Programmable Real Time Networks

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Network Slicing – A Distinguishing Feature of 5G Wireless

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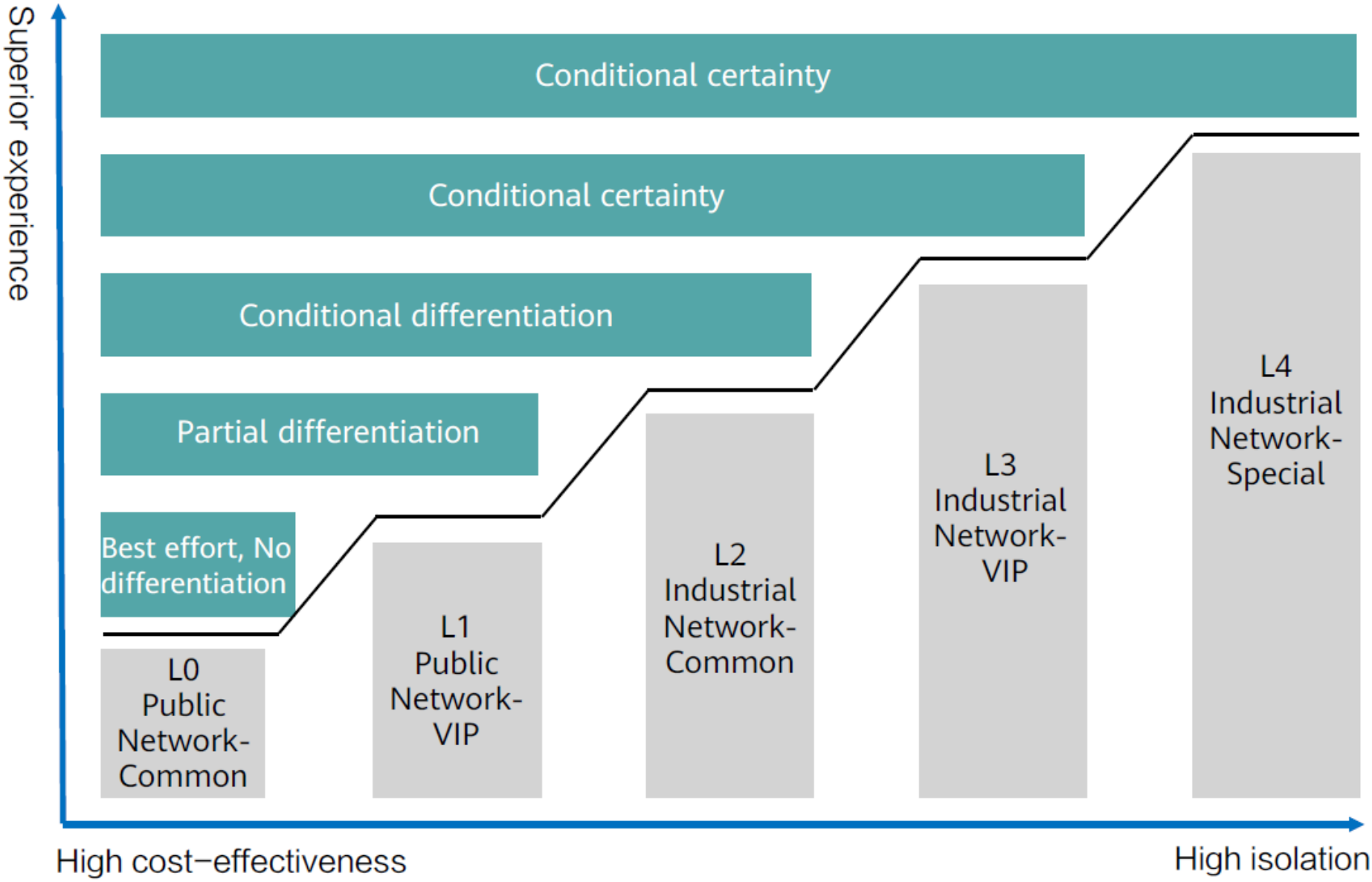
Network Slicing – A Distinguishing Feature of 5G Wireless

- Network Slicing Framework
- Cloud Based 5G Architecture
- Network Slicing Constituents
- Key Enablers
- Advances
- Concluding Remarks

Network Slicing – What is it?

- A logical (virtual) network customized to serve a Specific Application or Service
  - Support end-to-end resource management
- Capabilities Needed
  - Operate different network slices in parallel with isolation
  - Conform to service-specific security assurance requirements
  - Create, manage a network slice configuration via suitable Application Programming Interfaces (APIs)
  - Scalable in Capacity
  - Allow New network slice addition, update, deletion or Configuration Modifications

