

# *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

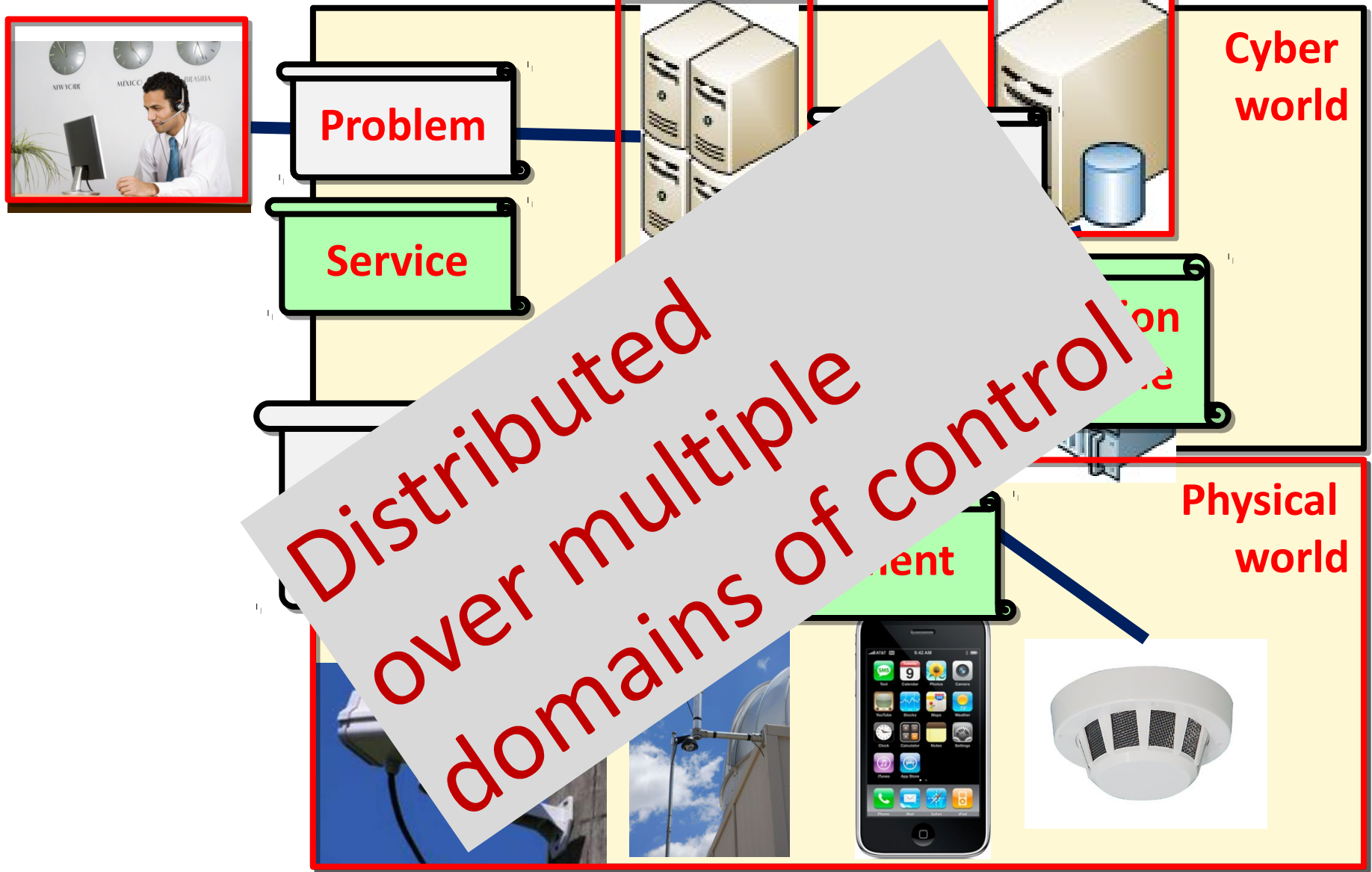
# Cyber-physical system (CPS)



WIKIPEDIA  
The Free Encyclopedia

- 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

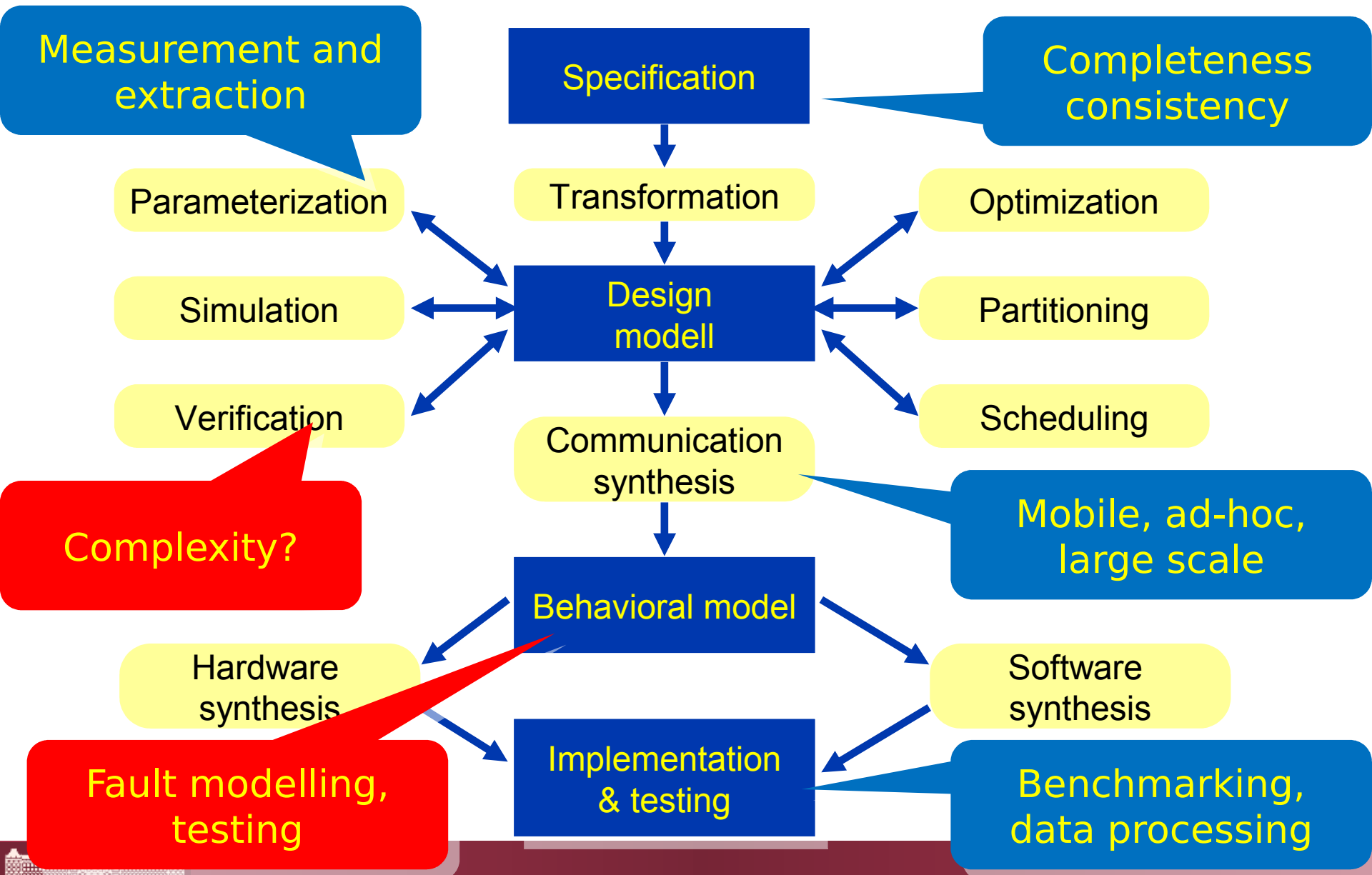
# Internet of things – cyber physical systems



