# Network Slicing from UE to Cloud

*Aki Nakao*

*Professor, The University of Tokyo*

*Chairman of Network Architecture Committee*

*The Fifth Generation Mobile Network Promotion Forum (5GMF)*

5GMF
The Fifth Generation Mobile Communications Promotion Forum

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# Overview of 5GMF

# 5G in the World

Future IMT Vision in ITU-R WP5D

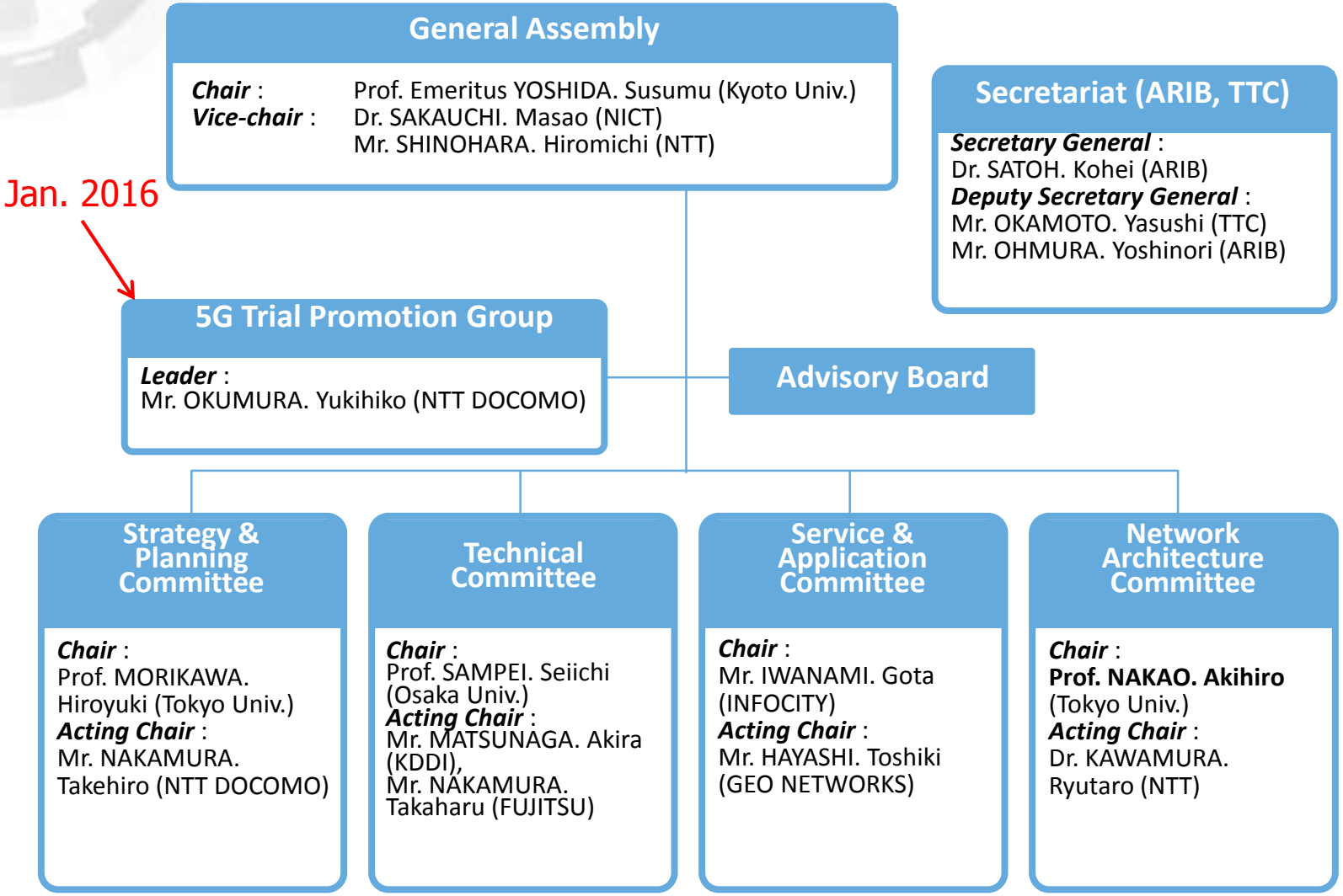
ITU-T Focus Group on IMT-2020


3GPP A GLOBAL INITIATIVE — 5G Study Items

ngmn the engine of broadband wireless innovation — 5G Initiative

GSMA — Vision2020/ Network2020

# Organizational Structure of 5GMF



# 5GMF members


Members:93 (as of 12 May 2016)  Ordinary members:74, Individual members:14, Special members: 3 (MIC, ARIB, TTC)

# 5GMF White Paper published on 2016/May!

http://5gmf.jp/news/20160705160541/

5GMF invited to give a lecture talk among 5GPPP community at EUCNC 2016

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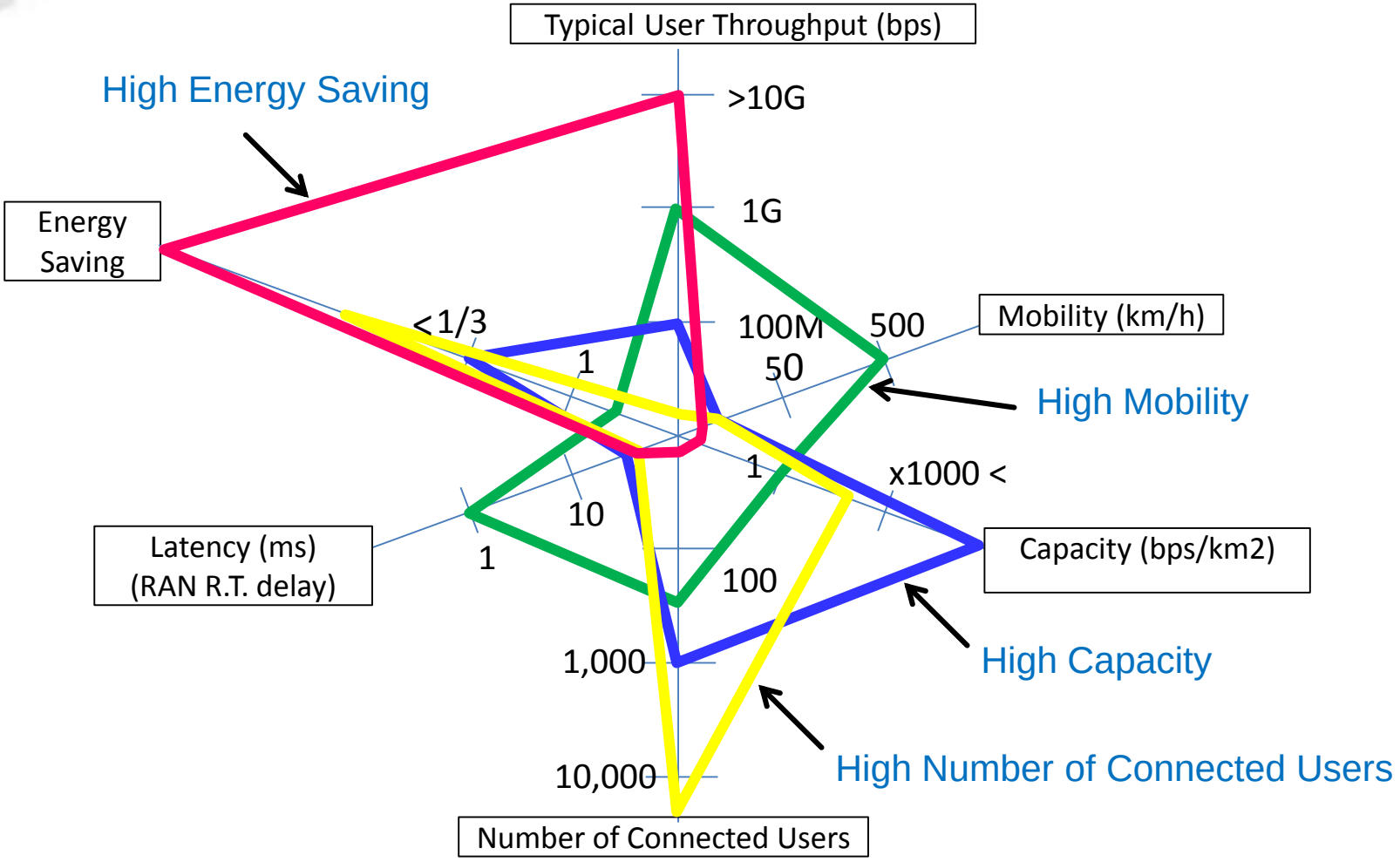
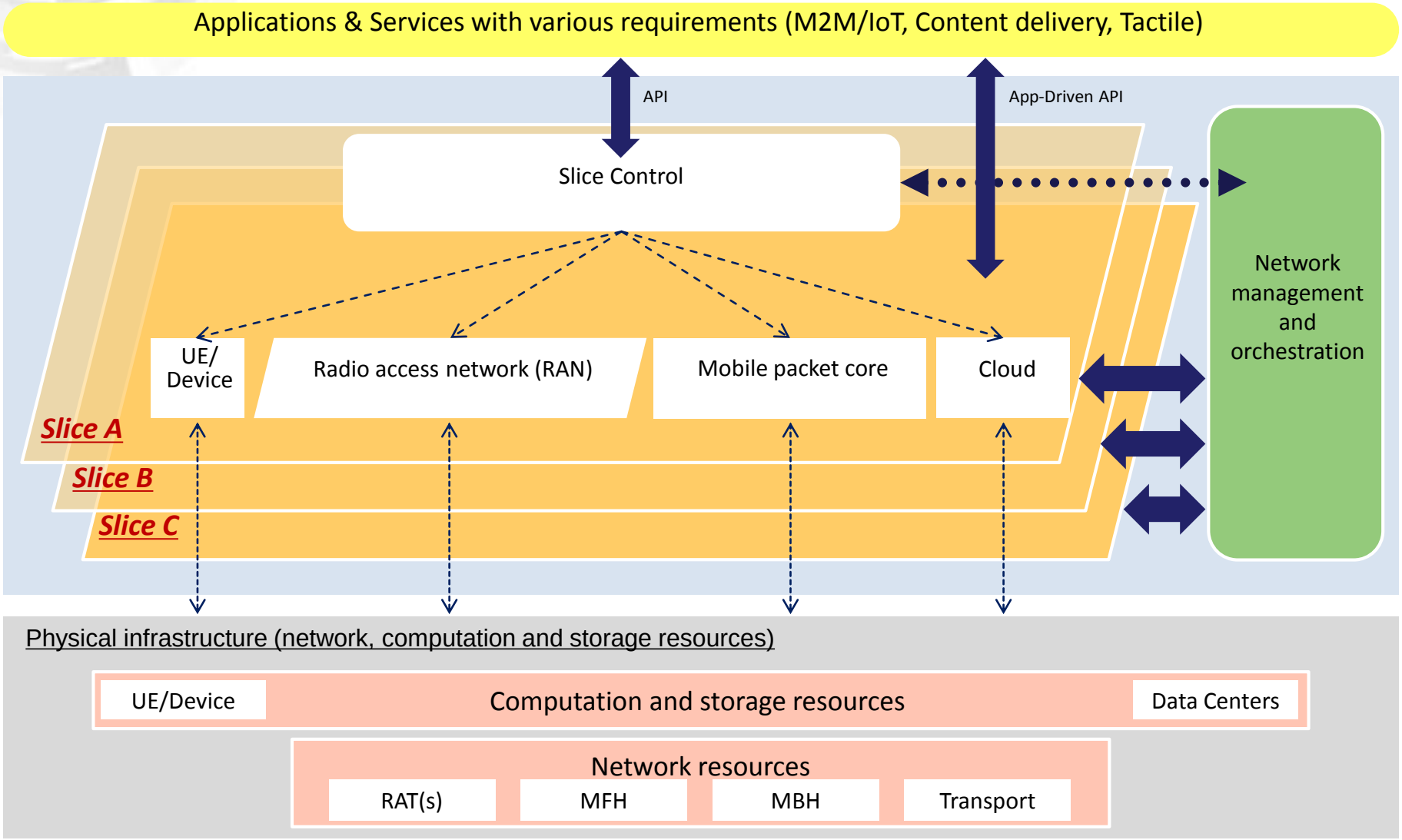
# What are the architecture design principles and building blocks you are working on for 5G era