Slice Capability Levels

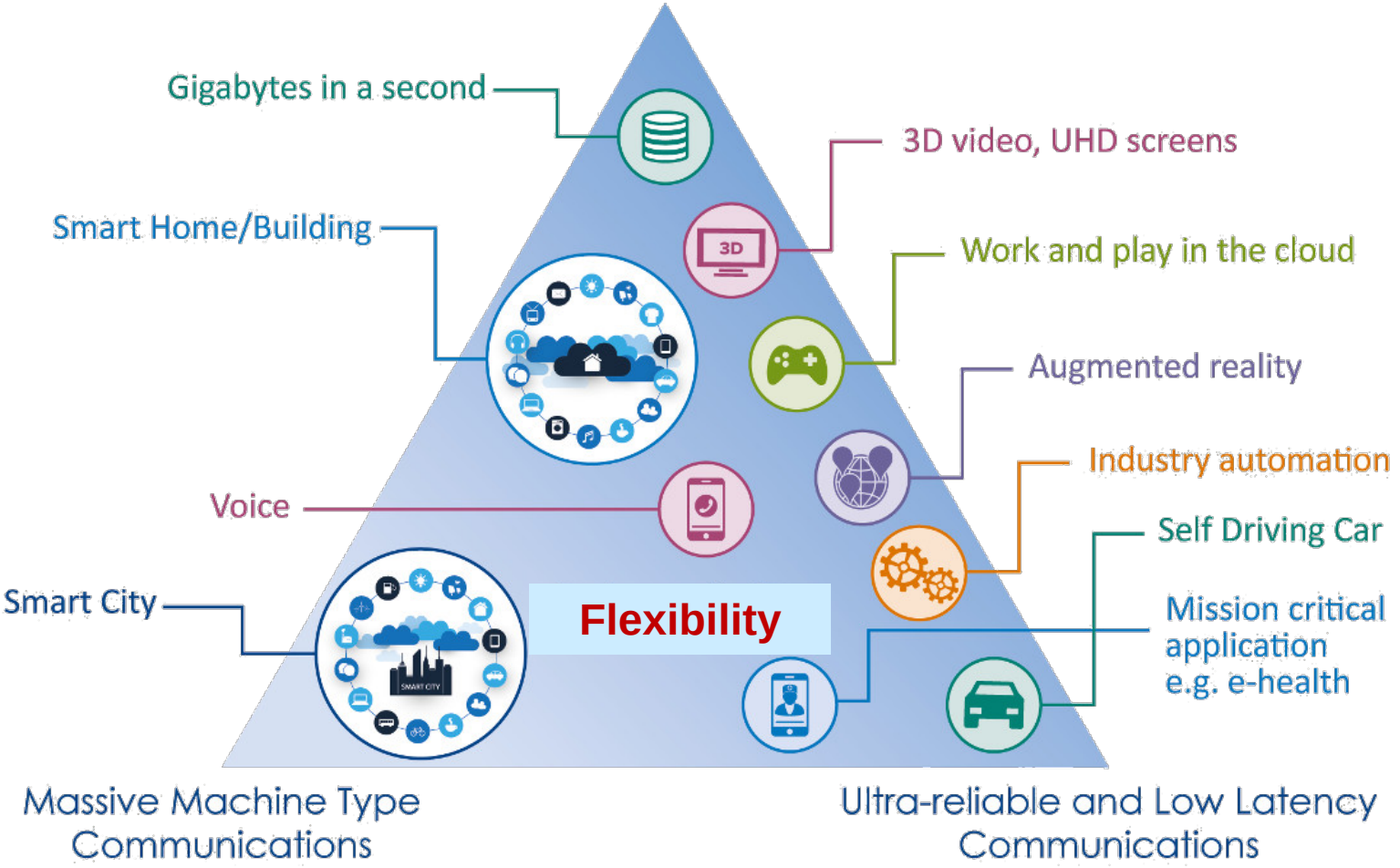


IoT Applications and 5G Offers

50 Mbps – 10 Gbps

eMBB

Enhanced Mobile Broadband



mMTC

10 M/Km²

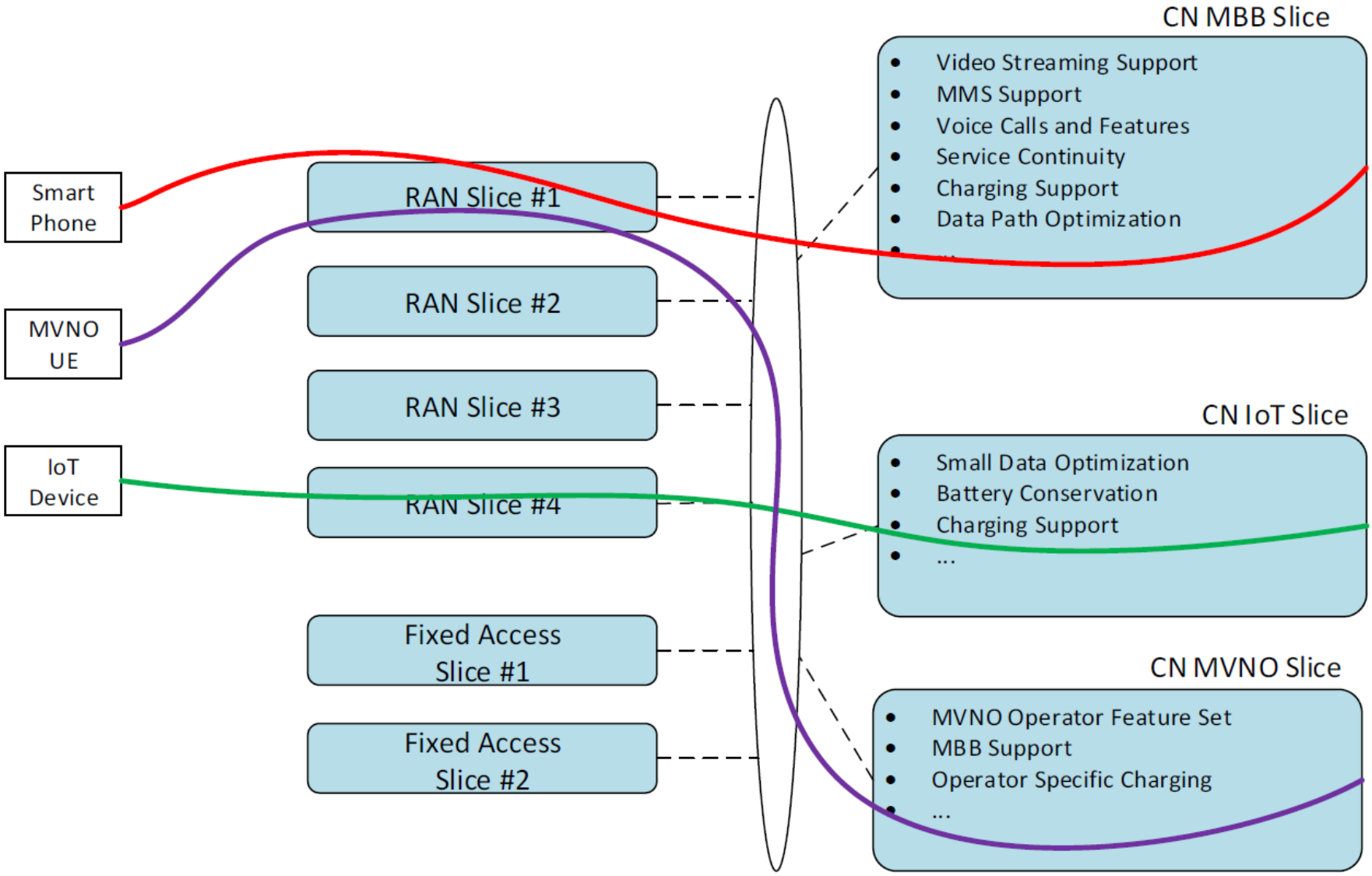
