E2E Service Slicing Platform for Application-Driven Wireless Network

Ravi Ravindran and G.Q.Wang

ravi.ravindran@huawei.com and gq.wang@huawei.com)

(Huawei Research Lab, Santa Clara)

(Open Networking Summit, Mar, 2016)

Agenda

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5G-ICN Motivation

- 5G Objectives and Target Architecture
- Application Driven Networking (ADN)
- Information-Centric Networking

2

5G-ICN Architecture & Network Slicing

- 5G-ICN Network Architecture
- 5G-ICN Network Slicing
- Cross Layer Vs Overlay Slicing

3

5G-ICN Platform

- Virtual Service Edge Router (VSER) Platform
- Services (Video/IoT)
- ICN Mobile Edge Service Delivery Model

5G Requirements

uirements have been set in [1]

Application Requirements

- Traditional and Emerging IoT (M2M))
- 1-10ms depending on the application
- >1000x Capacity, >10-100x Bandwidth
- Security, Mobility, Disaster Scenarios

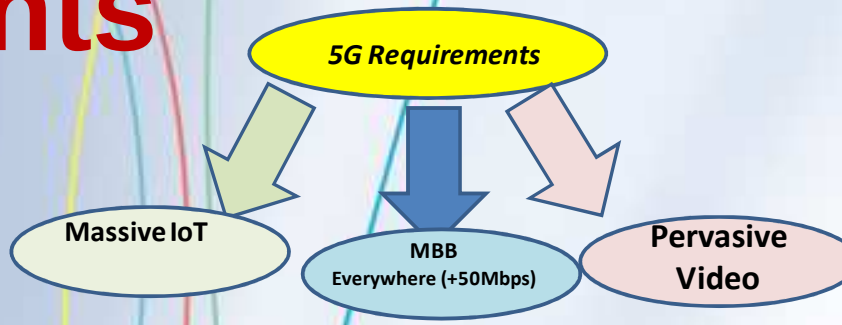
Enable Service Centric Networking

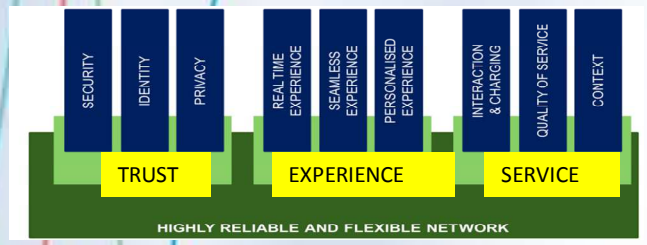
- Allow new Business Models
- XaaS (Naas/SaaS/PaaS)
- Leverage NFV/SDN
- Not only Connectivity Services
- Service Platform for Users and ASPs
- Personalized and Contextualized

Evolving Network Architecture

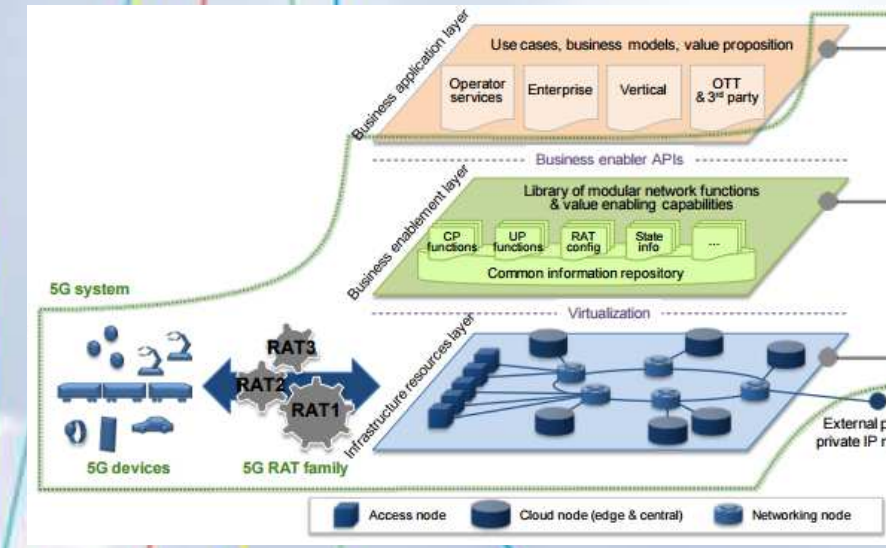
- Network Slicing Frameworks
- Application Driven Networking Vision
- ICN based Network Architecture for ADN

GMN White Paper on 5G:
://www.ngmn.org/uploads/media/NGMN_5G_White_Paper_V1_0.pdf



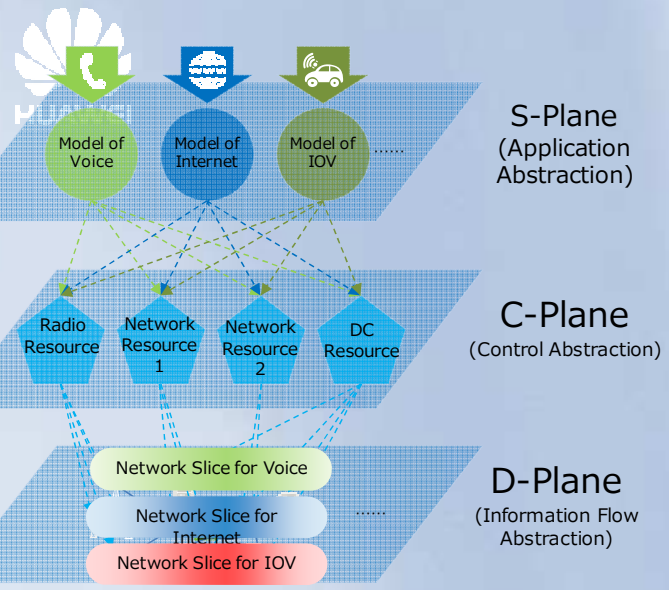


5G Value Creation Capabilities



5G Target Architecture

lication Driven Networking (ADN) Vision



App Oriented Network Restructure

+

App Oriented Network Scheduling

+

App Oriented Layered Control

1. Application abstraction
2. App driven management of network and data resources
3. On-demand network reconstruction

1. Fast and slow control to achieve optimal resource allocation for apps

1. Decouple control of different services
2. Guaranteed performance and scalability for apps

ADN Goals:

1. Application layer abstraction in the Service Plane
2. Application Driven Control Plane
3. Information layer abstraction in the Data Plane
4. Heterogeneous services on a unified infrastructure.