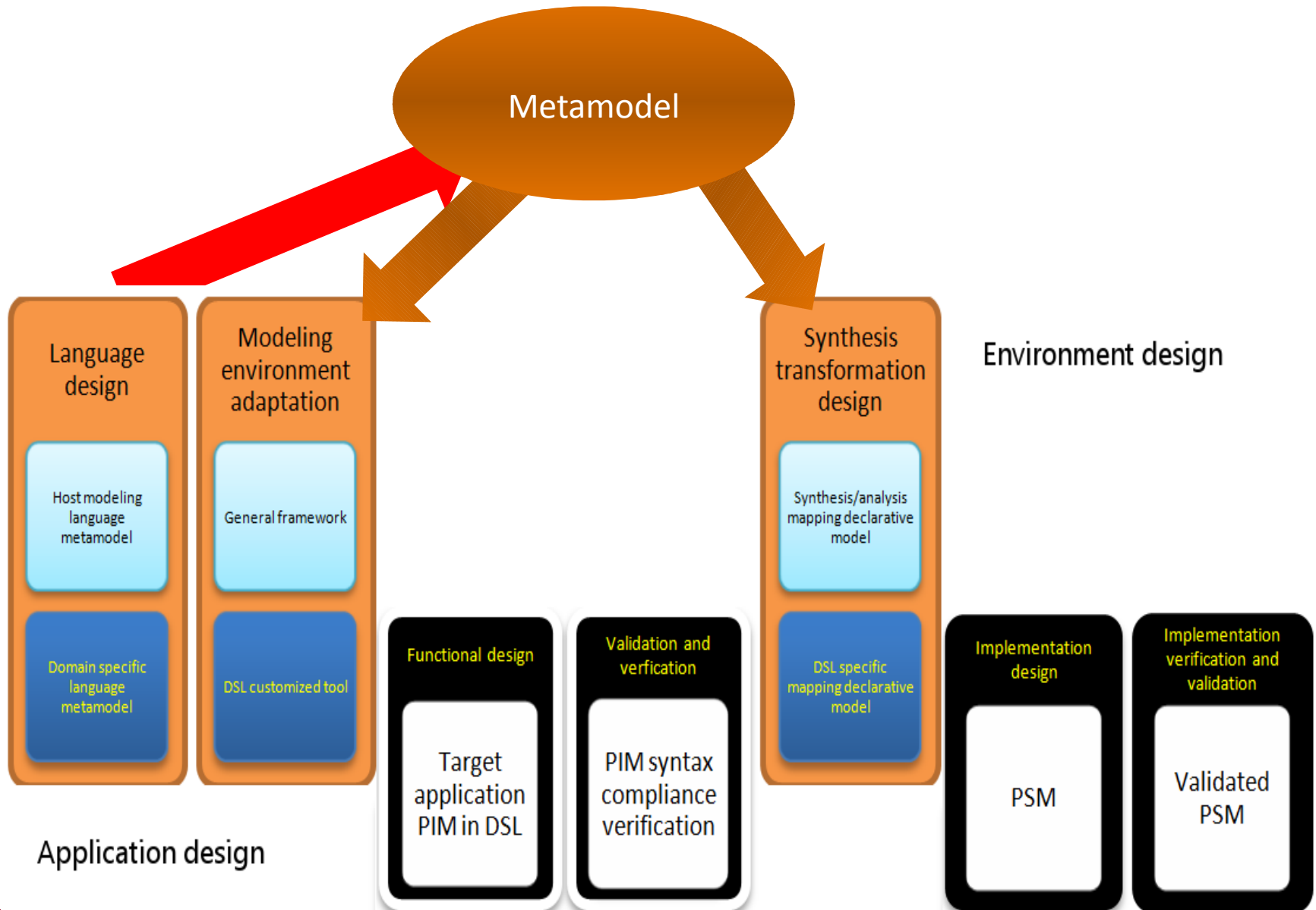
# MDA in embedded systems design

ARTEMIS SRA: ruling over complexity needs MDA

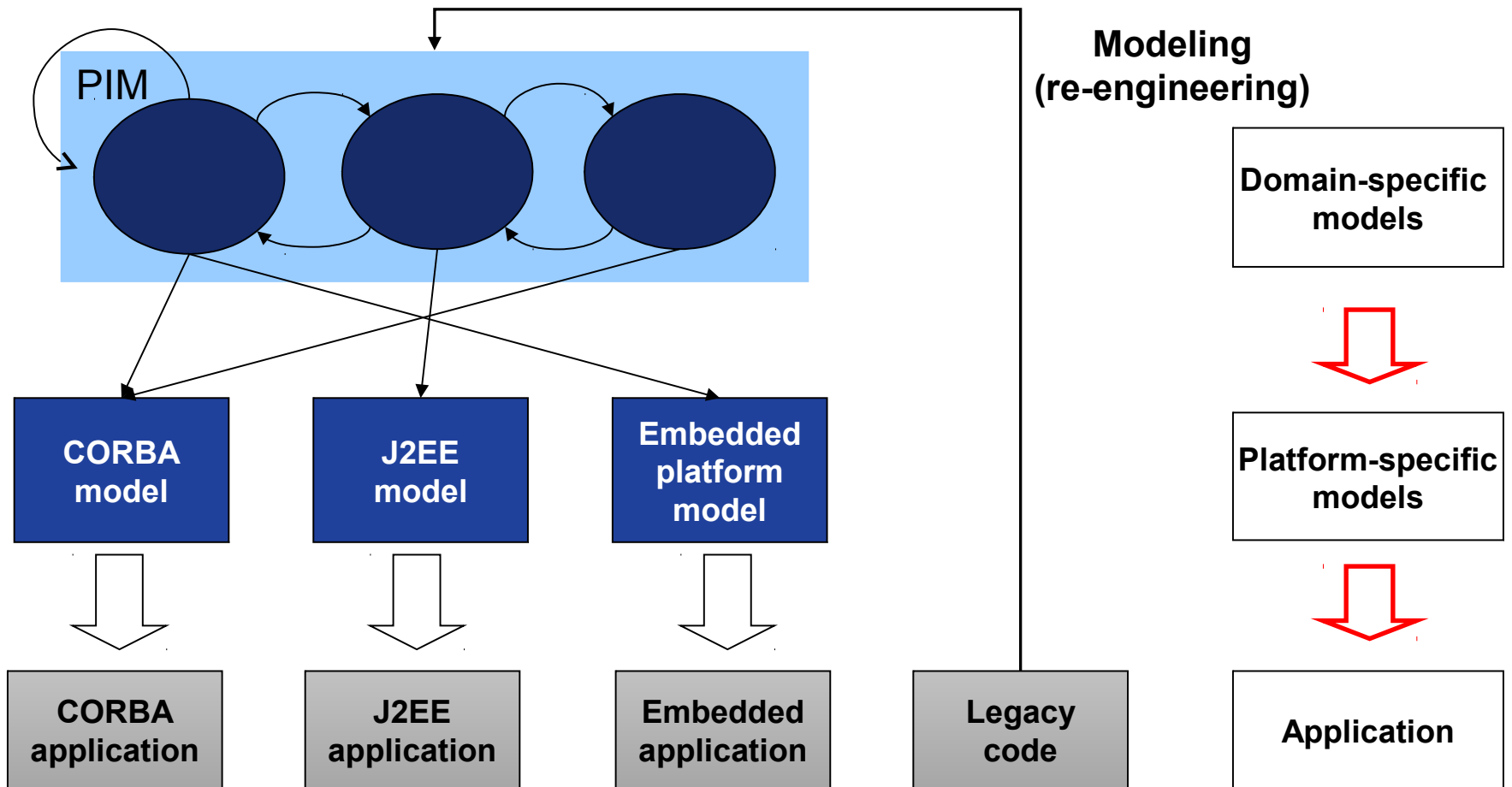