UR-LLC

1 ms

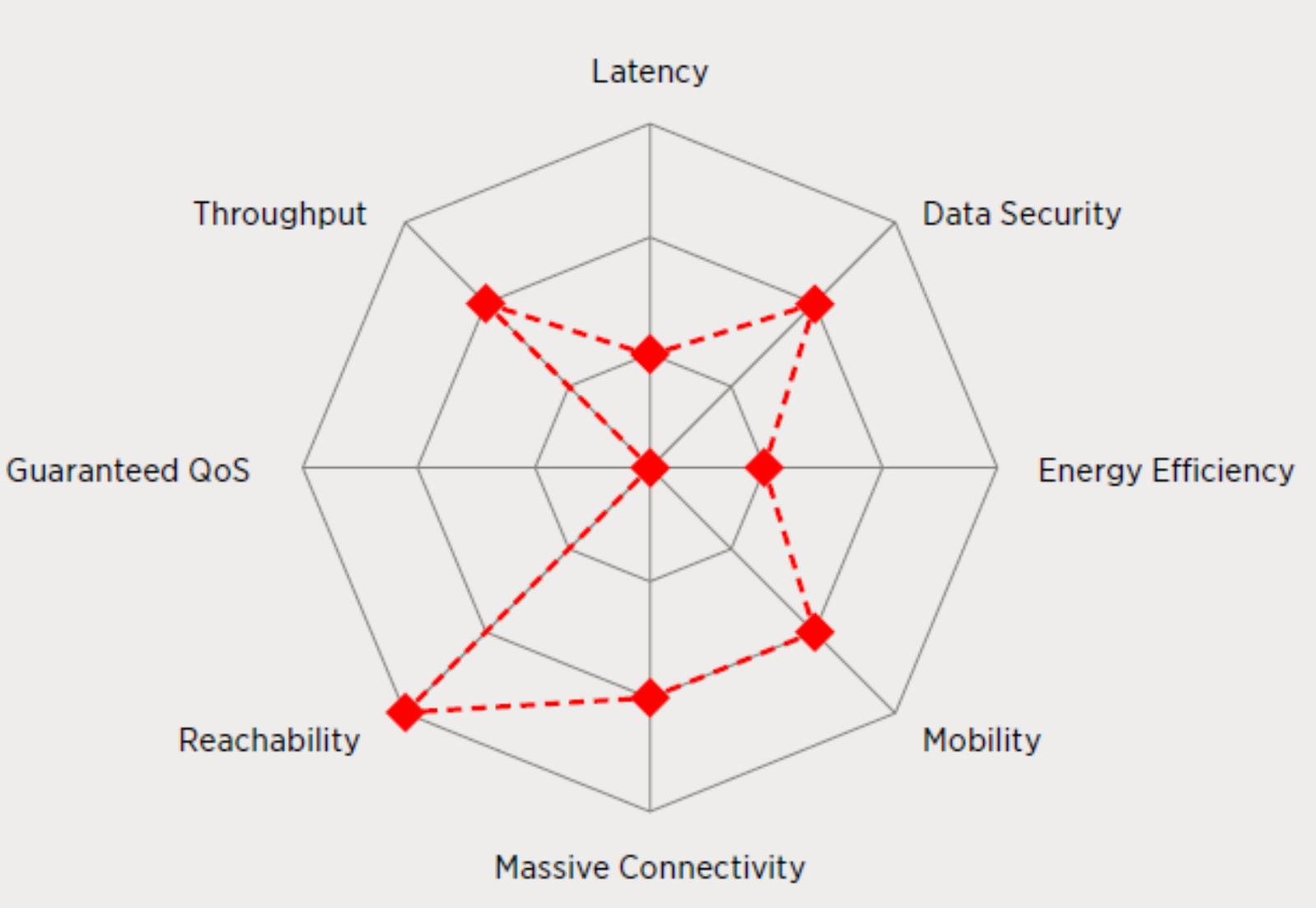
99.999%

eMBB: Enhanced Mobile Broadband
mMTC: Massive Machine Type Communications
UR-LLC: Ultra Reliable – Low Latency Communications

