SONY

ROS / ROS 2
with
Kubernetes and KubeEdge

Oct.19th.2023

ROSCon 2023 @ New Orleans, US

Agenda

- Who are we?
- Background
- Problems
- Goals / Requirements
- Kubernetes
- KubeEdge
- Sample Deployment
- What’s missing? Next-gen proposal
- Community

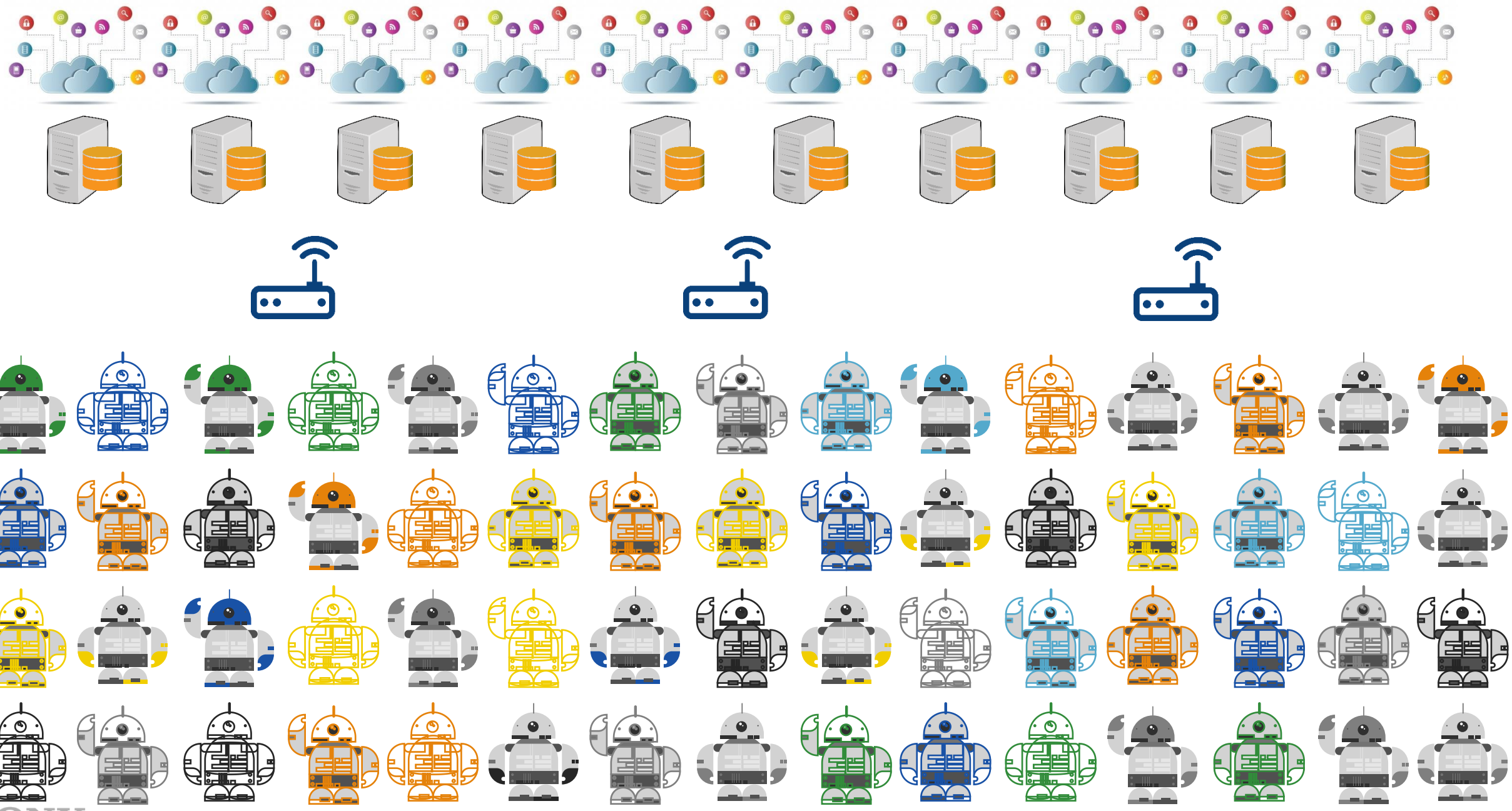
Who are we?