# Critical system design and challenges



# MDA for embedded systems

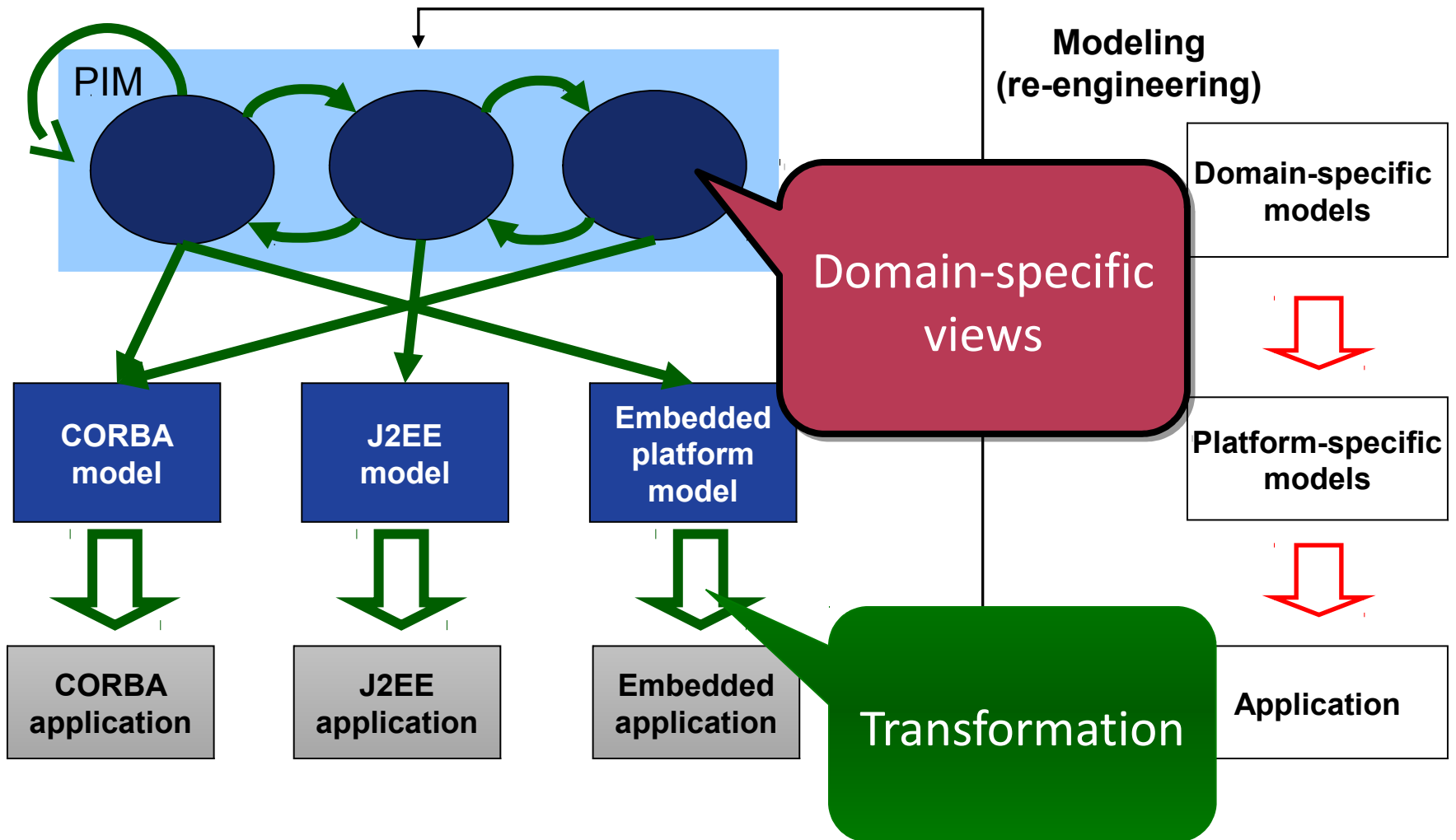


# MDA, DSM in practice

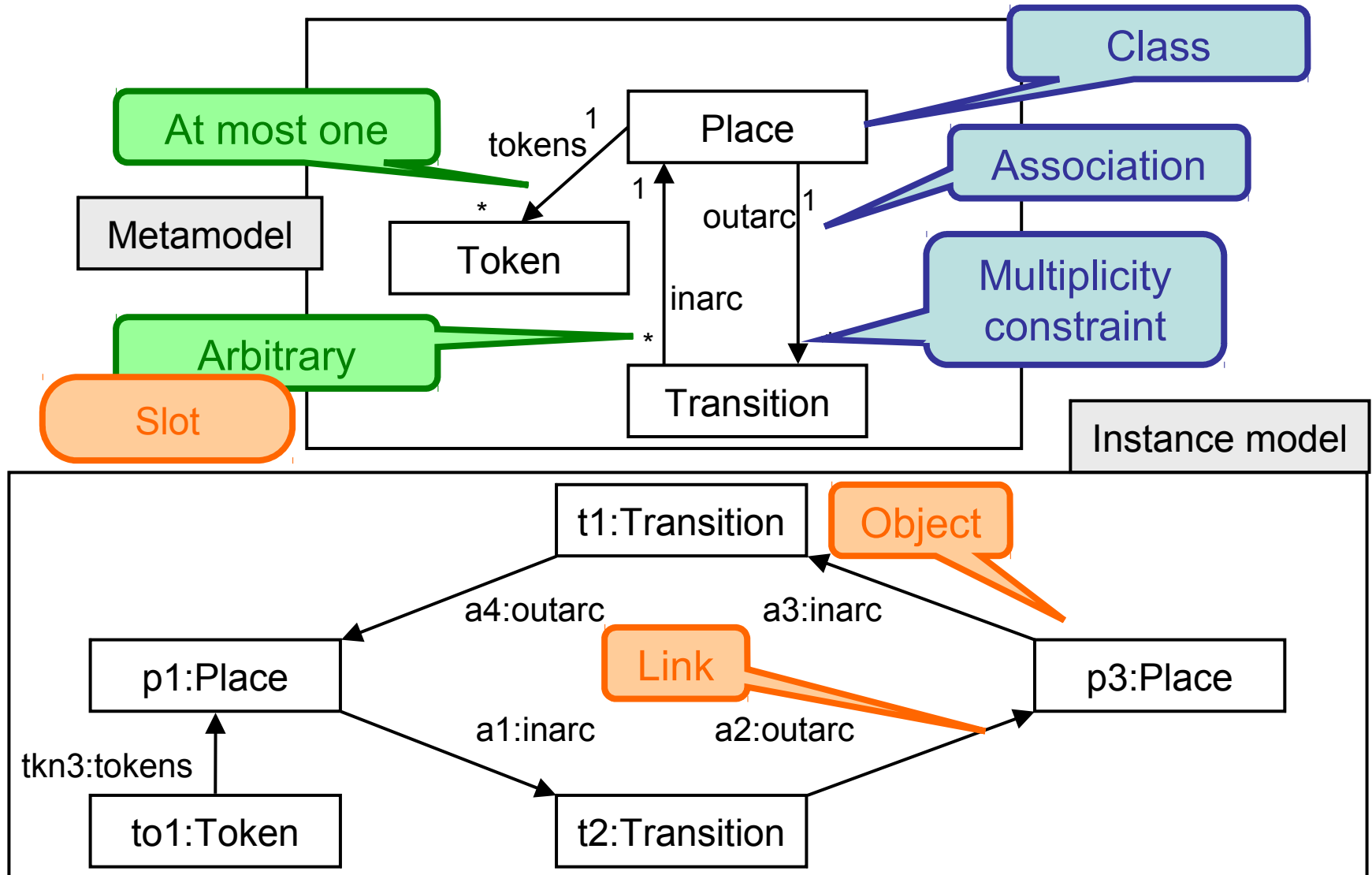