Examples of Network Slices



5G Network Slicing Attributes

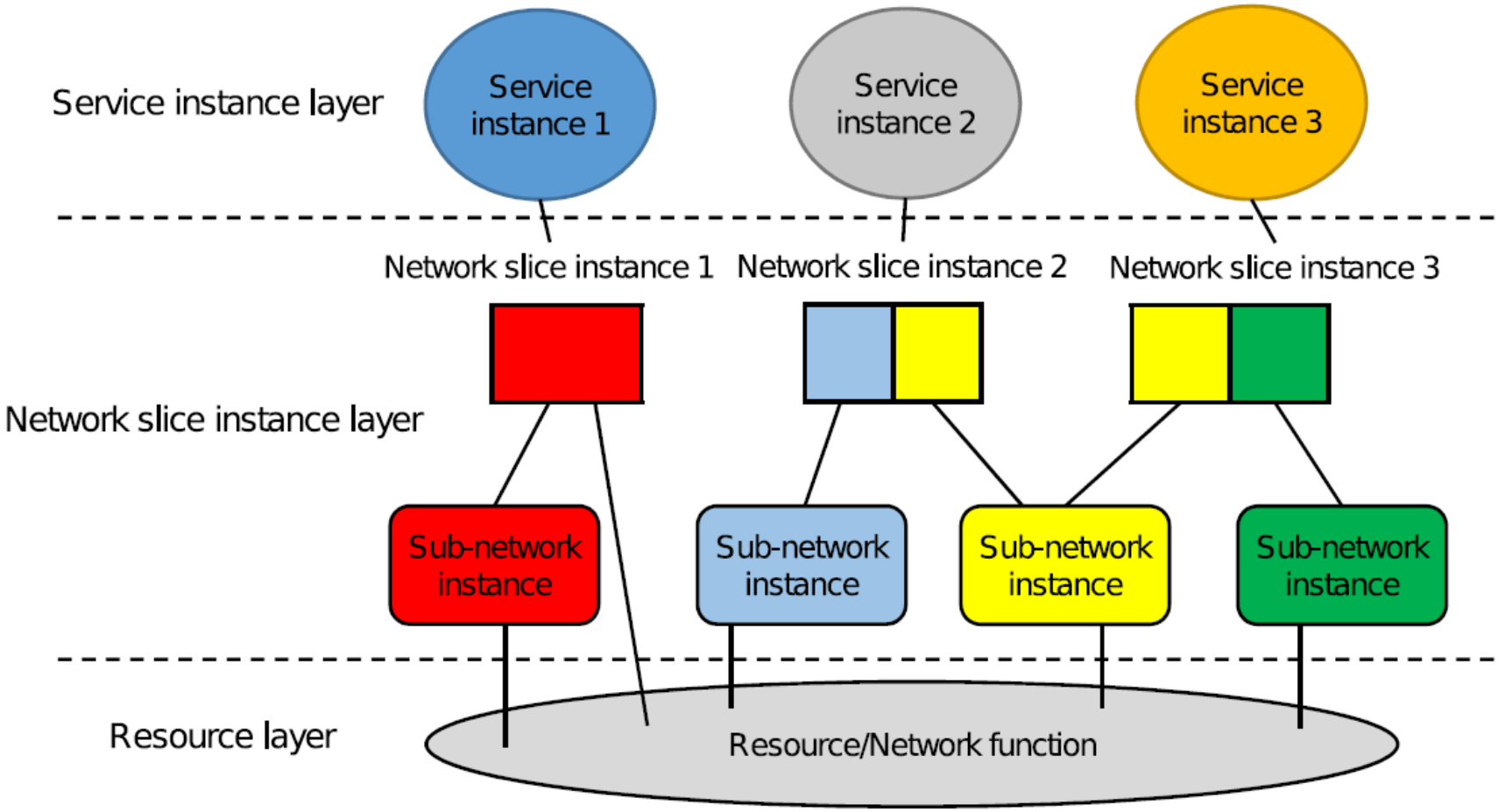


Slicing – Restaurant Example

Typical Customer Requirements: Expense, Calories, Carbs, Sugar content

Customer	Appetizer	Main course	Dessert
Younger	Salad	Sumptuous Buffet	Chocolate Cake
Senior Citizen	Spring Rolls	Hamburger	Mixed Fruits
Diabetic	Small Fries	Pizza	One Banana
Cost Conscious	Combination Platter	Vegetable Sandwich	Apple Pie

Components of Network Slicing



Underlying resources hidden from direct exposure to the high applications but are shared for creating customization for the applications

