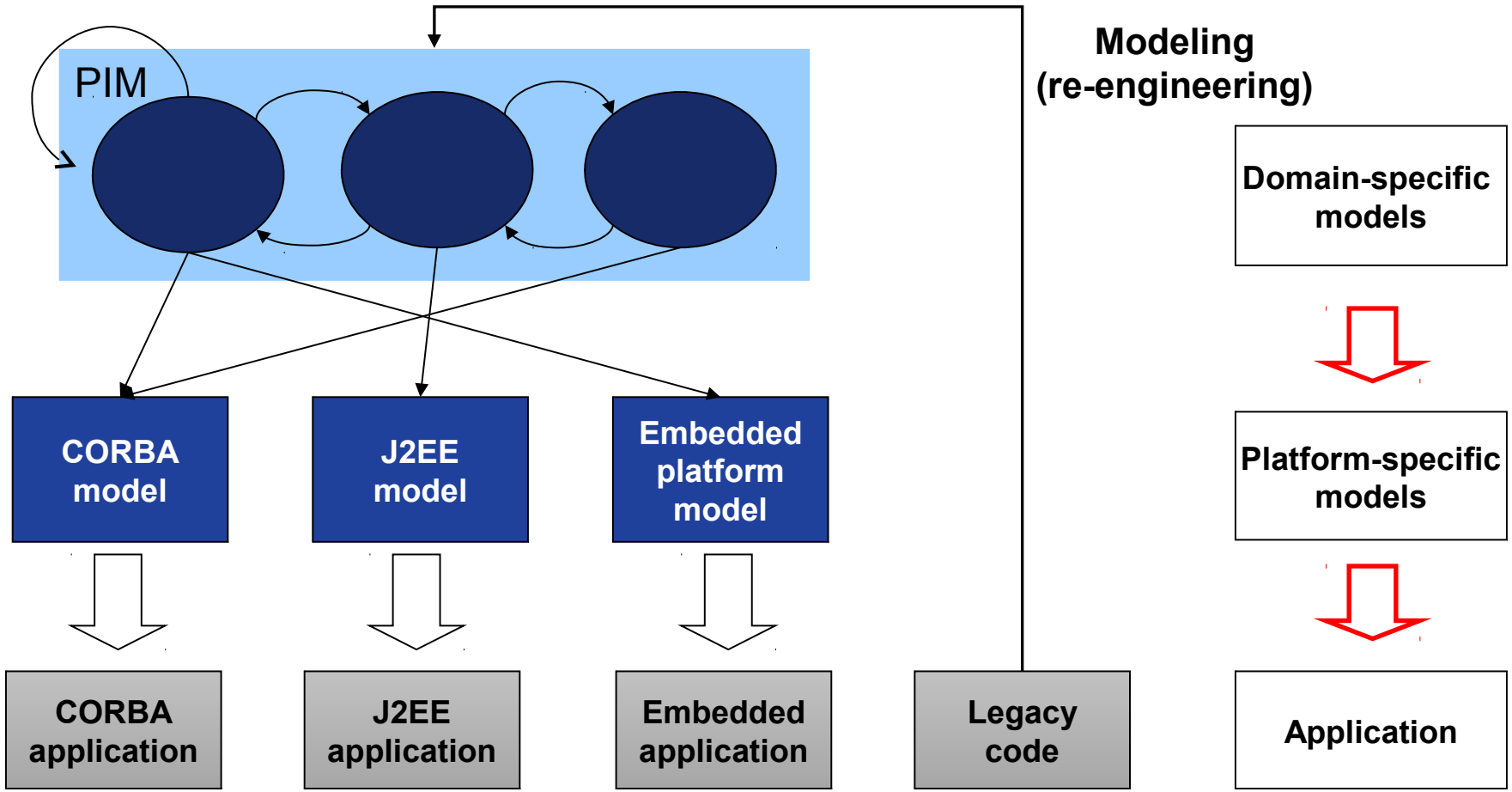
Critical system design and challenges



MDA for embedded systems



