SYSTEM DESIGN FOR 5G CONVERGED NETWORKS

Hans J. Einsiedler, Dirk v. Hugo (T-Labs)

5G: MOBILE (R)EVOLUTION

5G 2020 — Everything connected

4G 2010 — Mobile Broadband

3G 2000 — Mobile Internet

2G 1990 — Voice & SMS
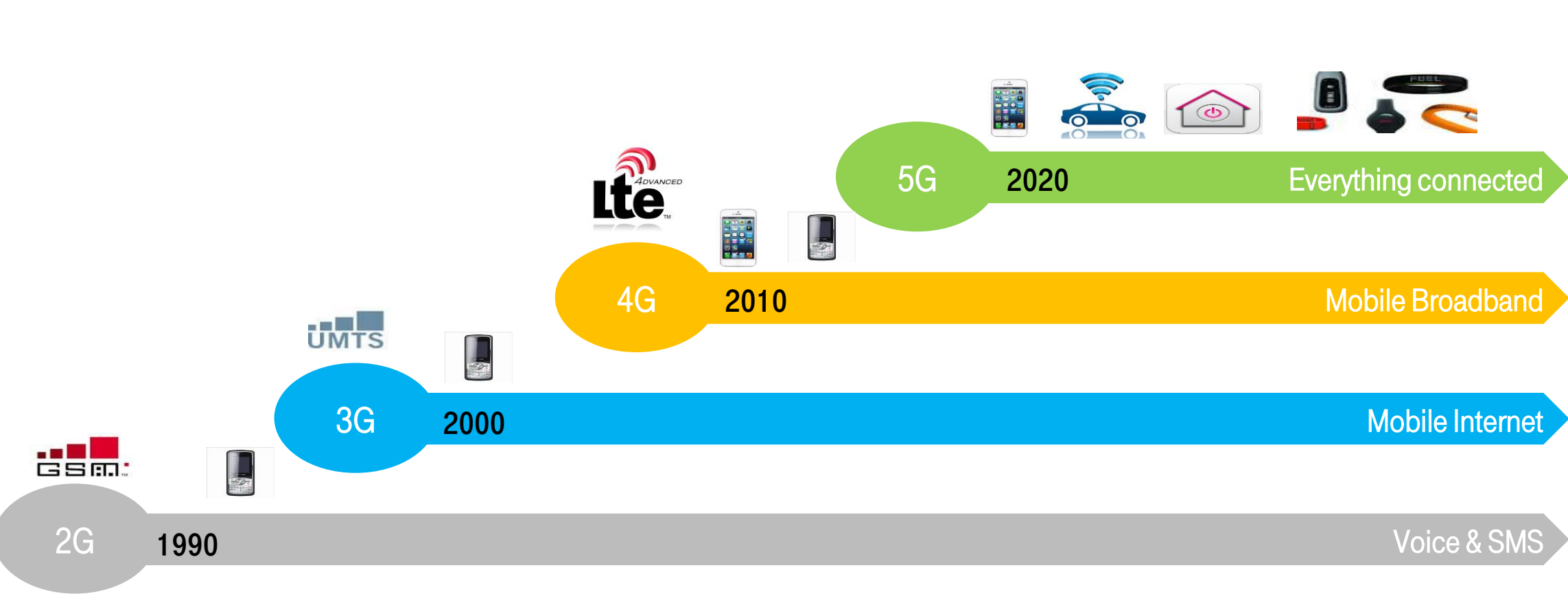
FROM **PHONES** TO **SMARTPHONES** TO **SMART-THINGS**

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WHY WE NEED 5G!
SATISFACTION OF FUTURE USE CASES

Broadband access everywhere	Broadband access in dense areas	Higher user mobility	Massive Internet of Things
50+ MBPS EVERYWHERE	**PERVASIVE VIDEO**	**HIGH SPEED TRAIN**	**SENSOR NETWORKS**

Extreme real-time communications	Lifeline communications	Ultra-reliable communications	Broadcast-like services
TACTILE INTERNET	**NATURAL DISASTER**	**E-HEALTH SERVICES**	**BROADCAST SERVICES**

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THE MOST IMPORTANT USE CASE - THE UNKNOWN ONE!
WE CANNOT SEE INTO A CRYSTAL BALL!

