The Fifth Generation Mobile Communications Promotion Forum (5GMF)

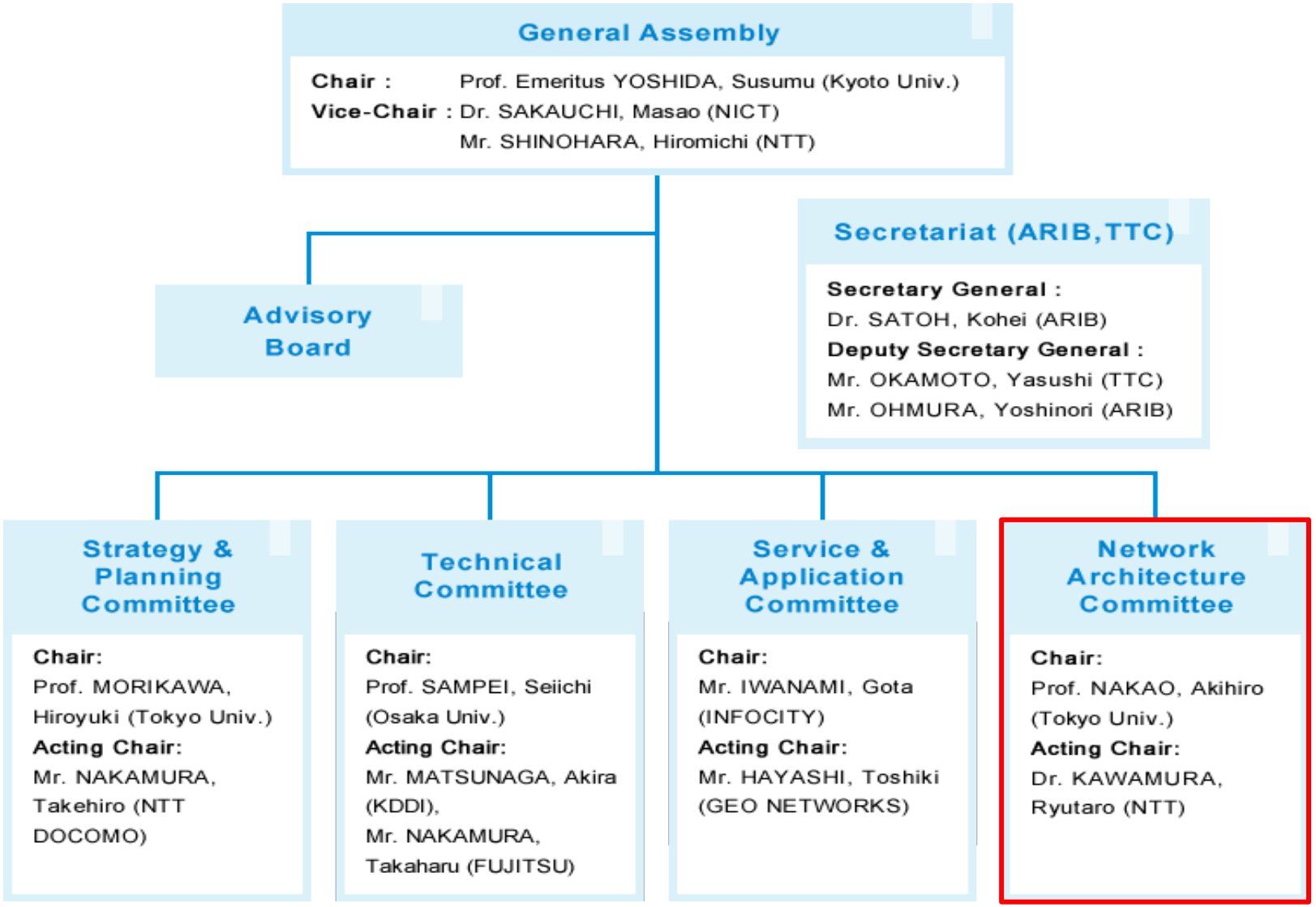
Networking Technologies for 5G

Network Architecture Committee
5GMF

Contents

1.Mission of the network architecture committee

Organizational Structure of the 5GMF



Network architecture committee

Network Architecture Committee

Chairman
Akihiro Nakao, Tokyo Univ.

Acting chairman
Ryutaro Kawamura, NTT

Mission

- ✓ Study overall network architecture for 5G mobile
- ✓ Study requirements and technologies for network infrastructure

Deliverable

- ◆ Networking technology roadmap
- ◆ White paper detailing on networking technology for 5G