- Tomoya Fujita (Presenter)
  - Software Engineer, Sony R&D US Laboratory
  - ROS TSC (Technical Steering Committee)
  - KubeEdge SIG Robotics Chair
  - fujitatomoya@github , tomoyafujita@linkedin

- Co-Authors
  - Yin Ding (Engineering Manager, Google)
    - KubeEdge TSC, Co-Founder of KubeEdge Project
    - Leading the Kubernetes Hardening team
  - Kevin Wang (Lead of Cloud Native Open Source Team, Huawei)
    - KubeEdge TSC, Co-Founder of KubeEdge Project
    - CNCF Ambassador, TOC contributor
  - Fei Xu (Senior Engineer, Huawei)
    - KubeEdge TSC, Maintainer

Background

- Broad use cases.
- Distributed and Connected System.
- Collaborative and Orchestrated Application.
- Circulatory Functioning System and Development
- Specific Hardware Acceleration.
- Security. (Device, Data, Network)

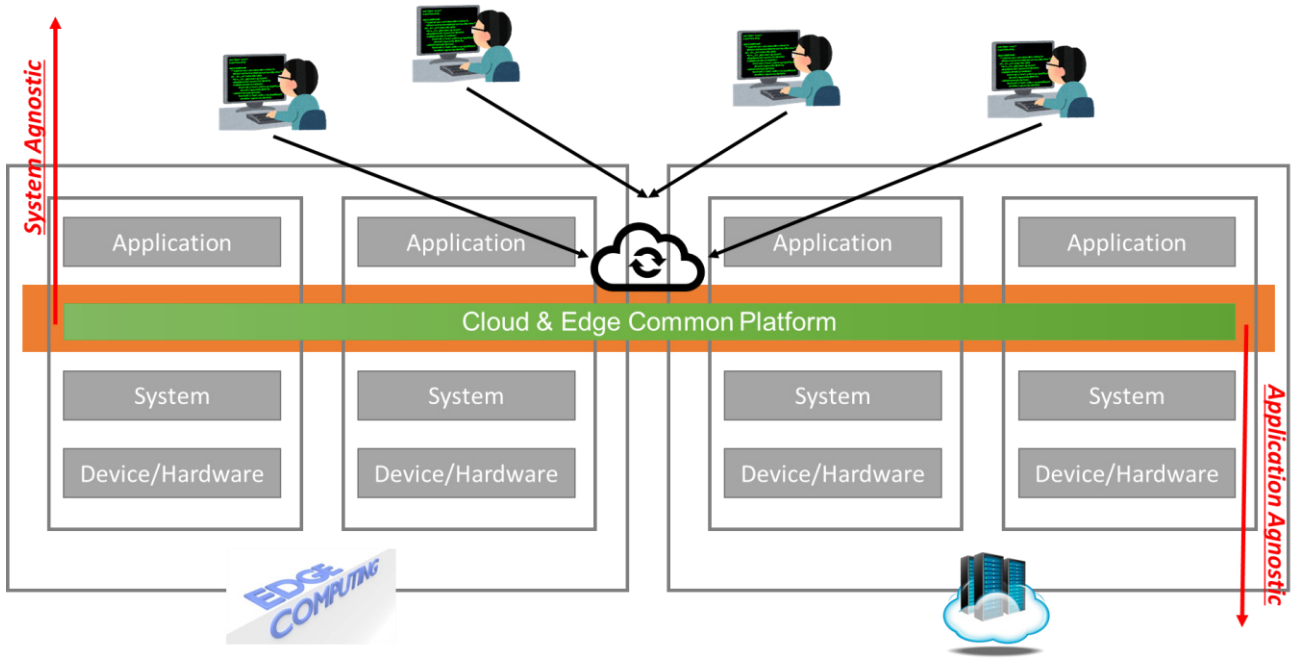


What is the pain?

- Platform Dependencies.
- Proprietary hardware support.
- Application Modularity.
- System and Security Integration.
- Application Specific Network Bridge.
- Application Developer Friendly.

Goal / Requirements

- Flexible Application Deployment.
- Zero Trust Security Support.
- Application Agnostic Network Configuration.
- Extend Device Capability.
- System Global Observability.
- Platform Agnostic Device Abstraction.