FIA：Design Targets

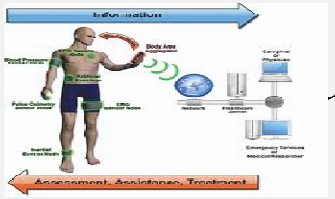
istic design for future Apps, hyper-connection, mobility and secu

Internet of （things/service/people/information）

Smart Home

V2V

Wearable Net



FIA

amazon

iTunes

YouTube

facebook

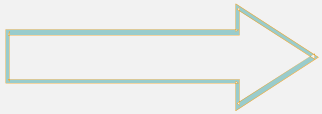
Info Net

Apps

L3/IP

L2/MAC

L1/PHYs



Apps

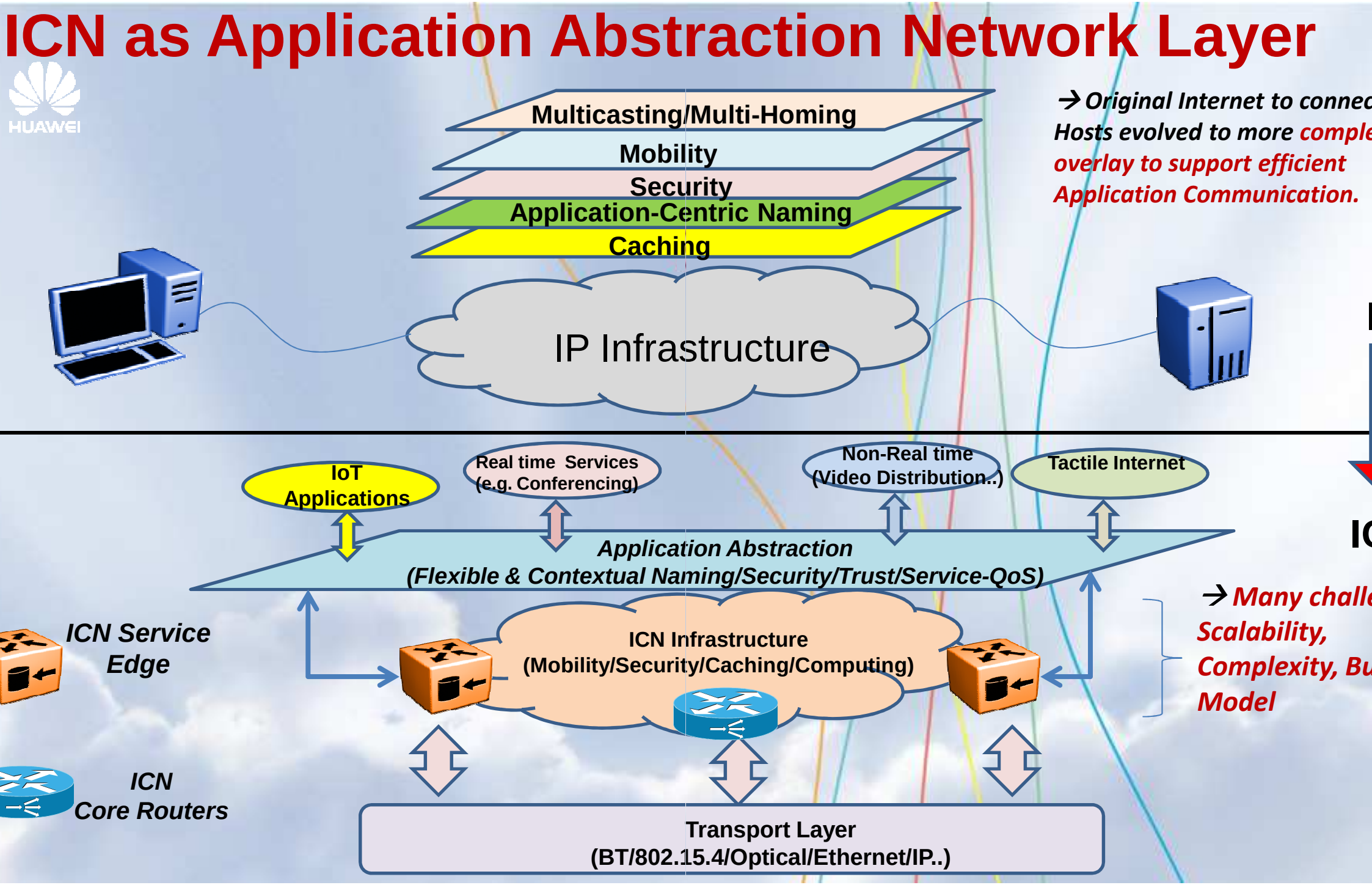
Info-centric

L3/L2/MAC

L1/PHYs

New “waist”, New architecture, New Apps

ICN as Application Abstraction Network Layer



5G-ICN Network Architecture

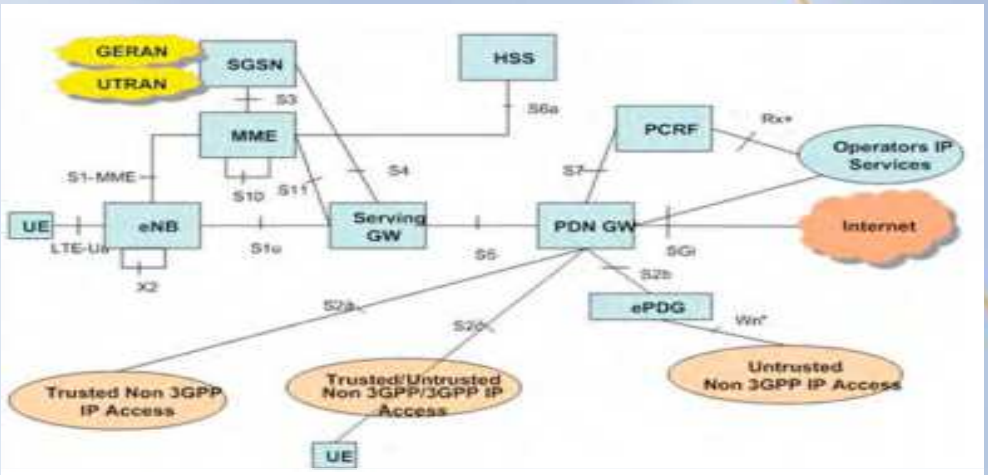
- 5G-ICN Network Slicing Framework

- Cross Layer Vs Overlay Slicing

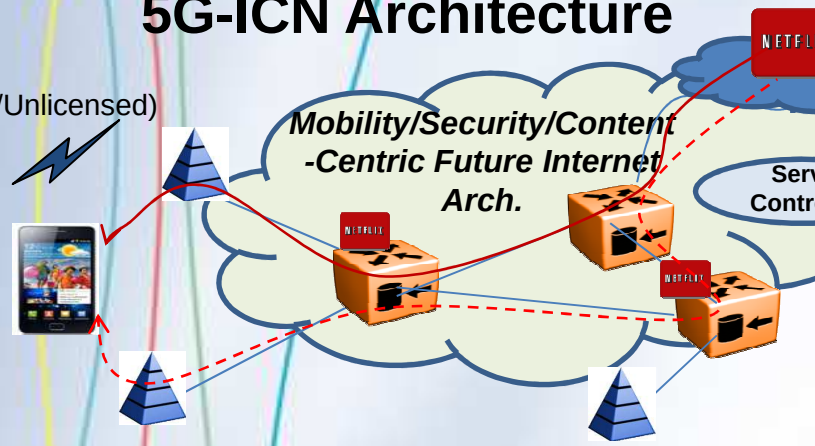
Evolving to 5G-ICN Architecture

HUAWEI

LTE Network Architecture



5G-ICN Architecture



Current Architecture

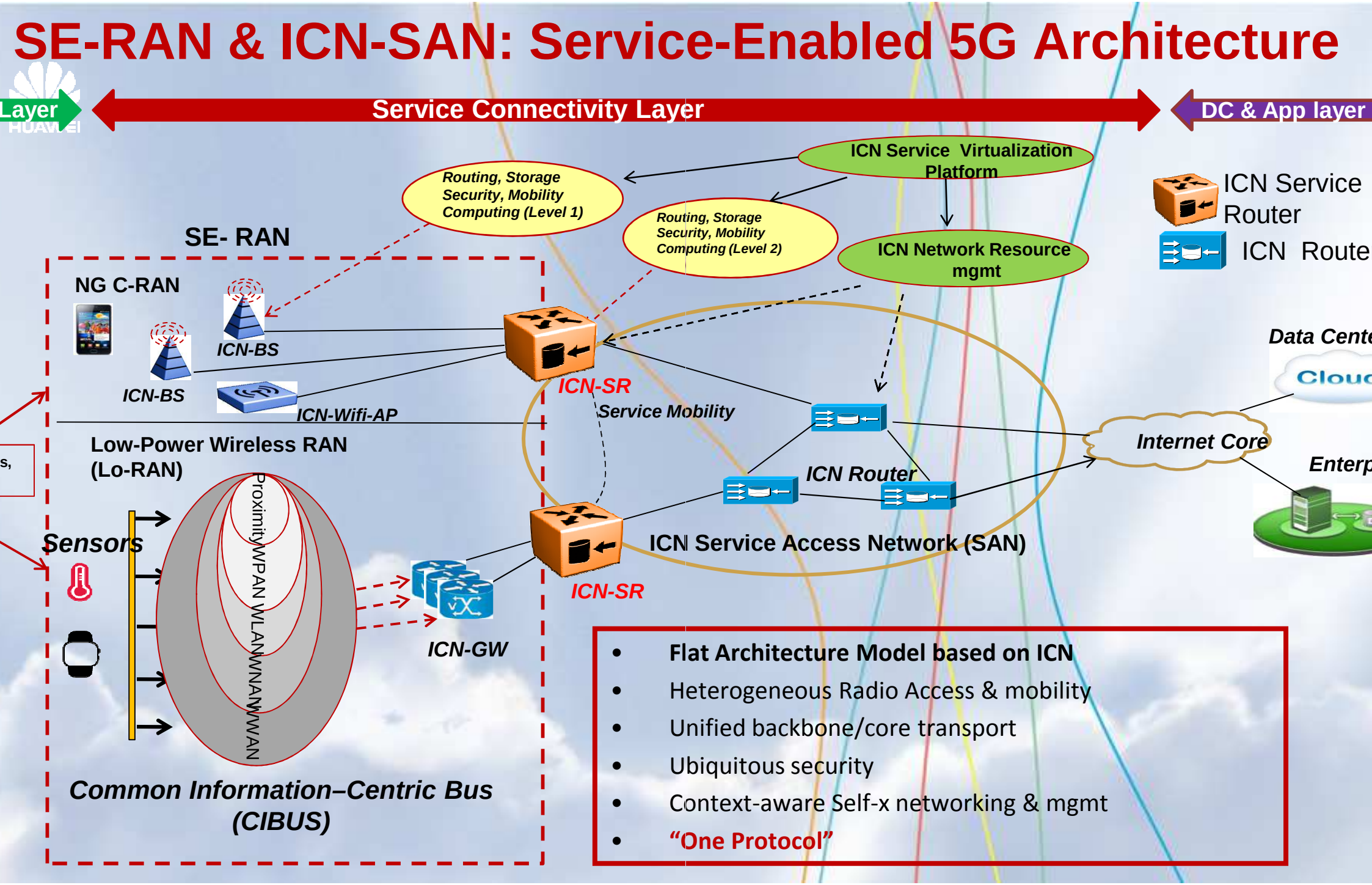
- Hybrid 3GPP & IP Arch
- Complex Control interfaces.
- Technology Specific (2G/3G/4G)
- IP Tunneling in Data Path
- Application Gateways
- Bottlenecks, Sub optimal routing

5G-ICN Architecture

- ✓Flat Application-centric Network Architecture.
- ✓No Gateways or Tunnels