MDA, DSM in practice



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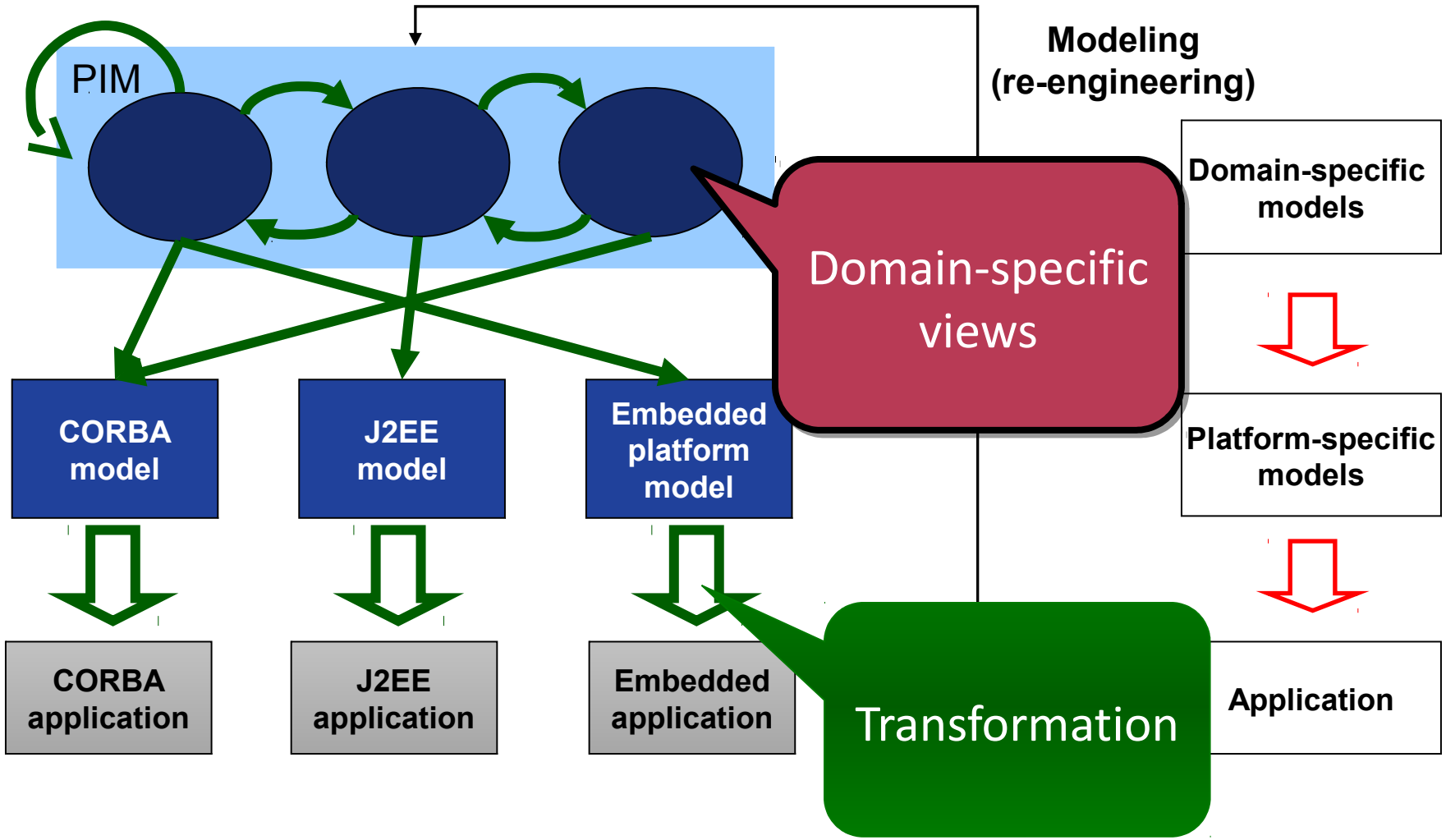
