# Cloud infrastructure for Robot 4.0

Wang Haitao

Wang Zhigang
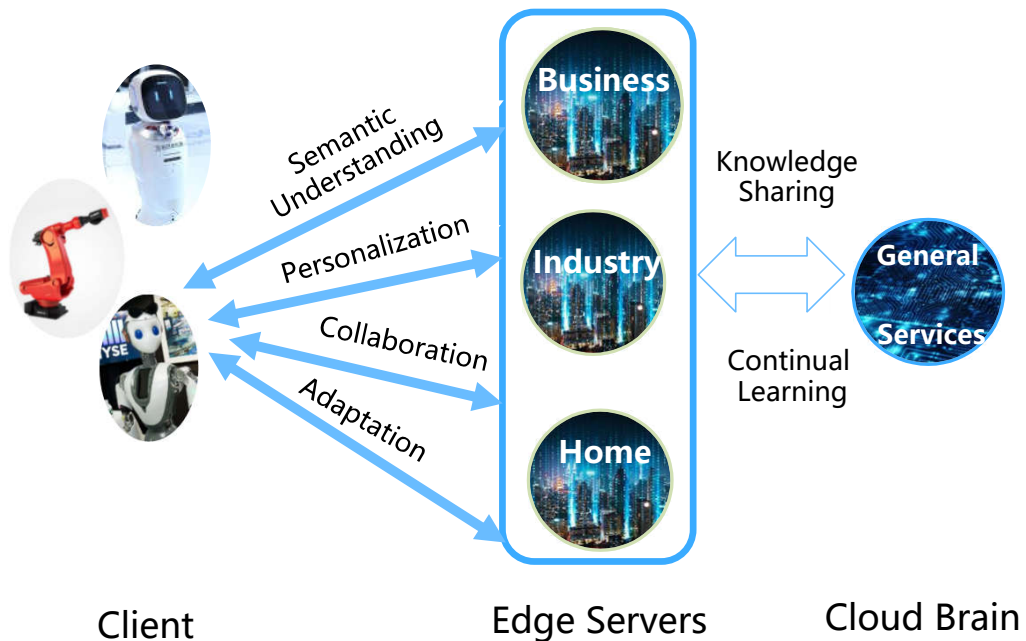
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intel.

# Agenda

- Robot 4.0 in a glance
- 3 Cloud infra challenges to explore
- Summary and call to action

# Robot 4.0 in a glance

- ## Design Goal

  - Edge Enhanced Distributed Robot System

  - Workload Consolidation and Migration

  - Resource Sharing and Orchestration

  - Real-time and Deterministic Processing

  - Multi-robot Collaboration

  - Security



Semantic Understanding

Personalization

Collaboration

Adaptation

**Business**

**Industry**

**Home**

Knowledge Sharing

**General Services**

Continual Learning

Client

Edge Servers

Cloud Brain

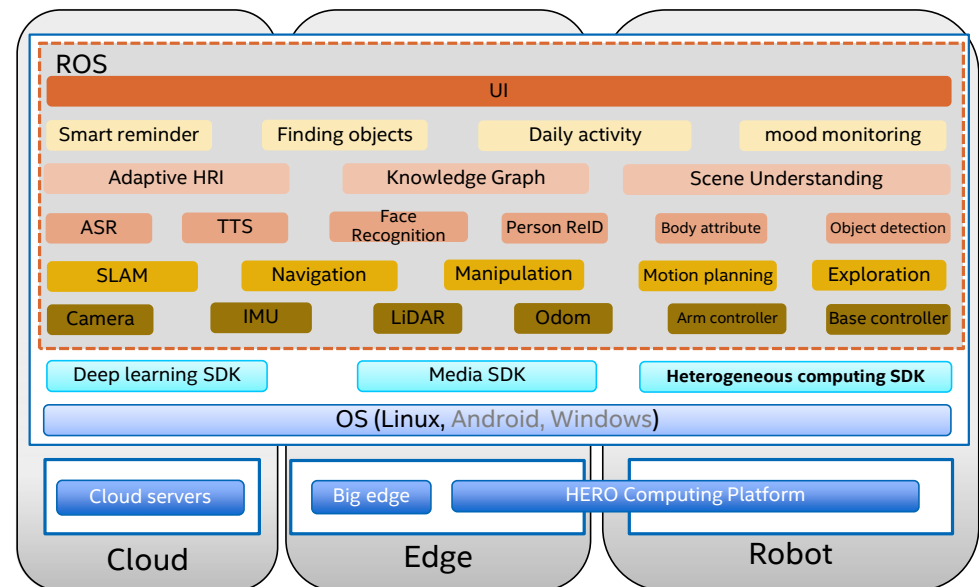# The 3 cloud infra challenges we've observed