- ✓In-build Mobility
- ✓In-build Security, Storage and Computing
- ✓Technology Neutral (any RAN)
- ✓Application-centric Control
- ✓Plugin Radio, Licensed/Unlicensed

f. Raychaudhuri, "**Next Generation Mobile Network Architecture**", WinLab IAB Review meeting , 2015.
ww.winlab.rutgers.edu/iab/2015-02/Videos/08.mp4

SE-RAN & ICN-SAN: Service-Enabled 5G Architecture



- **Flat Architecture Model based on ICN**
- Heterogeneous Radio Access & mobility
- Unified backbone/core transport
- Ubiquitous security
- Context-aware Self-x networking & mgmt
- **"One Protocol"**

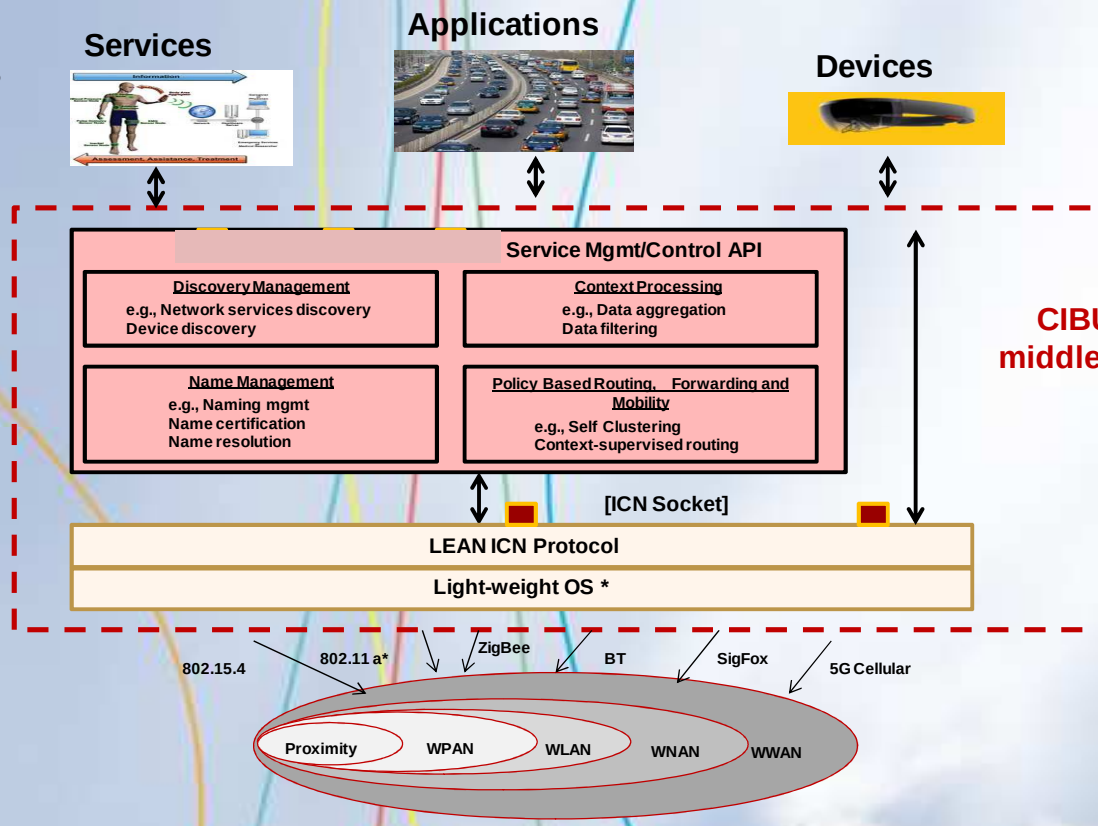
SE-RAN Functional Features

IG C-RAN

- Flat Architecture and Heterogeneous Radio Access
- **ICN Edge Cloud** Intelligence all the way to the BS and UE
- **Distributed Routing, Storage/Caching, Computing, Mobility Functions**
- Application/Services Binds to Names
- **Name Based Routing/Forwarding**
- Mobility/Migration
- **Multi-homing/Multicasting**
- **Data based Security and Trust** (Enforceable on the Infrastructure)
- D2D/P2P/MP2MP
- Adaptable and Service Centric (Low Latency, High Throughput etc.)