# Requirements For User Scenes (Examples)

- 5G systems do not always need to achieve their maximum performance.
- 5G systems will be determined based on individual use scene requirements.



# Network Softwarization and Slicing



# Definition of Slice

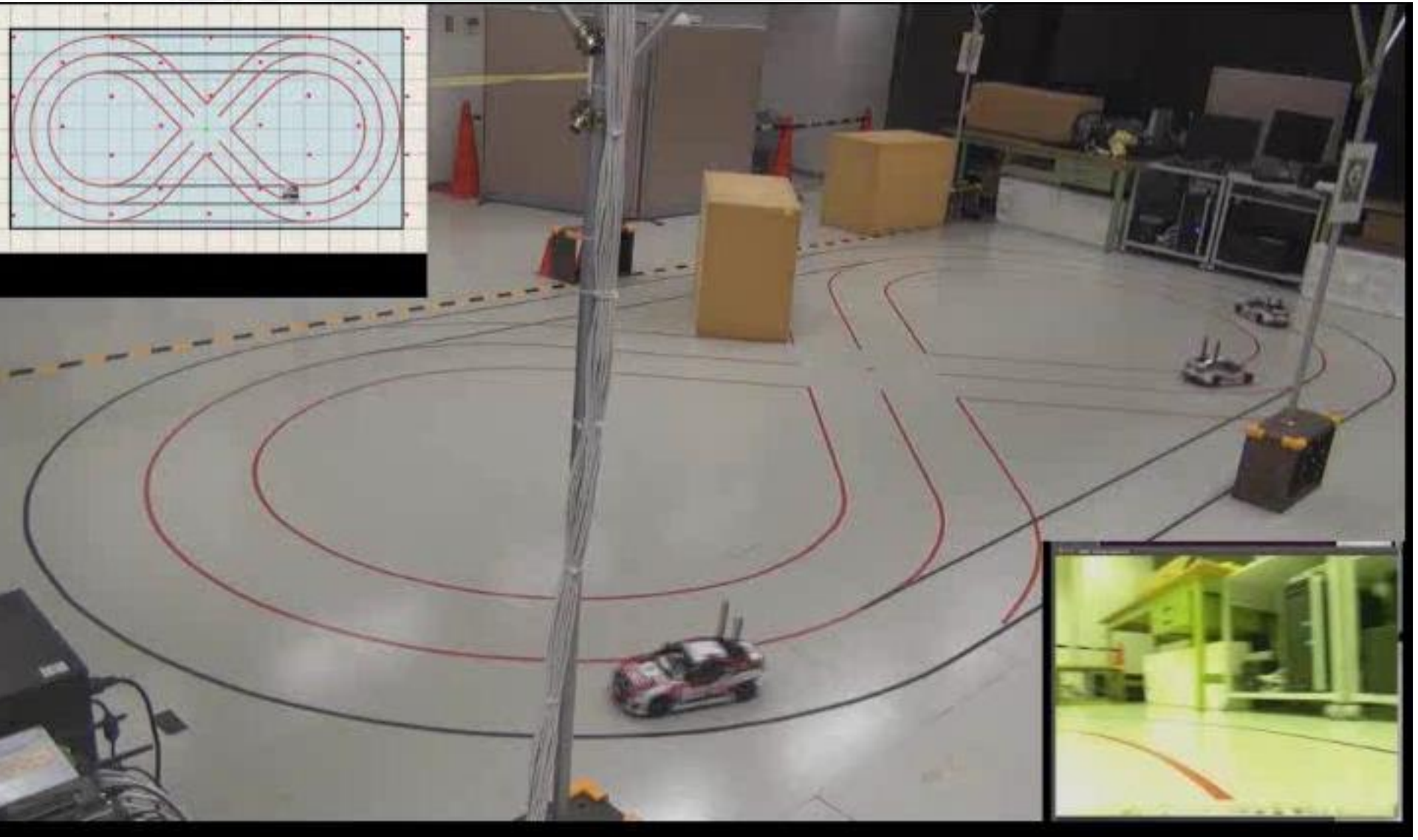
**Slice = An Isolated set of programmable resources**

**Two important features to be required**

- **Resource Isolation**
- **Programmability**

**Note: virtualization and partitions are aiding techniques for slicing…**

# Connected Car Experiment with Toyota



# Internet of Moving Things

## Google Maps picks up mapping analytics and visualization startup Urban Engines

Posted Sep 16, 2016 by Brian Heater (@bheater)

Next Story


https://techcrunch.com/2016/09/16/urban-engines-2/

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# On Going Projects on Network Slicing

# EU-Japan Collaboration Project Proposal

# 5G!Pagoda

*"A network slice for every service"*

**Federating Japanese and European 5G Testbeds to Explore Relevant Standards and Align Views on 5G Mobile Network Infrastructure Supporting Dynamic Creation and Management of Network Slices for Different Mobile Services.**

**サービスに応じたスライス動的生成・管理機能の実証と標準化を目的とする日欧連携 5G 移動通信基盤テストベッド**


**Call:** EUJ1-2016 - 5G - Next Generation Communication Networks

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Aalto-yliopisto

Fraunhofer FOKUS

ERICSSON

EURECOM

KDDI R&D LABS

東京大学 THE UNIVERSITY OF TOKYO

HITACHI

orange

MANDAT INTERNATIONAL

UDG UNIVERSAL DEVICE GATEWAY

NEC NEC Networks & System Integration Corporation

Waseda University

# 5G!Pagoda Project Scope

- Softwarized Network Realization w/ NFV, SDN and 5G
- Research-Innovation and Standardization
- Objectives are

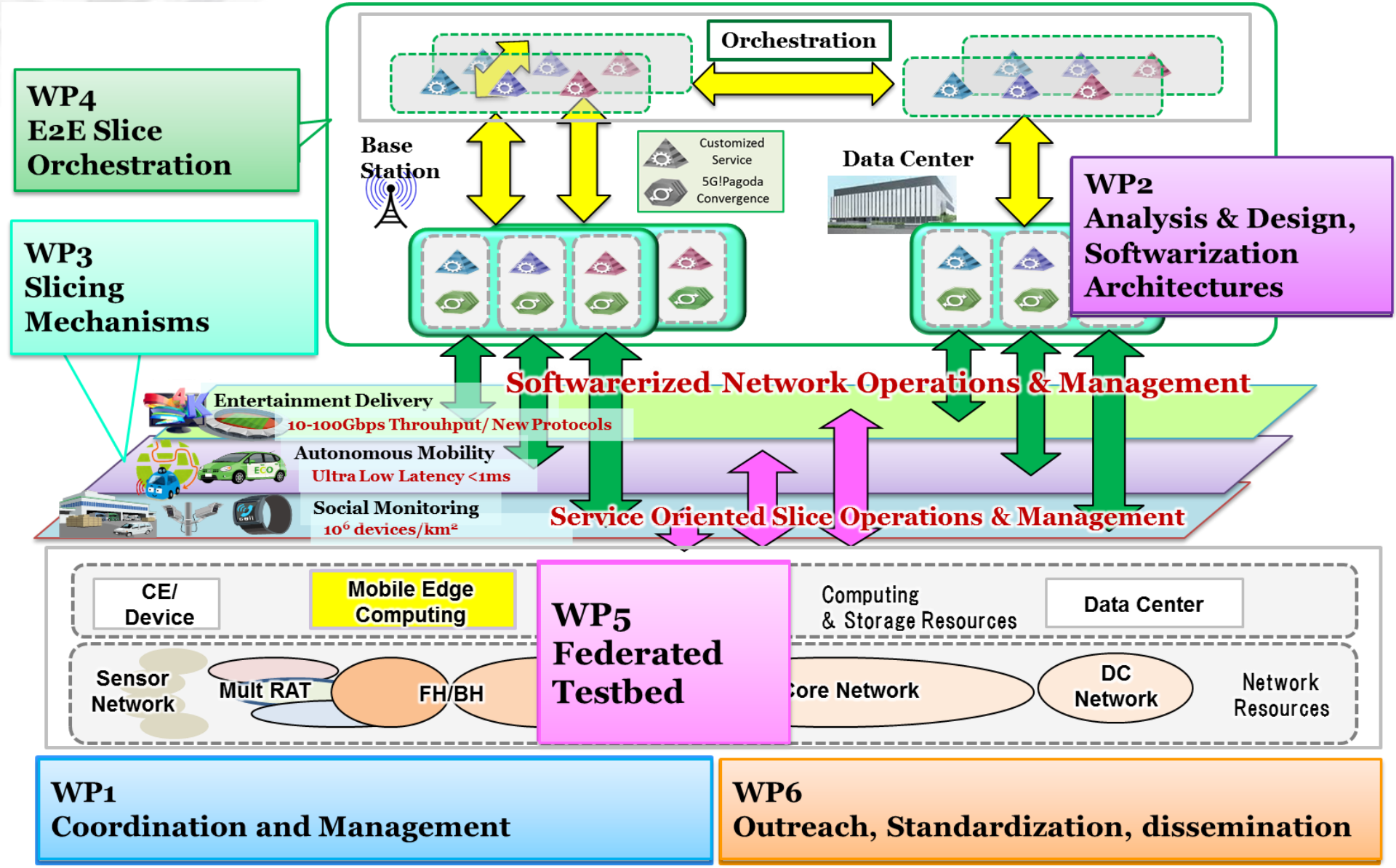
i) the development of a scalable 5G slicing architecture towards supporting specialized network slices composed on multi-vendor network functions, through the development of

ii) a scalable network slice management and orchestration framework for distributed, edge dominated network infrastructures, and convergent software functionality for

iii) lightweight control plane and

iv) data plane programmability and their integration, customization, composition and run-time management towards different markets.