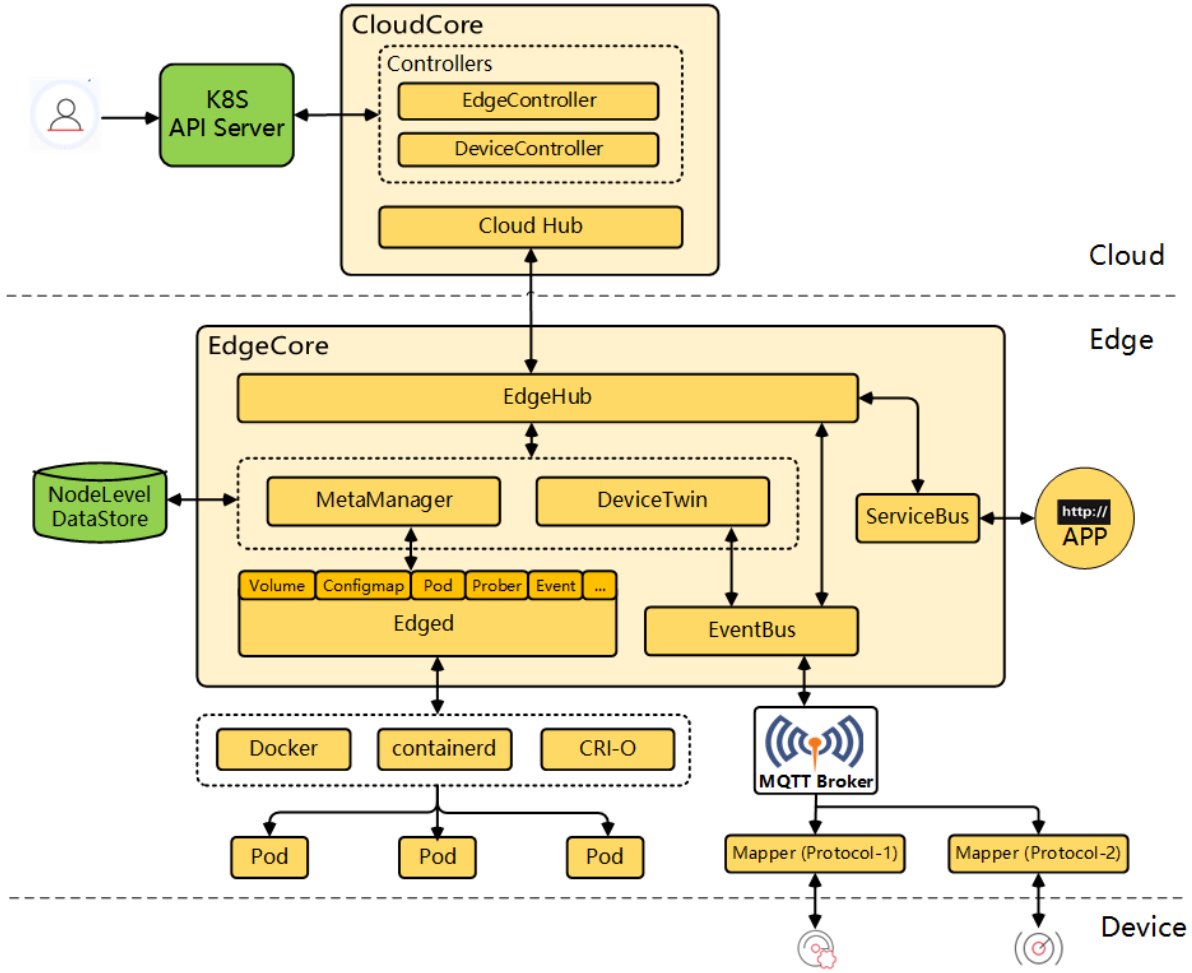
Kubernetes (Service Mesh)

- **Application Deployment and Orchestration.**
- **Device Capability and Label Control.**
- Custom Resource Extension.
- **Auto- Scaling and Healing.**
- **Roll Up/Down, Canary Test.**
- **Role Based Access Control.**
- **Device-Plugin / Container Device Interfaces.**
- **Container Network Interfaces.**
- Traffic Management.
- Observability.
- Security Policy.

KubeEdge

is built upon Kubernetes and provides core infrastructure support for networking, application deployment and metadata synchronization between cloud and edge.

- Cloud-Edge Coordination
- Edge Computing
- Edge Autonomy
- Simplified Deployment
- Kubernetes-native Support
- Resource Efficient