ommon Information-Centric BUS (CIBUS)

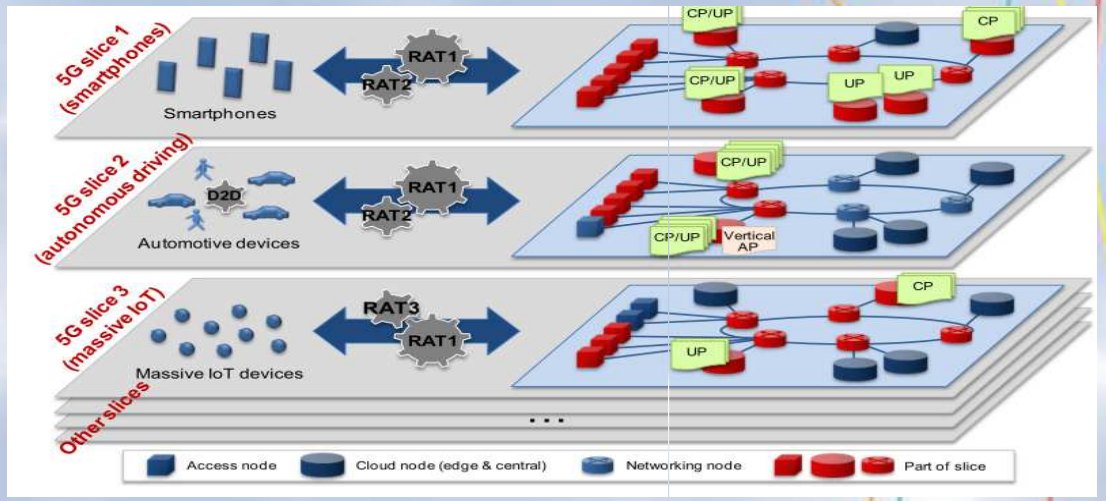
- Addresses the need for next 50B IoT devices on 5G
- Middleware over Constrained and Non-Constrained Devices
- **Enables Self-X (Discovery, Routing, Service Point Attachment)**
- **Contextualized Device/Service Discovery & Processing**
- Heterogeneous Radios (WPAN,LORAN, WLAN etc.)
- Local/Global Naming Service
- Hierarchical Data Processing
- **Security/Trust Management**
- PUB/SUB System for Large scale Content Distribution
- Open-APIs for Inter-IoT system connectivity



CIBUS Middleware

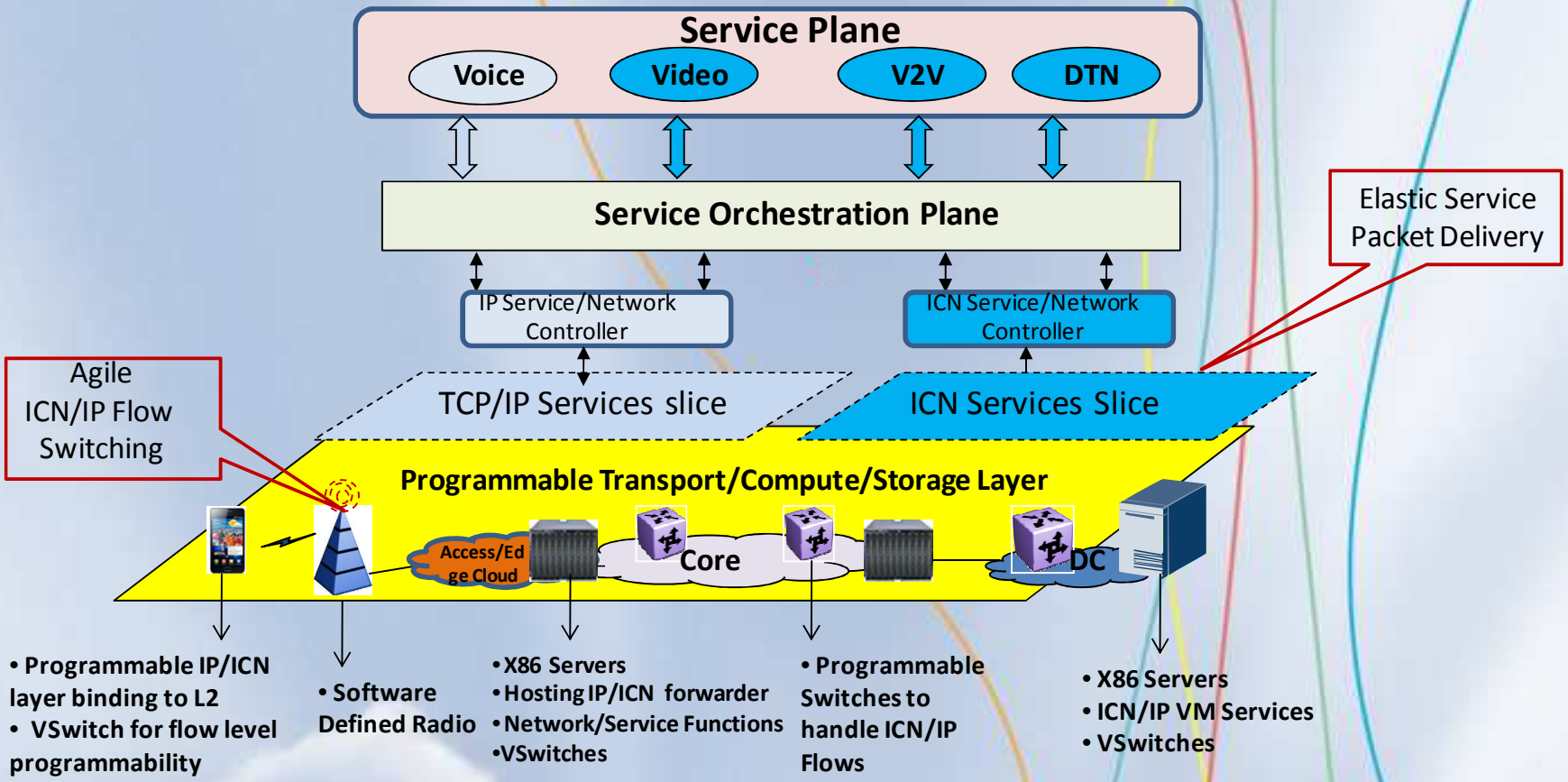
5G Network Slicing

- **Realize end-to-end dedicated network for specific service scenario.**
  - Spans UE, RAT, Infrastructure, Edge Clouds, DCs
- **Meet specific service objectives of Security, Latency, Throughput, Reliability etc.**
- **End-to-end virtualization of Compute, Bandwidth, Storage, Data , Device resources.**
  - Virtualization allows resources to be efficiently flexibly managed among various slices.
  - **Multi-modal delivery connectivity: M2M, P2P, P2MP and MP2MP**
  - **New APIs and Service Functions in the Network Architecture**
- **Specialized Control Plane and Service Control functions to enable rich services.**
  - E.g. Mobility-as-a-service, Security-as-a-service , Context Processing etc.
- **Creates scope for new network Architectures like ICN to address 5G Challenges**



NGMN White Paper.