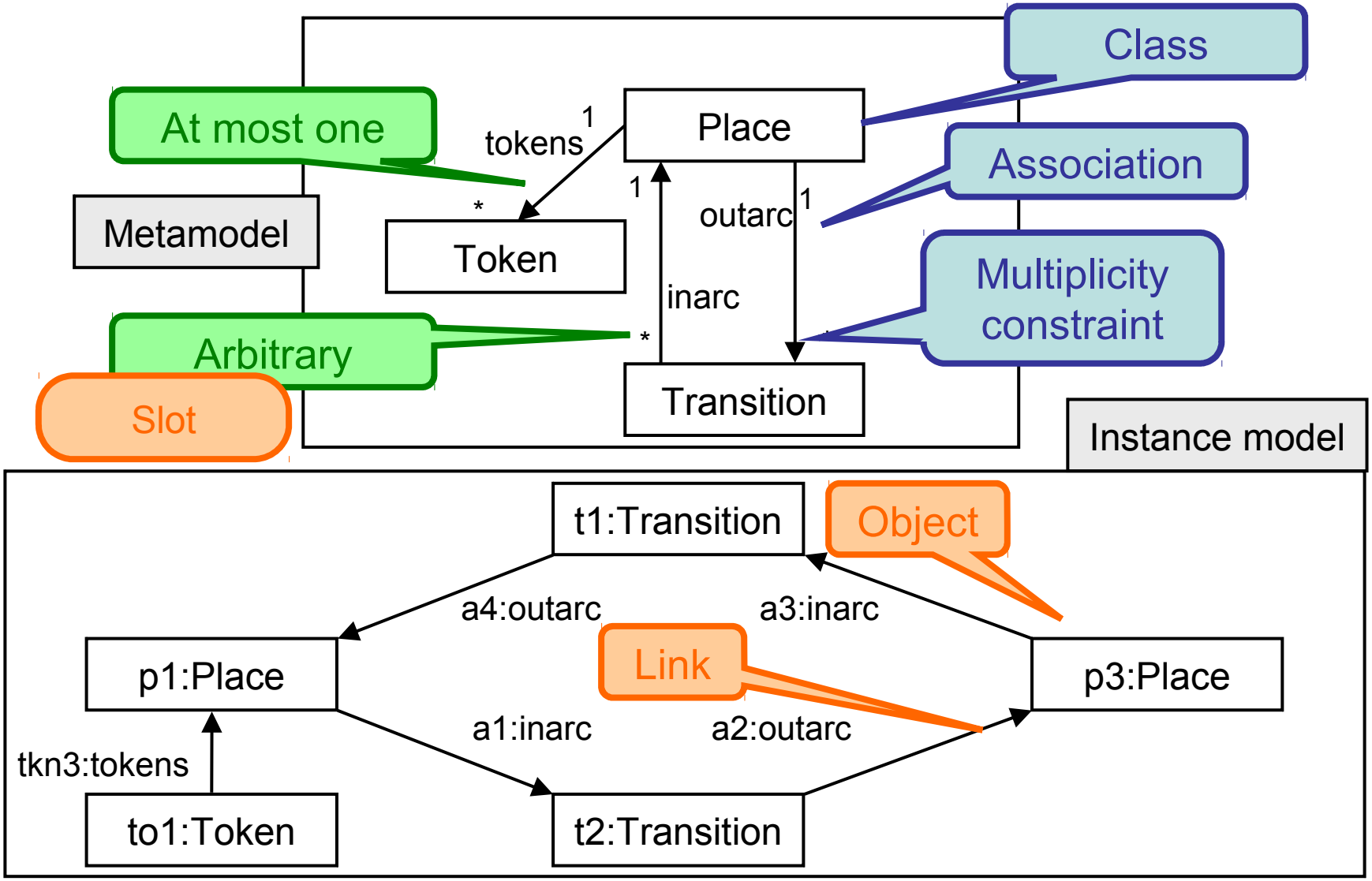
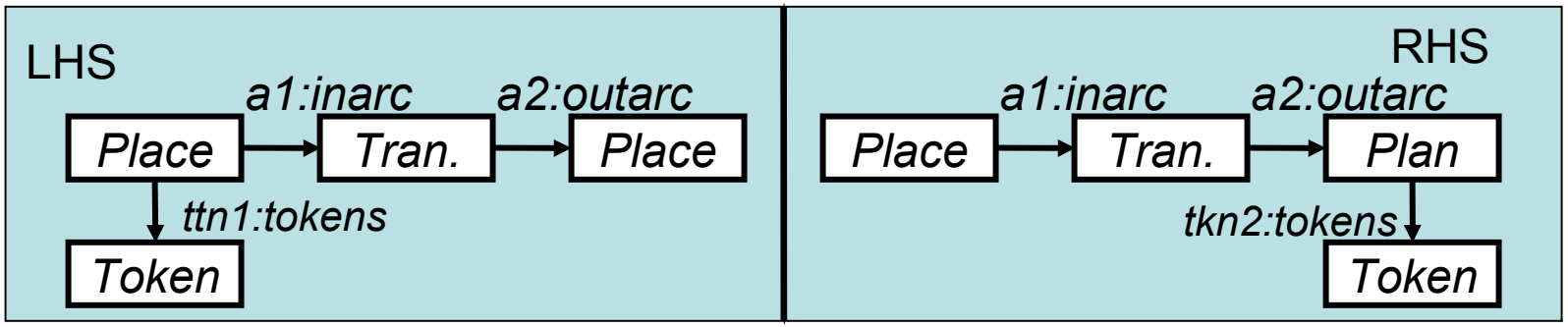
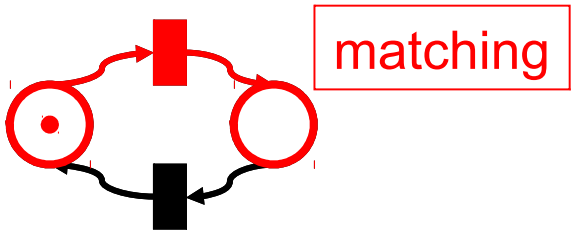