https://kubeedge.io/docs/

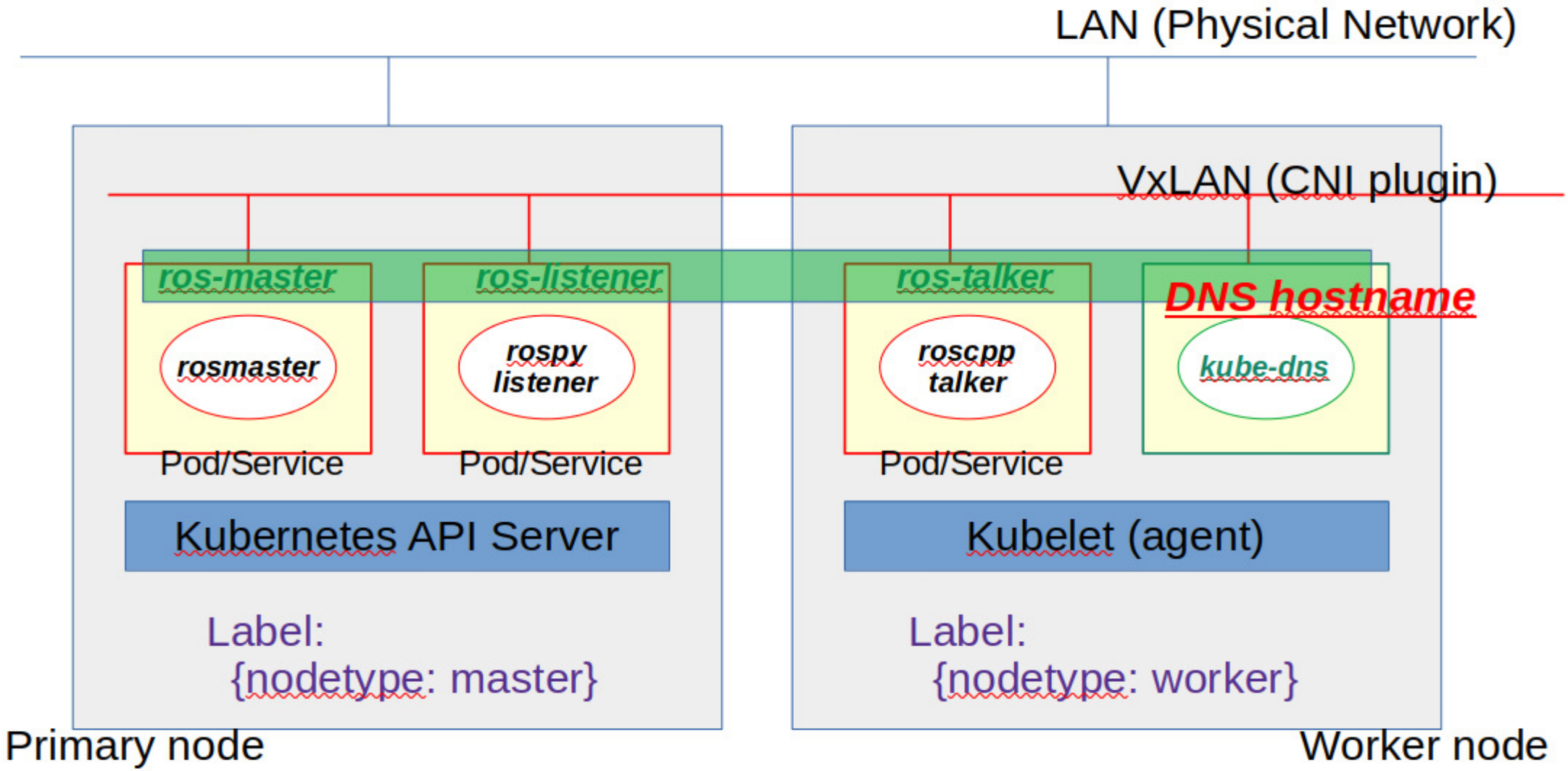
Sample Deployment

Theory is good, but please see how it works in the flesh!