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BUSINESS SCENARIOS AND MODELS
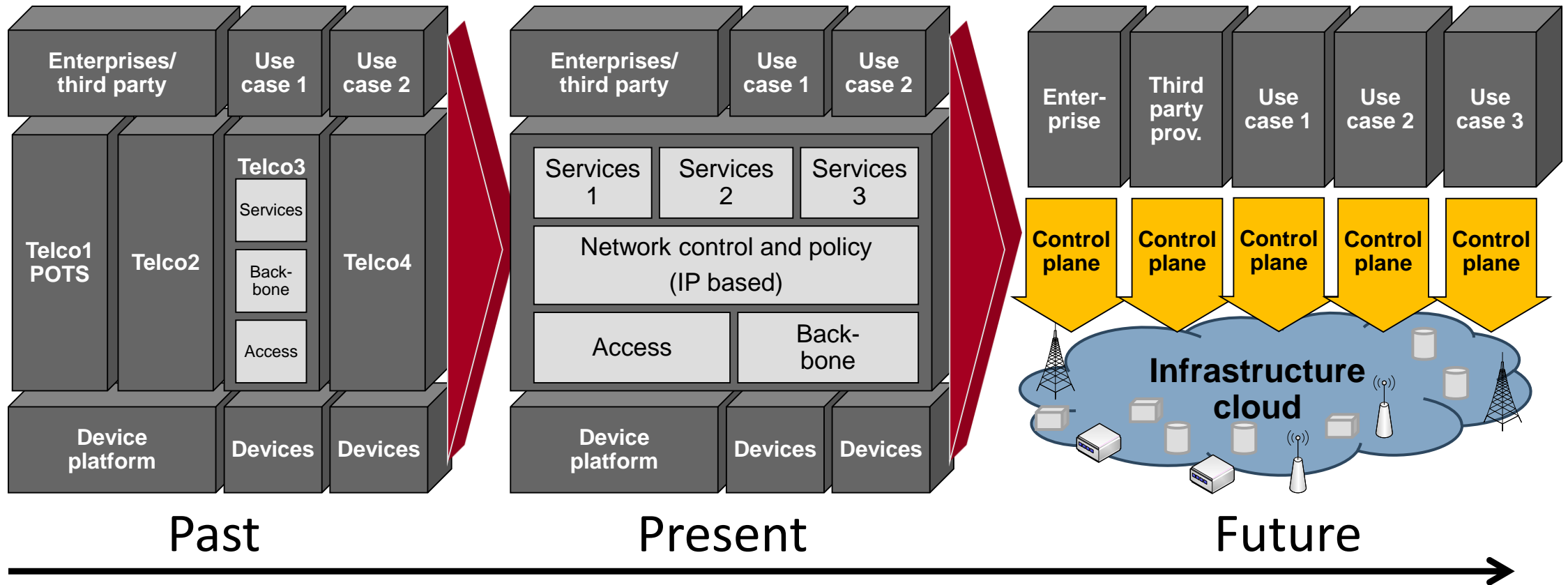## CURRENT KNOWN AND DISCUSSED USE CASES ARE THE DRIVERS

- Residential customers – home network operation and management
- Mobile customers
- Enterprise
- Machine type communication
- Network federation
- Network sharing – Virtual (mobile) network operator
- Frequency sharing (e.g. via licensed shared access)
- Network management, service infrastructure, infrastructure split
- Roaming (local breakout versus home network control)

