A Cross Platform Communication Mechanism For ROS Based Cyber Physical System

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WHY ROS EDGE NODE IS NEEDED?

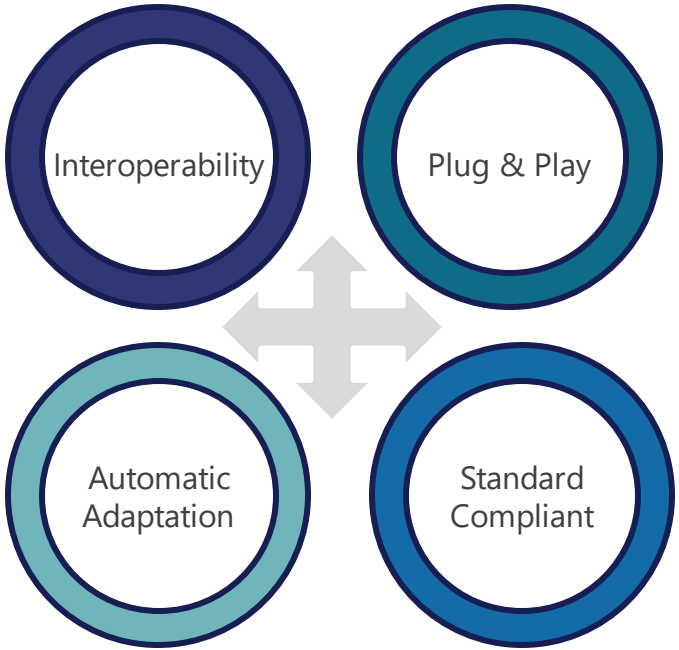
- Complex intelligent IoT ecosystems is required to react to system requirements and environment changes
- ROS-based CPS is used in various IoT Domains, interoperability will bring potential benefits
- Lack of interoperability between heterogeneous platforms
- Emerging IoT standards prevent to integrate new IoT platforms
- Off-the-shell IoT devices/platforms don't support secondary development

ROS Edge Node aims to solve the interoperability between ROS-based CPSs and various heterogeneous IoT platforms in a dynamic and federated environment

FEATURES OF ROS EDGE NODE

An adaptor integrating ROS-based CPSs with BRAIN-IoT platform

It enables the communications between ROS-based CPS and other heterogeneous IoT systems in an intelligent and autonomous infrastructure