5G-ICN Network Slicing Framework



Network Slicing framework requires programmability at Transport/Compute/Storage levels.

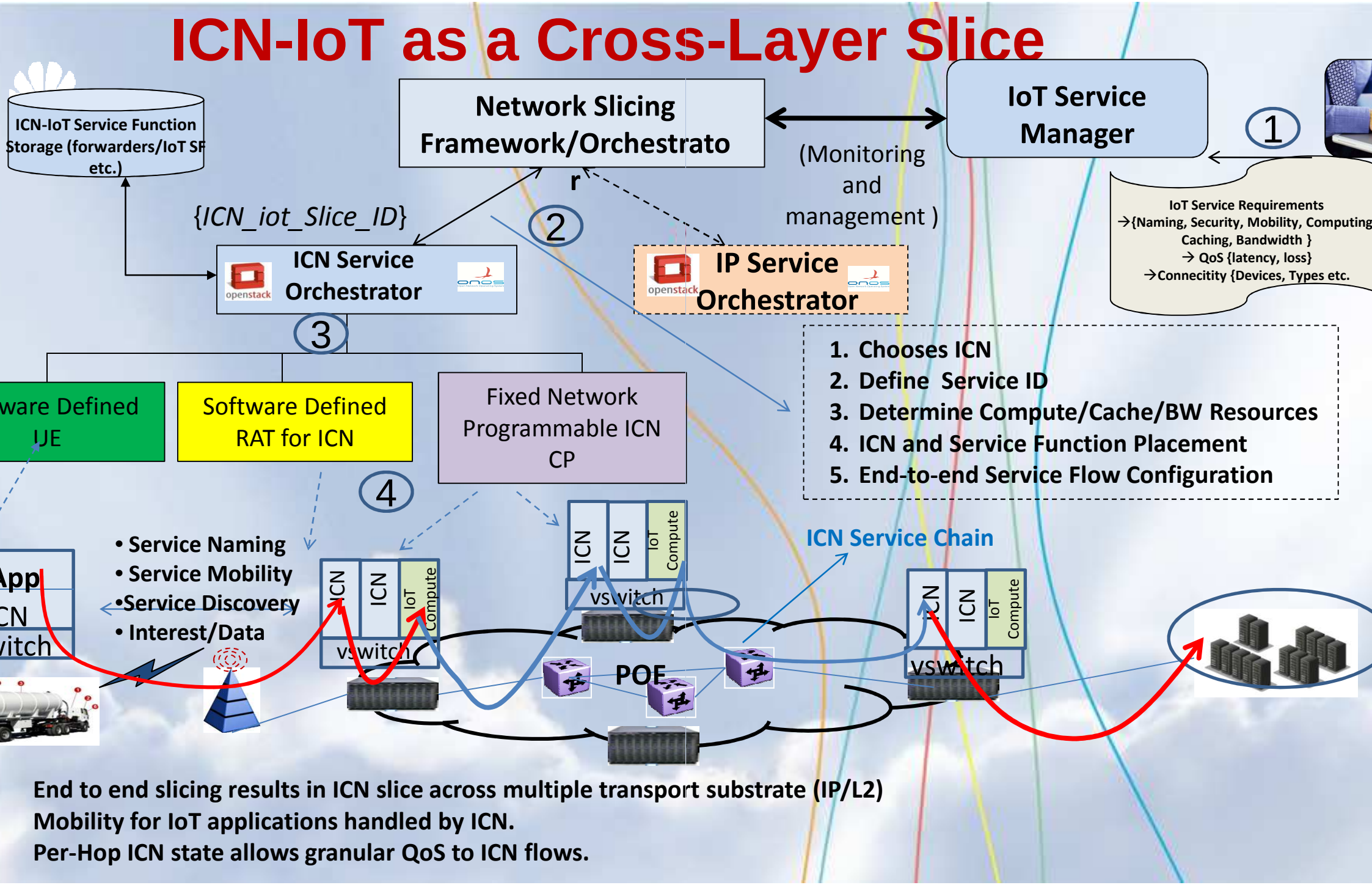
Realizes the objective of Application Driven Networking with a Bare Transport

The objective is to create elastic ICN/IP slices and its associated control/service plane on demand.

Identified are also some of the end-to-end technology enablers

TU, FG, IMT 2020 – "Network Standardization Requirement for 5G"
://www.itu.int/en/ITU-T/focusgroups/imt-2020/Documents/T13-SG13-151130-TD-PLEN-0208!!MSW-E.docx

ICN-IoT as a Cross-Layer Slice

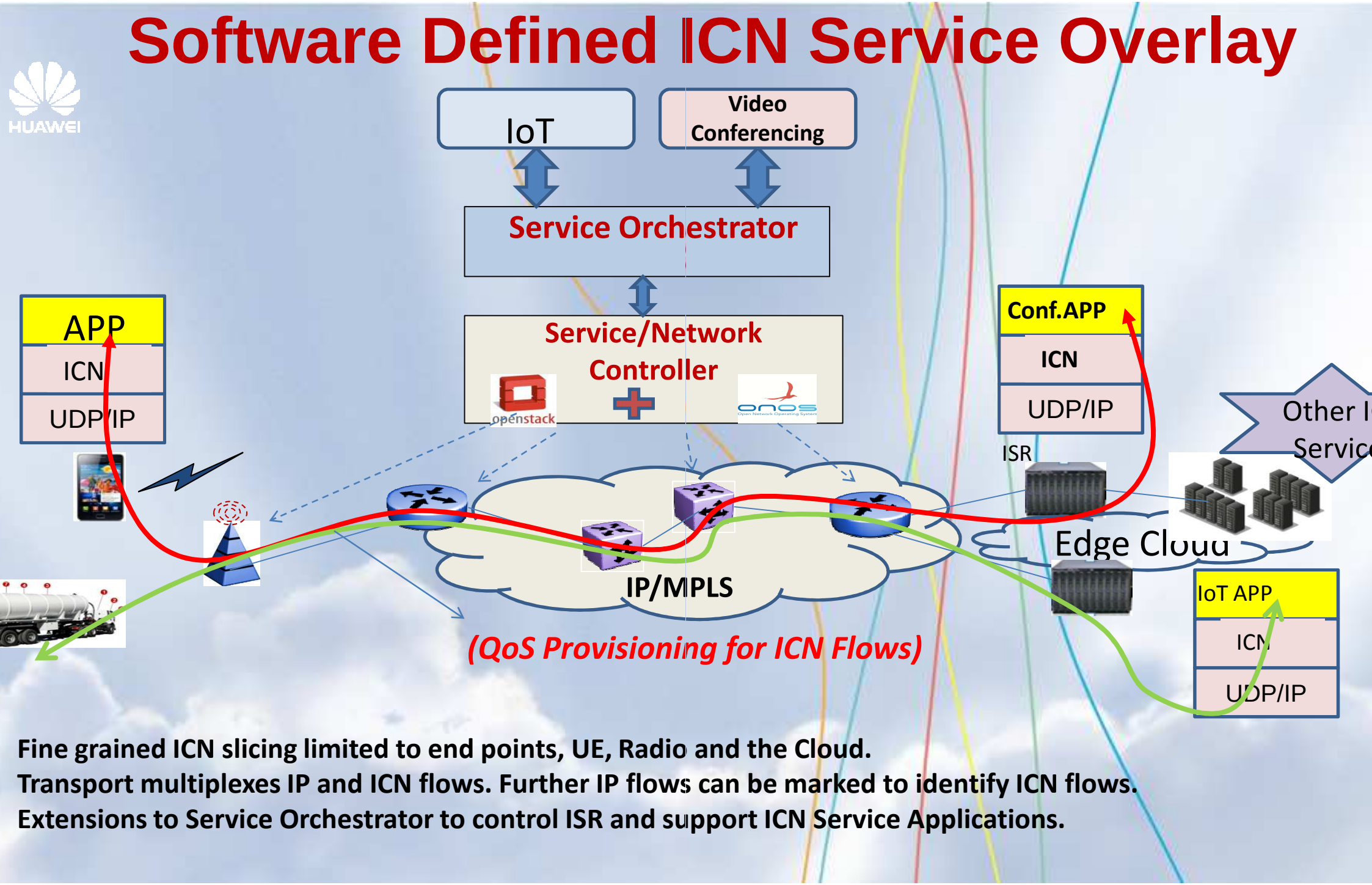


End to end slicing results in ICN slice across multiple transport substrate (IP/L2)

Mobility for IoT applications handled by ICN.

