Model Based Methodology and Framework for Design and Management of Next-Gen IoT Systems

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CHALLENGES IN NEXT GENERATION IOT SYSTEMS

Challenges → to → **Contributions**

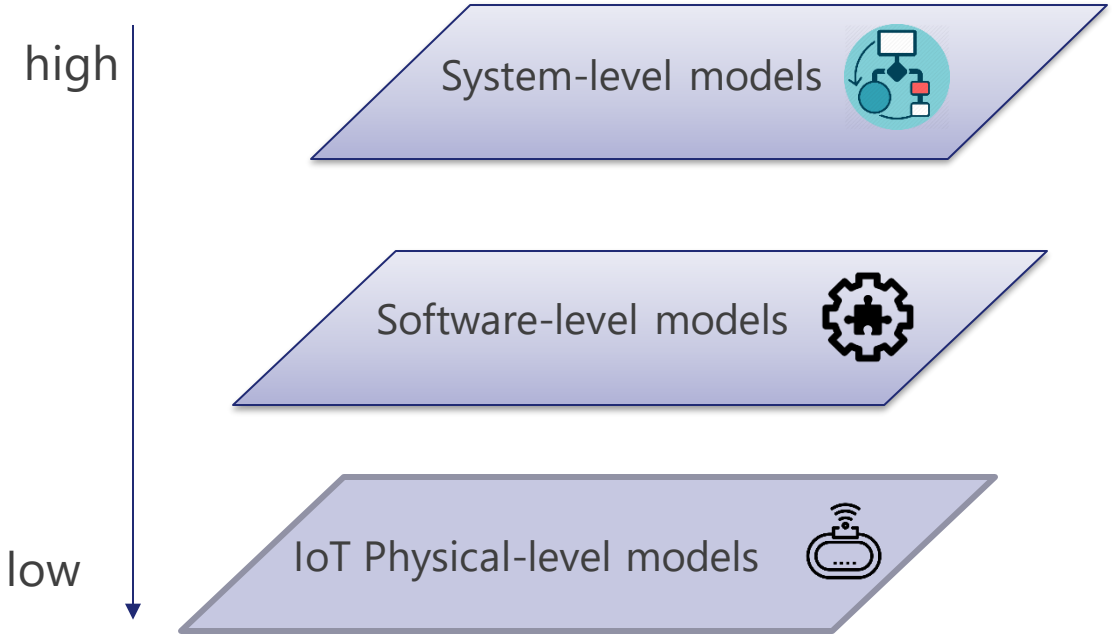
- More complex scenarios that involves the cross IoT platforms/device communication
- IoT systems management and monitoring becoming harder
- Complexity of IoT applications development increased dramatically
- Cost-efficient requirement and physical constraints on IoT System validation

A Model-Based Engineering (MBE) approach to ease the development of the IoT systems offering:

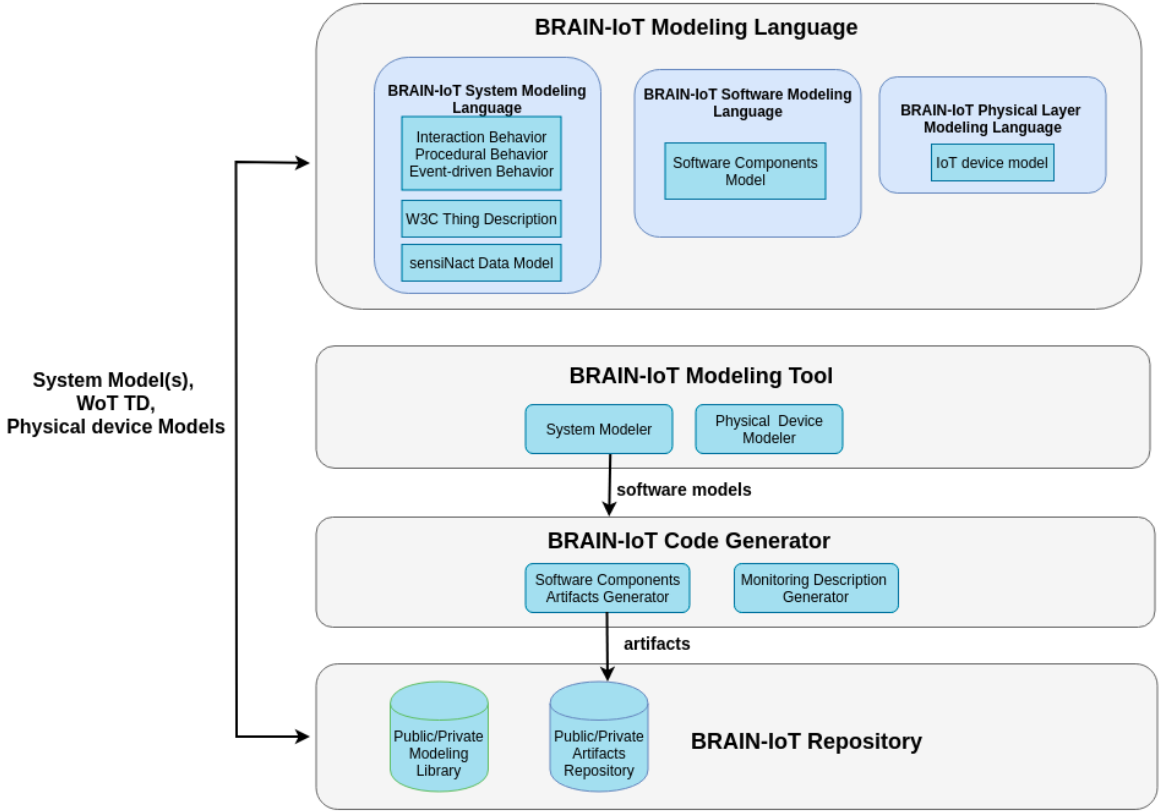
- Three abstraction layer modeling methodology
- IoT service composition supporting interoperability among heterogenous systems
- Formal verification and validation of the models
- The automatic code generation
- Co-simulation approach with the mixed virtual and real entities runtime IoT applications monitoring