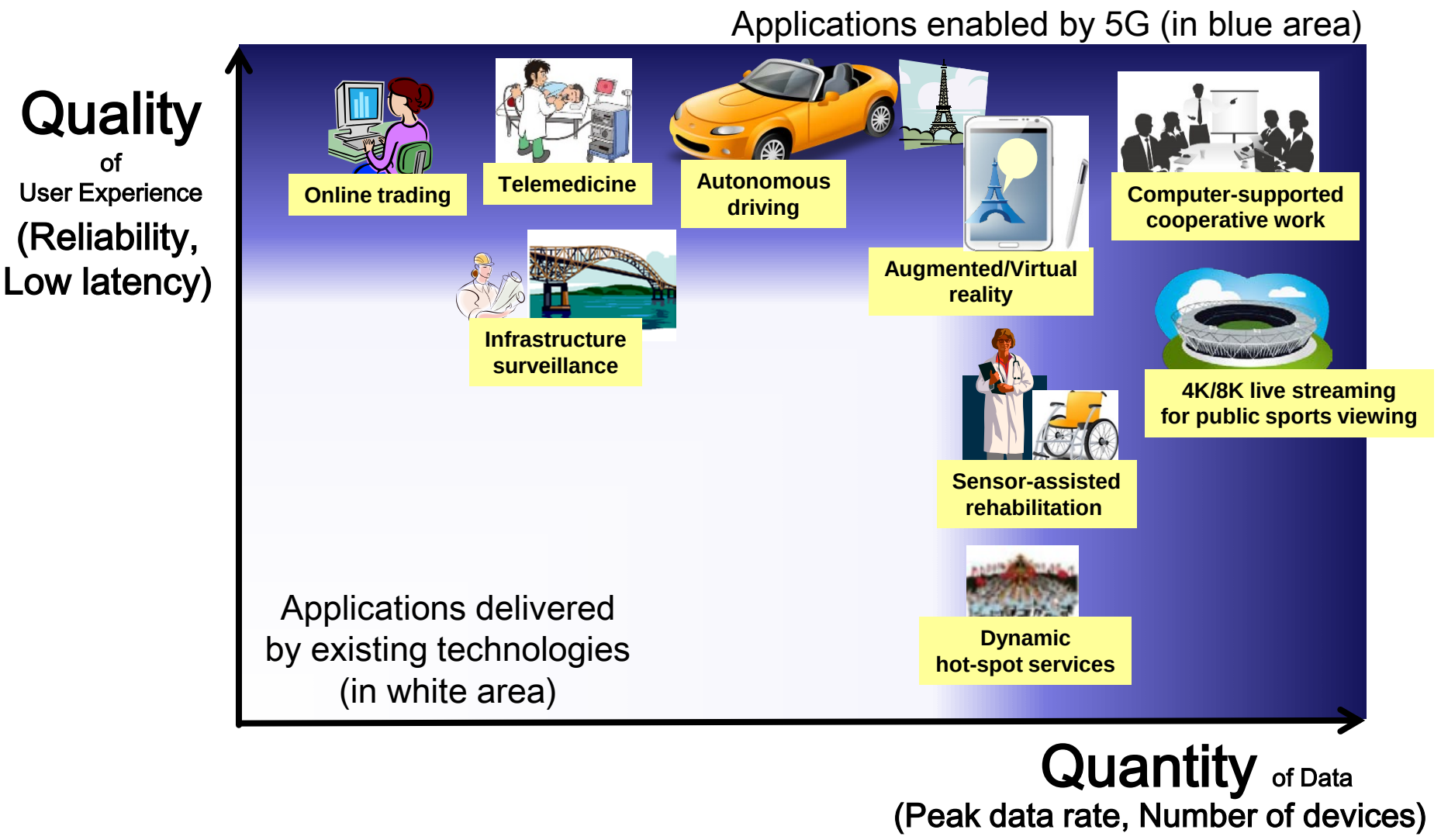
Strategy Working Group

Chair
Ryutaro Kawamura, NTT

The working group for facilitating discussions

2.Market trends

Potential applications enabled by 5G



3.Scenarios towards 5G

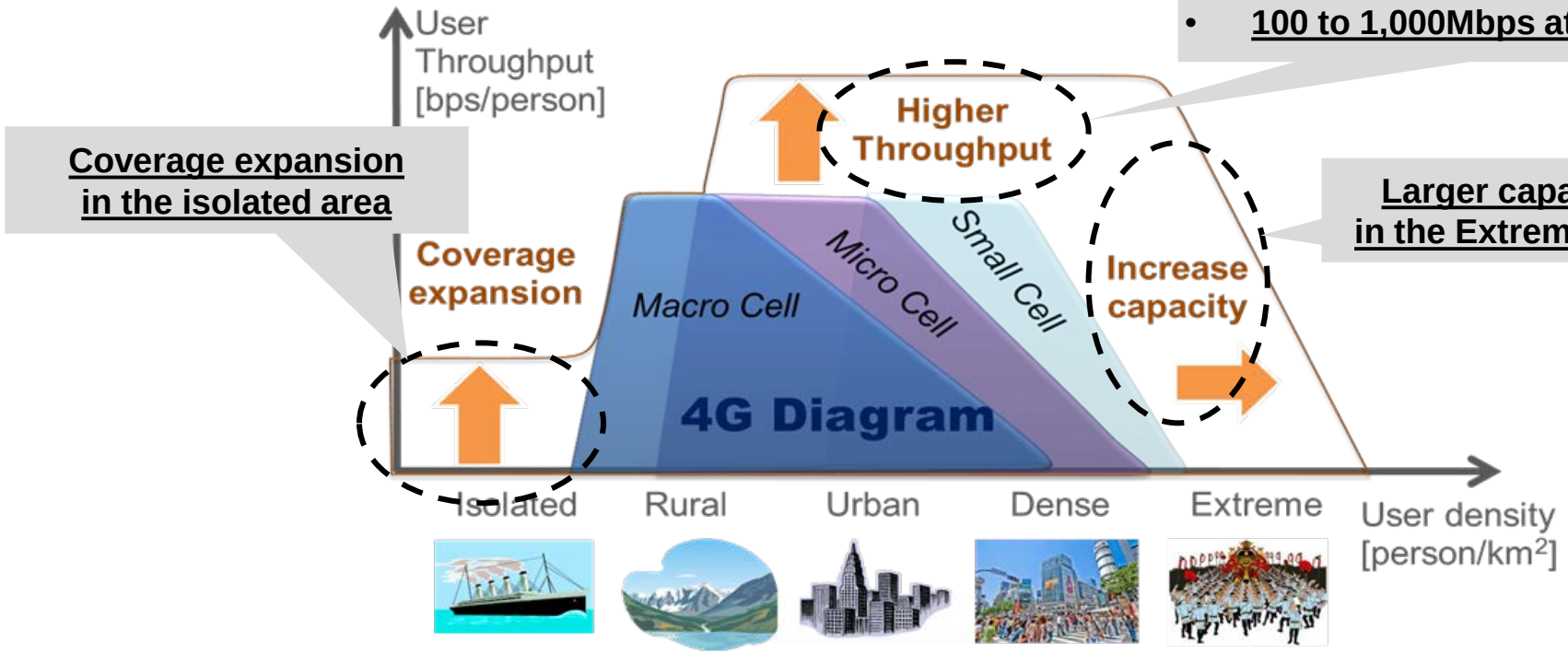
Based on pre-studies on
future mobile networking by
the Telecommunication Technology Committee (TTC) in Japan

Technological issues to consider

◆ Increase of data traffic on mobile communications

- ➢ Expanding coverage
- ➢ Enlarging user throughput
- ➢ Increasing capacity
- ➢ Accommodating large traffic fluctuation

- around 10Gpbs at peak
- 100 to 1,000Mbps at any given time



Requirements for future mobile communications(User density and throughput)

Technological issues to consider

◆Load increase in C-plane

- ➢ **Advancement of diversified types of service such as IoT/M2M**

◆Ultra low latency

- ➢ **Provision of new services requiring real-time performance**
  - **Real-time control for tactile communication, AR, M2M**

◆Ultra energy(electric power) saving

- ➢ **Expansion of the number of links, equipment and capacity**

◆Ultra large-scale disaster/congestion/failure resilience

- ➢ **Responsibility of mobile networks as social infrastructure: needs for resilience, recovery, promptness etc.**

Proposal for introduction of 5G

The network side will need the capability to efficiently accommodate a greater variety of traffic and connect with a wide variety and huge number of M2M/IoT terminals.

Core NW: a new network architecture based on SDN/NFV technologies to efficiently accommodate multiple services and requirements.

Mobile front/backhaul: the appropriate layout of function for ultra large capacity as well as the enhancement of transmission technologies.

NW management: new SDN/NFV and virtualization technologies for scalable and flexible network management to deal with short-service life cycles.

4. Network requirements and the relevant component technologies

Based on pre-studies on
future mobile networking by
the Telecommunication Technology Committee (TTC) in Japan