# Working Items and Goals



# Contribution from U-Tokyo

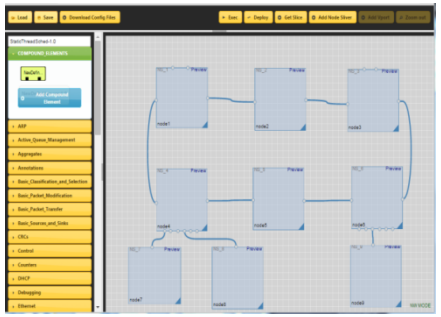
## ◆ *Open Source based Network Softwarization Platform*

Click! Open Source

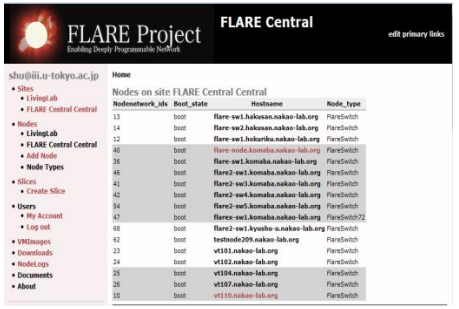
Click! Optimization

TILERA SDK

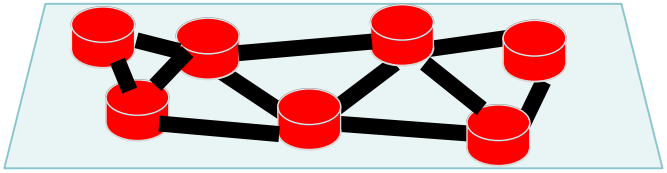
***Network Functions Software Defined Data Plane***



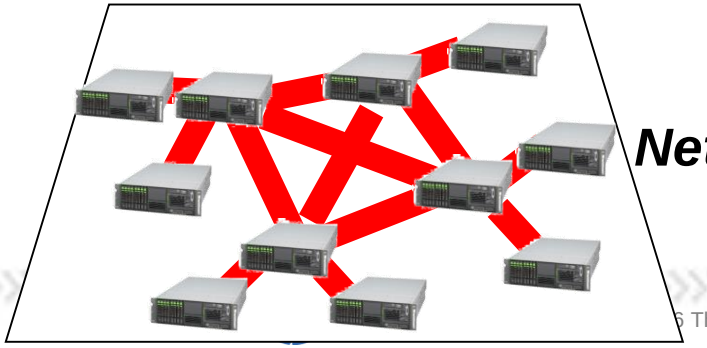
***Toy-Block Networking GUI***




***Resource Management Center***



***Slice (Logical NW View)***



***Network of FLARE nodes (Physical NW View)***

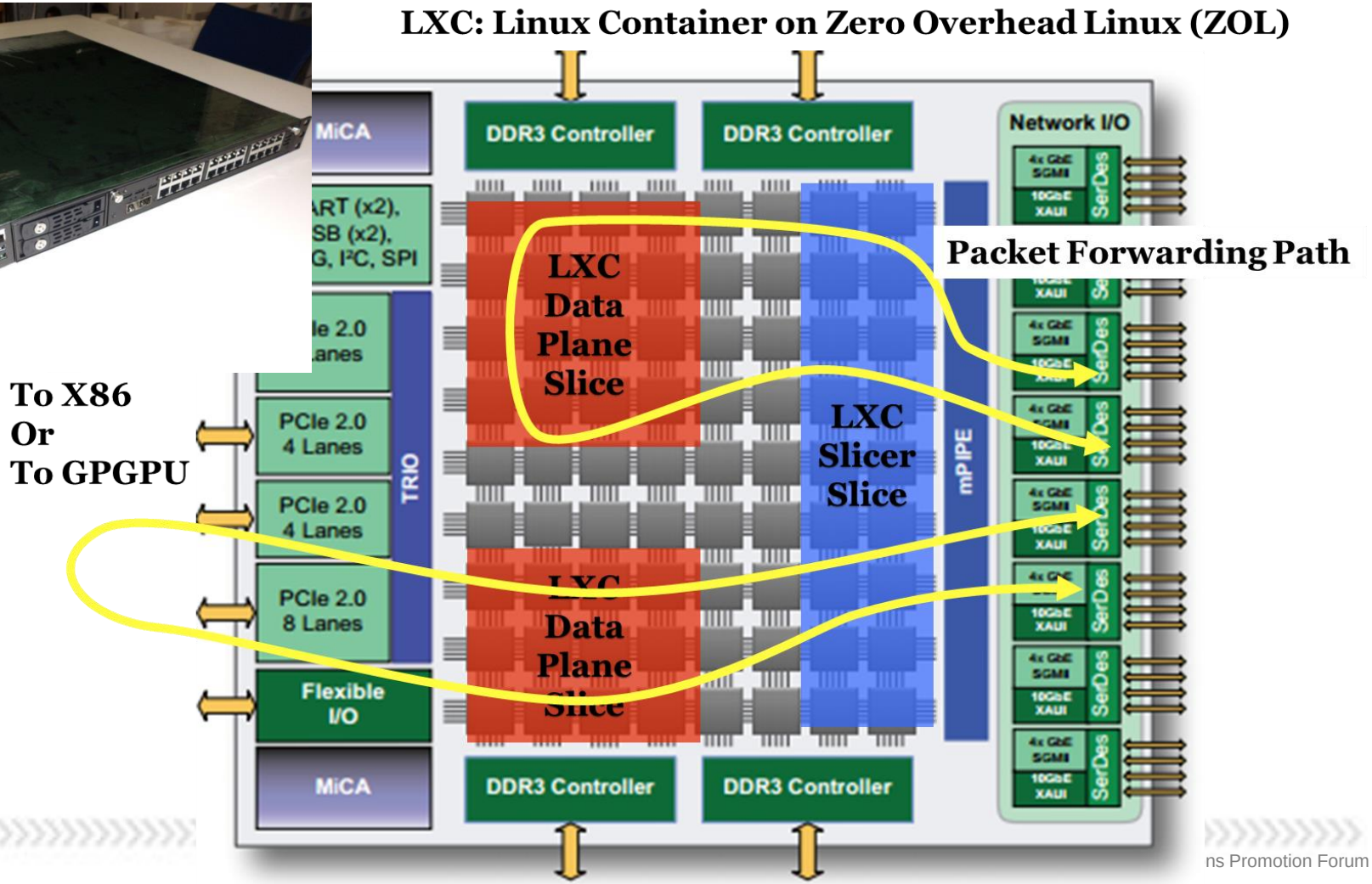
# Contribution from U-Tokyo

THE UNIVERSITY OF TOKYO

東京大学 THE UNIVERSITY OF TOKYO

- ***FLARE Platform will be enhanced towards 5G Slicing***

  Current Spec: 72 core EZ-Chip Network processor, GbE: 24 ports and 10GbE SFP+: 2 ports, Up to 128GB memory / 1TB SSD, Redundant Power supply

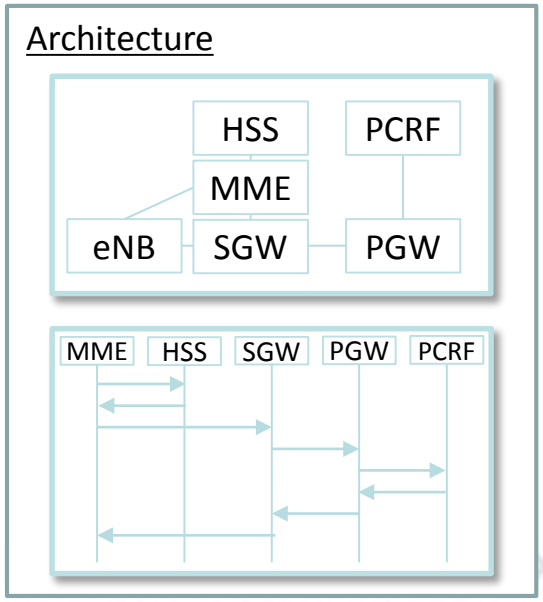


# Contribution from KDDI Research

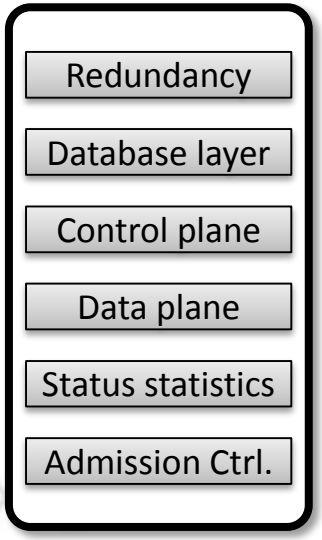
- **Developing a platform allowing Automatic Implementation of Comm. Systems from architecture.**
  - ✓ **Common features as software libraries: database, and control- and data-planes**
  - ✓ **Common Orchestrator to control and mange multiple comm. systems**

Platform **automatically generates** and evaluates the state machine from the given architecture, and implement **the execution codes** without the fatal failure of the system