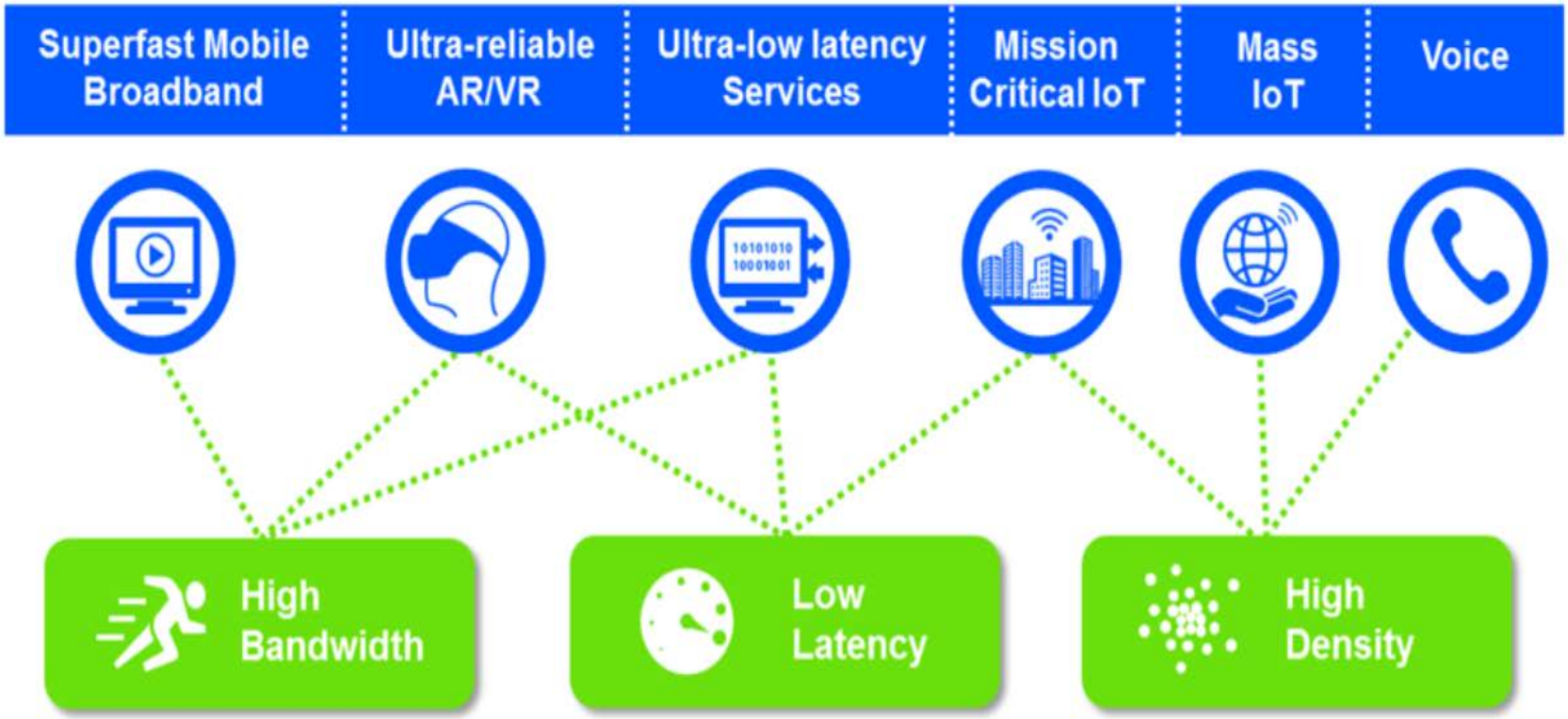
Template Approach

Significant Flexibility and Ease of Development

- **Standard Library or Customization Option**

Template Constituents

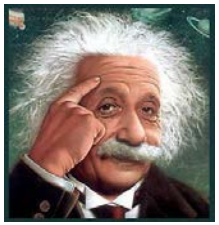
- **Components that need to be instantiated**
- **Features to enable**
- **Configurations to apply**
- **Resource assignments**
- **Associated workflows, e.g., life cycle upgrades and changes**