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EVOLUTION OF THE NETWORK INFRASTRUCTURE
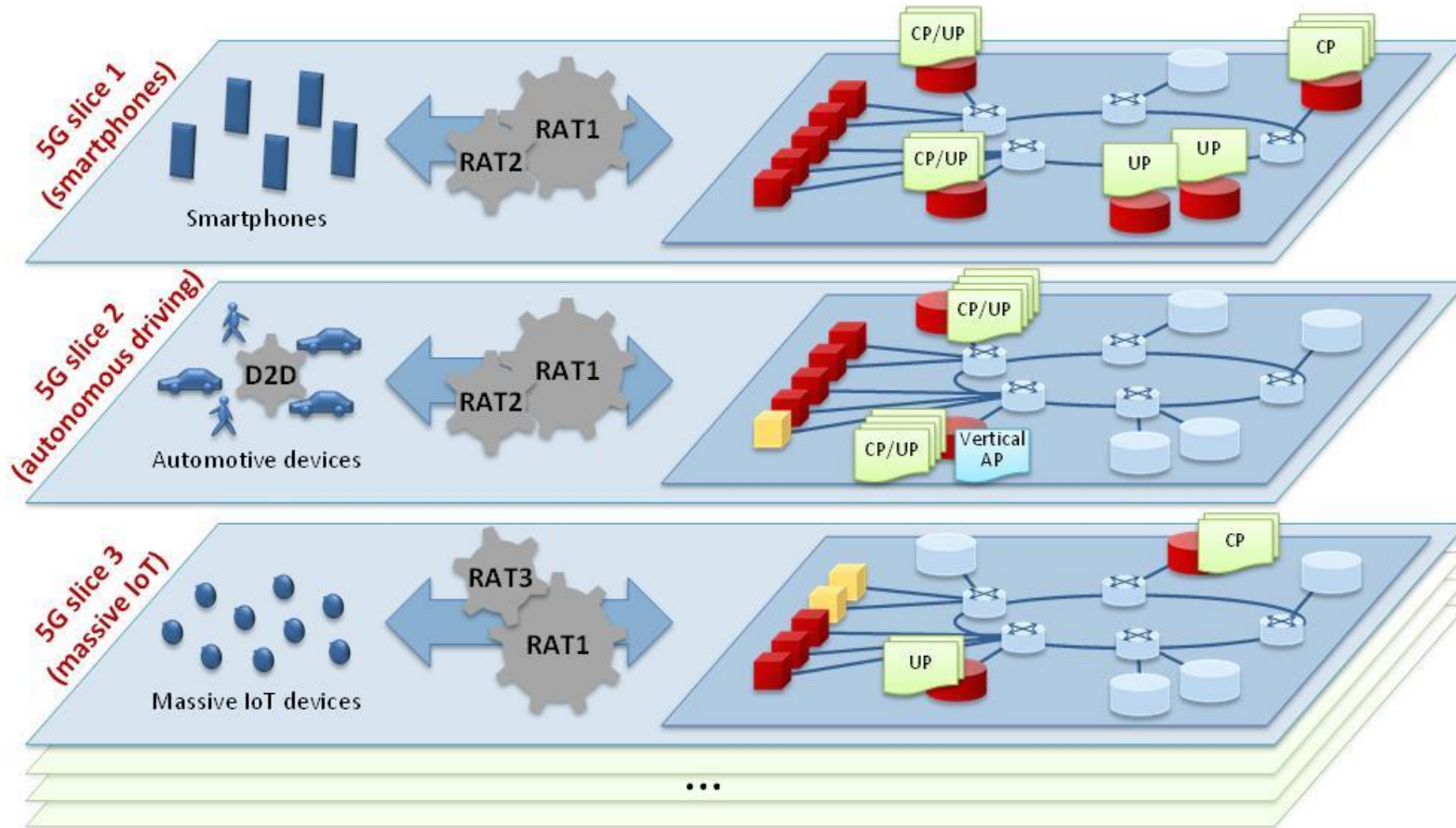## FROM SILOS OVER MONOLITHS TOWARDS VIRTUAL SILOS

Past

- Enterprises/third party
- Use case 1
- Use case 2
- Telco1 POTS
- Telco2
- Telco3 (Services, Back-bone, Access)
- Telco4
- Device platform
- Devices
- Devices

Present

- Enterprises/third party
- Use case 1
- Use case 2
- Services 1
- Services 2
- Services 3
- Network control and policy (IP based)
- Access
- Back-bone
- Device platform
- Devices
- Devices

Future

- Enter-prise
- Third party prov.
- Use case 1
- Use case 2
- Use case 3
- Control plane
- Control plane
- Control plane
- Control plane
- Control plane
- Infrastructure cloud

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USE CASES MAPPED TO NETWORK SLICES
REQUIREMENTS WILL DEFINE THE NETWORK SLICES