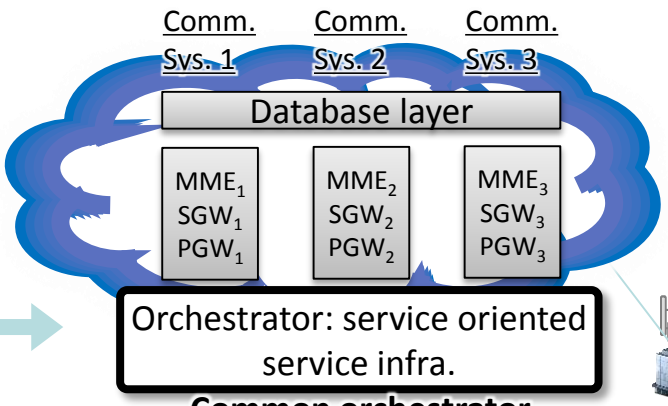
**System designer provide architecture of comm. System to Platform**




**Platform automatically implement… comm. system**




**Softwarized mobile core**




**Common orchestrator rapidly sensing state change by distributed OSS included**

# Contribution from Waseda University

Waseda University

- ***ICN(an Emerging Network Architecture) slice realization on 5GPagoda frame work***
  - ✓ Smooth connection mechanism with RAN
  - ✓ New protocol set for automatic FIB configuration
  - ✓ Name structure, Node naming, Mobility
- ***Demonstration of an application service on ICN***
  - ✓ Candidate will be **IoT related**
- ***Standardization activities***
  - ✓ Mainly in ITU-T(FG IMT-2020 etc.)
  - ✓ Already contributed one document to FG IMT-2020

# Contribution from NESIC

NEC Networks & System Integration Corporation

## Performance

- Network Slicing R&D
- Slice Deployment in our MVNO

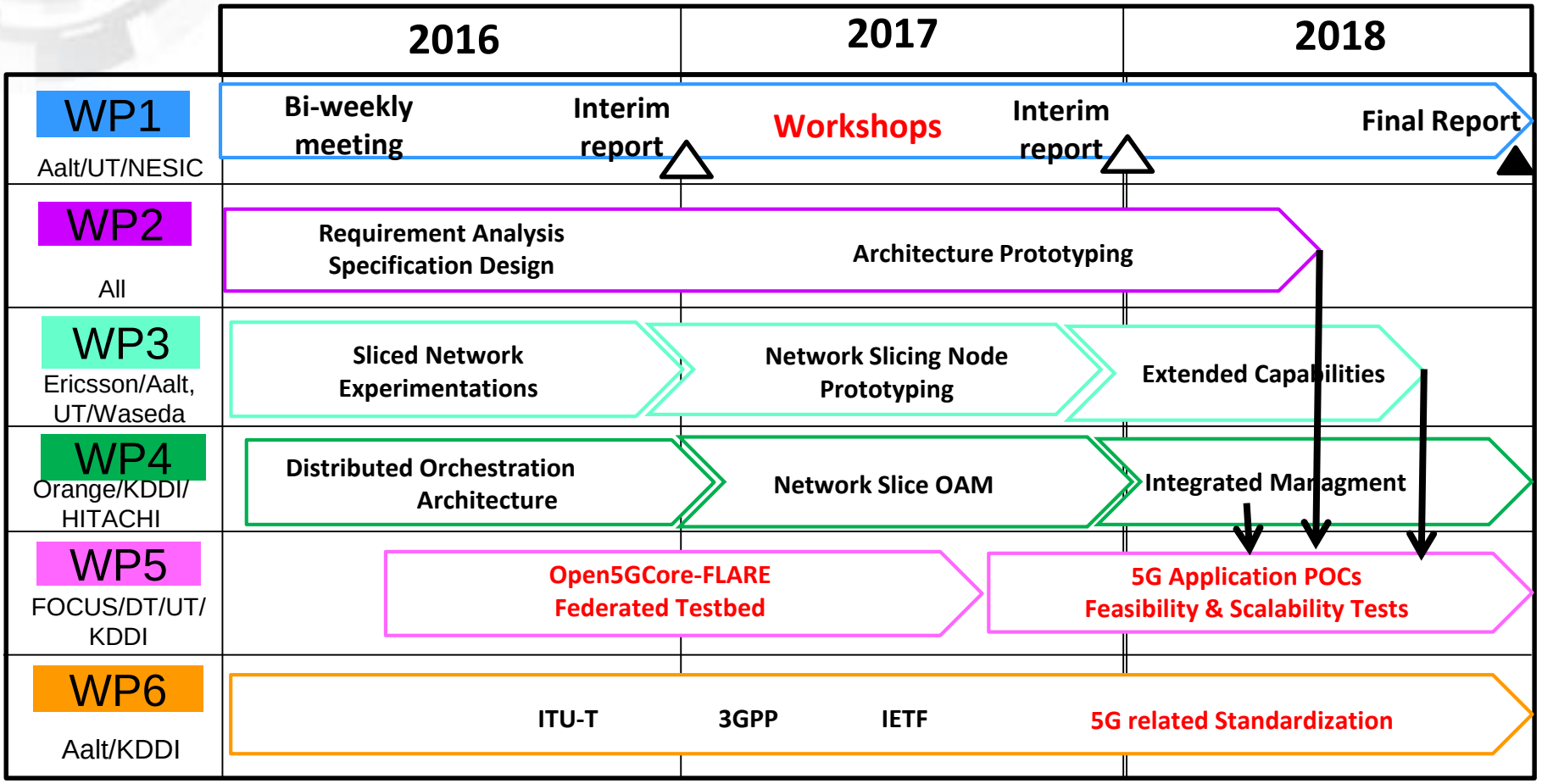

- Lots of Experiences on carrier NFV & SDN PoC

## Know-how

- **MVNO Operations & Management**
- **IoT service Experience**
- SI skills on reliable Carrier NW
- Collaborative FLARE R&D since 2014

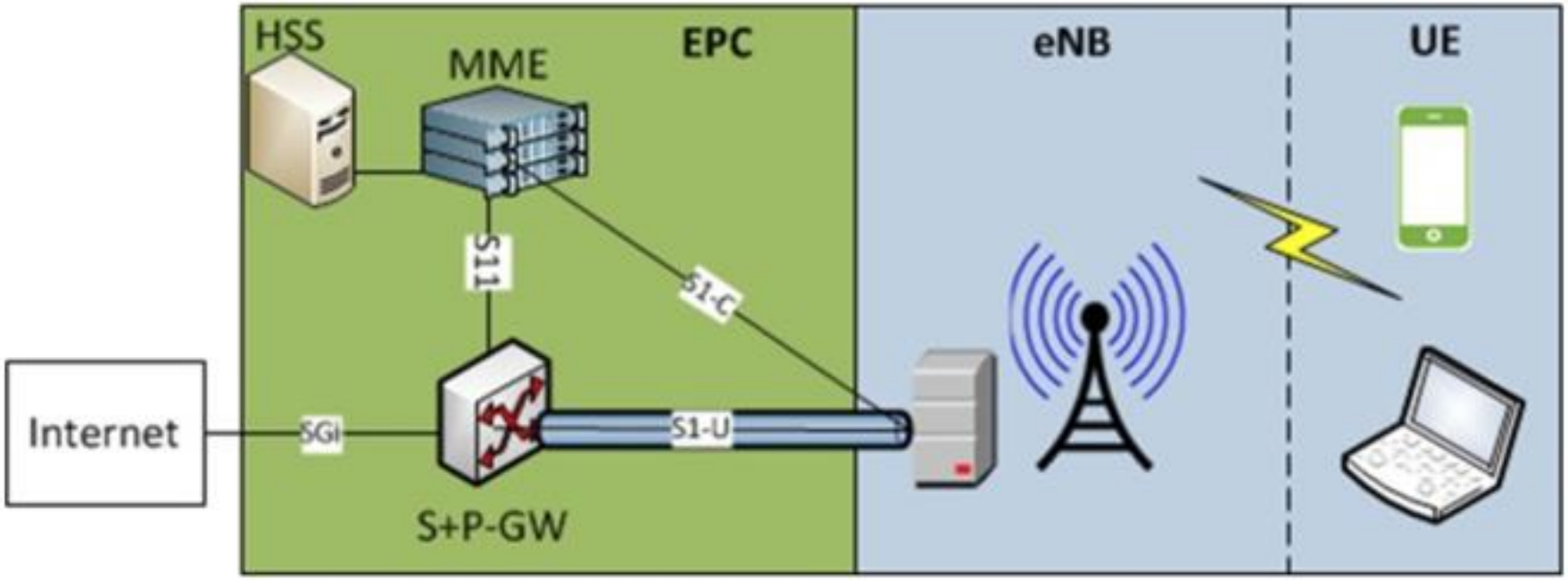
① Contribute to a specification of network slice operations w/ edge computing functions, a prototype development, and field trials
② Verifies on “Time To Market” and “E2E Quality Satisfaction” capability