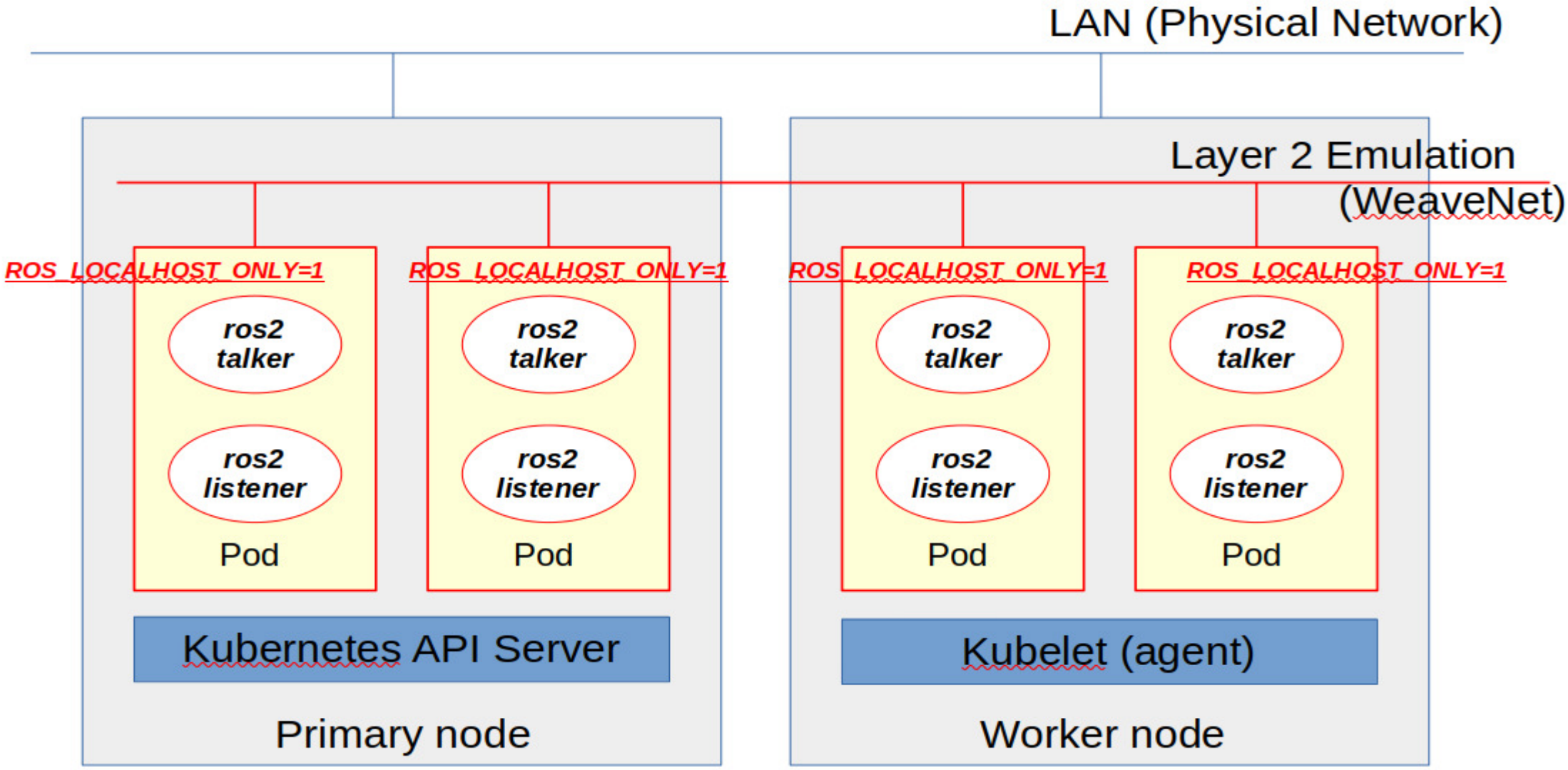
ROS Kubernetes Tutorials

Contribution(Issues/PRs) always welcome!