Per-Hop ICN state allows granular QoS to ICN flows.

Software Defined ICN Service Overlay



Fine grained ICN slicing limited to end points, UE, Radio and the Cloud.
Transport multiplexes IP and ICN flows. Further IP flows can be marked to identify ICN flows.
Extensions to Service Orchestrator to control ISR and support ICN Service Applications.


5G-ICN Platform
- VSER Platform
- Services (Video/IoT)
- ICN Mobile Edge Service Delivery
- ONS Demo

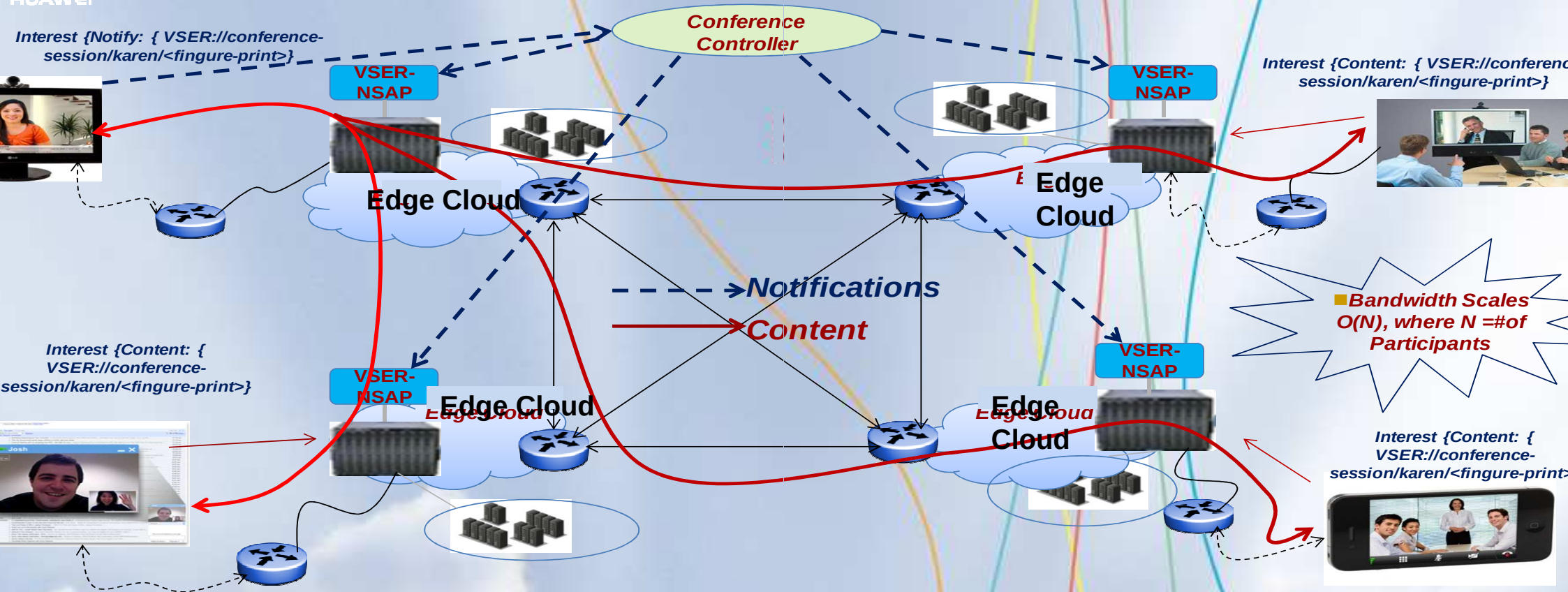
VSER Platform: Virtual Service Edge Router

VSER Platform Highlights

- COTS Platform
- ICN Service Virtualization
- ICN *Service Function* Life Cycle Orchestrat and Management (by OpenStack and Flooc
- ICN Based Service Function Chaining
- Service Discovery, Service Contextualizati over UE to VSER i/f
- PULL/PUSH, MP-to-MP communication
- Unified control functions interworking wi SDN/NFV
- Optimized software stack using Multi-thre CCNx forwarders

akraborti, Ravi Ravindran et al, " **A Scalable Conferencing framework over ICN Based VSER Platform**", ICN, Sigcomm, 2015
avindran et al, "**Towards Software Defined ICN Based Edge Cloud Services**" IEEE, CloudNet, 2013
bifard, R. Ravindran et al, "**An Information Centric Networking Approach Towards Contextualized Edge Service** ", IEEE, CCNC, 2015

erverless Scalable Audio-Video Conferencing over VSER



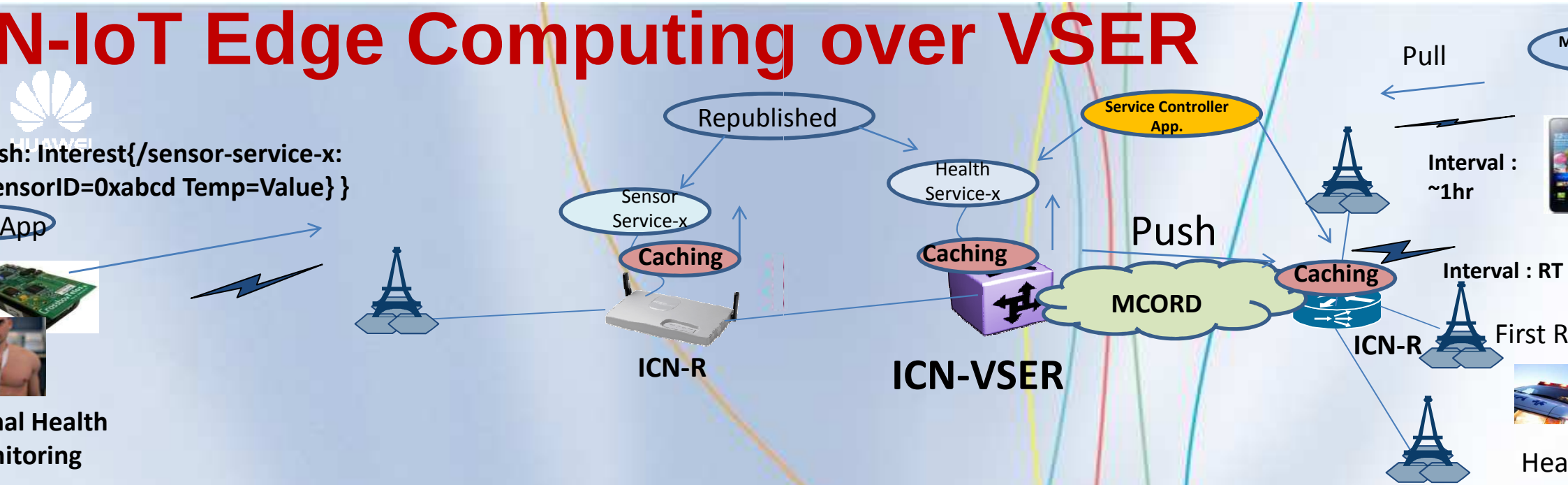
onference Controller Functions

- Enable MP-2-MP Connectivity
- Conference Level Virtualization : ***Multiple Simultaneous Conferences , Service Scaling, Dynamic Name Based Routing, Conference Monitoring and Management.***
- Context level Adaptation