RAT= Radio Access Technology; CP = Control Plane; UP= User Plane; AP= Access Point; IoT= Internet of things; D2D = Device to Device
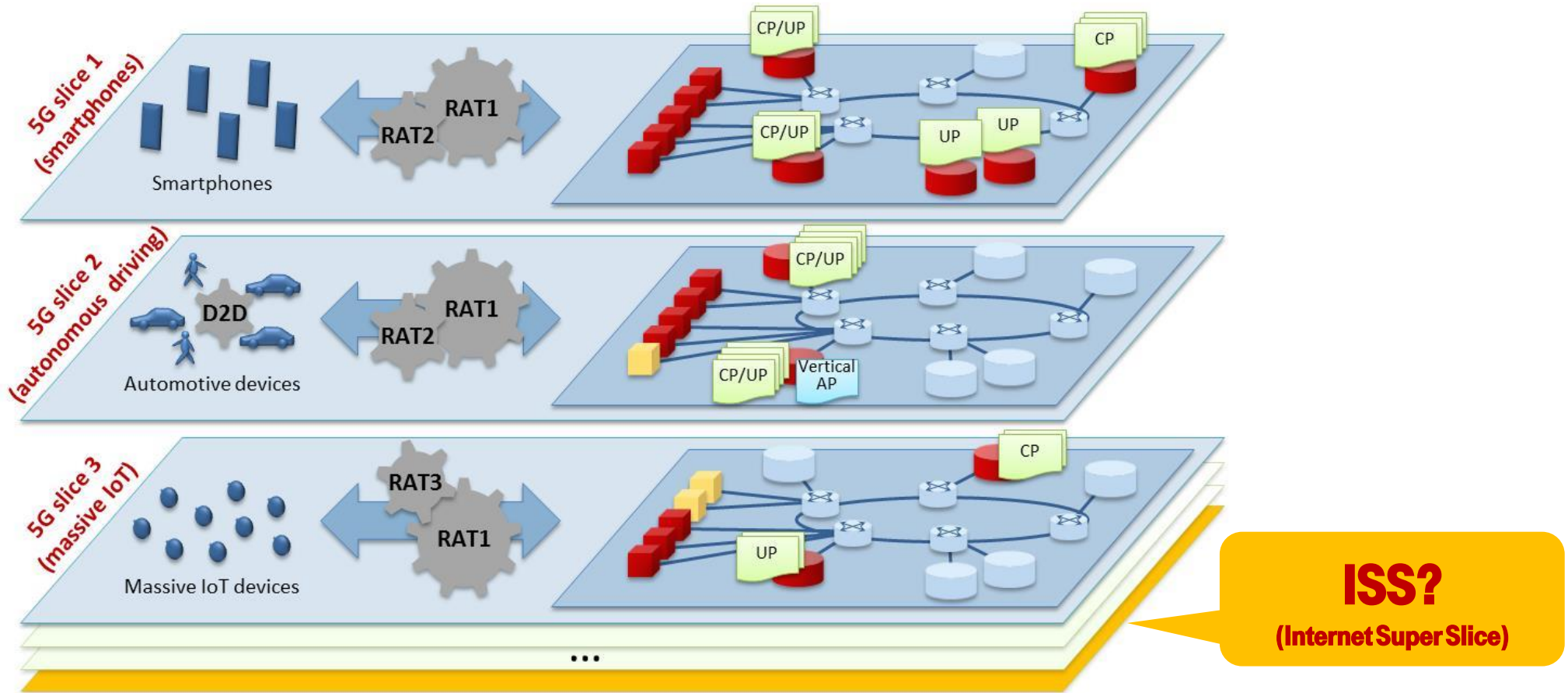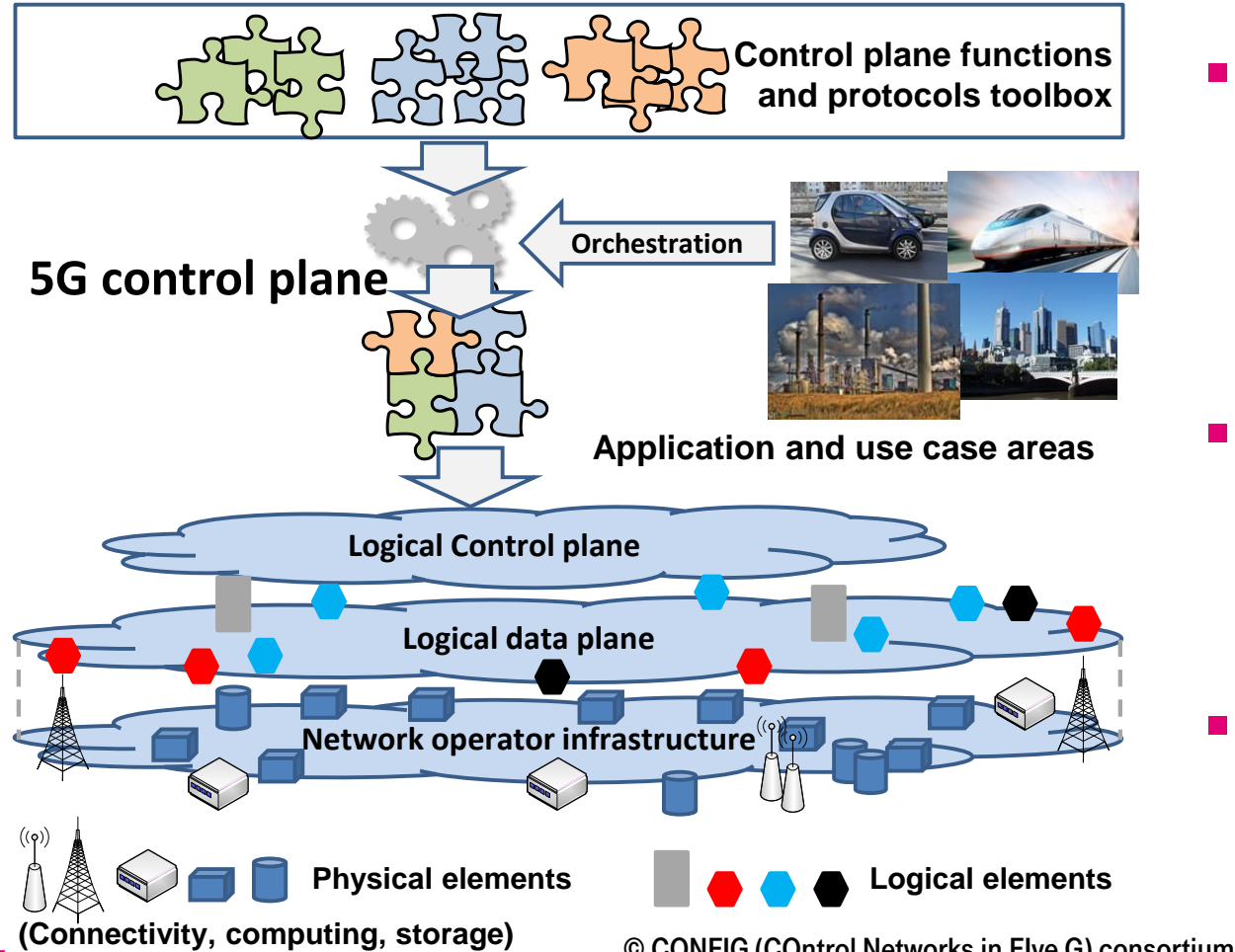
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