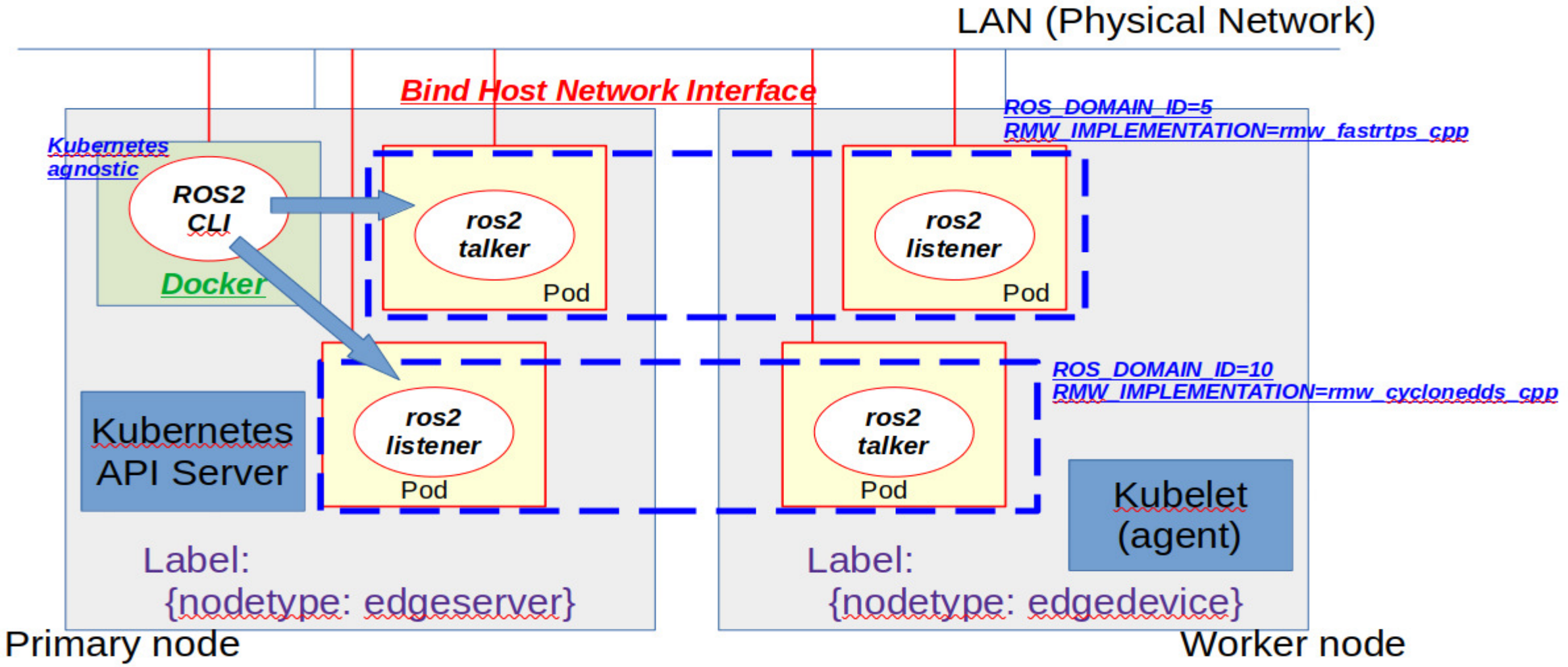
ROS Multi-Node Deployment



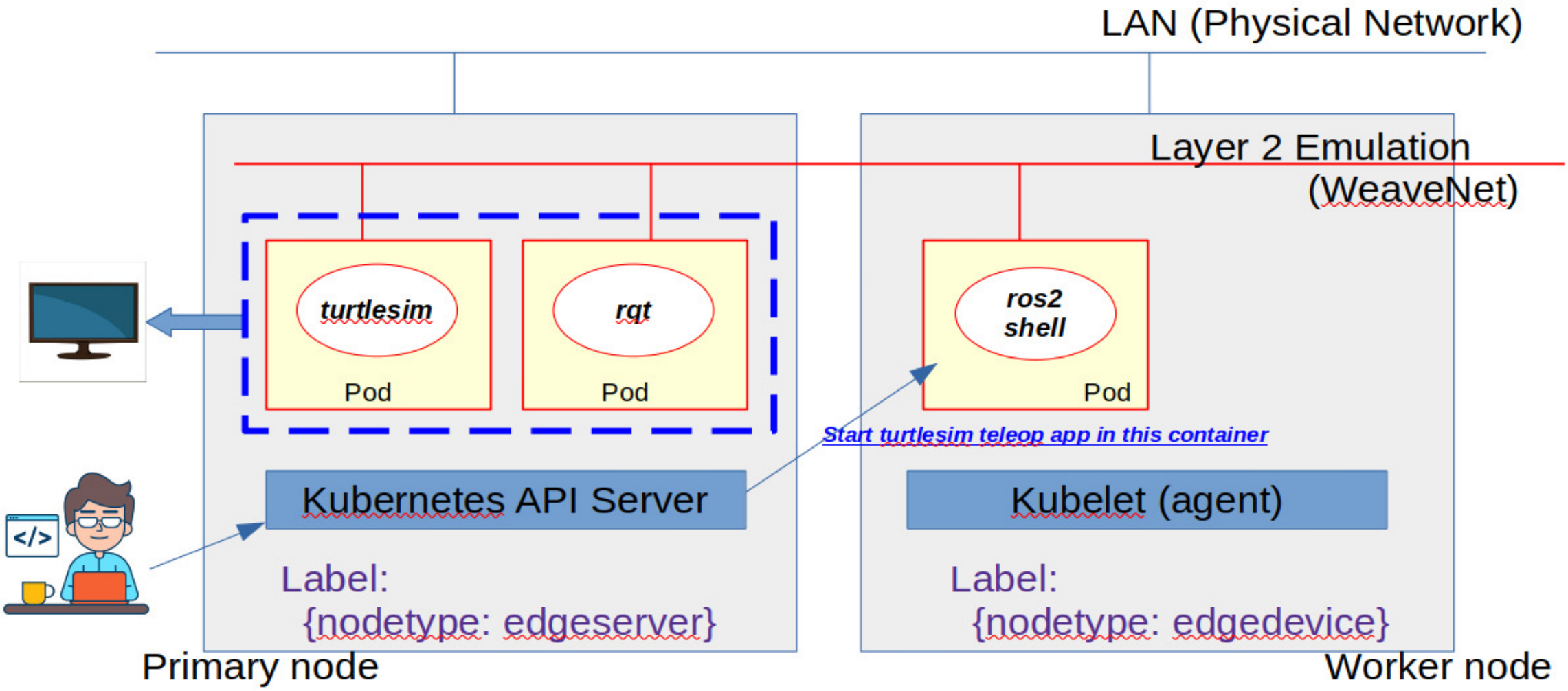
ROS 2 Localhost Only



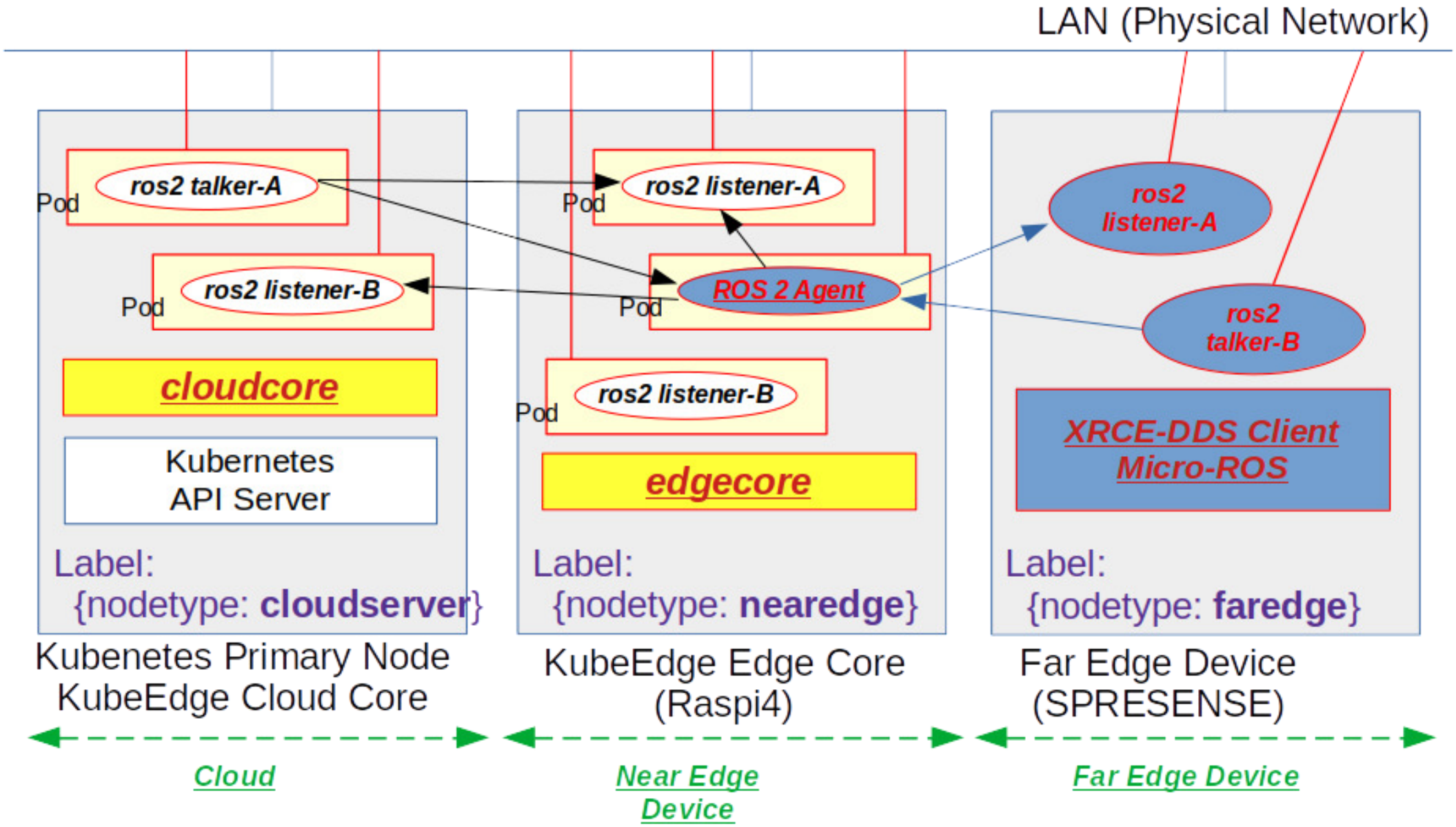
ROS 2 Logical Partition / Multiple RMW Implementation