# 5G!Pagoda Roadmap



# Open Air Interface (OAI)

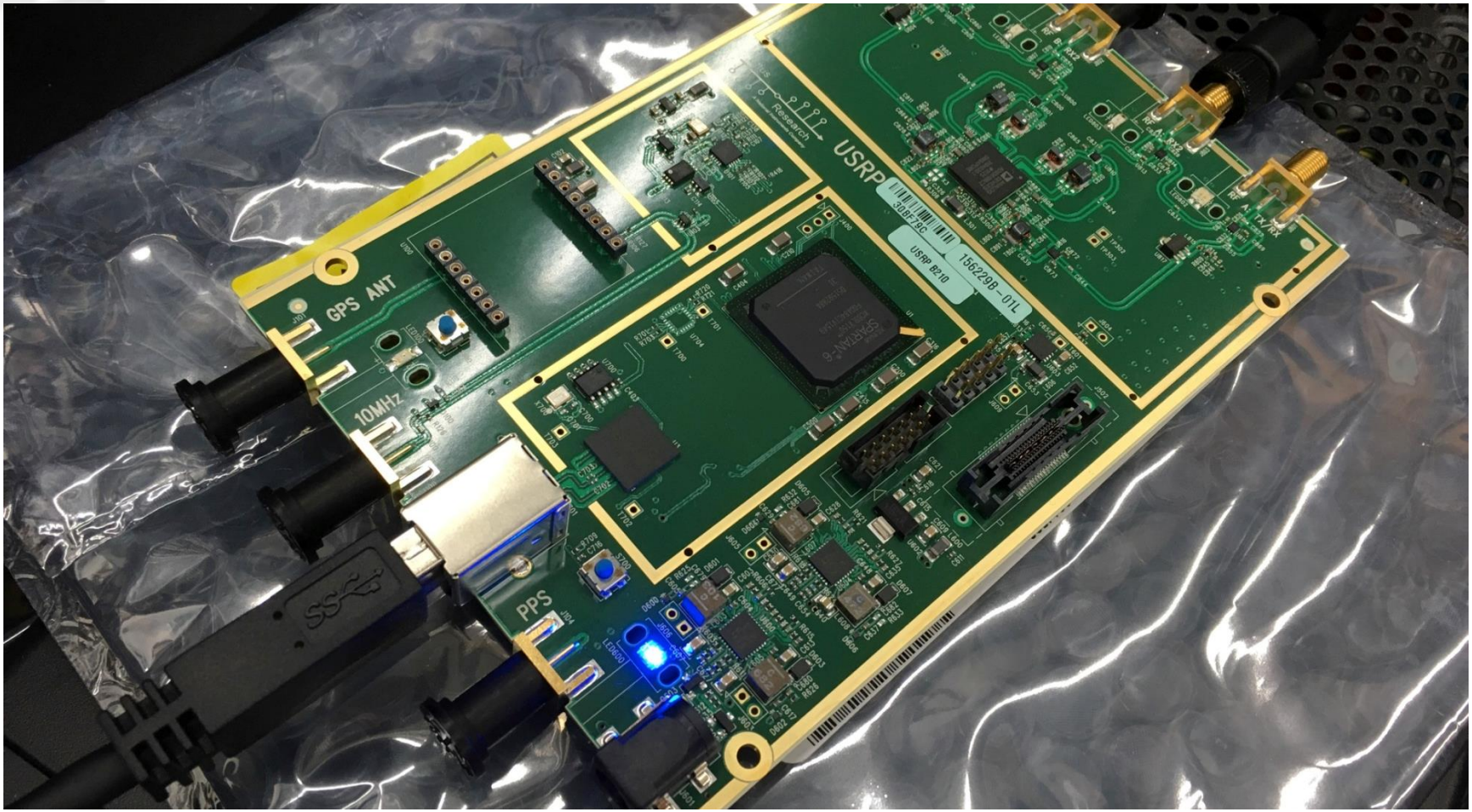
# Software Defined Radio




Software Defined LTE/5G Network !