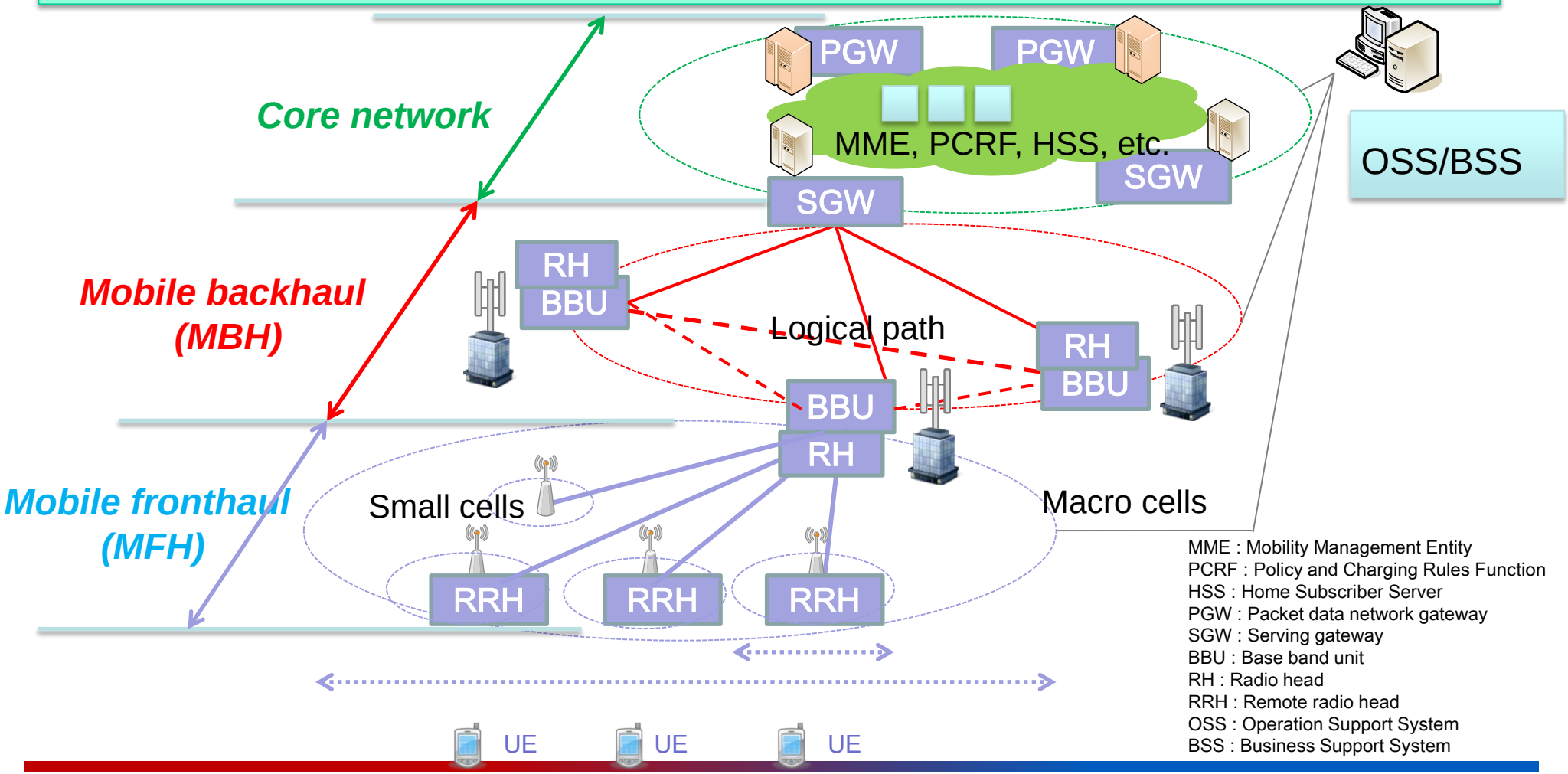
Requirements for 5G Network

5G networks will support various services including IoT/M2M, and will handle various types of traffic.

Requirements for 5G networks			**Related network capability**
traffic characteristics	traffic volume	low～high	transport capability
	burstiness	highly bursty ～non bursty	signaling capability
	traffic variation	-flat rate -depending on time	dynamic resource allocation
	latency	ms～ , N/A	placement of network functions (e.g. Mobile edge computing)
scalability	number of devices		transport capability, signaling capability
device characteristics	mobility	fixed, mobile (～500km/h)	network architecture (e.g. multiple RATs)
	power consumption		

Mobile network structure

Area structure breakdown in mobile network:
Core network, Mobile backhaul(MBH) and Mobile fronthaul(MFH)



MME : Mobility Management Entity
PCRF : Policy and Charging Rules Function
HSS : Home Subscriber Server
PGW : Packet data network gateway
SGW : Serving gateway
BBU : Base band unit
RH : Radio head
RRH : Remote radio head
OSS : Operation Support System
BSS : Business Support System

Relevant component technologies

■ Mapping of relevant component technologies to resolve technical issues (Summary)

Issues	Core network system technologies	SDN technologies	NFV technologies
Ultra large capacity U-plane		✓	✓
Load increase in C-plane	✓	✓	✓
Ultra low latency	✓		
Ultra large scale disaster/ congestion/failure resilience		✓	✓
Various types of terminal/ traffic/ operators and NW mgt.	✓	✓	✓
Inter-working with other RATs	✓		✓
Issues on transport layer	✓		

✓ relevant component technologies to resolve technical issues

Relevant component technologies

■ Mobile backhaul

Issues		New technologies				
		Frame processing	Space division multiplexing	Wave length multiplexing	NW power saving	NW optimization
Ultra large capacity U-plane	N-times extension		✓	✓		
	Cost increase	✓				✓
Ultra low latency						✓
Ultra power saving	Power consumption increase by N-times	✓			✓	
	Wasted power				✓	✓

Relevant component technologies

■ Mobile fronthaul

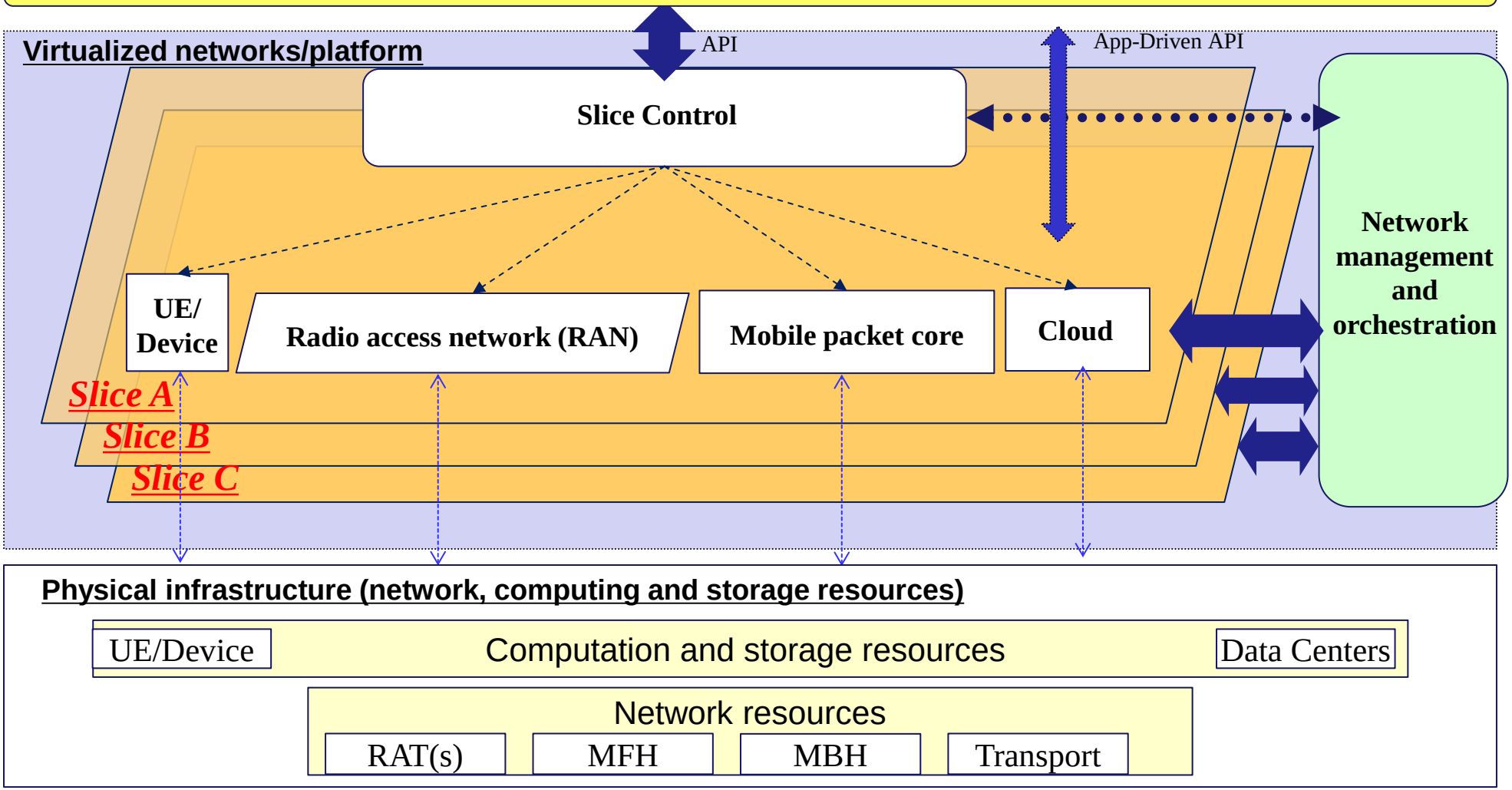
Issues		C-RAN transmission	Data compression	TDM-PON	Modulation	Space division multiplexing	Wavelength multiplexing	NW power saving
Ultra large capacity U-plane	N-times extension	✓	✓		✓	✓	✓	
	Cost increase	✓	✓	✓	✓			
Ultra low latency								
Ultra power saving								✓
Ultra large scale disaster/ congestion/failure resiliences		✓						