akraborti, Ravi Ravindran et al, "**ICN Based Scalable Audio/Video Conferencing over Virtual Service Edge Router (VSER) Platform** " ICN Sigcomm, 2015

ngam, Ravi Ravindran et al, "**Realtime Multi-Party Video Conferencing Service over Information-Centric Network**", Workshop on Mutimedia Streaming in ICN (MuSIC), 2

N-IoT Edge Computing over VSER



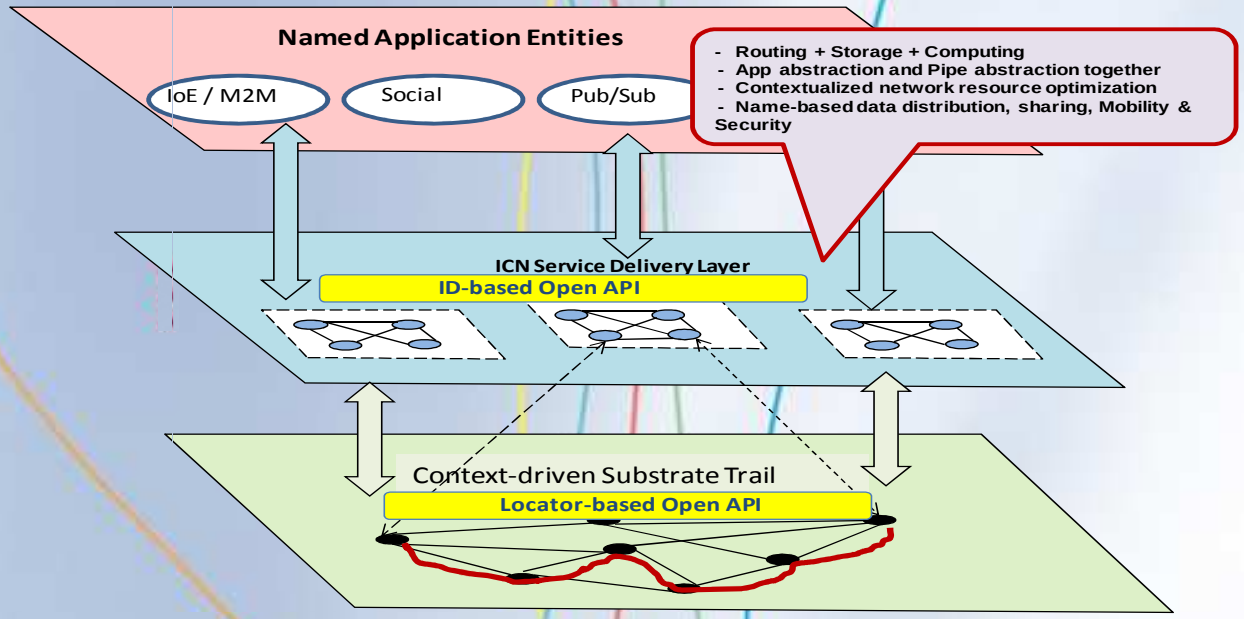
- ICN based IoT enables Self Configuring systems [1].
- ICN Allows Push/Pull simultaneous mode, Cache improves Scalability + Reliability of the system
- Here consumers need to be notified based on their varying criticality
  - E.g. User/First-Responder/Healthcare Provider
- Less critical consumers can rely on cache while more critical consumers rely on notification.
- Notifications lost cannot be reproduced, cache helps from this perspective too.
- Increases the Scalability + Reliability of the IoT system.

S., Zhang, Y., Raychaudhuri, D., Ravindran, R., Zheng, Q., Wang, GQ., and L. Dong, "**IoT Middleware over Information-Centric Network**",
l Communications Conference (GLOBECOM) ICN Workshop, 2015.

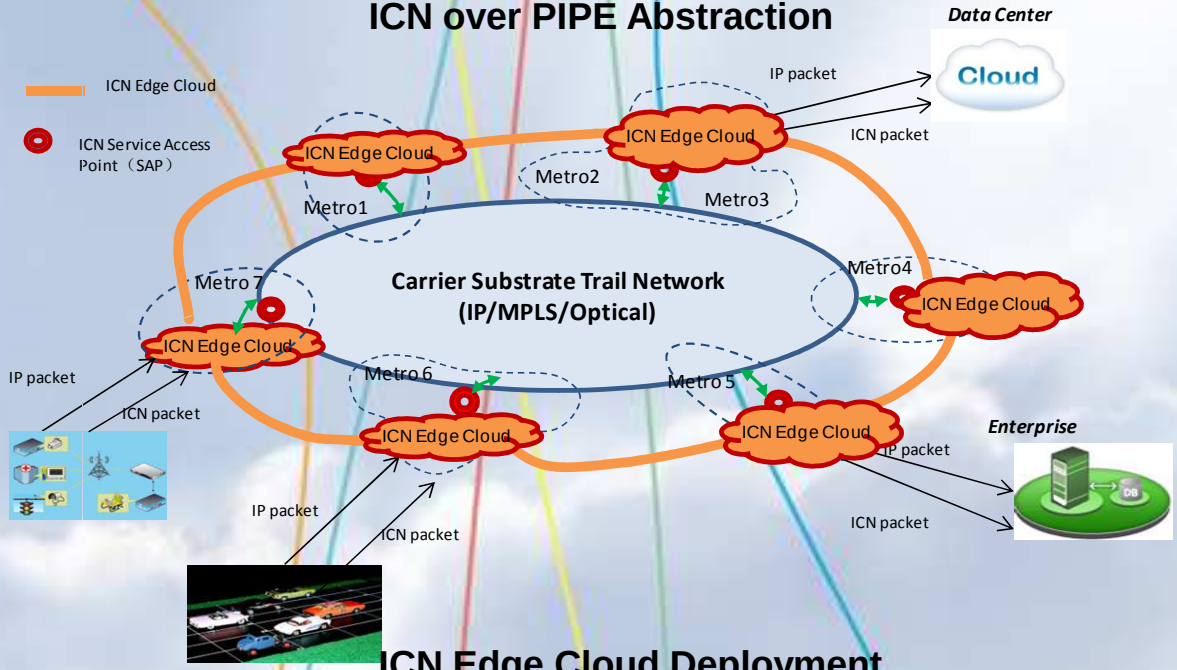
Mobile Edge Service for Operators

obile Edge Cloud Services

- Virtualized CO
- Open Service APIs
- Contextualized Service Delivery
- Network-as-a-DataCenter
- Smart Pipe & Better policing, and QoS
- Access-Service to Service-access
- Seamless Service Mobility
- Scale backbone
- Simplified network architecture