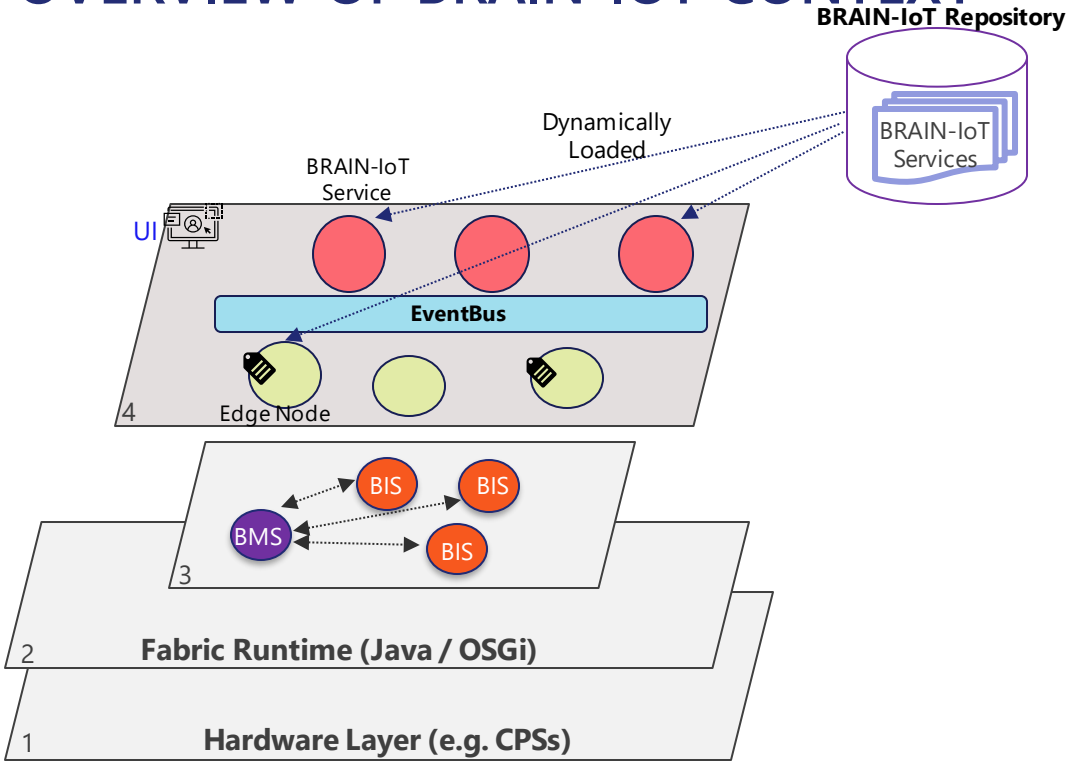


An event-driven approach automates the software modules deployment at BRAIN-IoT runtime in a distributed execution environment according to specific system requirements and user events

A code generator automatically abstracts the ad-hoc ROS functionalities provided by different ROS-based CPSs and speeds up the adaptor development process

It exploits the Web of Things (WoT) Thing Description (TD) describing the services provided by ROS-based CPSs, making it more portable to the production environment, not restrict to the OSGi implementation