5.Comprehensive architecture of 5G mobile networks

Network Softwarization view of 5G mobile

Goal : End-to-End Quality and Extreme Flexibility to Accommodate Various Applications

Applications & Services with various requirements (M2M/IoT, Content delivery, Tactile)



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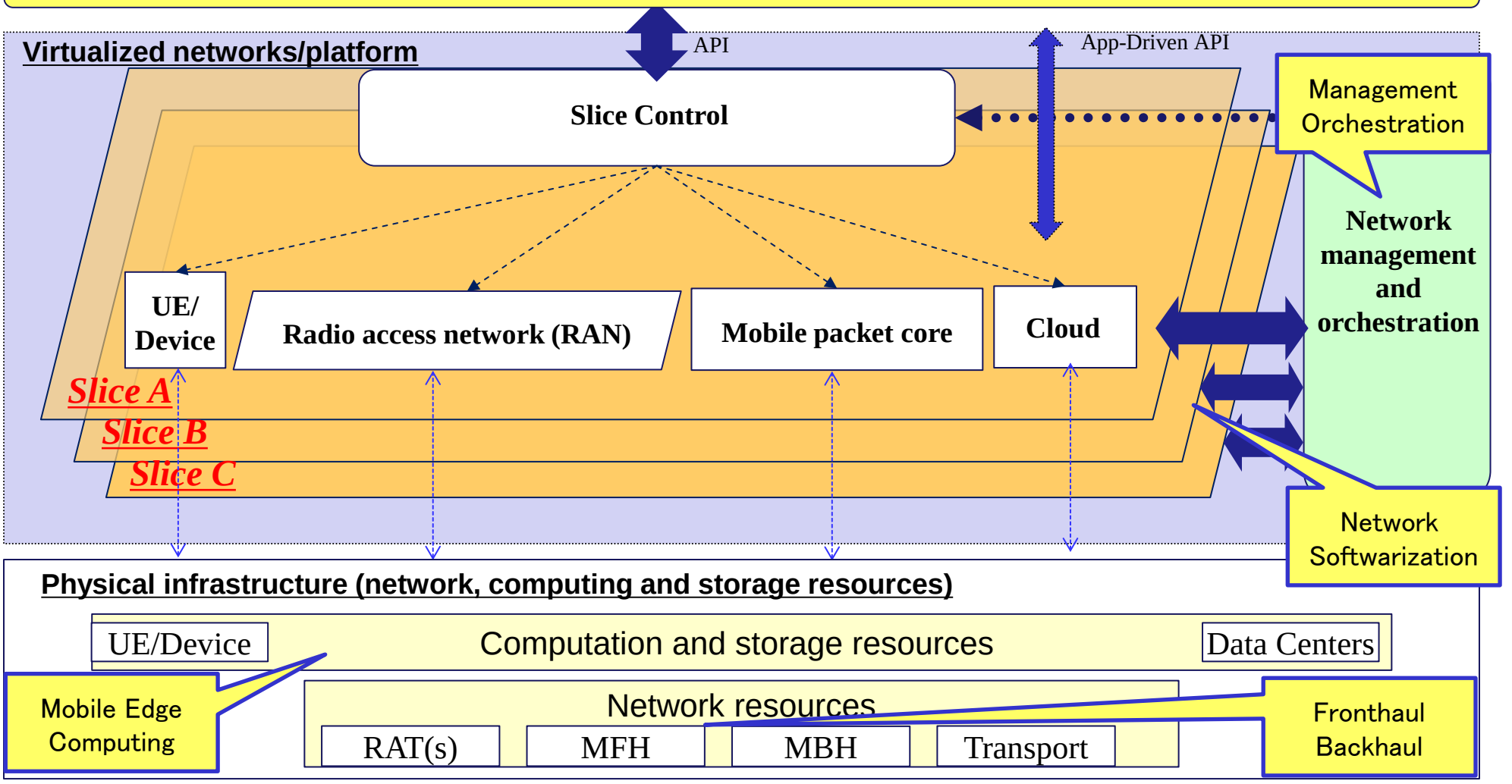
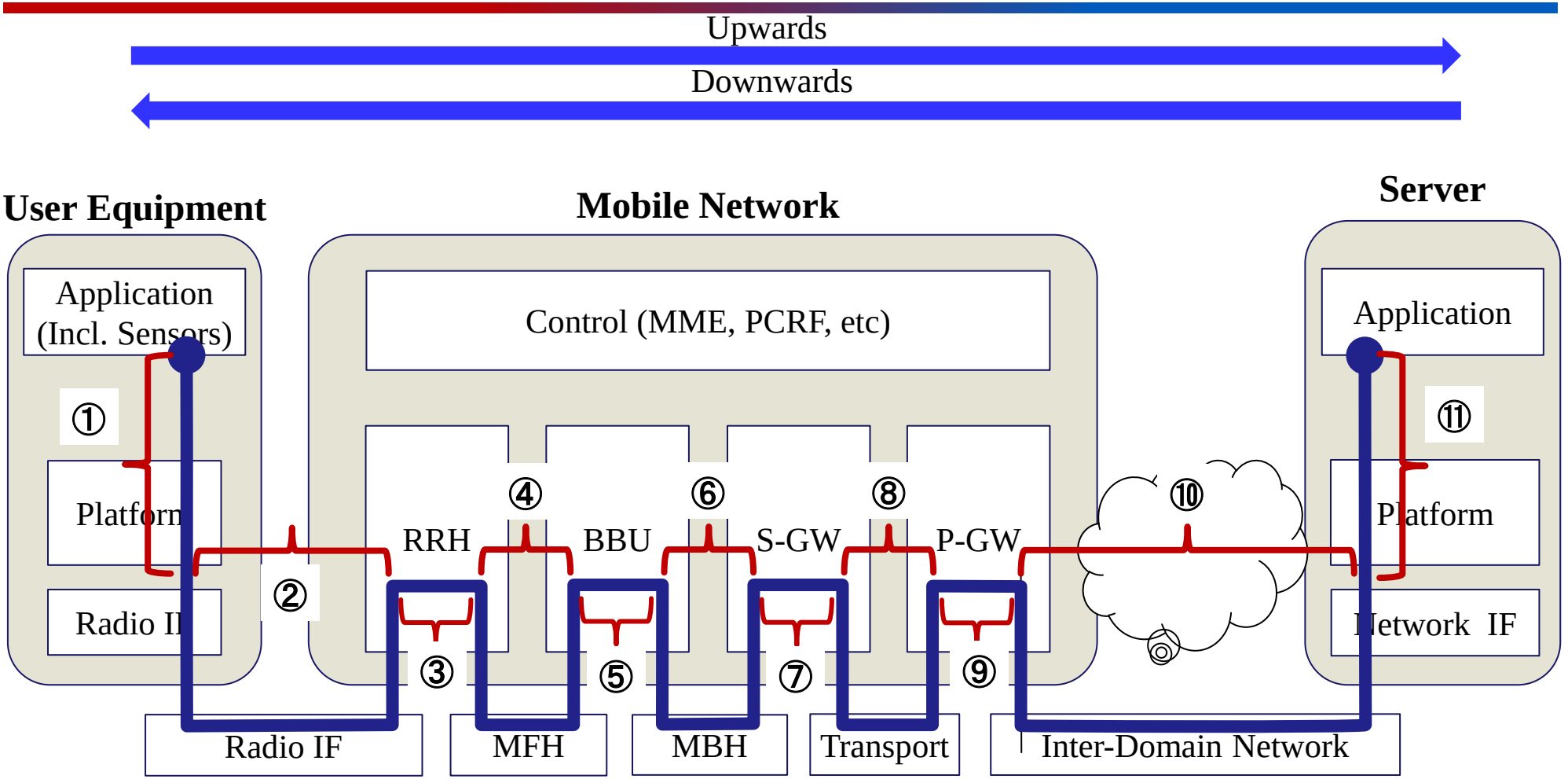