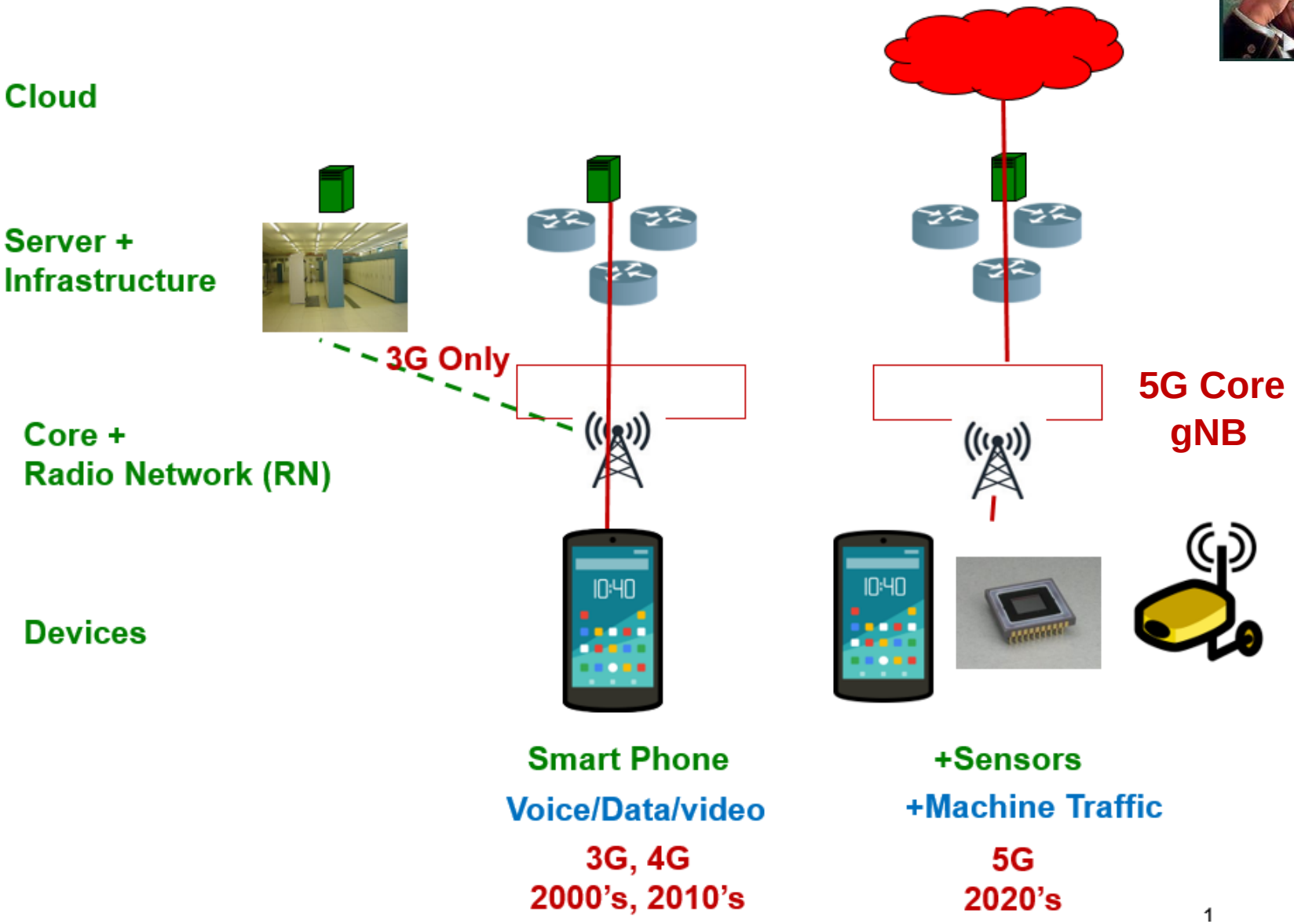


What Makes 5G Special for Network Slicing

- Cloud Based 5G Architecture
  - Versatility of Centralized and Mobile Edge Computing (MEC)
- Separation of Control and User Planes
  - Control and User plane resources can be scaled and located independently
  - Support for Migration to Cloud Based Deployment
- Network Function Virtualization (NFV)
  - Orchestrate network packet processing in virtual server environments
  - Manage routing, packet processing, and security
- Software Defined Networking (SDN) technology
  - Provide isolated logical networks and intelligently steer traffic through the infrastructure
  - Migration of all resource management operations to a Centralized Programmable Controller

3G/4G Architectural Evolution to 5G Technology





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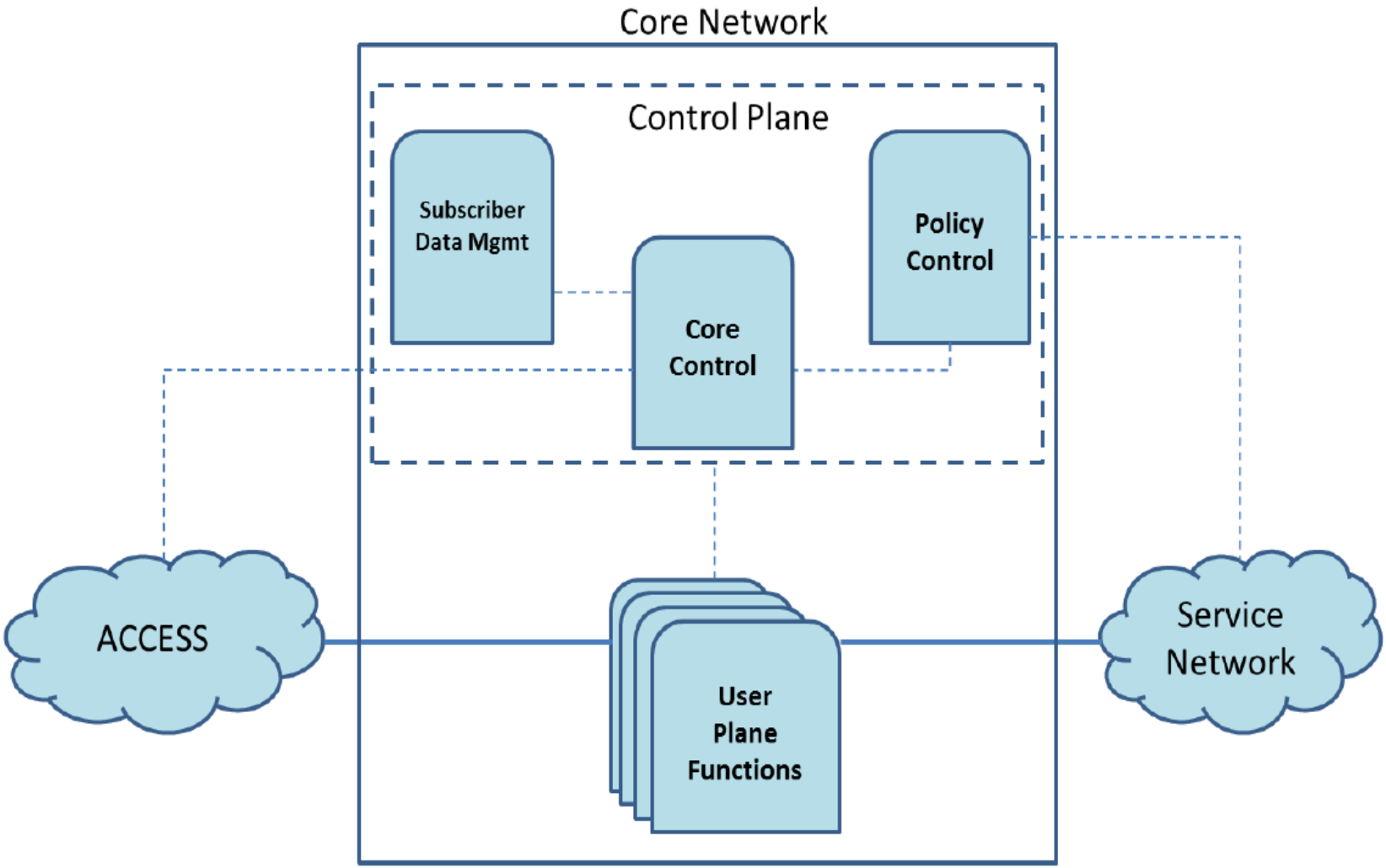
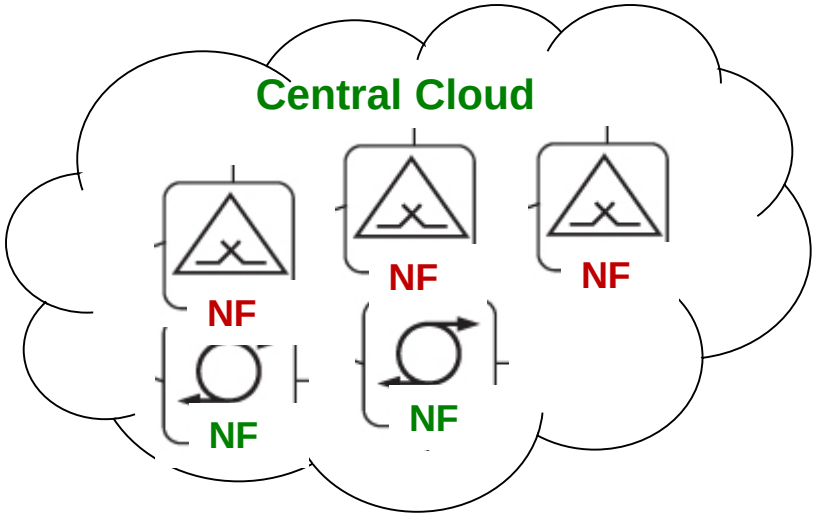
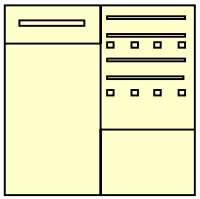
Control and User Plane Separation