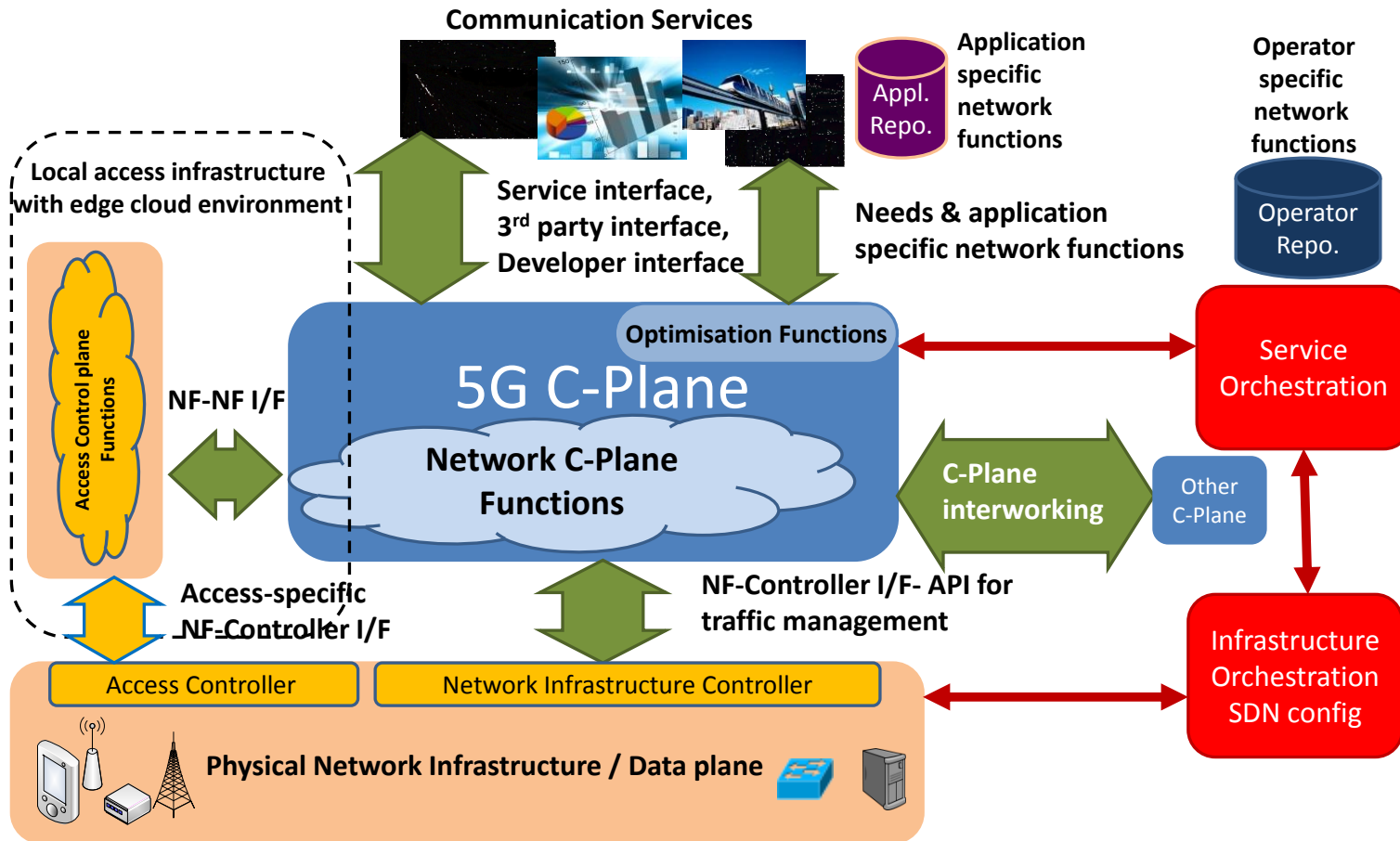# REQUIREMENTS LEADS TO CONTROL PLANE
FULL FLEXIBLE SYSTEM CONCEPT