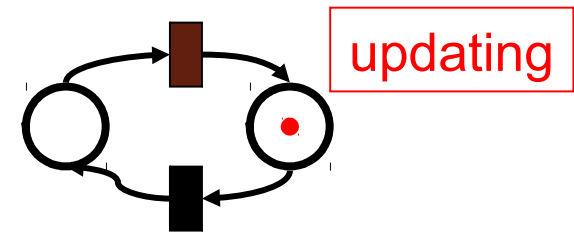
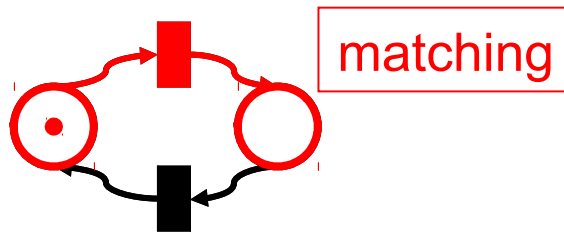
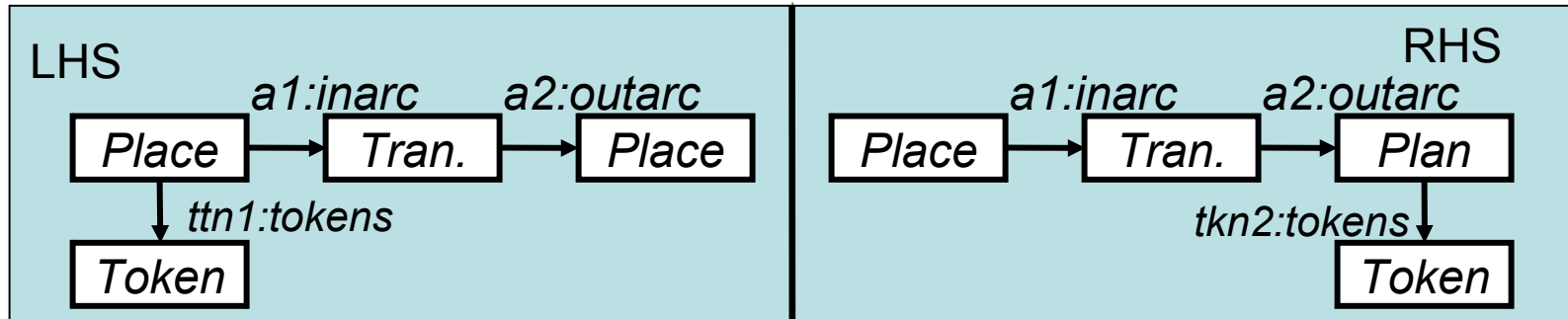
# MDA, DSM in practice