E2E Delay Breakdown



RRH (Remote Radio Head)
BBU (Base Band Unit)
S-GW (Serving Gateway)
P-GW (Packet Data Network Gateway)

MFH (Mobile FrontHaul)
MBH (Mobile BackHaul)
MME (Mobility Management Entity)
PCRF (Policy and Charging Rule Function)

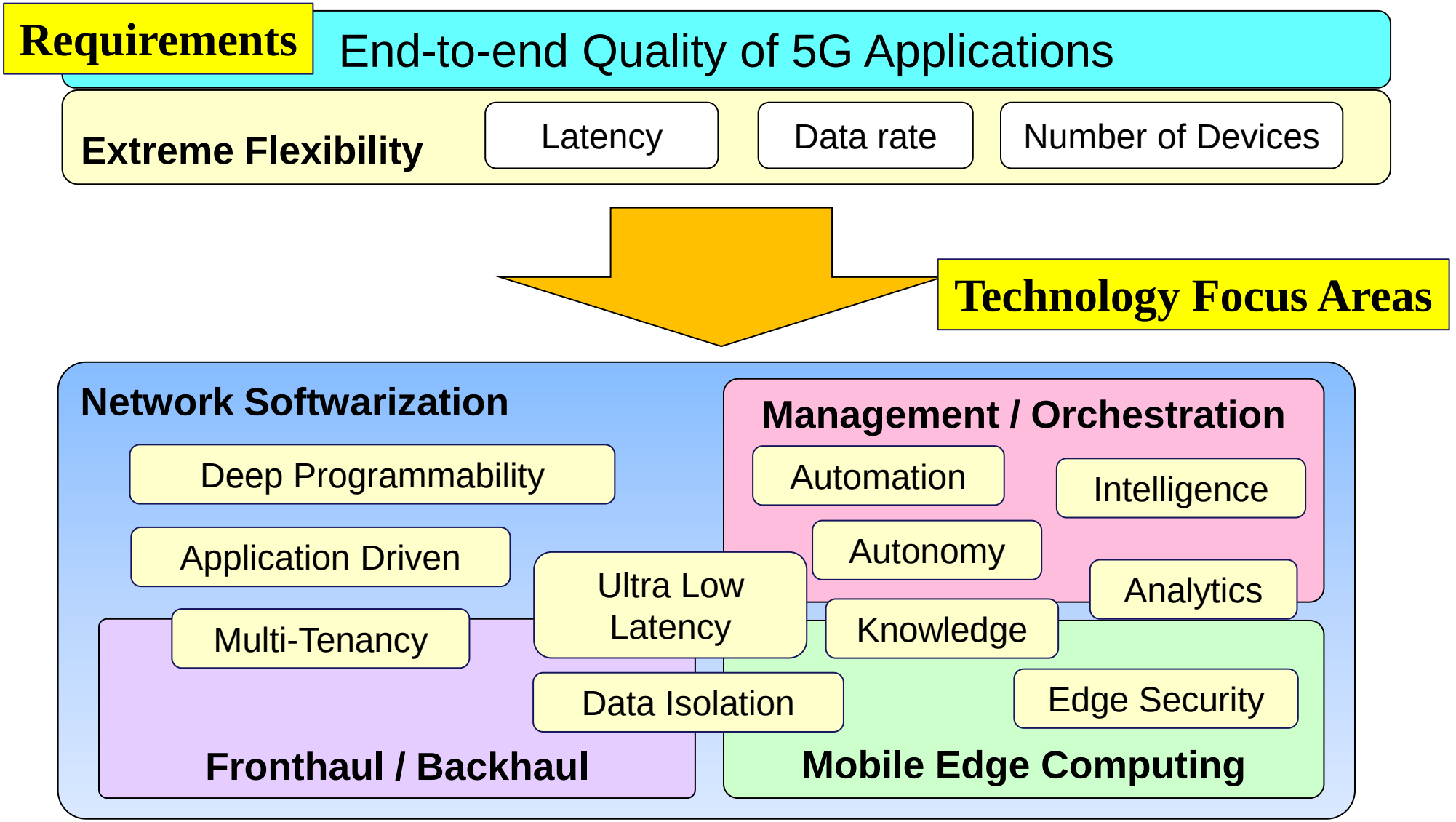
②+③+④+⑤<= 1ms（Oneway）

Description of each segment

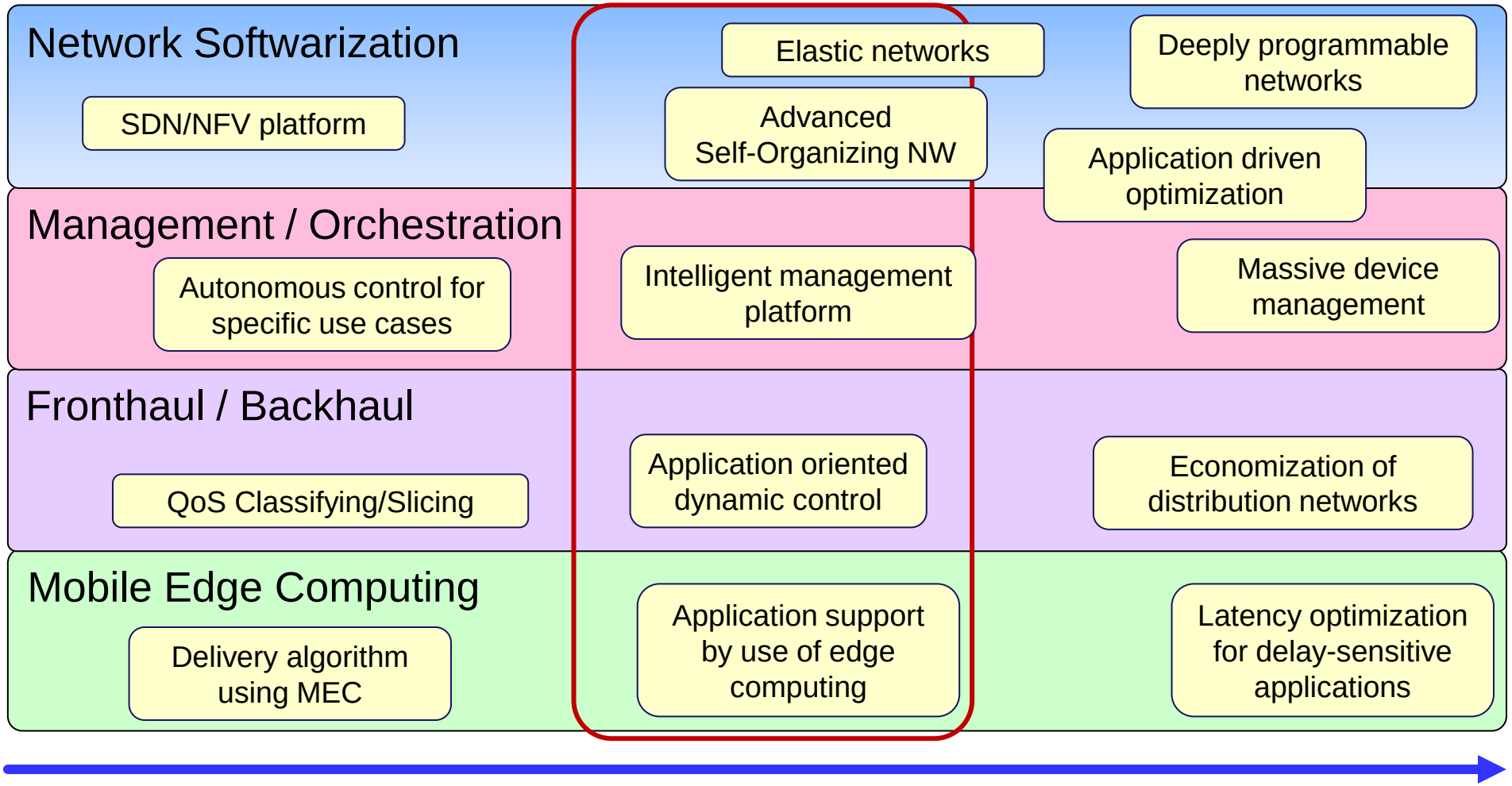
①UE Processing Delay
②Air Interface Delay
③RRH Processing Delay
④Fronthaul Transmission Delay
⑤BBU Processing Delay
⑥Backhaul Transmission Delay
⑦S-GW Processing Delay
⑧Transport Network Delay
⑨P-GW Processing Delay
⑩Inter-Domain Network Delay
⑪Server Processing Delay