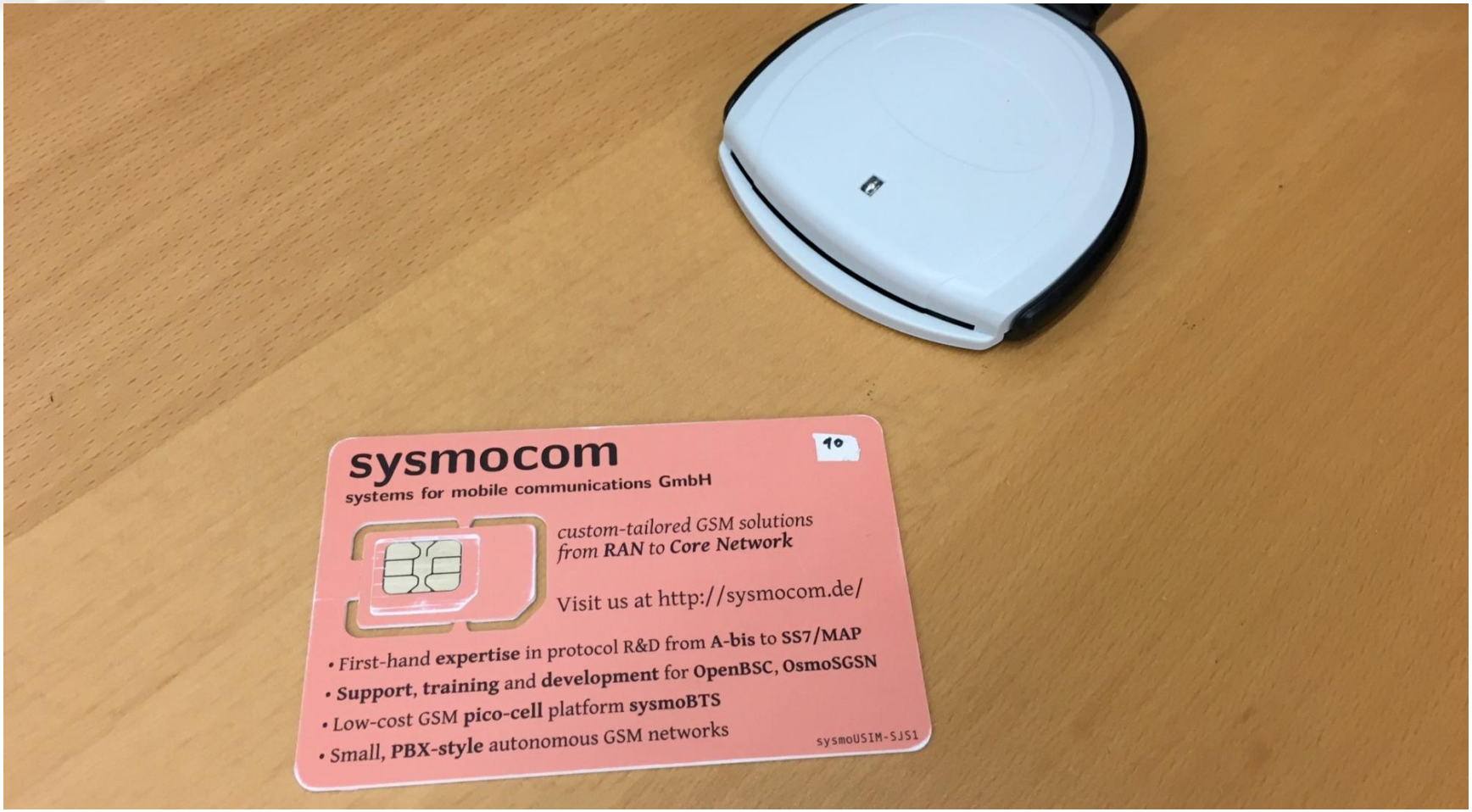

Programmable SIM

# Software Defined Radio

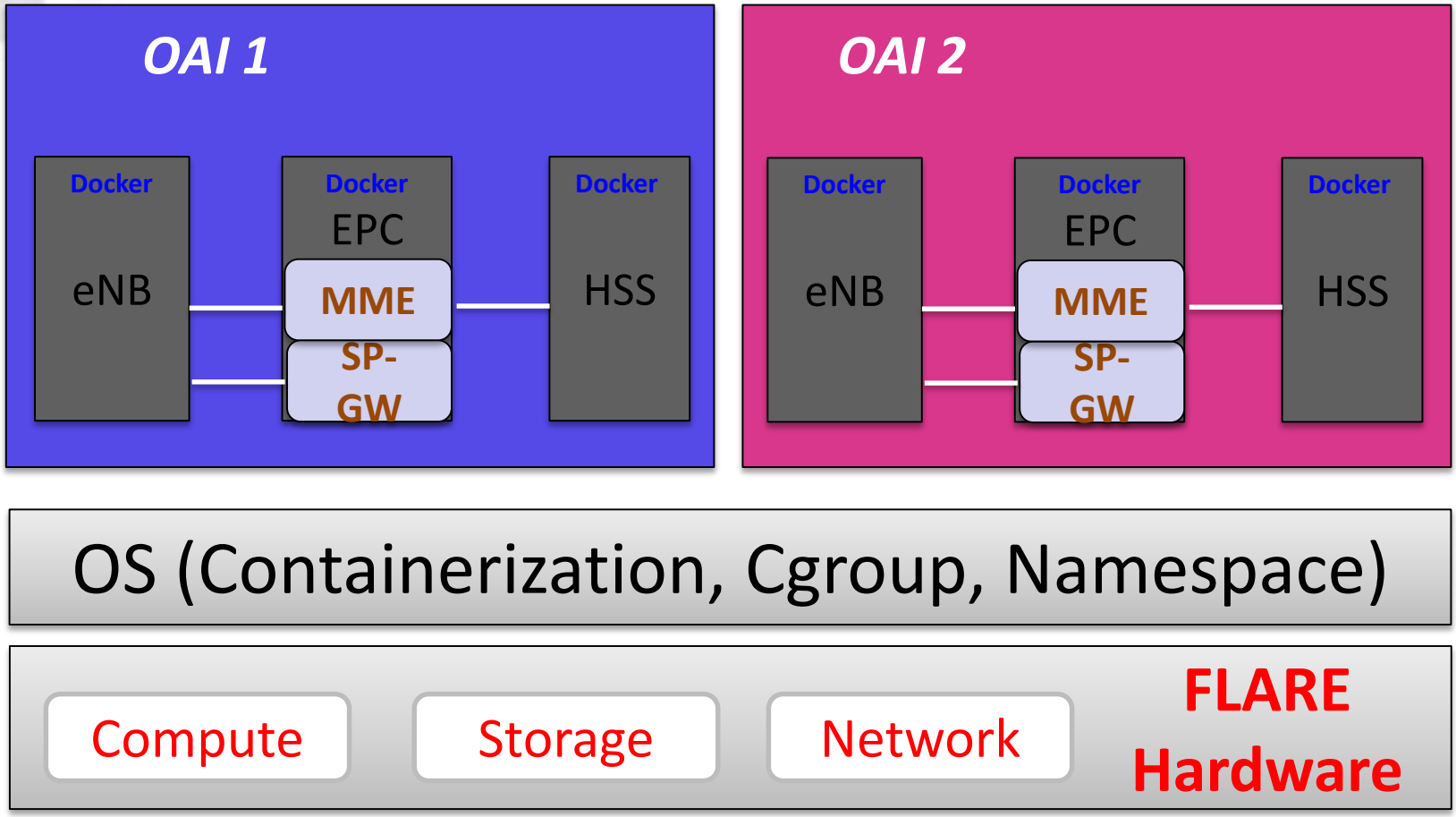


# Software Defined Radio

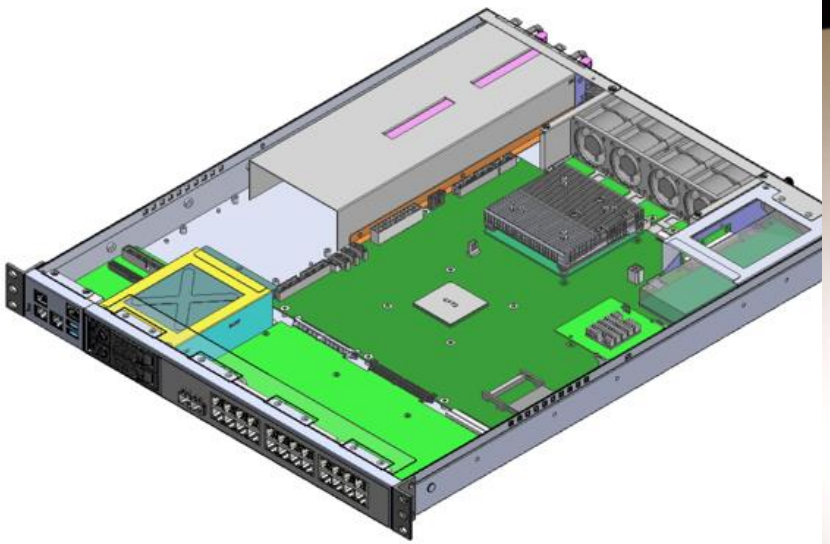
# Programmable SIM

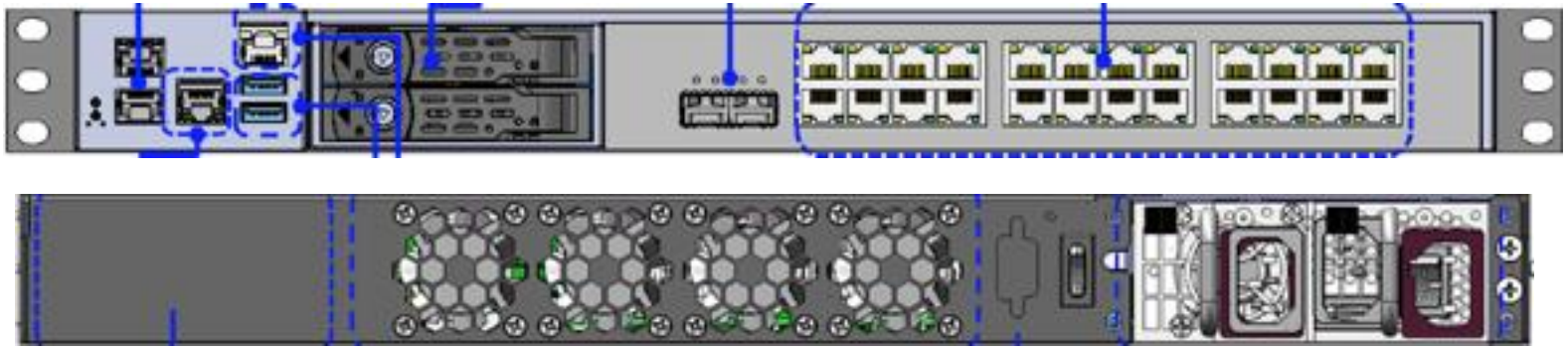


# Architecture of OAI Slicing in FLARE



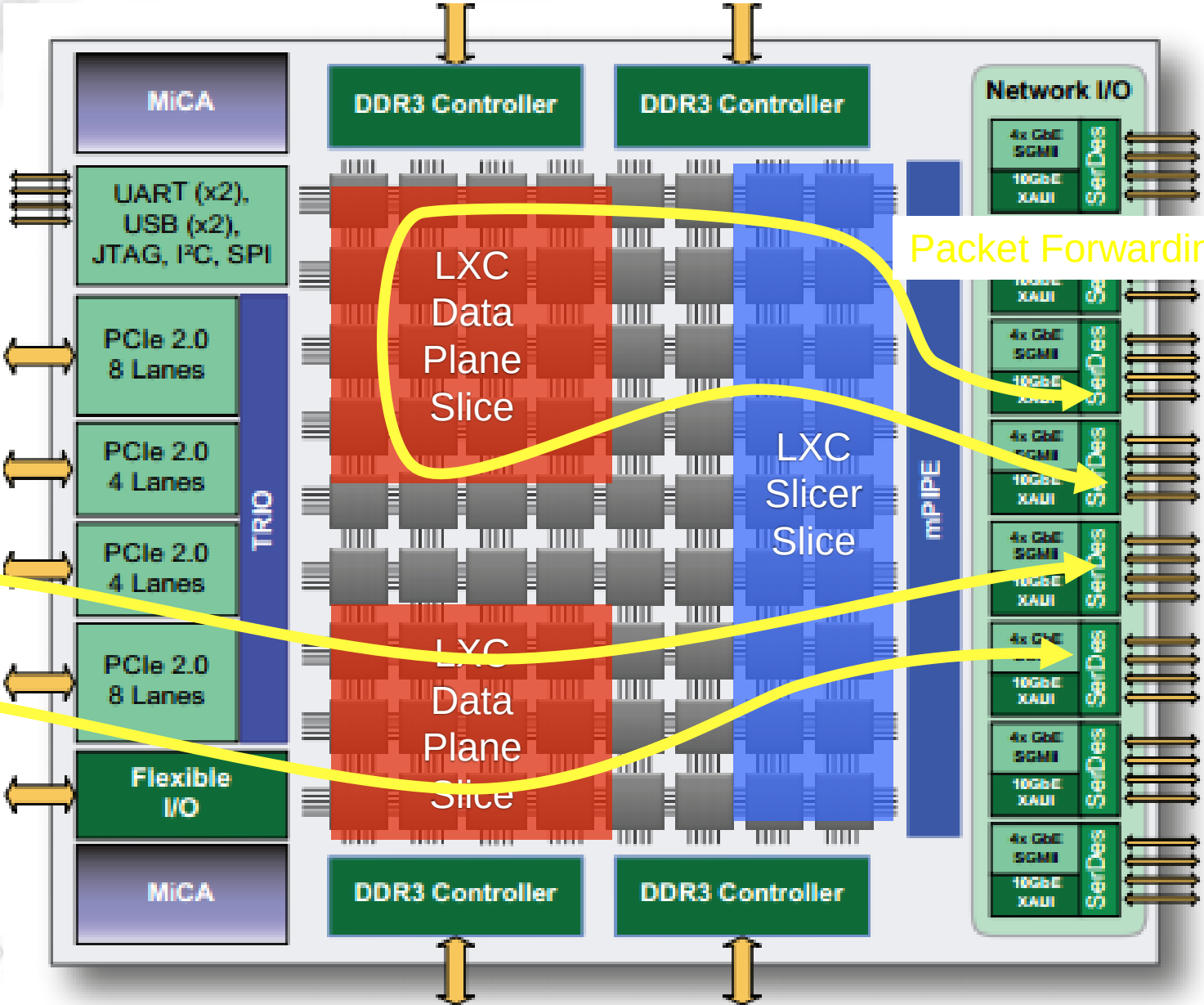
# FLARE Node Hardware





- 72 core EZ-Chip Network processor
- GbE: 24 ports and 10GbE SFP+: 2 ports
- Up to 128GB memory / 1TB SSD
- Redundant Power supply