BRAIN-IOT MODELING METHODOLOGY

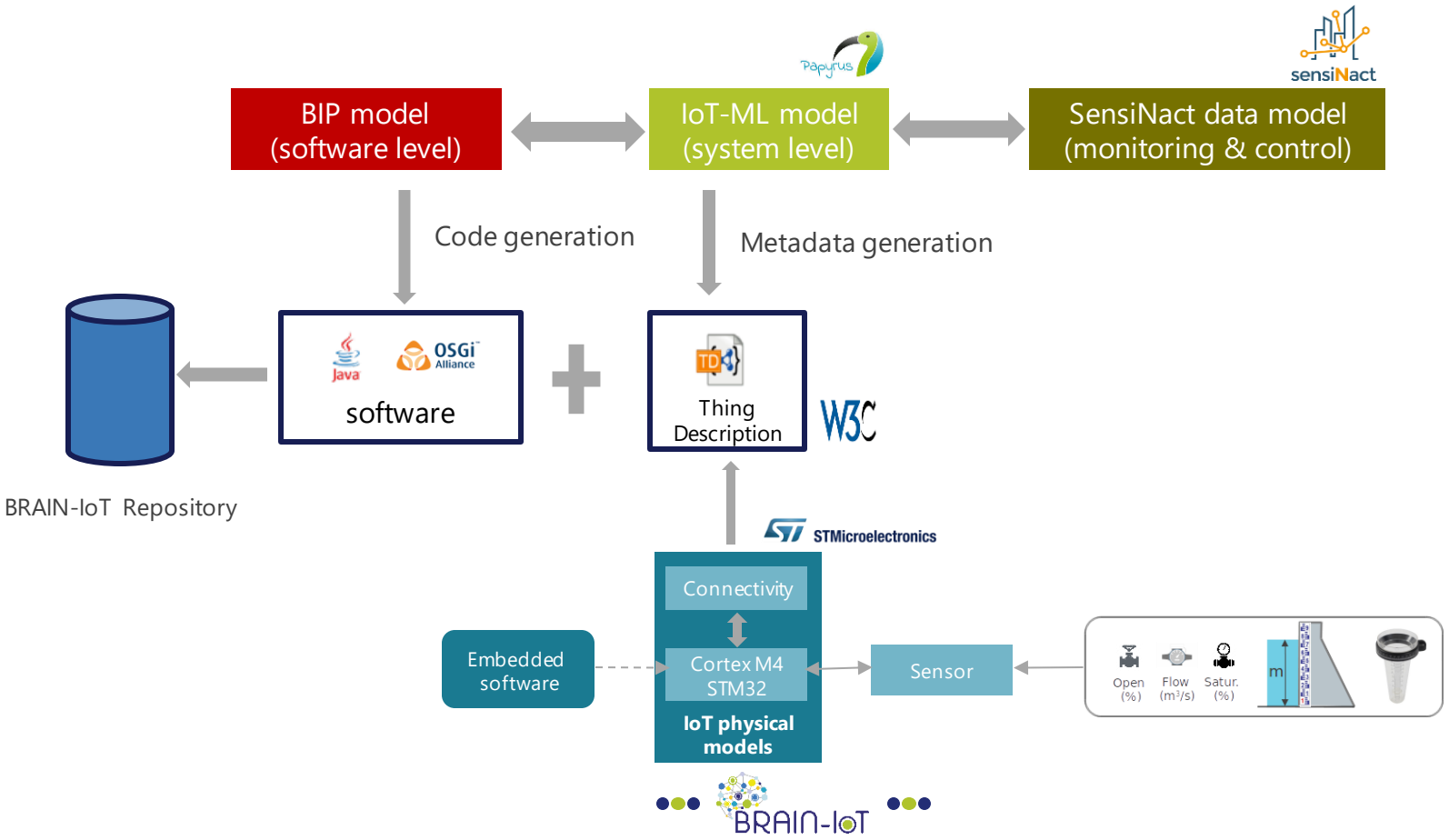
Three modeling abstraction layer



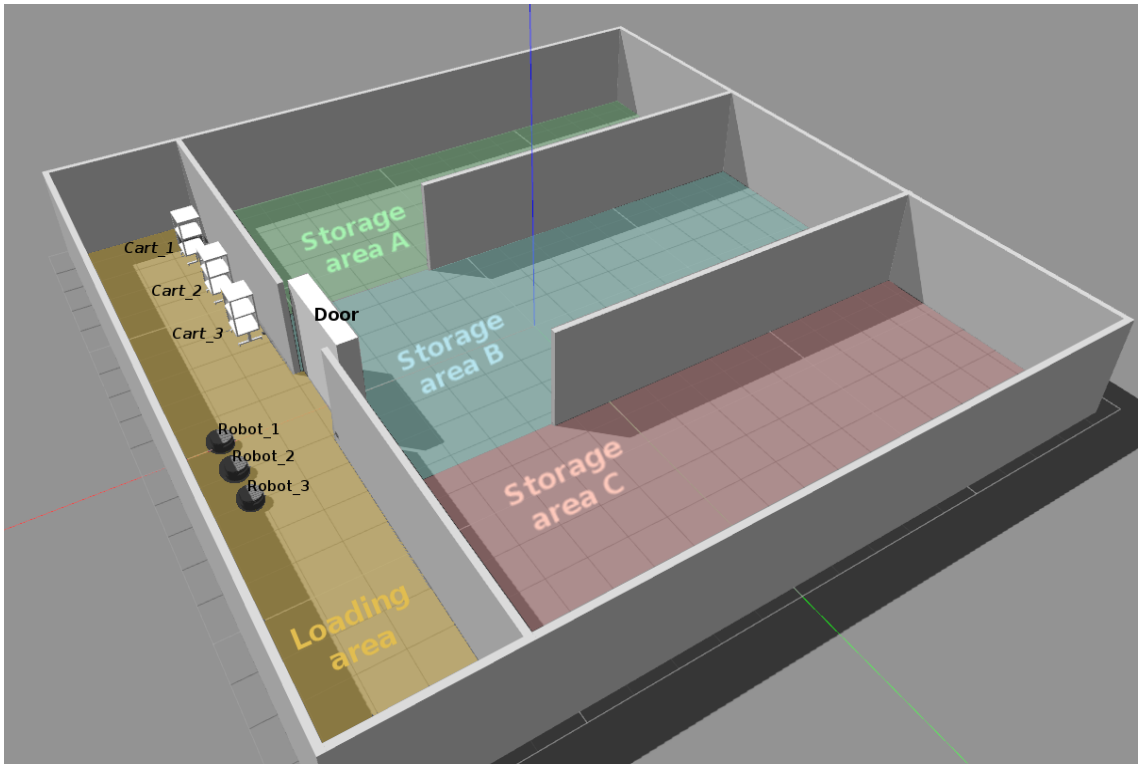
BRAIN-IOT MODELING & VALIDATION FRAMEWORK



FRAMEWORK IMPLEMENTATION



USE CASE 1: SERVICE ROBOTIC

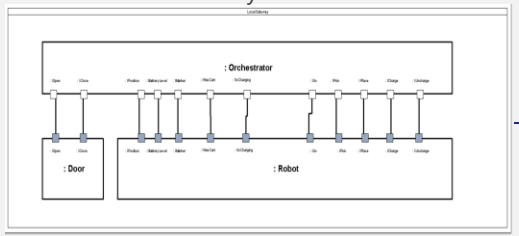


Goal: The **carts** in the load area should be transferred to the storage area by the **Robots** passing through an **automated door**.