6.Technology roadmap toward 5G mobile networks

Technology roadmap: Focus Area



Technology roadmap: Timeline



Detailed topics in each focus area

Network Softwarization	Extremely flexible networks that support e2e services with diversified requirements
Management / Orchestration	1) Management and orchestration for intelligent mobile networks
	2) Application driven network control and management
	3) Management evolution for application handlings in 5G networks
Fronthaul / Backhaul	1) QoS classify/slicing using virtualization technologies for high density transmission
	2) Dynamic control of NW resources and path optimization according to applications and traffic amount
	3) Economization and low latency using PON technologies Downsizing and cost reduction of optical devices
Mobile Edge Computing	Support of delay-sensitive services & applications

Network Softwarization

Scope

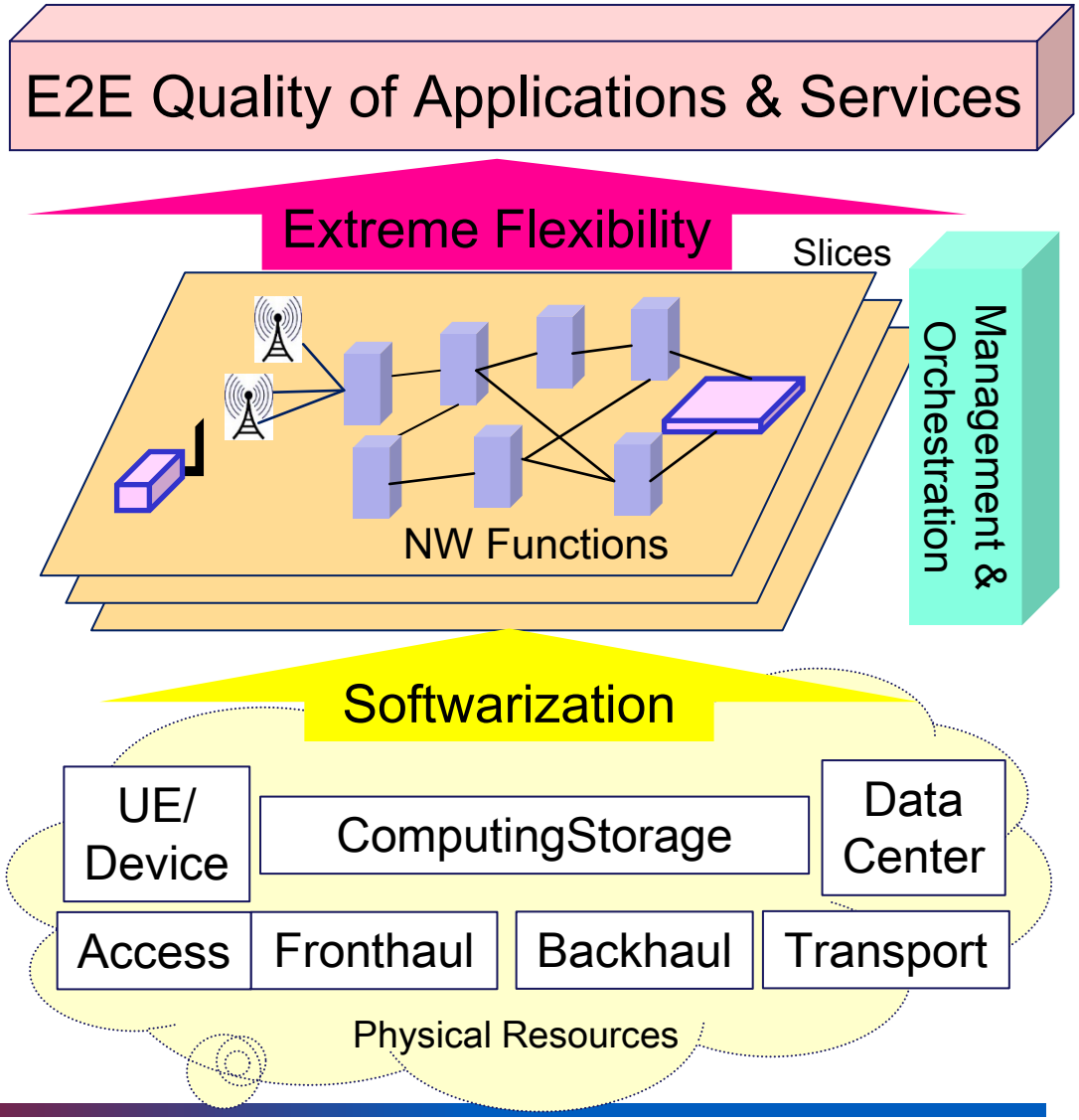
Extremely flexible networks that support e2e services with diversified requirements

Challenges

- Allow combinations of any network functions (e.g., Access, MFH/MBH, transport and others)
- Optimize CAPEX with prompt delivery of new services.
- Reduced OPEX with scalable operation.