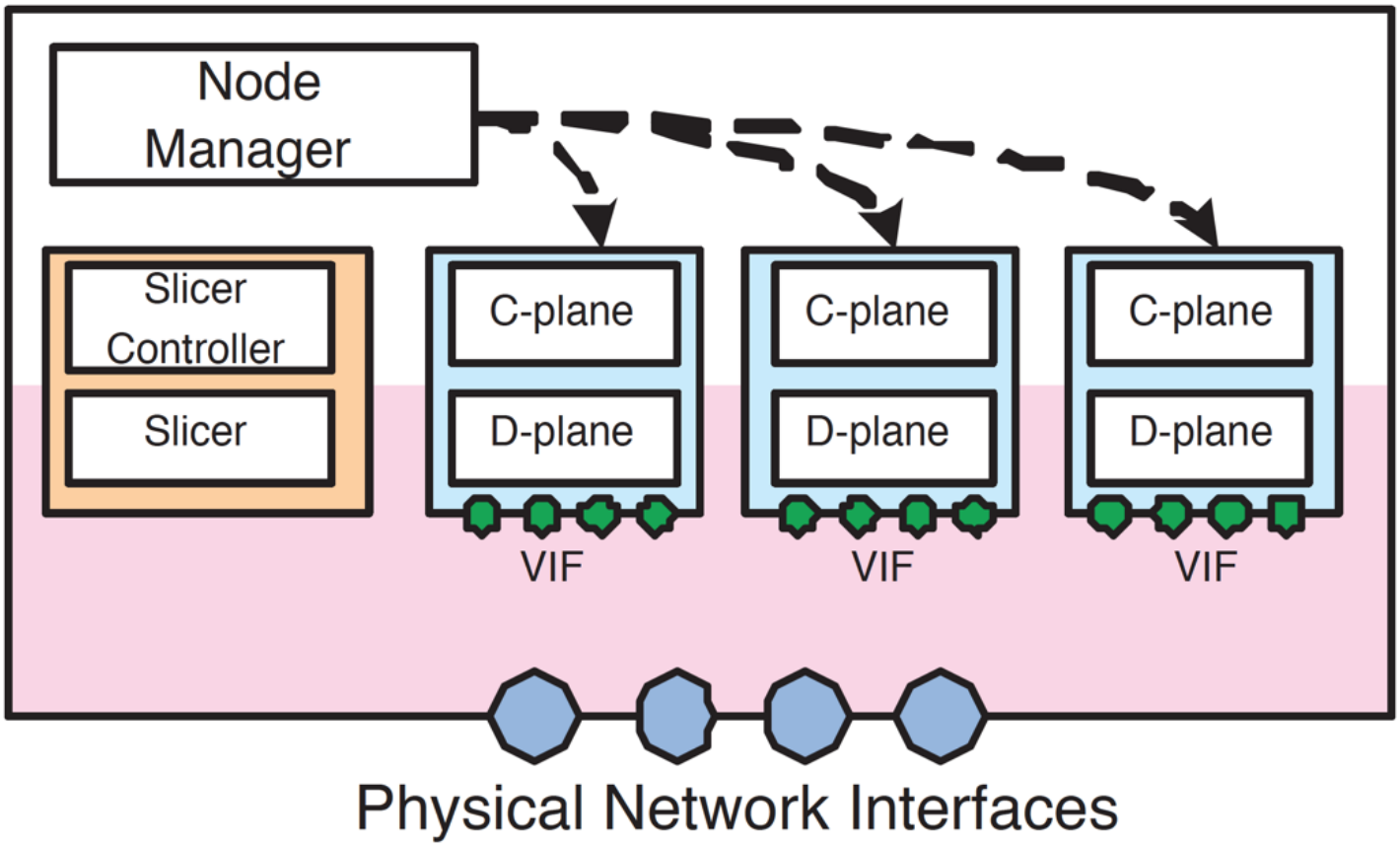
# Sliceable Data Plane in FLARE Node



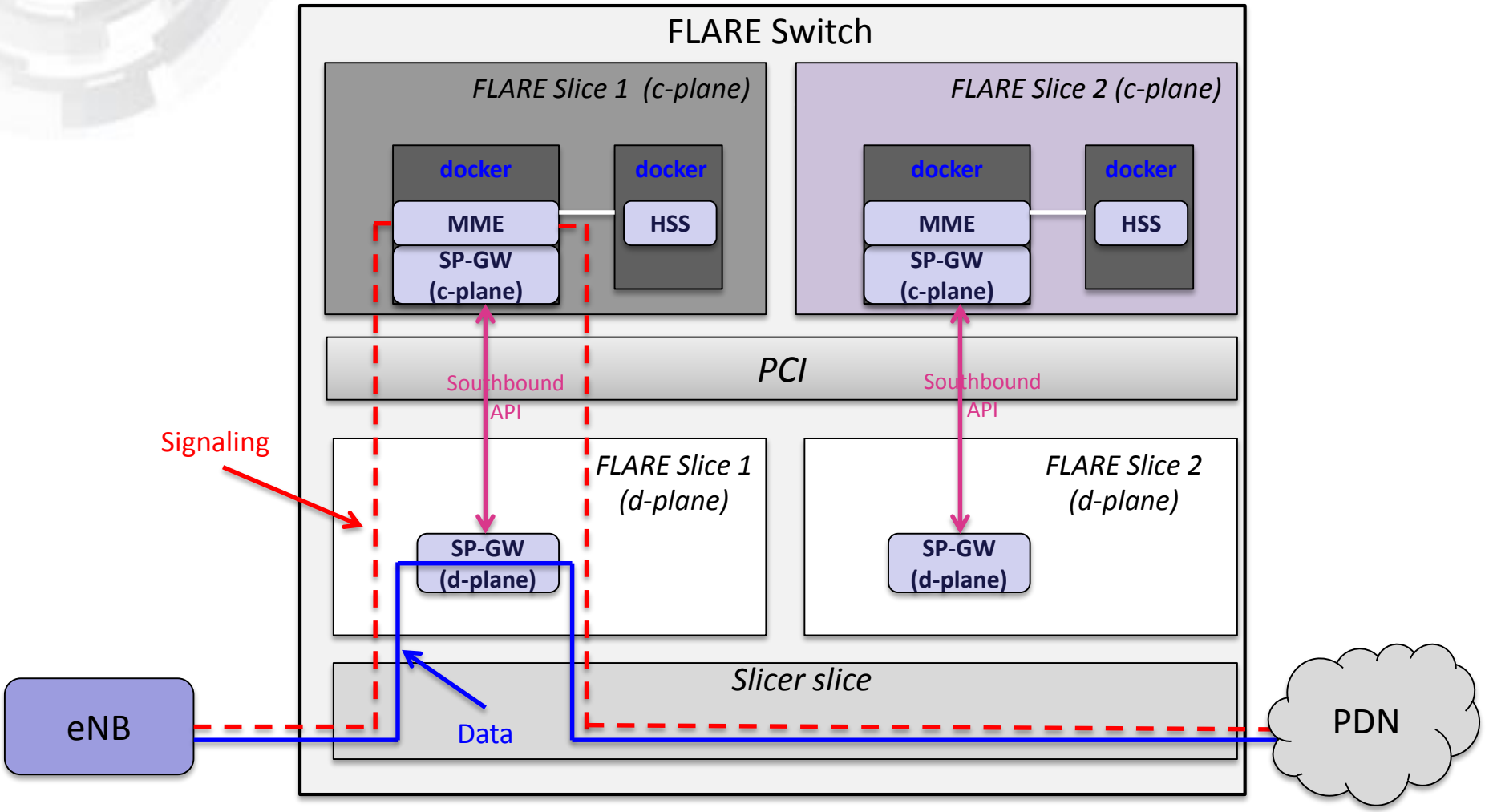
# FLARE Node Architecture

Cplane
(Intel x86
processor)

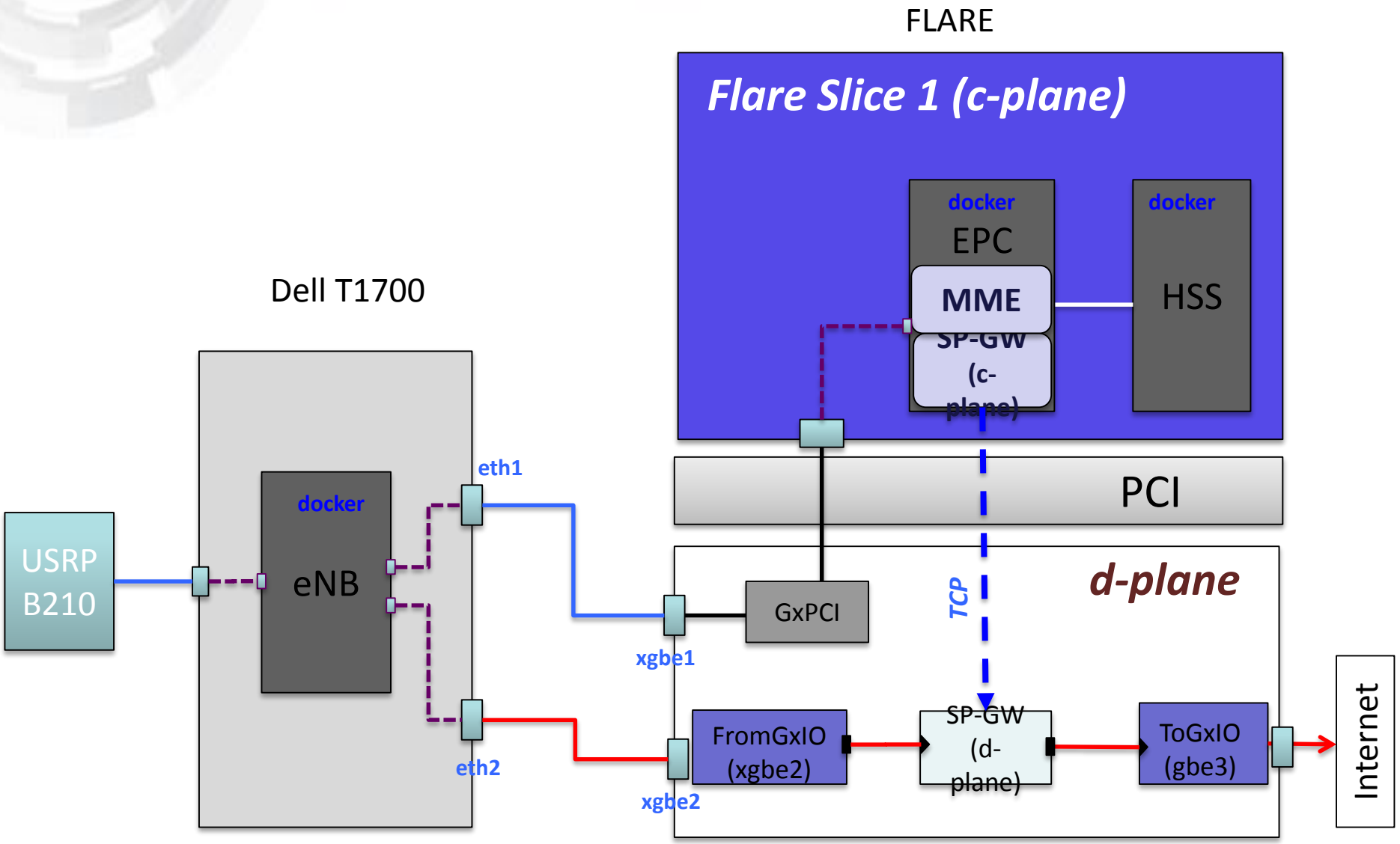
Dplane
(Many core
processor)