ROS 2 Deployment Intermediate

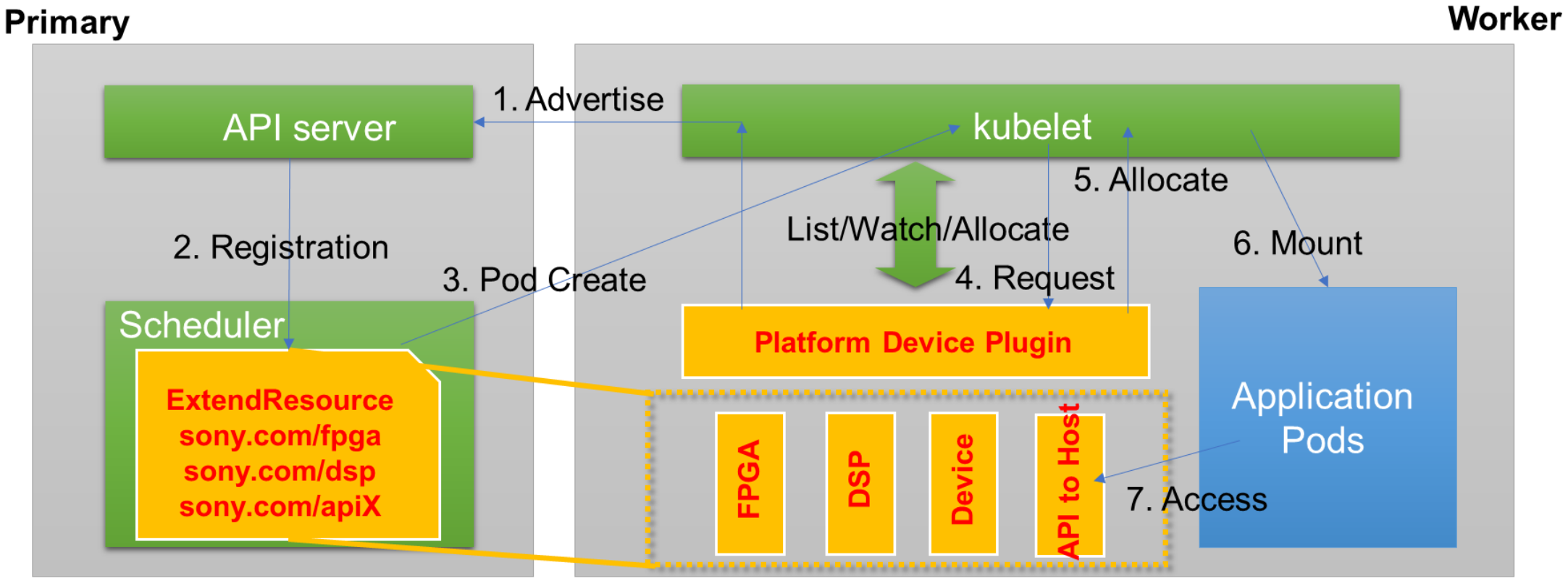


ROS 2 / Micro-ROS with KubeEdge (W.I.P)