OVERVIEW OF BRAIN-IOT CONTEXT

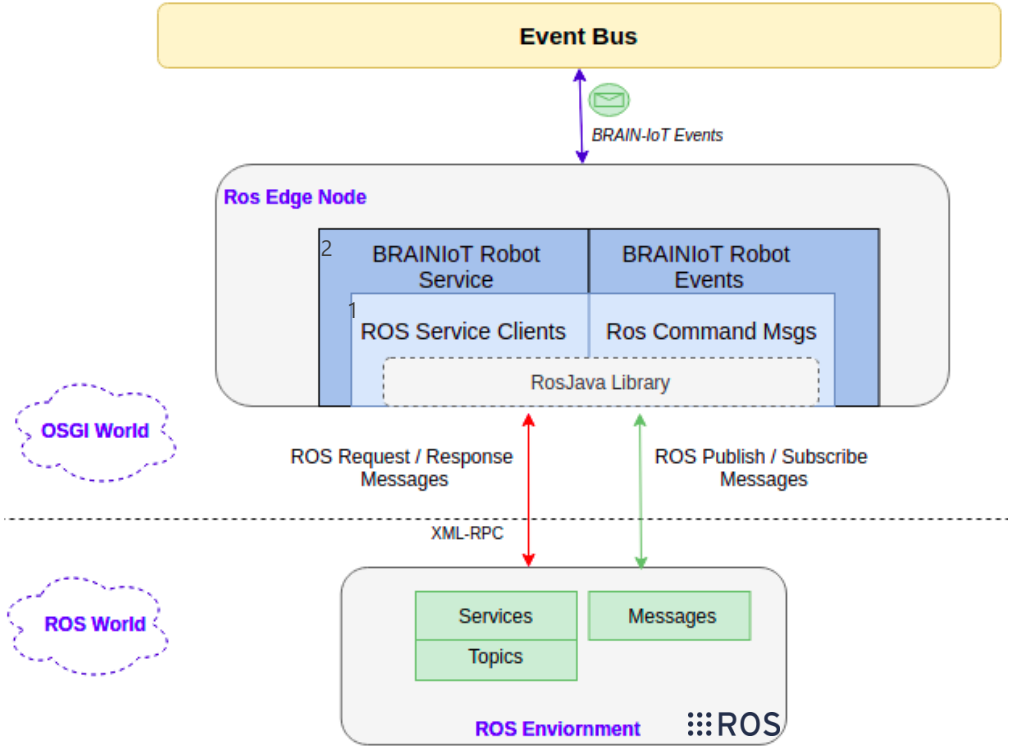


BRAIN-IoT Structural layers

- L1 (**Physical**): a set of physical computing resources (e.g. Linux Server, ROS-based robots).
- L2 (**Fabric**): a set of OSGi/Java agents and infrastructure services providing discovery, system provisioning and communication services.
- L3 (**System**): a set of inter-related software components containing infrastructure service (e.g. **BMS**, **BIS**) for searching, deploying other services.
- L4 (**BRAIN-IoT Services**): system software modules with capabilities.