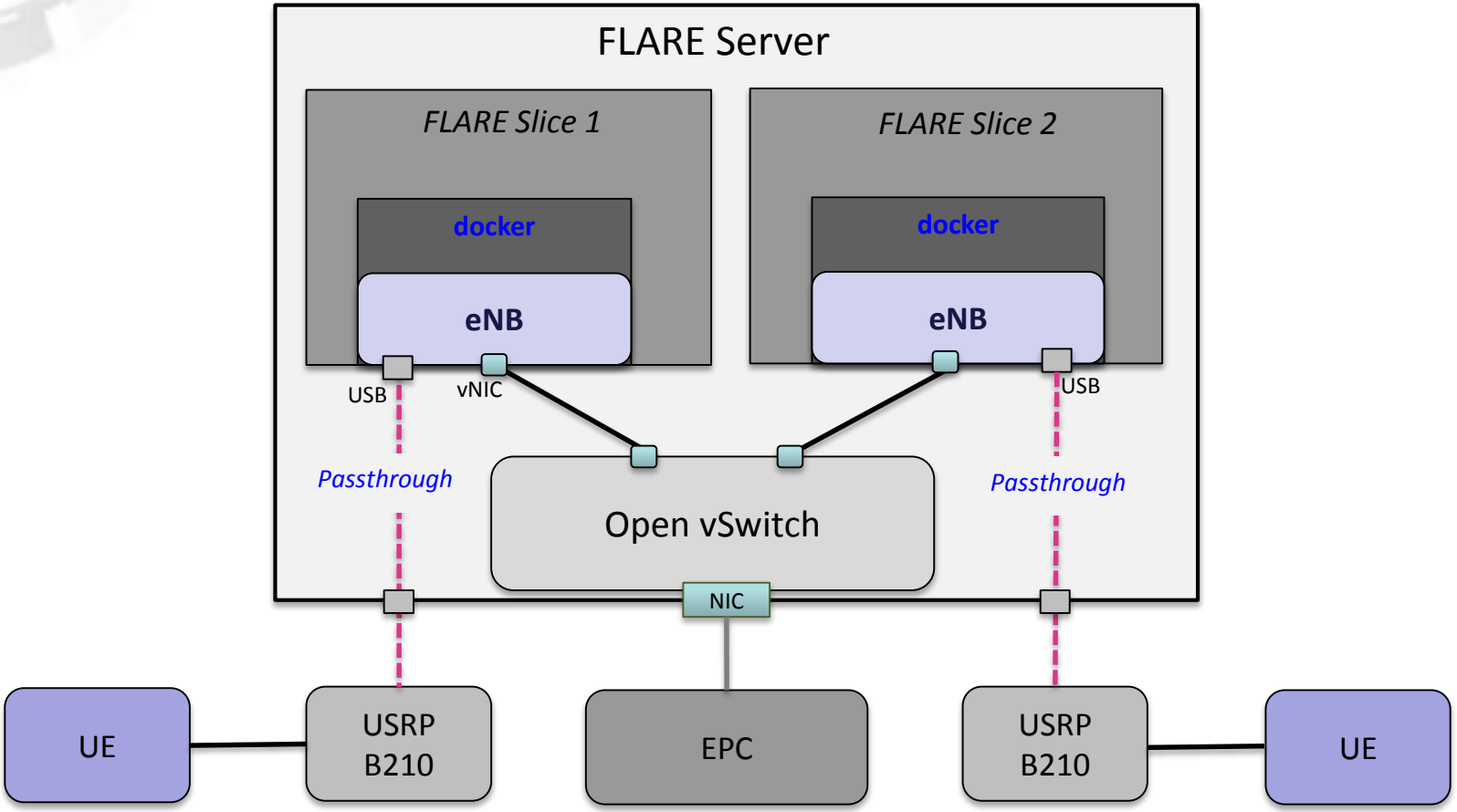
# Dockerized EPC on FLARE Node



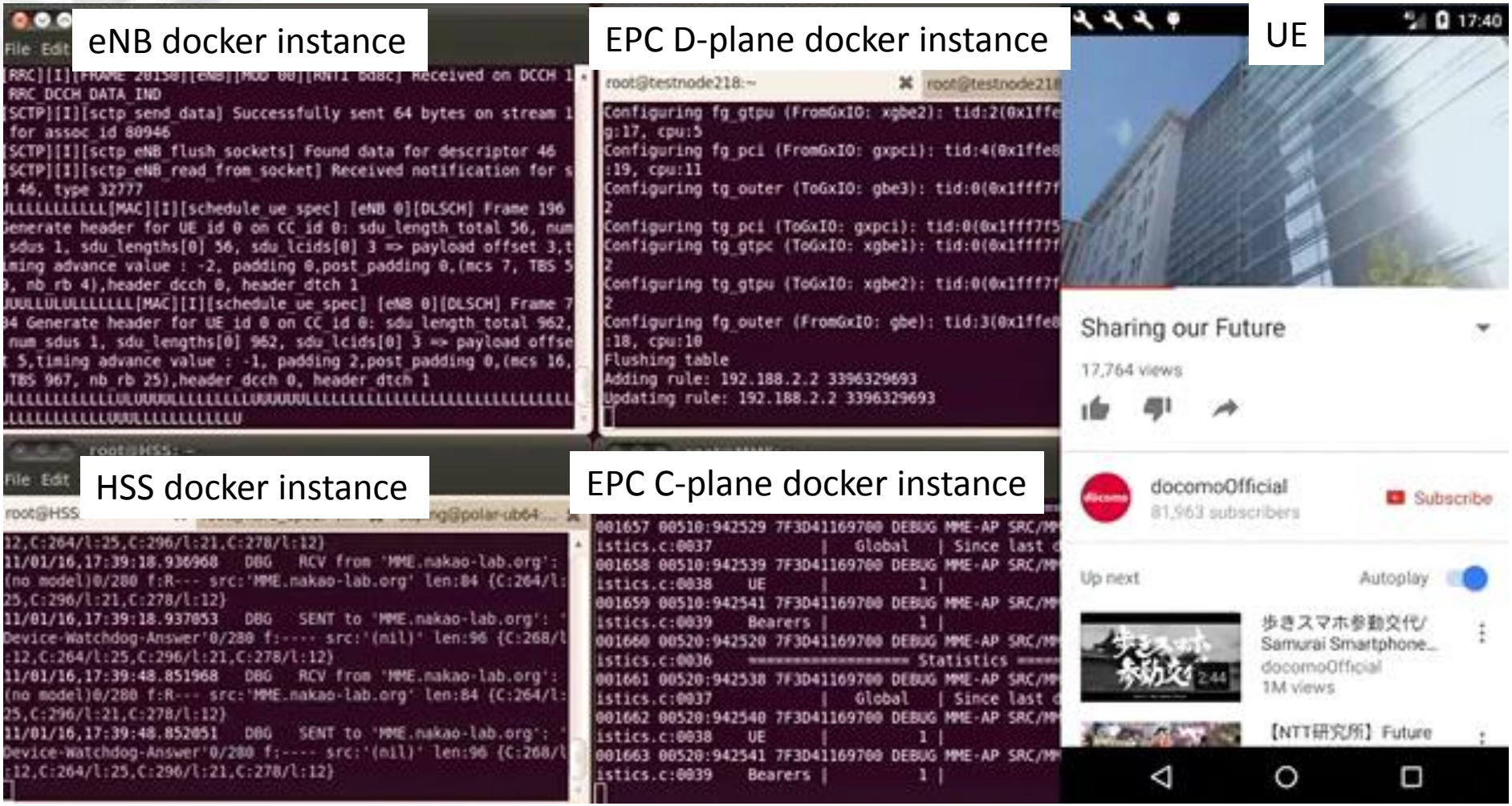
# Dockerized EPC on FLARE Node



# OAI eNB Integration in FLARE Node

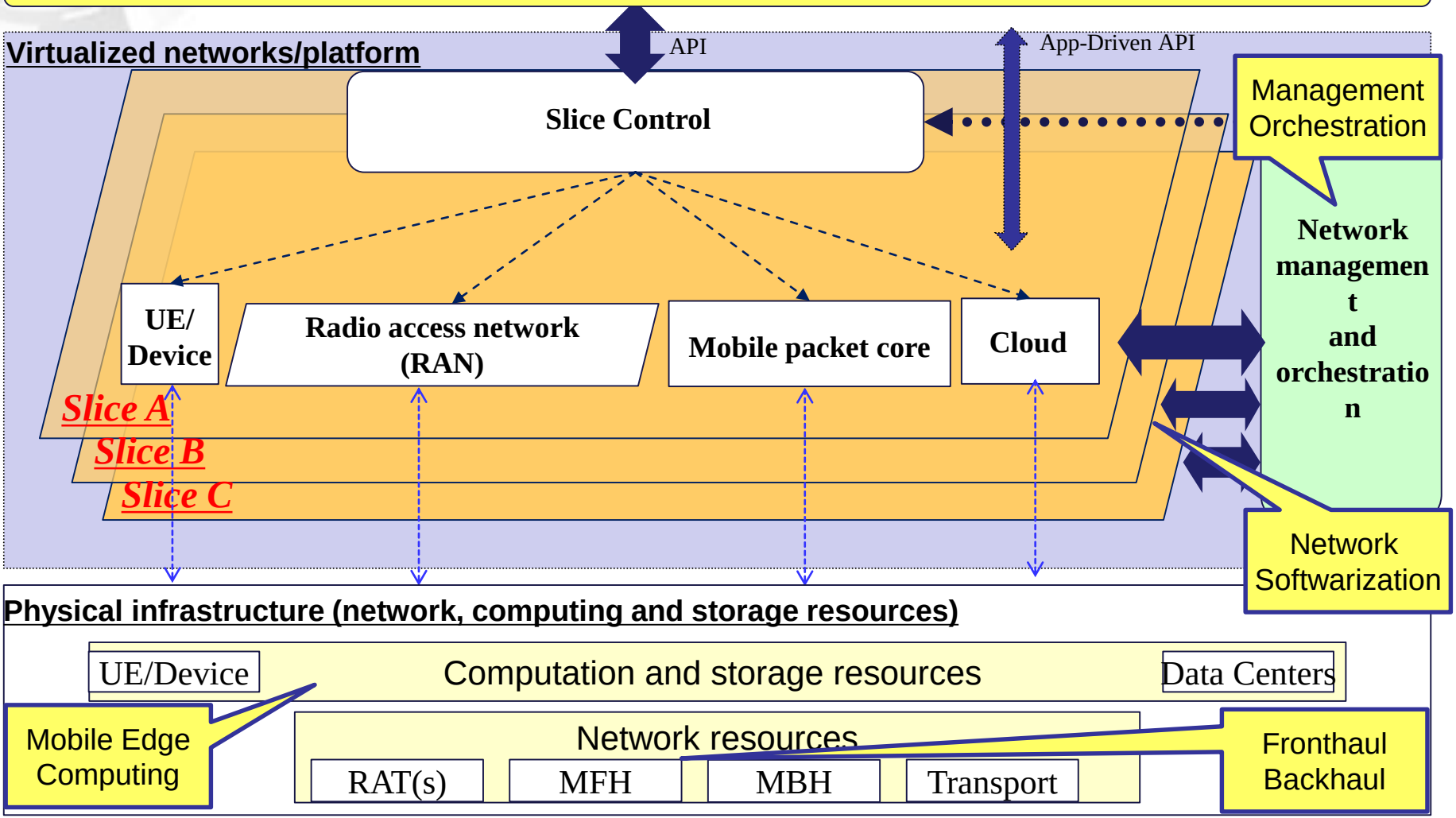


# LTE in A Slice in Operation



# Network Softwarization view of 5G mobile network

**Goal : End-to-End Quality and Extreme Flexibility to Accommodate Various Applications & Services with various requirements (M2M/IoT, Content delivery, Tactile)**



# Conclusion

- Network Softwarization / Network Slicing is key technology for 5G mobile applications
- Edge computing is essential for IoT communication
- Network isolation for different handling for eMBB, mMTC and URLLC services