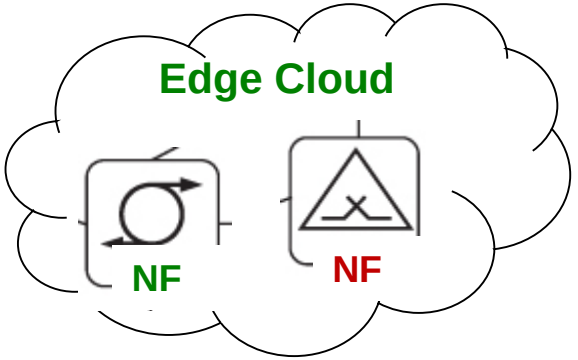


Generalized Cloud Based Network Functions





5G Core

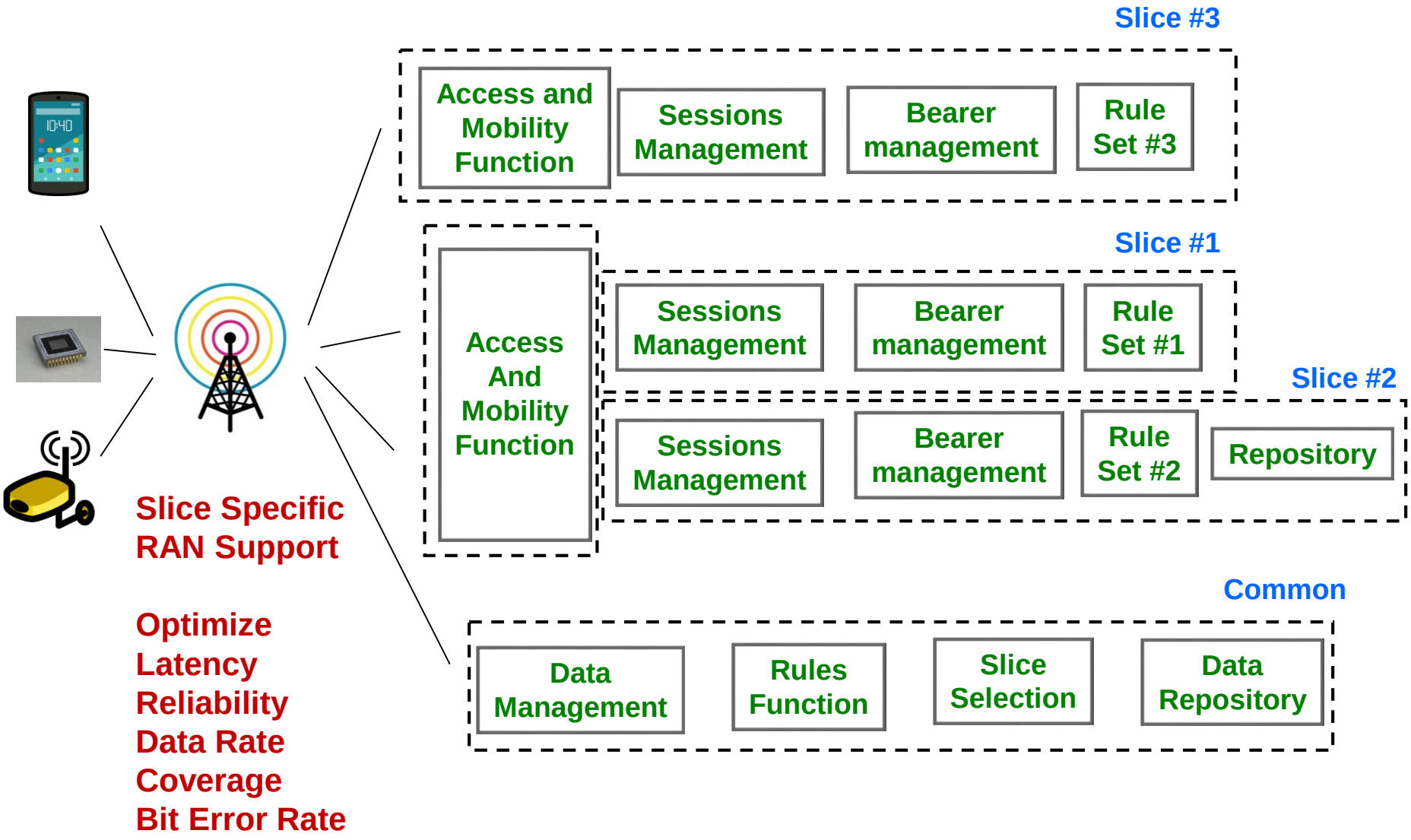


Mobile Edge Computing (MEC)