BMS: Behaviour Management Service
BIS: Bundle Installer Service

ARCHITECTURE OF ROS EDGE NODE



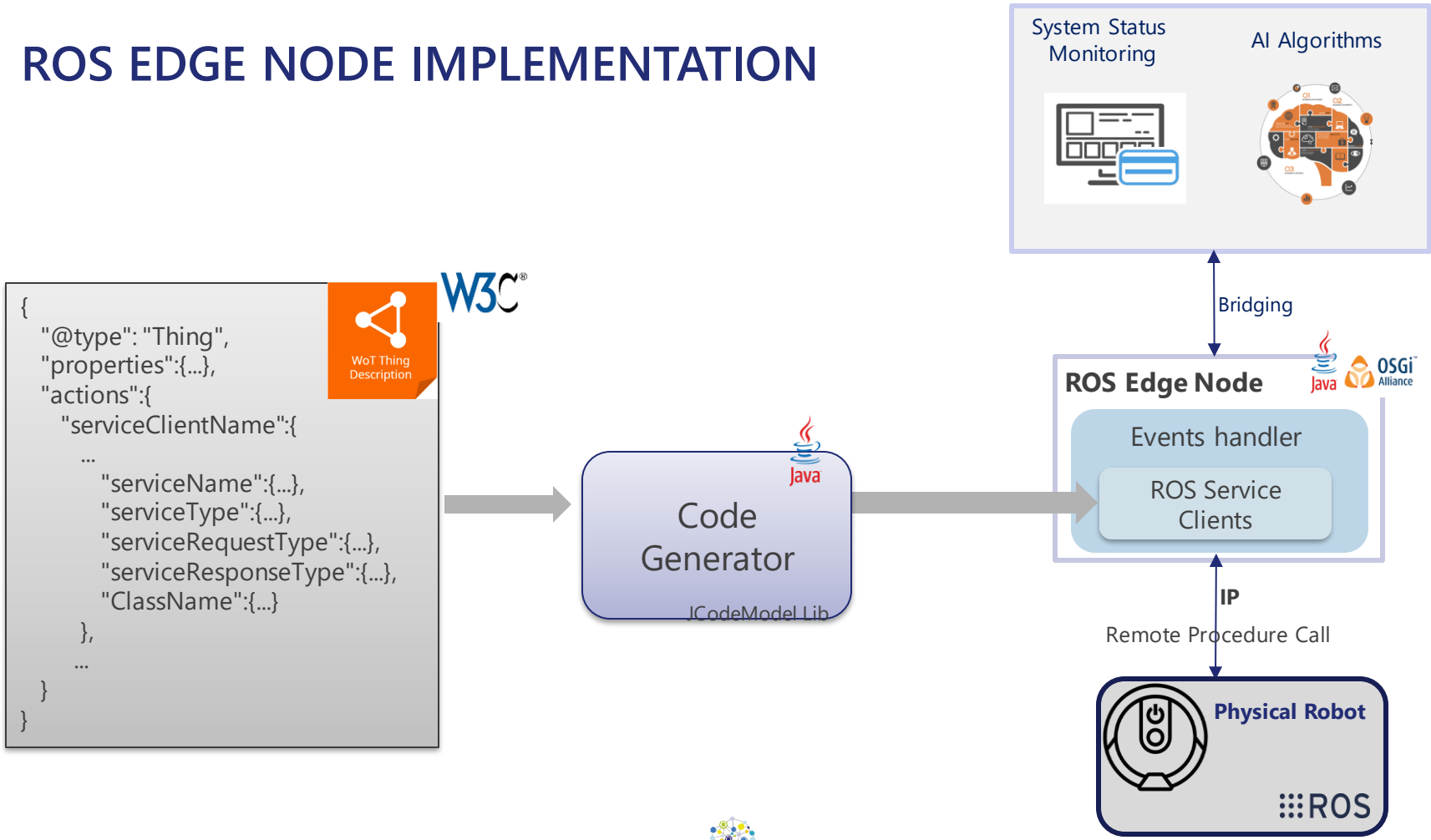
1. Abstraction of ROS Functionalities

- **List of clients** of **ROS** services/publishers/subscribers
- Mapping between **native messages** in ROS and **Java types**

2. Integration with BRAIN-IoT EventBus

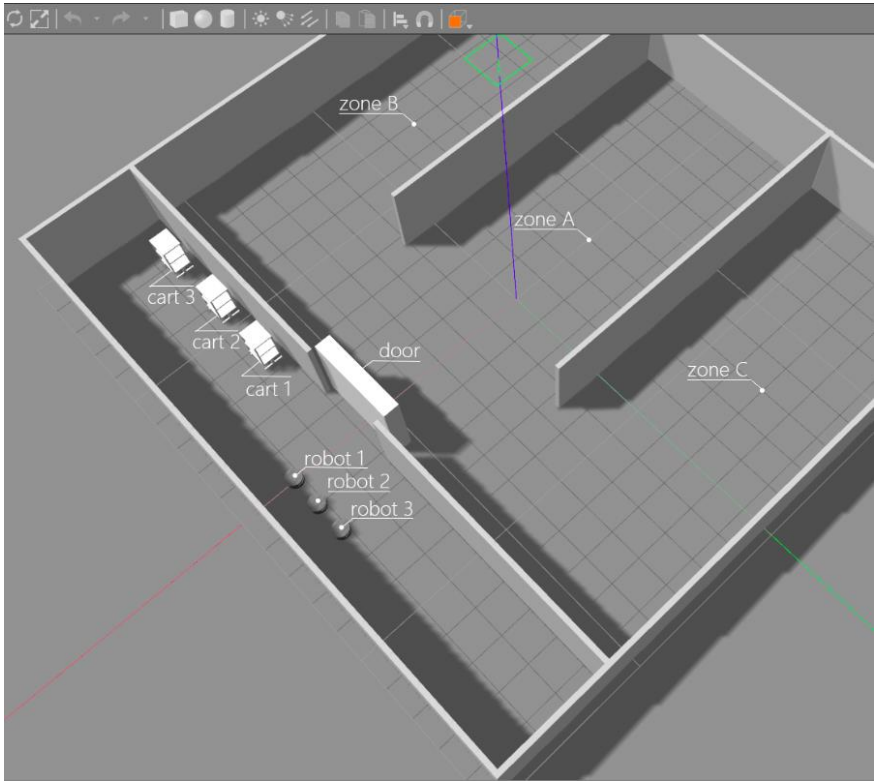
- **Formatting** of events and ROS message in java type
- **Interact** with ROS through ROS service clients