Approaches

1. Facilitate softwarization by abstraction and Programmable API definitions
2. Achieve simplified workflows to allow prompt delivery of services
3. Design scalable management architectures to avoid complex data management



1) Management and Orchestration for Intelligent mobile network

Scope

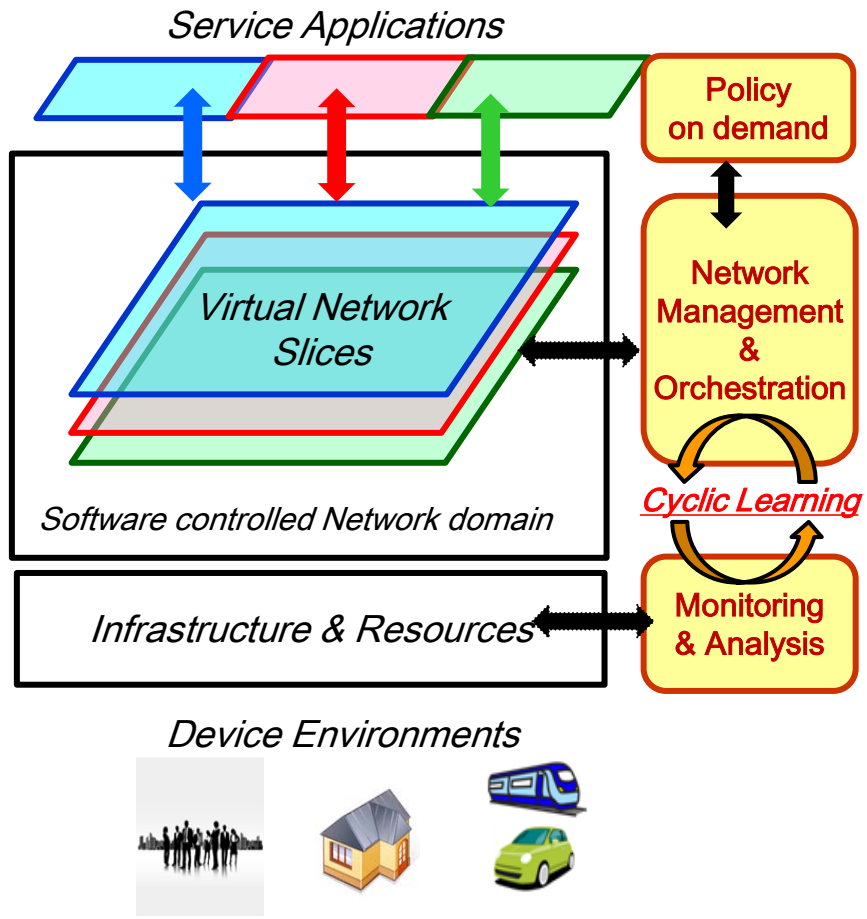
Comprehensive management and orchestration for intelligent network driving

Challenges

- Flexible, scalable and dynamic network building
- Capability and suitable QoE provision for diverse service requirements
- Autonomous network organization with intelligence

Approaches

- Organization and optimization of the virtual network slices and network resources
- Capability of demand based policy execution
- Deep learning with autonomous analysis



2) Application driven network control and management

Scope

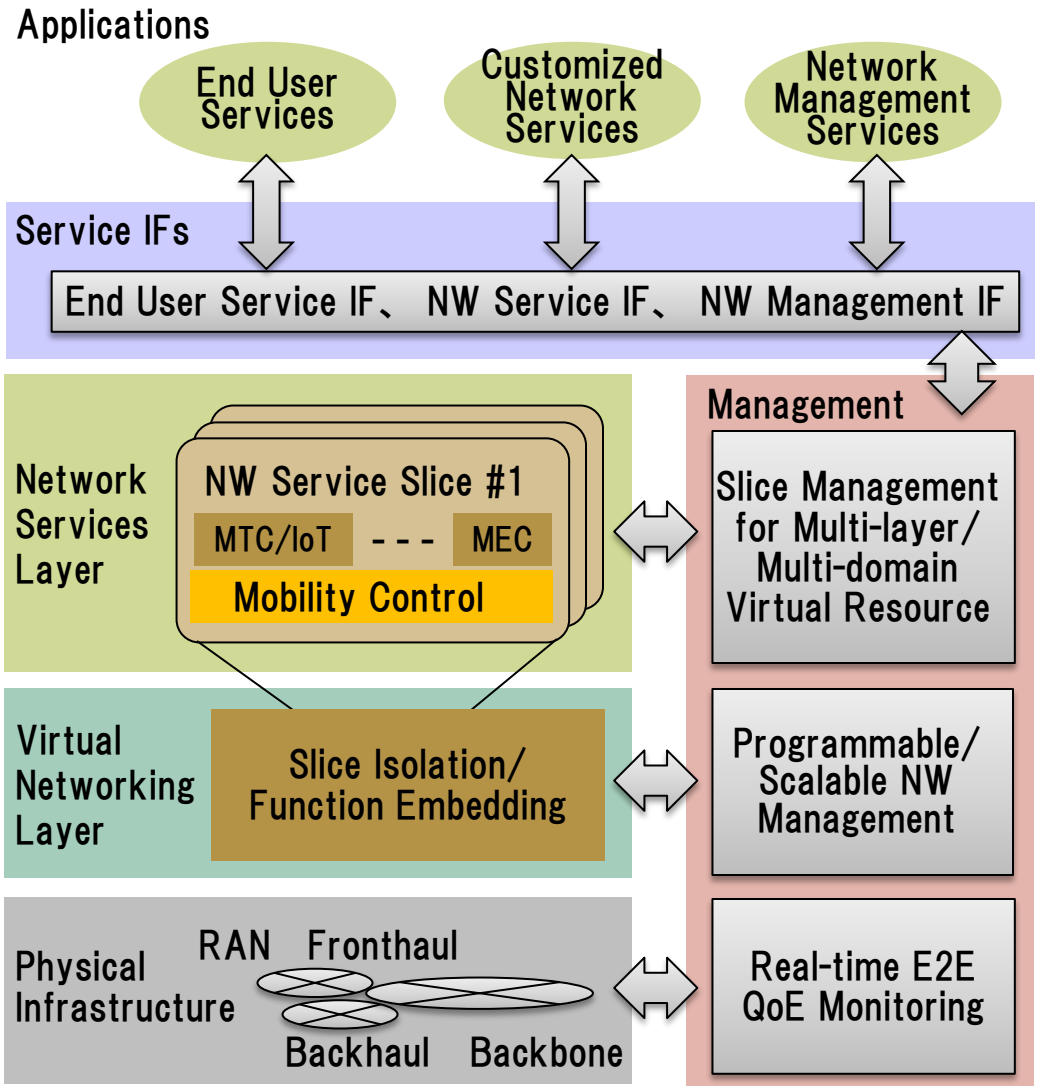
Application-driven and programmable network

Challenges

- On demand application-driven configuration
- Data processing network for MTC/IoT
- Complex virtual network management
- End-to-end experience quality management

Approaches

- User service, network customization, and network management APIs for configuration
- Dynamic slice network management for multi-layer and multi-domain mobile network
- Programmable and Scalable OAM for complex virtual network and huge management data
- Real-time E2E quality monitoring, analysis, visualization and control for application