■ Cloud edge collaboration

- Cloud-native infrastructure enhanced for progressive deployment

- Edge deployment for heterogenous AI computing

■ Deterministic network at scale

- Cloud native timing sensitive network support

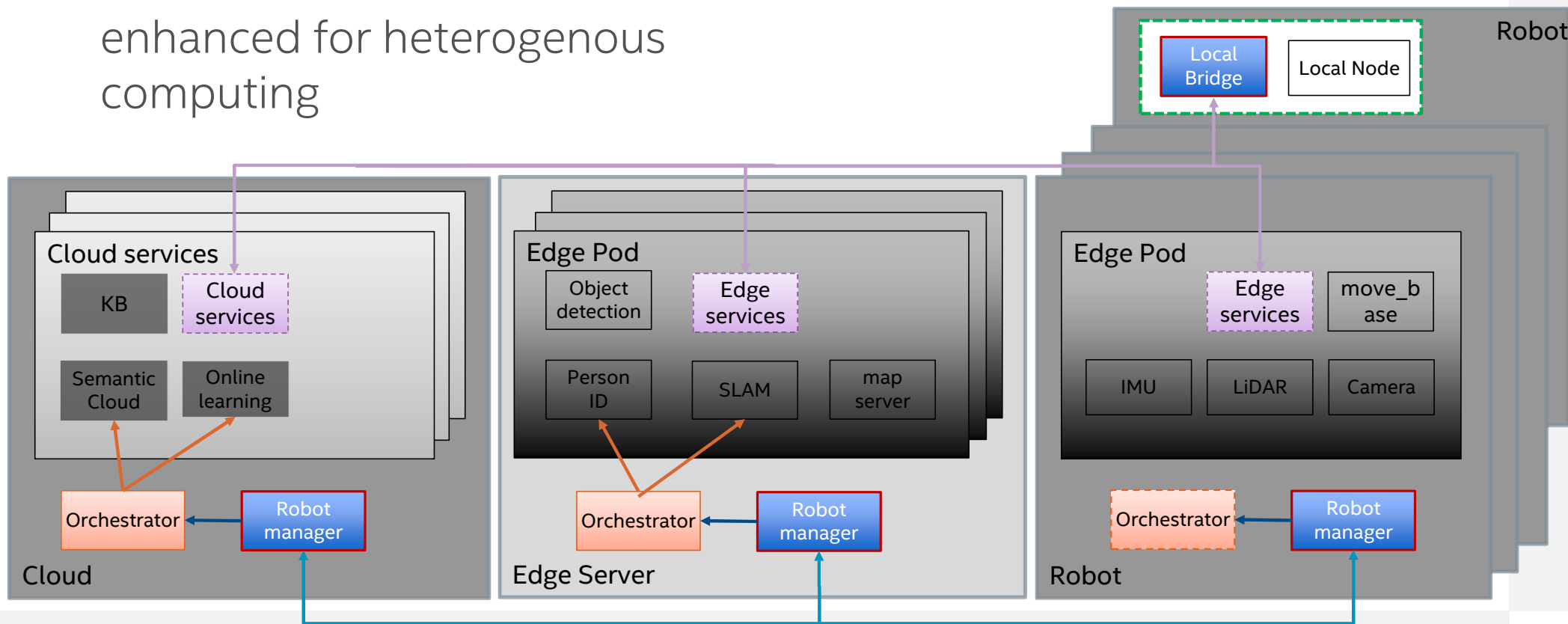- Deterministic enhanced distributive message queue

■ Orchestration over wireless

- Latency aware placement based on telemetry
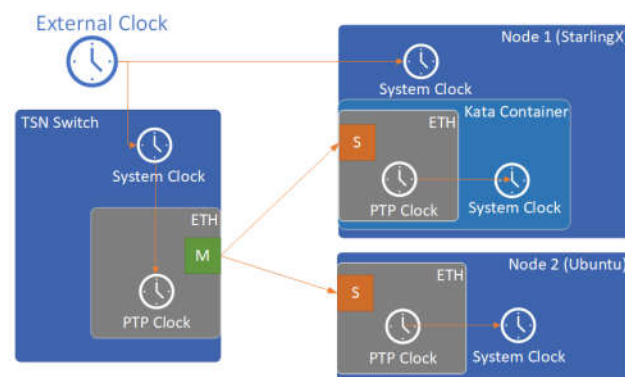
- Scale to multi-cloud, multi-RAT



ROS

| UI |
| Smart reminder | Finding objects | Daily activity | mood monitoring |
| Adaptive HRI | Knowledge Graph | Scene Understanding |
| ASR | TTS | Face Recognition | Person ReID | Body attribute | Object detection |
| SLAM | Navigation | Manipulation | Motion planning | Exploration |
| Camera | IMU | LiDAR | Odom | Arm controller | Base controller |

Deep learning SDK | Media SDK | **Heterogeneous computing SDK**

OS (Linux, Android, Windows)