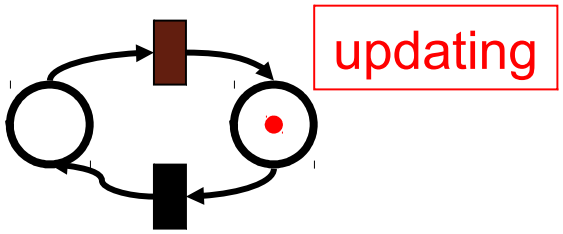
Metamodeling



Graph Transformation







Phases of GT matching

- Pattern Matching phase
- Updating phase: delete+ create

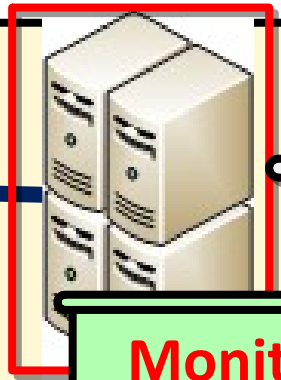
Pattern Matching is the most critical issue from performance viewpoint

MDA for iot

Solving complexity problems needs MDA

Models in the IoT

Problem+ Extra-functional



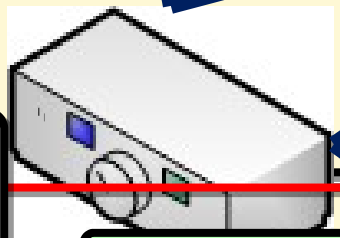
Cyber world

Service design pattern

Service

Monitoring

CIM

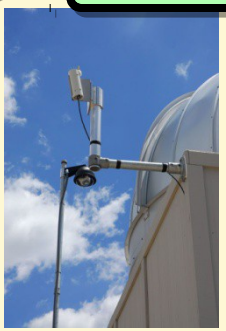


Configuration

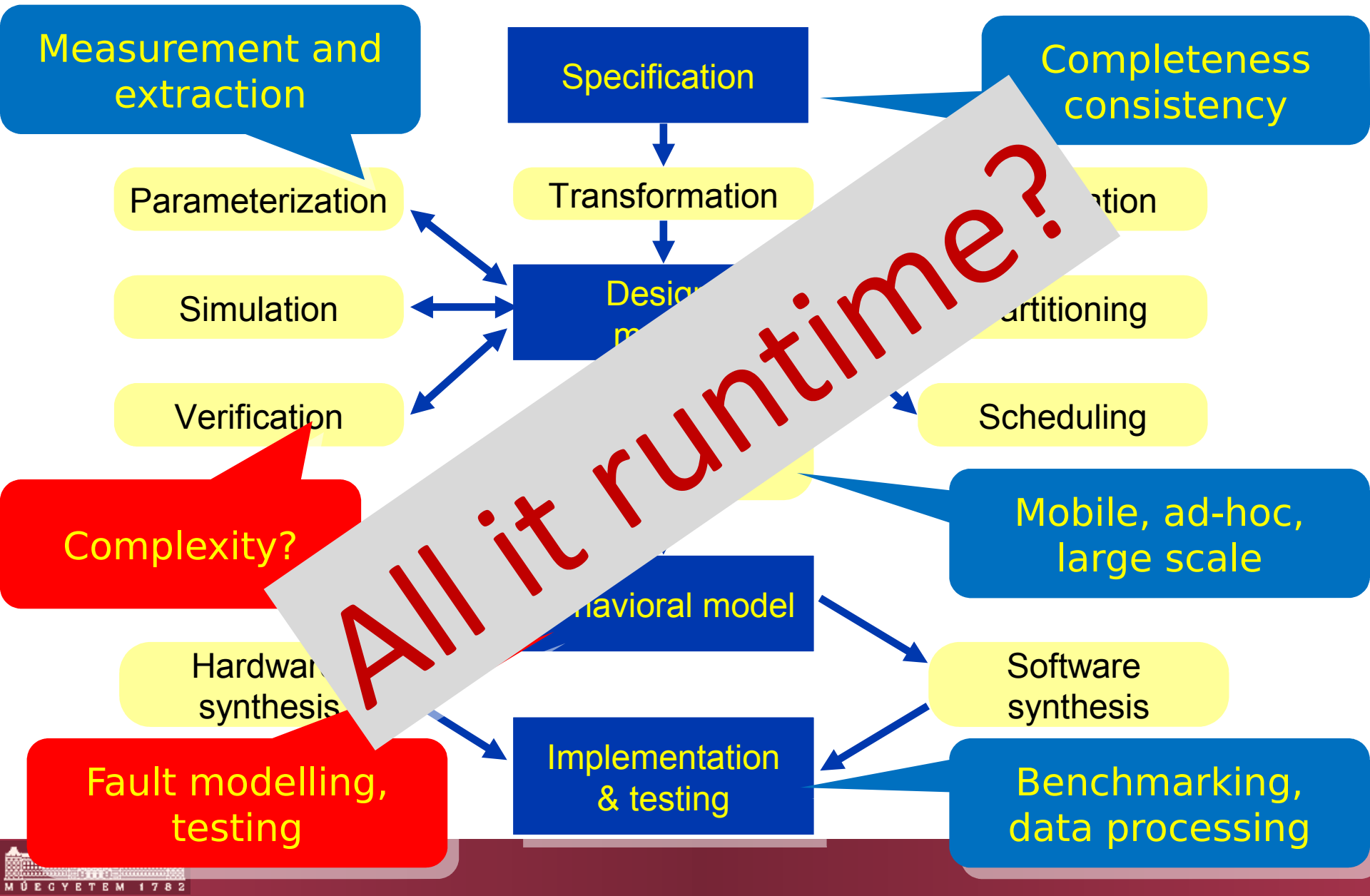
Component Capability Model