3) Management evolution for application handlings in 5G networks

Scope

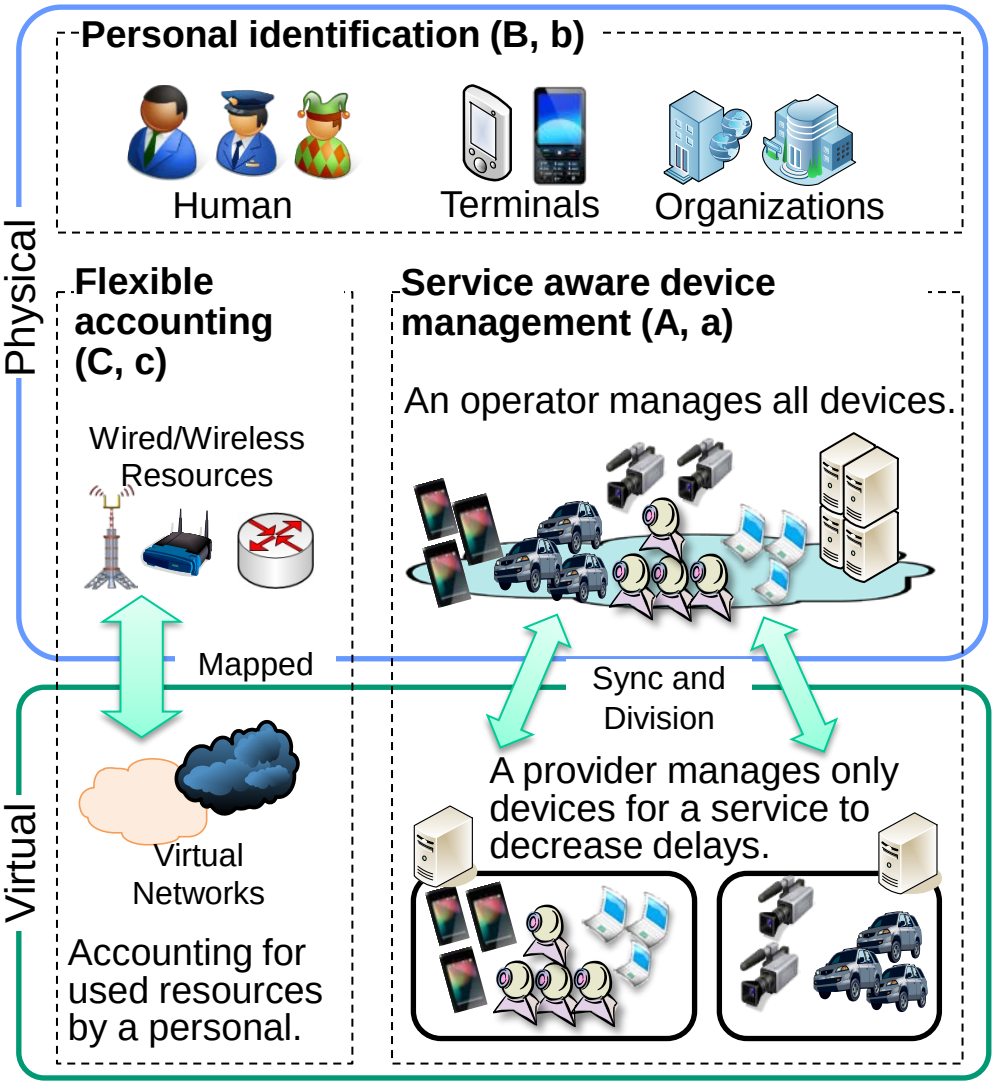
Realization of intelligence management scheme to handle 2020 period applications

Challenges

A) Manage over 50 billion services and devices on networks with short delay and per-service information isolation.
B) Identify personals (e.g. organization, human, device) as network function.
C) Non-contract based network for practical use of wired/wireless resources.

Approaches

- Research target (example)
  a. Service aware device management
  b. Personal identification
  c. Flexible accounting
- Based on 5G characteristics.
  (e.g. Virtualization, Softwarization)



Mobile fronthaul and backhaul

Scope

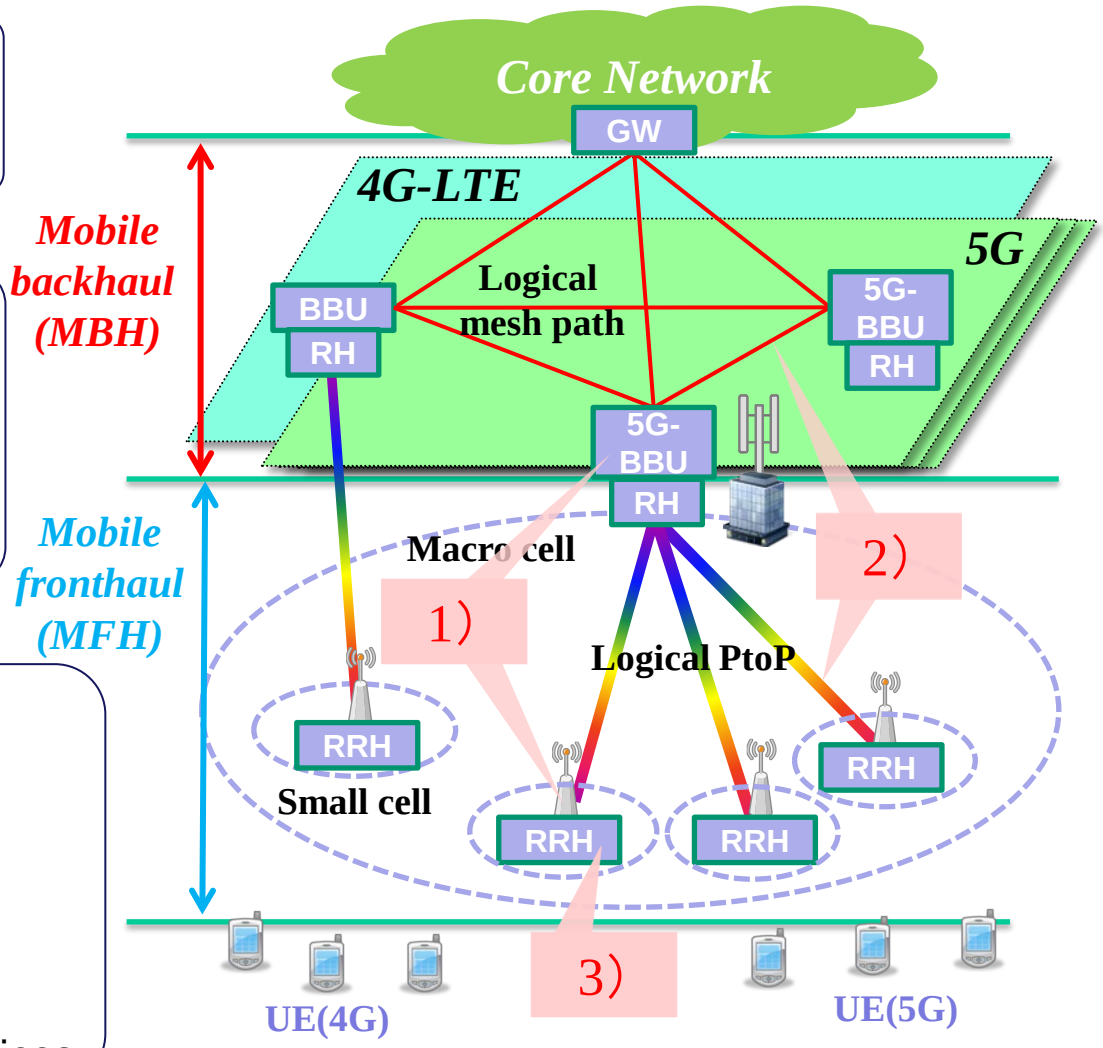
Dynamic resource control and QoS slicing to support diverse applications using virtualization and economization technologies

Challenges

- High density transmission systems
- Support for multiple generations RATs
- Realization of E2E QoS and Multi-tenancy service
- Low latency access
- Low power consumption, low cost systems

Approaches

1) QoS classify/slicing using virtualization technologies for high density transmission
2) Dynamic control of NW resources and path optimization according to applications and traffic amount
3) Economization and low latency using PON technologies
   Downsizing and cost reduction of optical devices



Mobile edge computing

Scope

Support of delay-sensitive services & applications

Challenges

- To deliver high quality contents in time for better user experiences
- To achieve end-to-end ultra-low latency to satisfy critical delay requirements

Approaches

- Information centric networks for in-time delivery of contents
- Use of local facilities: computing and storage resources in edge cloud
- Intelligent network control for delay minimization.