Cloud servers | Big edge | HERO Computing Platform

Cloud | Edge | Robot

# Cloud edge collaboration

- Cloud-native infrastructure enhanced for heterogenous computing

Robot

Local Bridge | Local Node

**Cloud services**

| KB | Cloud services |

| Semantic Cloud | Online learning |

Orchestrator ← Robot manager

Cloud

**Edge Pod**

| Object detection | Edge services |

| Person ID | SLAM | map server |

Orchestrator ← Robot manager

Edge Server

**Edge Pod**

| Edge services | move_base |

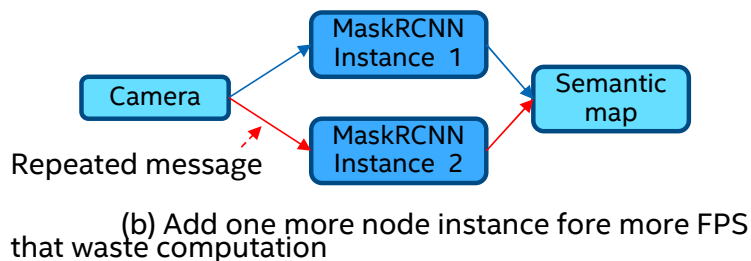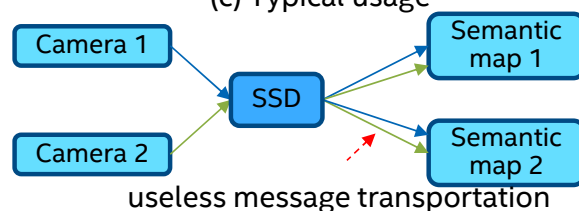| IMU | LiDAR | Camera |

Orchestrator ← Robot manager

Robot

# Deterministic network at scale

- Distributive message queue with timing sensitive network enhancement





(a) Typical usage

(c) Typical usage

Repeated message

(b) Add one more node instance fore more FPS that waste computation

useless message transportation

(d) One node instance server multiple clients

# Orchestration over wireless

- Enables functionalities such as access termination, traffic steering, multitenancy for services, service registry, service authentication, telemetry, application toolkits, appliance discovery and control

- Web-based GUI for easy application onboarding

- Built on top of consistent and standardized APIs (such as 3GPP, ETSI-MEC) exposed to the developers
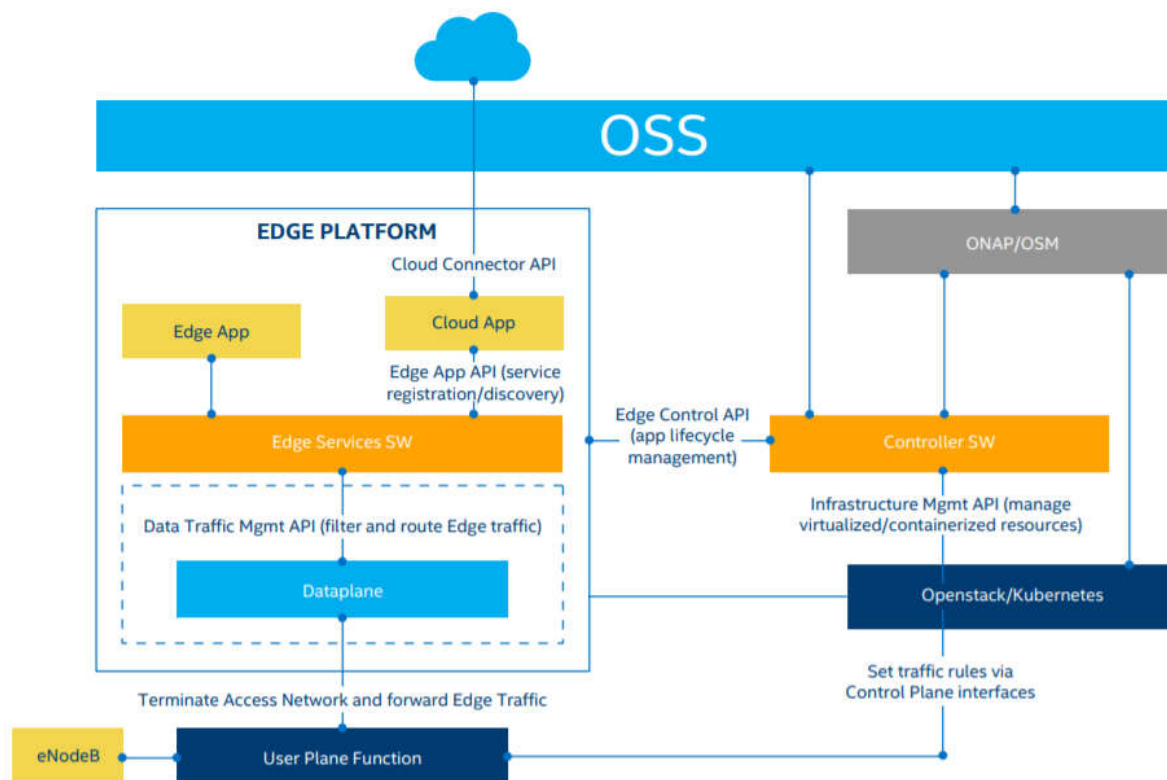
# Summary

- Robot 4.0 workload
- 3 Cloud infra challenges
- Demo link