# Metamodeling



# Graph Transformation



## Phases of GT matching

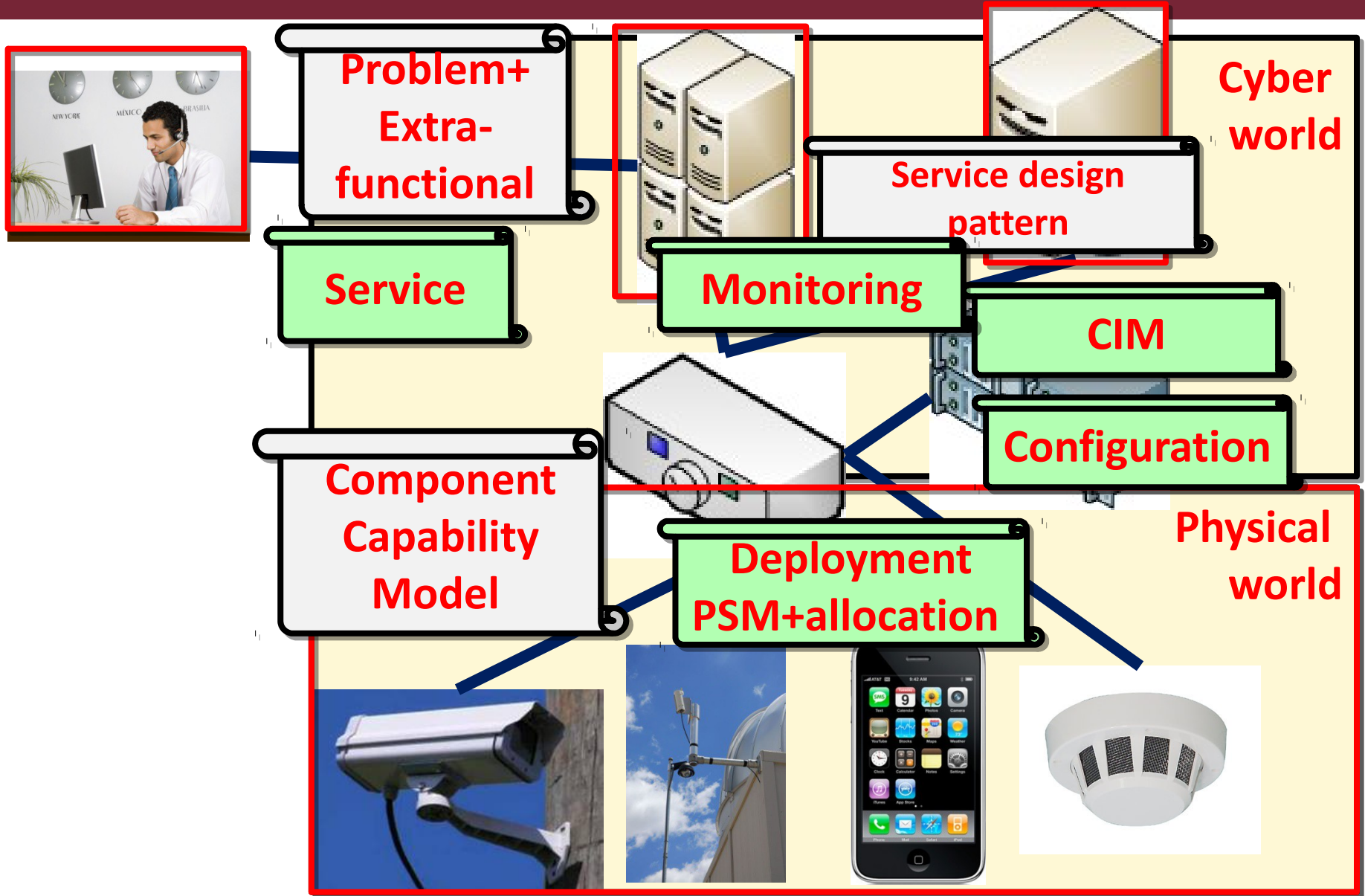
- Pattern Matching phase
- Updating phase: delete+ create