ROS EDGE NODE IMPLEMENTATION



DEMONSTRATION AND VALIDATION

A MULTI-AGENT ROBOTICS SYSTEM

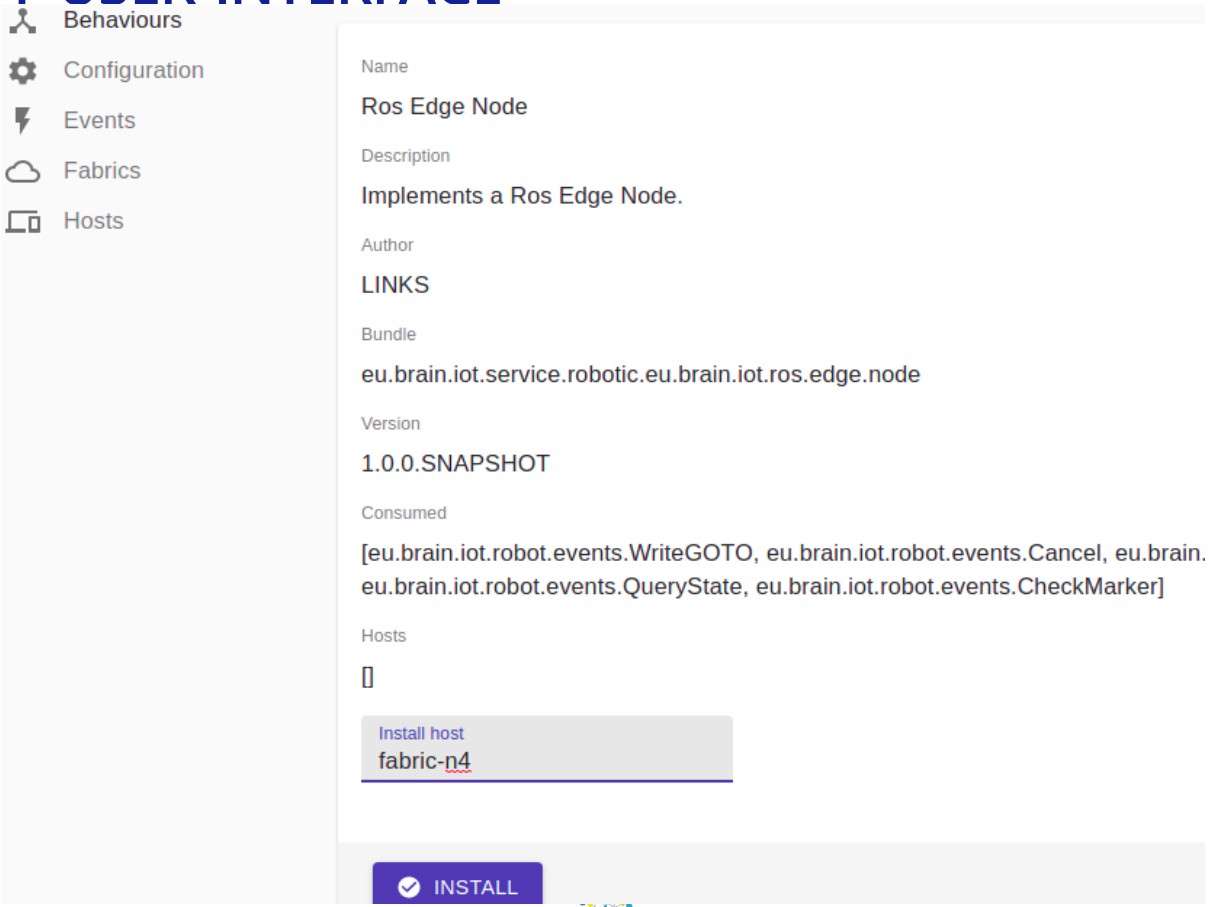


Objective: A swarm of **RB-1 BASE mobile robots** cooperate to move all **carts** from **picking area** to **storage area** passing through an automated **door** with a **QR** code.