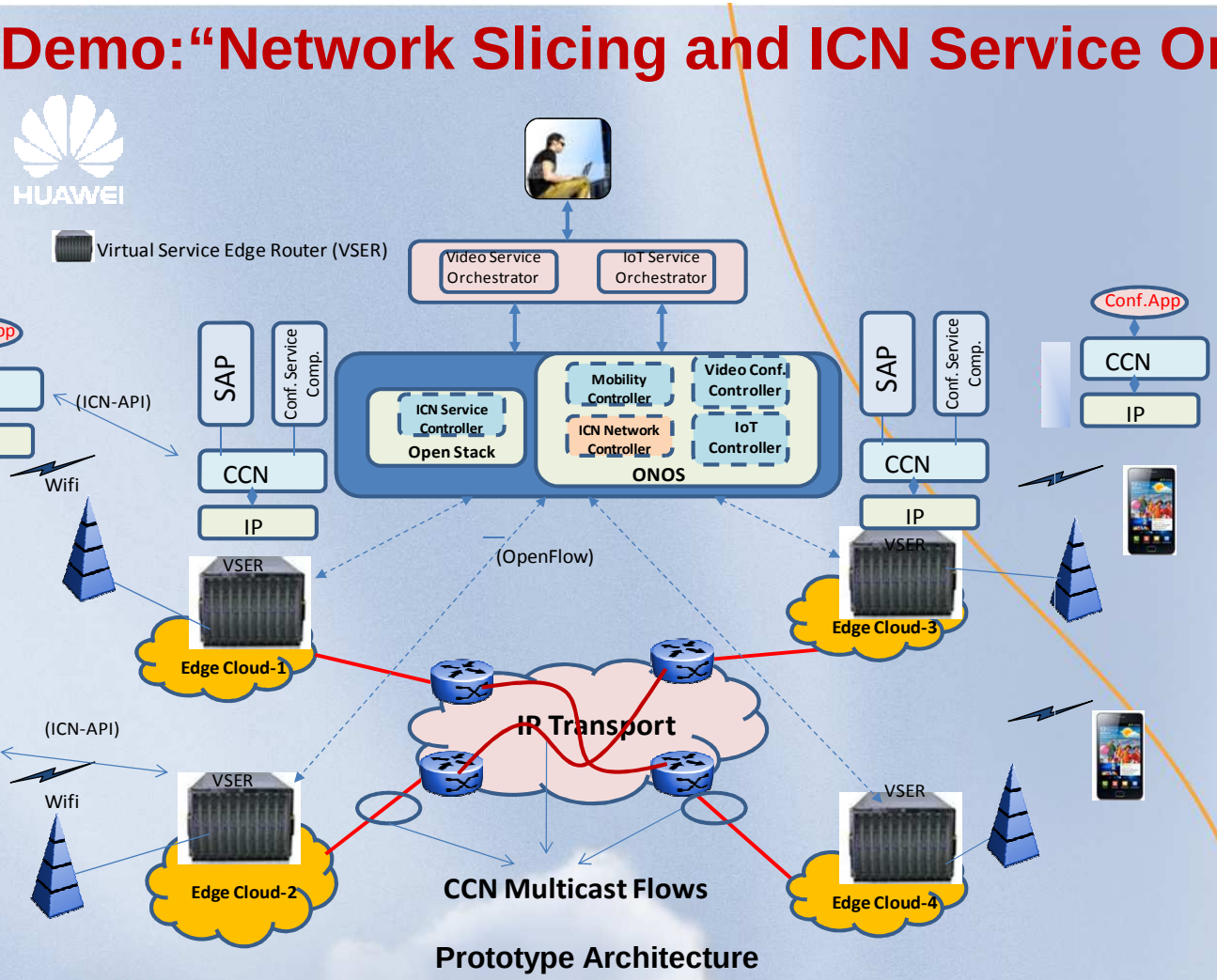


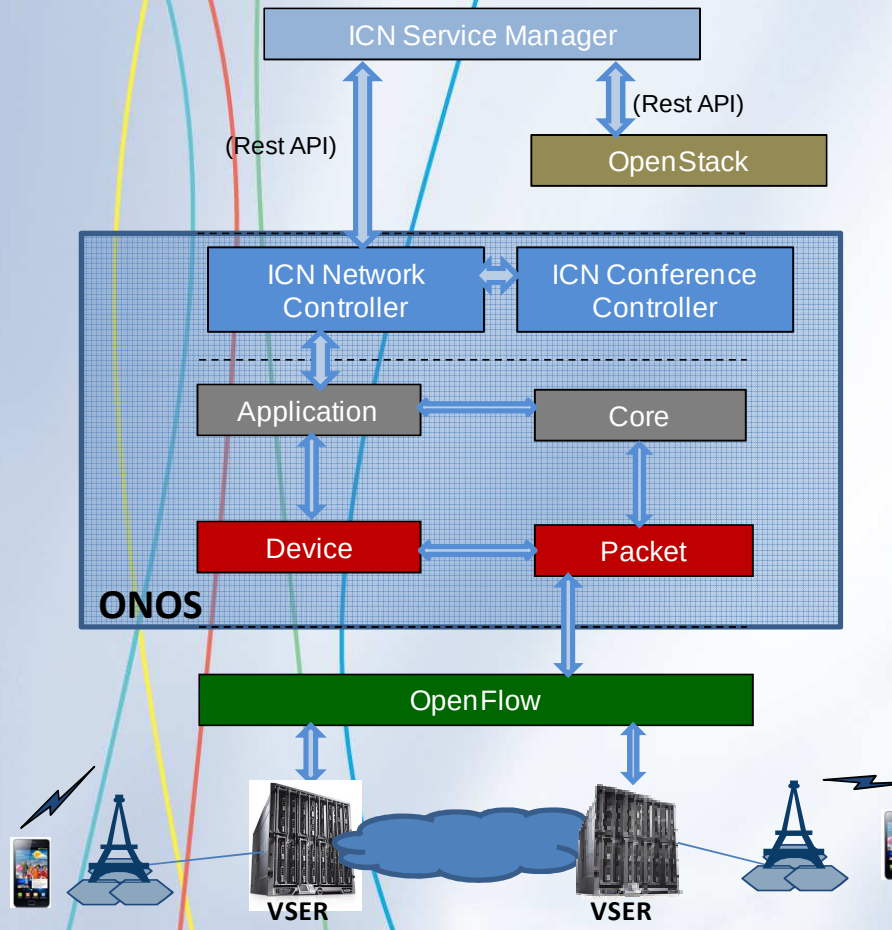
ICN over PIPE Abstraction



ICN Edge Cloud Deployment

Demo:“Network Slicing and ICN Service Orchestration for Future Applicati





nd-to-end orchestration of ICN based Video Conferencing Service

rogrammable CCN layer with OS and ONOS

– **Conf. Service discovery, Service Function Placement, CCN FIB configuration to bootstrap participant join/leave etc.**

pplication-independent multicasting feature which CCN enables in the backbone of the network.

Summary

- Future 5G target architecture is based on top-down service-oriented networking objectives.
- ICN provides a good application abstraction based networkin layer to meet ADN & 5G objectives
- 5G-ICN networking enables in-network mobility, security, caching, computing desirable by applications.
- Network Slicing in 5G allows new network architectures such as ICN to deliver services and to utilize resources efficiently.
- ICN based Mobile Edge Cloud Services is a immediate benefit to operators.

Thank you