Deployment PSM+allocation

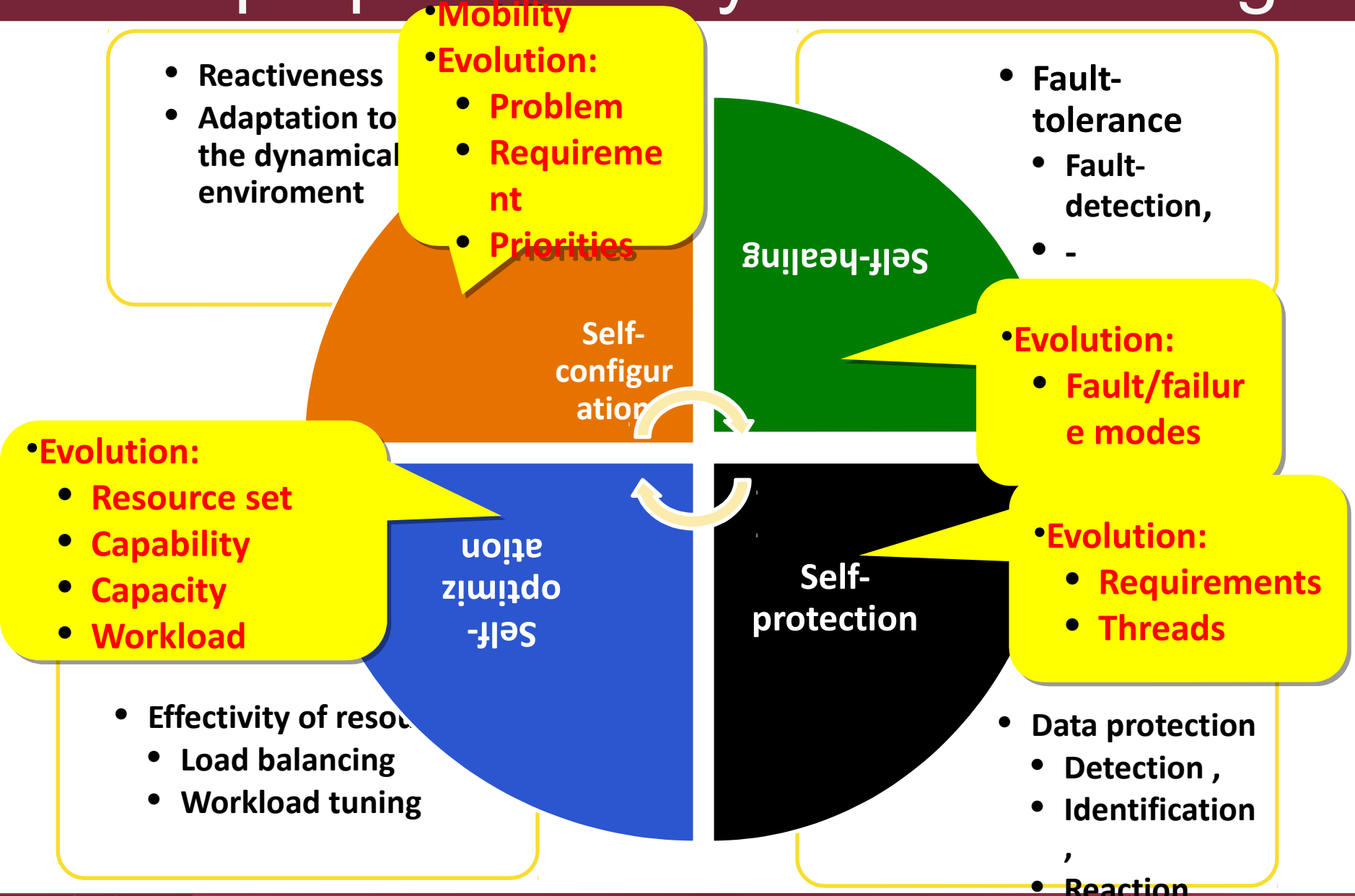
Physical world



Critical IoT system design and challanges



Self-* properties – dynamic challenges

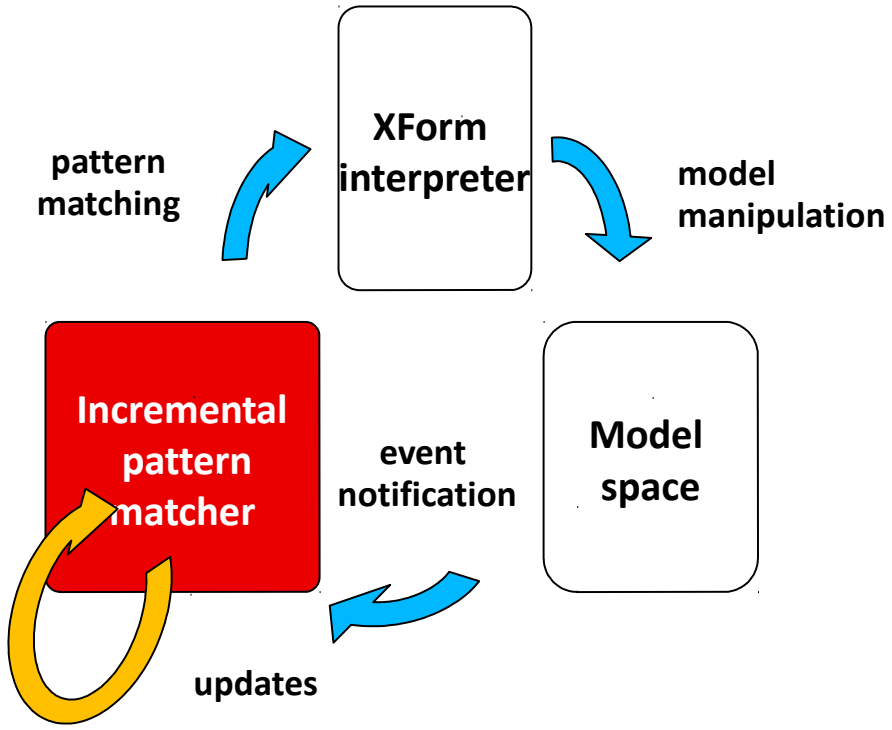


MDA for CPS

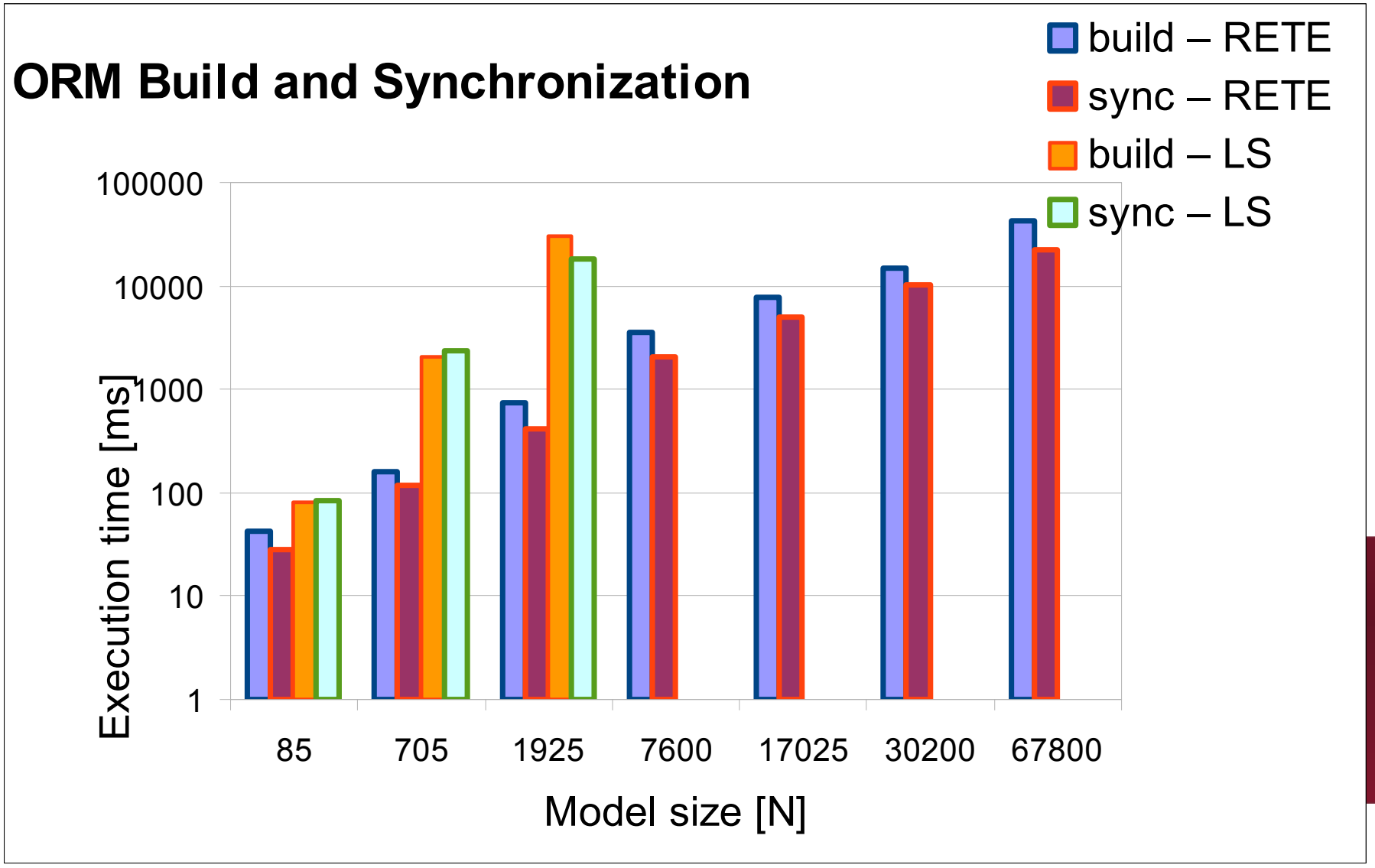
Assurance of the correctness of transformations?

Incremental model transformations

- Key usage scenario for MT: Intramodel manipulation
  - Model execution
  - Validity checking
- Evolving models
  - Problem: transformations are slow to (re-)execute
- Solution: incrementality
  - Map and apply the changes (but ONLY the changes) to the target model.