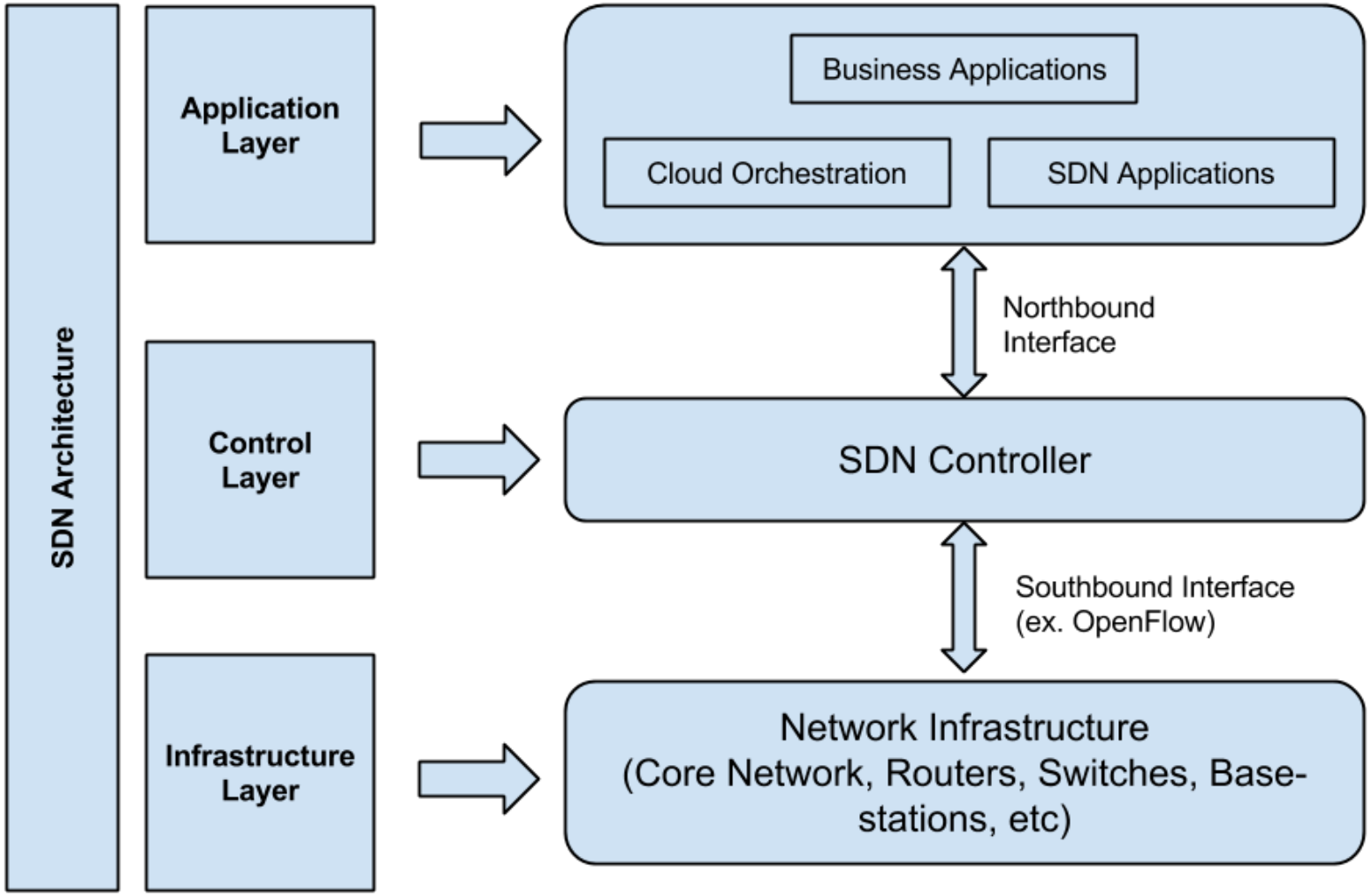
4G LTE Hardware Foundation
NF: Network Function

5G RAN

A Smorgasbord of RAN and Network Function Options



Software Defined Networking



Dynamically Controllable Network Topology

Network Slice Advances

Advances	Description	Solutions
Intelligent Service Function Chaining	Improve Energy and Computational Efficiencies	Optimal Node Localization Low Latency Routing
Mobility Aware Slicing	Mobility Handovers High Density and Mobility	Multi Radio Access Technology (RAT) Support
Network Slice Security	Inter-slice attacks Wide Range of Infrastructure Providers	Advanced Security Models and Schemes
Adaptive Security Mechanisms	Diversity of Applications Different Latency Requirements	SDN Orchestration Lightweight Authentication Schemes
Federated Learning Based Slicing	Number of Tunable Parameters Privacy Leakages in AI	Advanced Agents for Computational off-loading and Caching Efficient Resource Allocation
Adaptive Business Model Driven Services	Multiple Players Difference Business Interests	Dynamic Service Level Agreements between Multiple Slicing Players
Dynamic Spectrum Slicing	Spectrum Scarcity Variations in User Demands	Policy Based Dynamic Spectrum Slicing Schemes

Concluding Remarks

- Adapting System Resources to Applications, a Major Competitive Value of 5G Wireless
- A Robust Set of Standardized Offers
  - Enhanced Mobile Broadband (eMBB), Massive Machine Type Communications (mMTC), Ultra Reliable – Low Latency Communications (UR-LLC)
- Templated Approach for Slice Creation and Management
- Key enablers
  - Cloud Based 5G Architecture Foundation
  - Separation of Control and User Planes
  - Virtual Network Functions (VNFs)
  - Software Defined Networking (SDN)
- Major Advances in Security, Machine Learning, Multi Player Environment, Densification, and Mobility

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