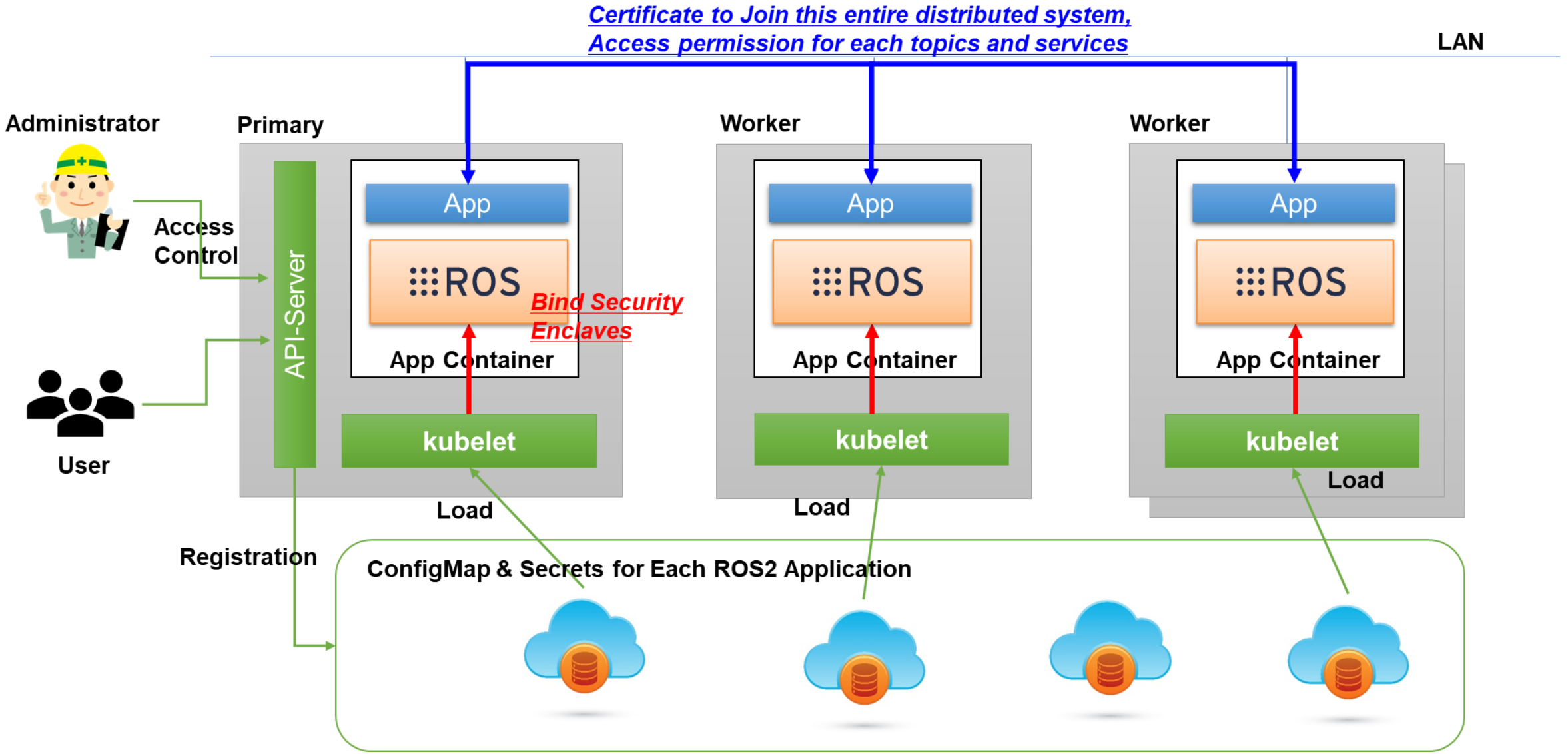


Device-Abstraction (Device-Plugin, Container Device Interface)

- Kubernetes Custom Resource Definition, that allows us to plugin vendor specific hardware and device to the containers.
- After advertising the custom resource to Kubernetes, Kubernetes controls those resources with workload based on application requirements.



Support SROS 2 security enclaves via ConfigMap



What's missing? Proposals?

- ~~Device Abstraction Enhancement~~
  - ~~KEP-3162: Add Deallocate and PostStopContainer to Device Manager API~~
  - ~~Add CDI devices to device plugin API resolved this issue.~~
- KubeEdge CNI support (e.g edgemesh, Cilium)
- More Edge Optimization / Configurable Options for Resource Constrained Device Support

- **Cloud-Native Robotics Management Solution**
  - `RoboDevOps` through Edge-Cloud Synergy
  - Cloud-Native Digital Twin for testing and data generation training
  - Robotics App Development Friendly
  - Cloud Robotics Custom Resource Definition and Operator Proposal
  - Edgemesh: adaptive cross-edge and edge-cloud data plane support
  - VSLAM algorithm with KubeEdge
  - Building a Robot-Oriented Intelligent Monitoring System

Community

ROS

Kubernetes IoT Edge WG

KubeEdge SIG Robotics

ROS Kubernetes Tutorials