Pattern Matching is the **most critical issue** from **performance** viewpoint

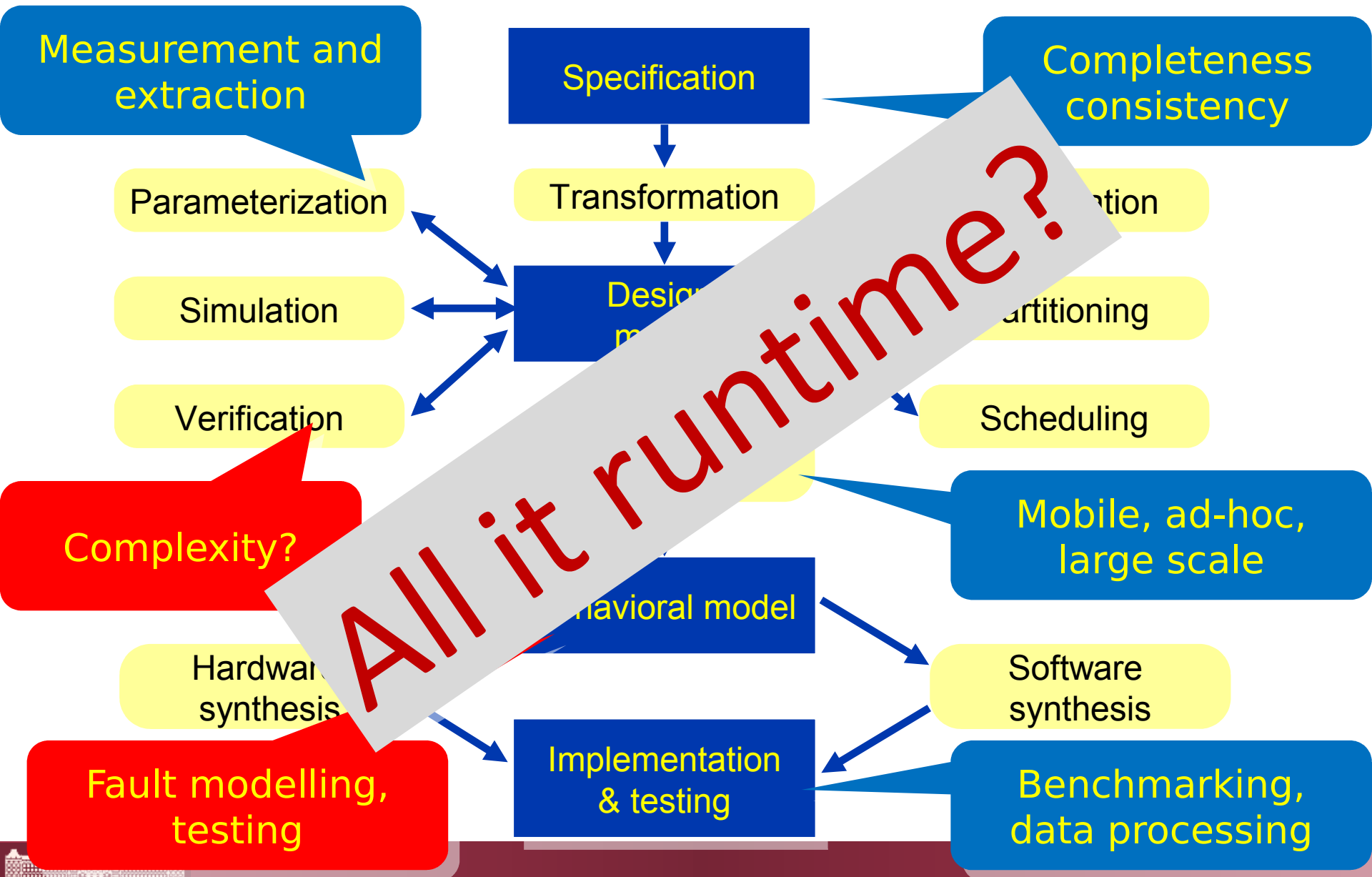
# MDA for iot

Solving complexity problems needs **MDA**

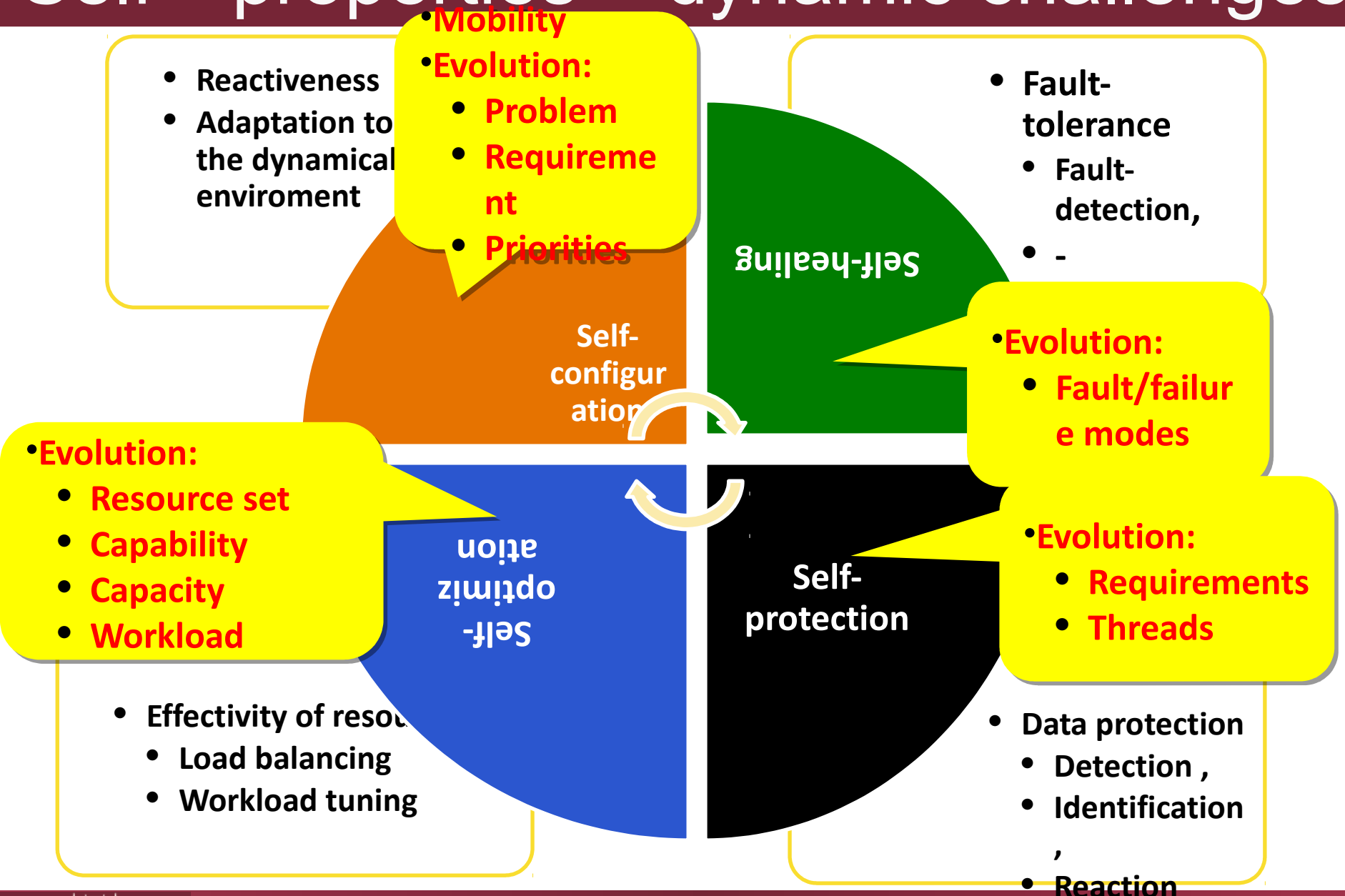
# Models in the IoT



# Critical IoT system design and challenges



# Self-\* properties – dynamic challenges



# MDA for CPS

Assurance of the correctness of transformations?



# Incremental model transformations

🐛 Key usage scenario for MT:

## Intramodel manipulation

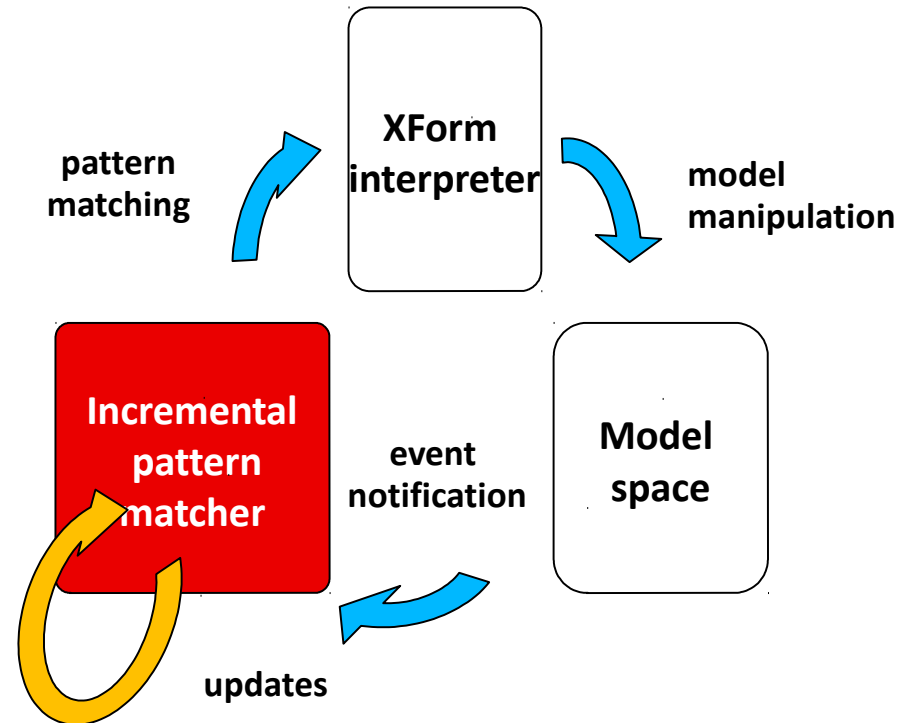
- Model execution
- Validity checking

🐛 Evolving models

- Problem: transformations are slow to (re-)execute

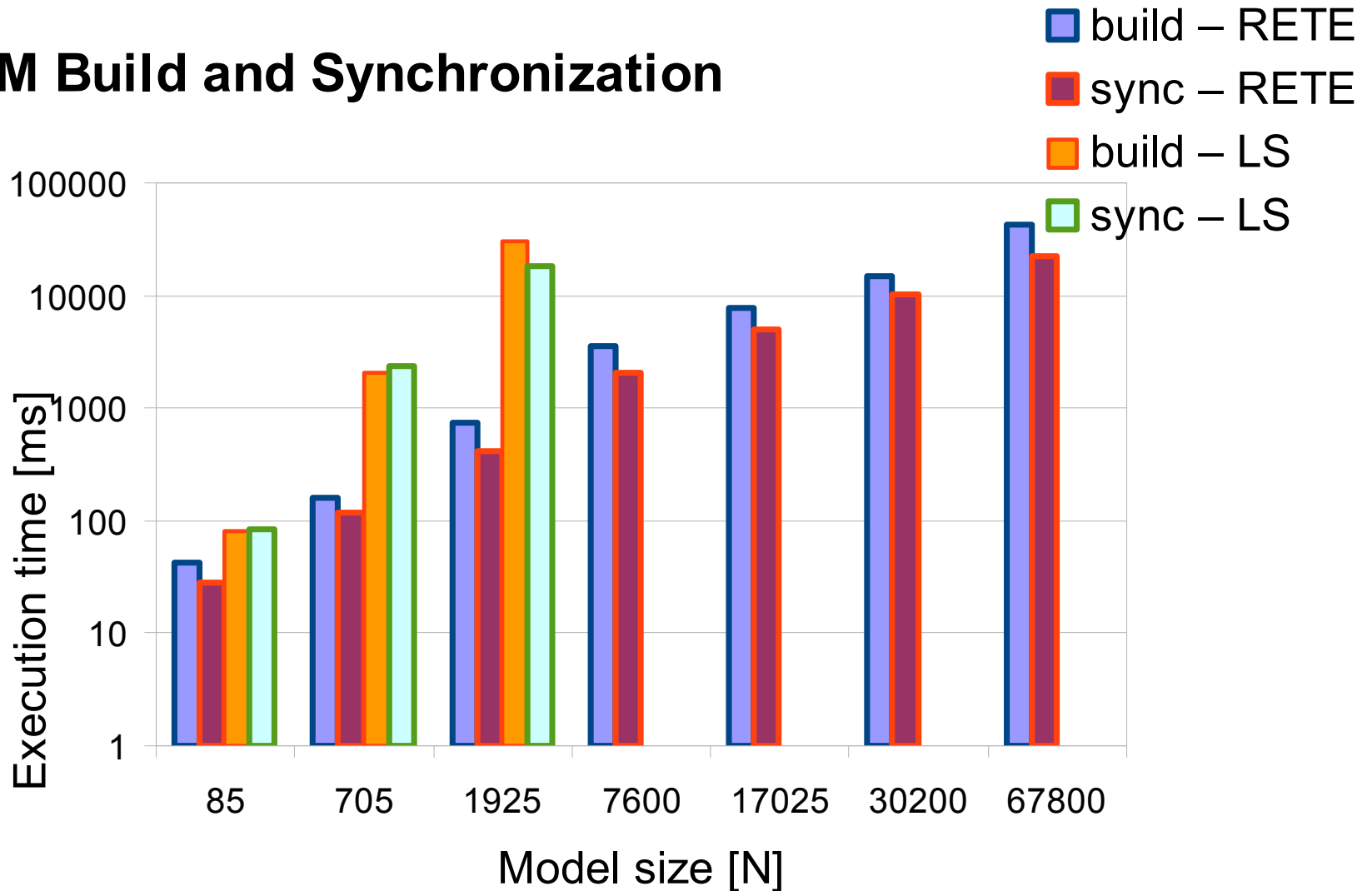
🐛 Solution: **incrementality**

- Map and apply the changes (but ONLY the changes) to the target model.



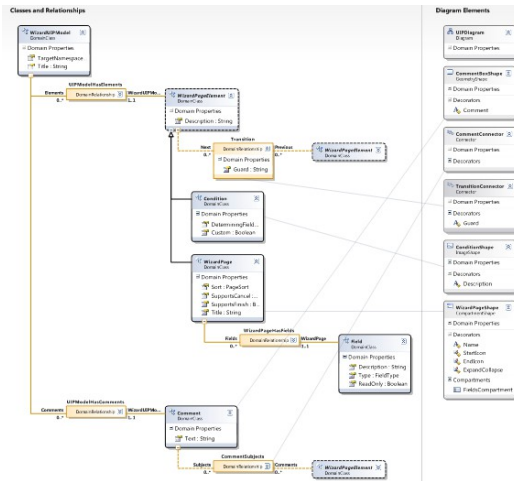