1. Door and carts are with the **QR code** attached.
2. Robots are equipped with **vision cameras** that allow the QR codes they find.

USE CASE 1 : SERVICE ROBOTIC SYSTEM MODELS

IoT-ML system model



BIP model

Java code generator

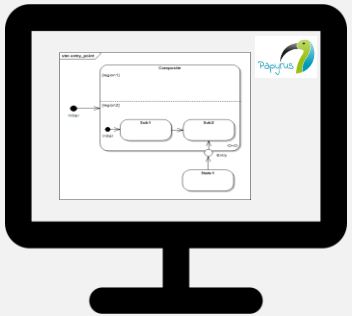
Orchstror.java
Door.java
Robot.java

Wrapping

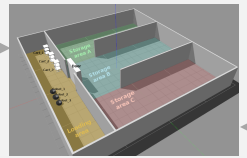
Orchstror.java
Door.java
Robot.java

Easy-development

OSGi bundles dynamic deployment



Robot runtime status monitoring



sensiNact Studio

- Warehouse runtime map coordinates monitoring
- Dynamic control of the robot number in a fleet

Model @ Runtime

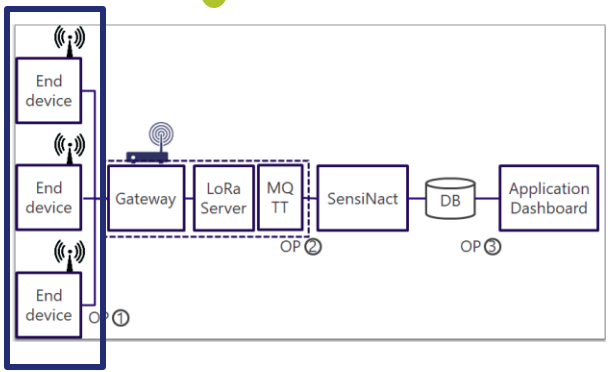
USE CASE 2: CRITICAL WATER INFRASTRUCTURE MANAGEMENT

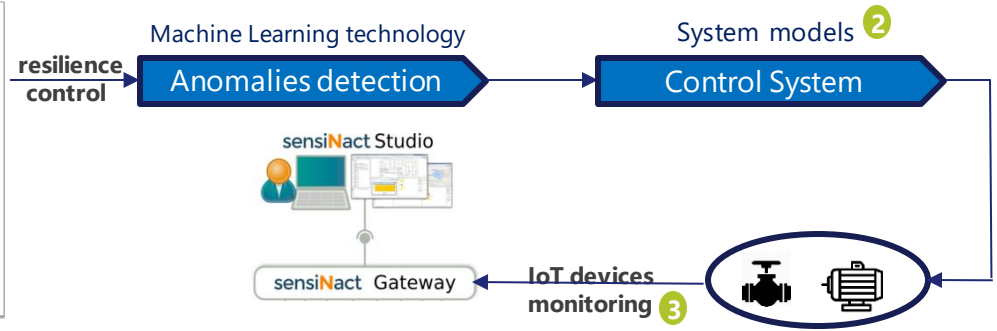
Goal: Develop an **adaptive**, smart **automatic controllable management** system, leveraging prediction models to:

1. Increase the security of water supplies
2. Optimize the underlaying cost
3. More accurate indicators for decision making, real-time, smart and adaptive control procedures

USE CASE 2 : CRITICAL WATER INFRASTRUCTURE MANAGEMENT

Modeled IoT devices 1





1 enables the IoT digital twin solution
- generating a huge amount of data with simulated models and reduce the cost of the physical devices.

2 allows adaptive behaviors in a critical environment
- implemented as a BRAIN-IoT system model to automatically react abnormal situation.

3 provides a user-friendly tool to visualize the runtime states of the critical devices
- the states of the valves and pumps can be supervised from the sensiNact Studio.

TAKE HOME MESSAGE

A Model based Methodology and Framework has been developed for the next generation IoT systems:

- System-level model, which captures the system functionalities and behaviors to help refinement of the software-layer modelling;
- Linking towards real devices and external services through meta-data representation in WoT TD;
- The application code is generated from model for monitoring and controlling the IoT infrastructure;
- System application validation leveraging the simulated IoT devices developed with the BRAIN-IoT physical layer modeling language;
- Monitor the IoT system behaviours and its configurations in a human-friendly graphical manner through the Models@Runtime approach at the execution time.

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BRAIN-IoT

model-Based fRamework for dependable sensing and Actuation in INtelligent decentralized IoT systems