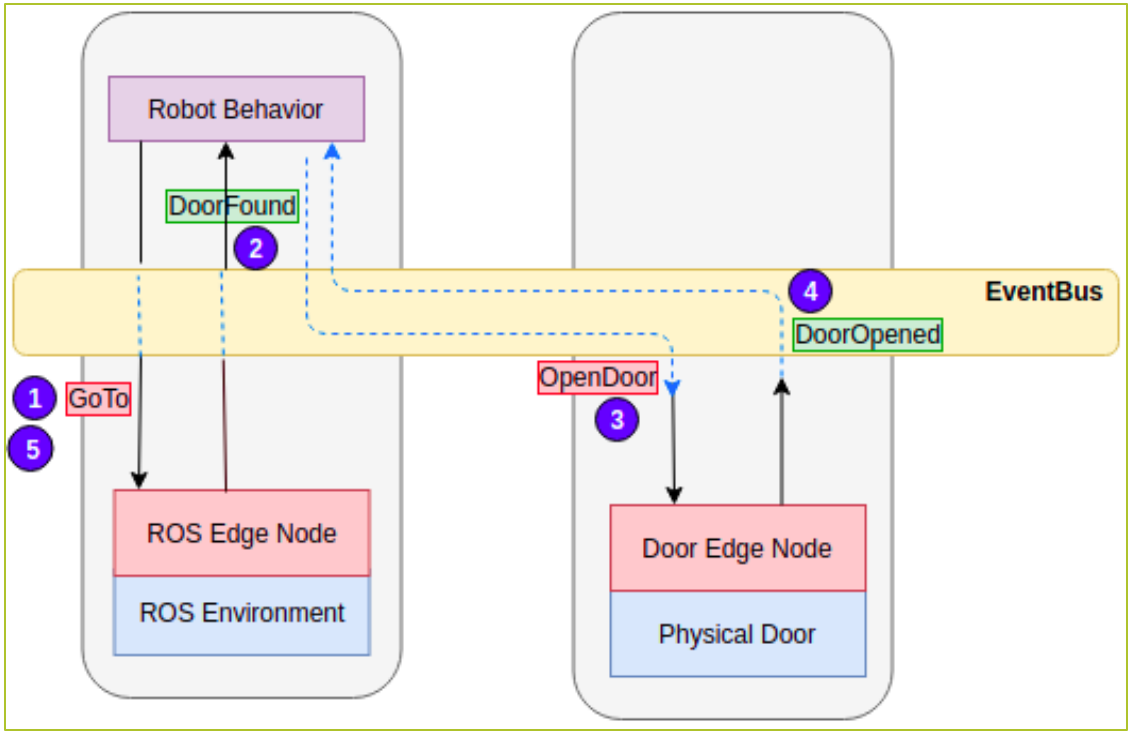
- **A multi-agent system** is created where each robot is controlled by a **Robot Behavior** service through **ROS Edge Node**.
- **A list of tasks** is shared by the Robot Behavior services.
- **Robots** are aware of the **door** by scanning the **QR** code.
- **Door** is controlled by a **Door Edge Node** through HTTP protocol.

DEVELOPMENT OF ROS EDGE NODE FOR RB1 BASE ROBOT

BRAIN-IOT USER INTERFACE



INTERACTION BETWEEN ROBOT AND DOOR



- **Interested event types** are registered to be received from the asynchronous EventBus interface at **runtime**
- ROS Edge Node **continuously queries** the status changes in ROS and issue **response events** to notify the application services. (e.g. **battery level**)
- Events are **filtered** in distributed EventBus

CONCLUSIONS

ROS Edge Node is developed as an adaptor to ROS-based Robotics systems in BRAIN-IoT platform allowing:

- **Interoperability** with other heterogeneous IoT systems through distributed EventBus.
- **Fast adaptation** to various ROS-based IoT devices/platforms using a Code Generator
- **Standard Compliant** by exploiting WoT TD, making it portable to production environment
- **Plug & Play** without stopping other services at BRAIN-IoT execution environment leveraging OSGi specification in sophisticated IoT scenarios

CONTACTS

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BRAIN-IoT

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