# ORM Synchronization benchmark results

## ORM Build and Synchronization



# Modeling and application generation

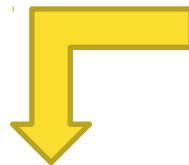
## Metamodel



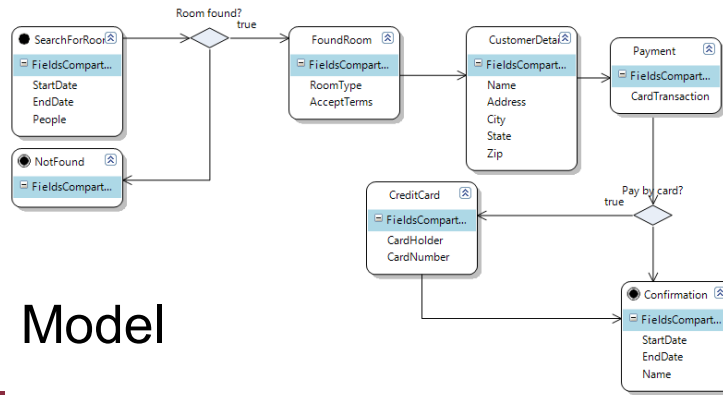
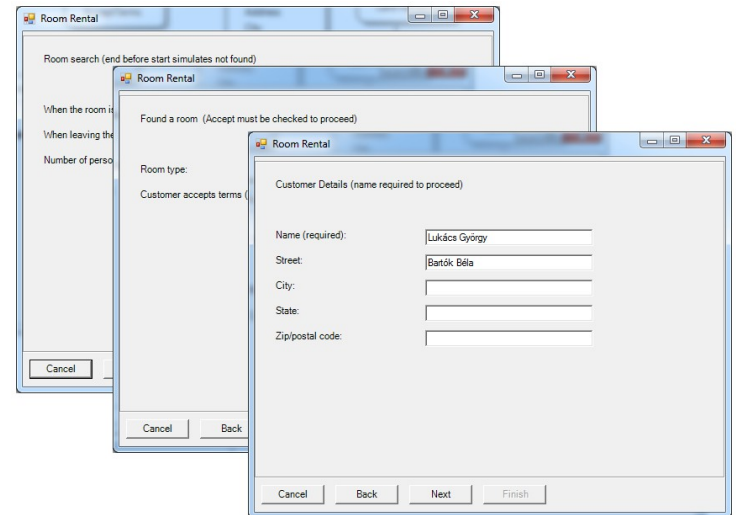
Evolution of the environment



Evolution of the application



## Application



Model



# summary

IoT core element: transformation

# Models in the IoT