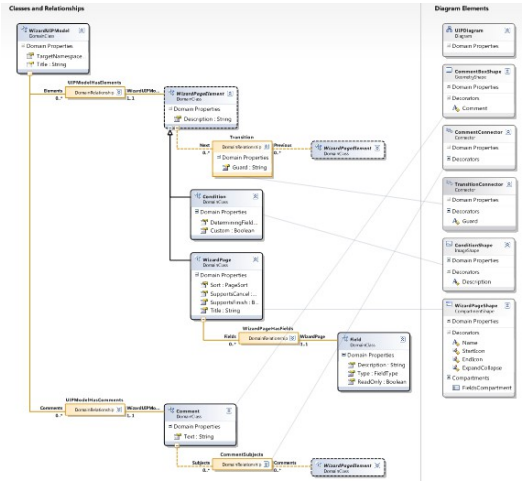


ORM Synchronization benchmark results

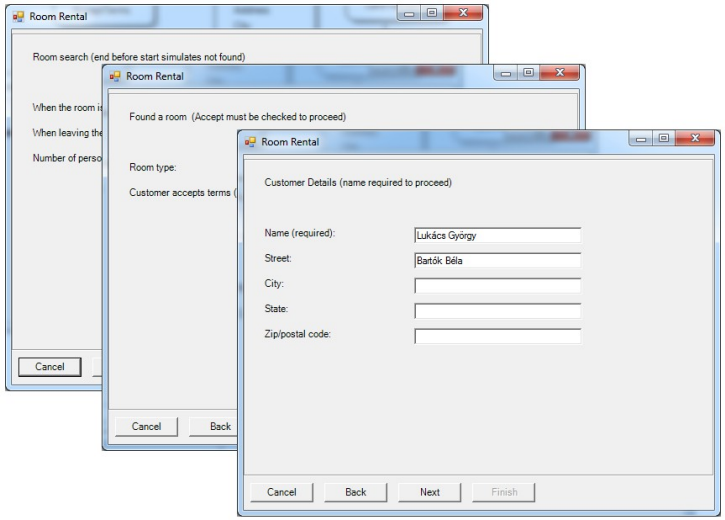


Modeling and application generation

Metamodel

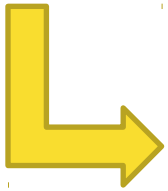


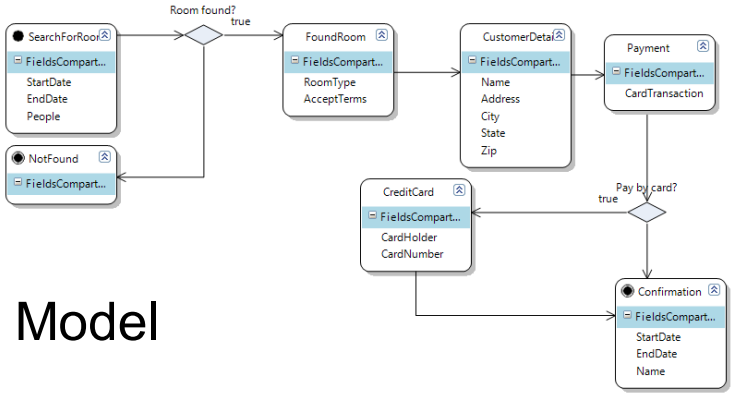
Application

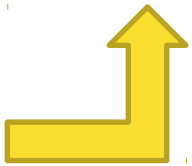


Evolution of the environment

Evolution of the application







Model

summary

IoT core element: transformation

Models in the IoT

Problem+
Extra-functional

Service

Component
Capability
model

Cyber
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Service design
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Monitoring

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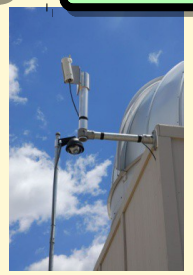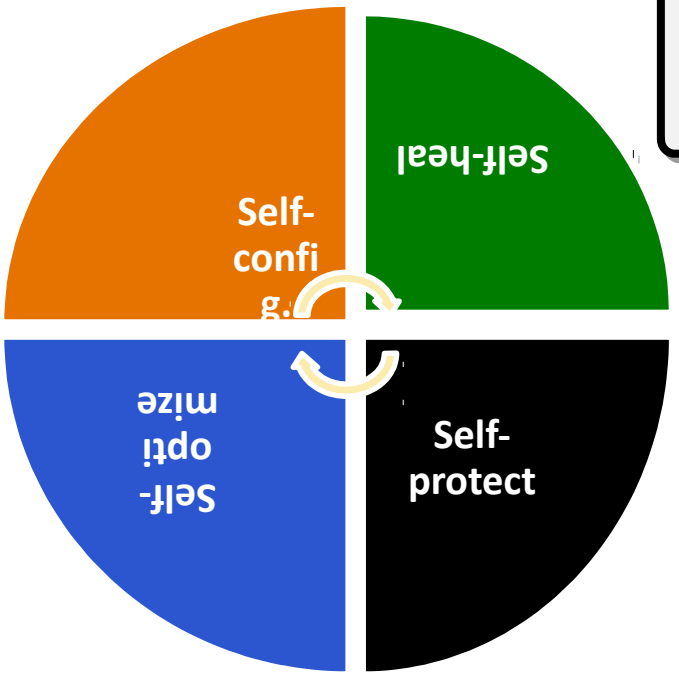
Deployment
PSM+allocation