Control plane functions and protocols toolbox

5G control plane

Orchestration

Application and use case areas

Logical Control plane

Logical data plane

Network operator infrastructure

Physical elements
(Connectivity, computing, storage)

Logical elements

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- Control plane functions and protocols will offer the possibility to orchestrate different control planes according to the requirements of the use case and application areas.

- Control plane will be initiated in a distributed infrastructure – not necessarily in a central virtualized environment.

- Modular approach offers the possibility to run different access technologies much easier in the same SDN environment.

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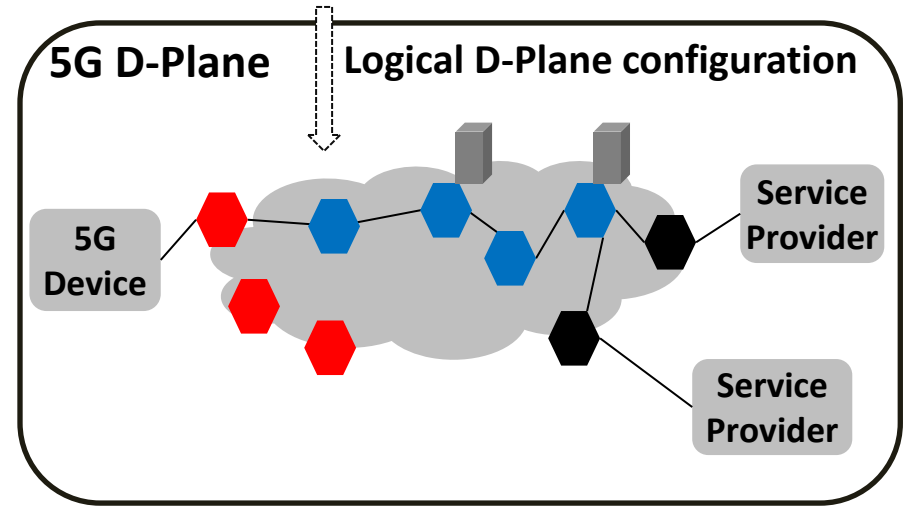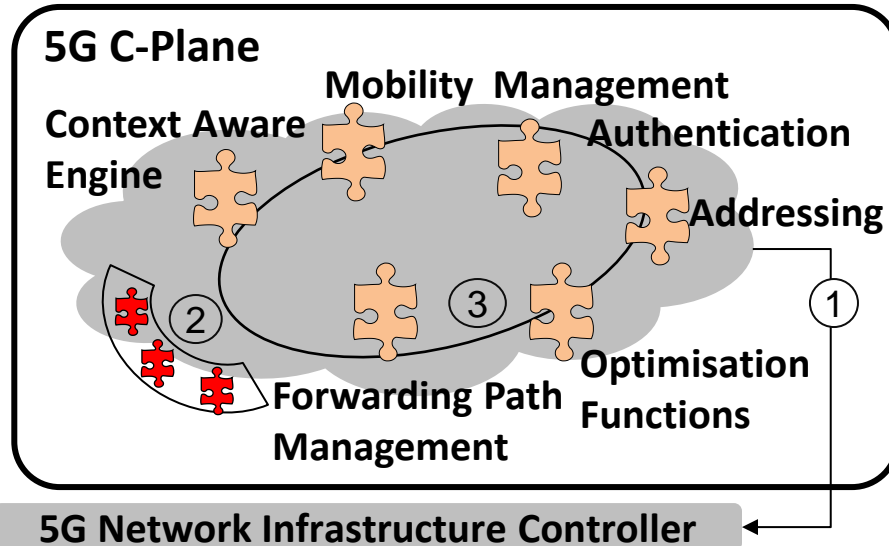# NEW CONTROL PLANE CONCEPT
INTERFACES AND INTERWORKING

Communication Services

Application specific network functions

Appl. Repo.

Operator specific network functions

Operator Repo.

Service interface, 3rd party interface, Developer interface

Needs & application specific network functions

Local access infrastructure with edge cloud environment

Access Control plane Functions

NF-NF I/F

5G C-Plane

Optimisation Functions

Network C-Plane Functions

C-Plane interworking

Other C-Plane

Service Orchestration

Access-specific NF-Controller I/F

NF-Controller I/F- API for traffic management

Access Controller

Network Infrastructure Controller

Infrastructure Orchestration SDN config

Physical Network Infrastructure / Data plane

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- Backwards compatibility to other systems is not mandatory.
- Novel control plane has different interfaces, towards:
  - other control planes – if its profitably,
  - the services and third parties including developers,
  - cloud edge infrastructures,
  - the physical network infrastructure.
- Control plane orchestration and infrastructure orchestration might be the same system.

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SYSTEM CONCEPT
LOGICAL C-PLANE CONTROLS THE LOGICAL D-PLANE

5G C-Plane

Context Aware Engine

Mobility Management

Authentication

Addressing

Optimisation Functions

Forwarding Path Management

② ③

①

5G Network Infrastructure Controller

5G D-Plane Logical D-Plane configuration

5G Device

Service Provider

Service Provider

Logical C-Plane

5G Logical Network Core Function
5G Logical Network Access Function
① 5G NF-Controller interface
② ③ Inter-5G NF interface

Logical D-Plane

5G Logical NF – Logical Access Points
5G Logical NF – Logical forwarding nodes
5G Logical NF – Logical D-Plane endpoints
5G Logical NF – Other Logical Network functions

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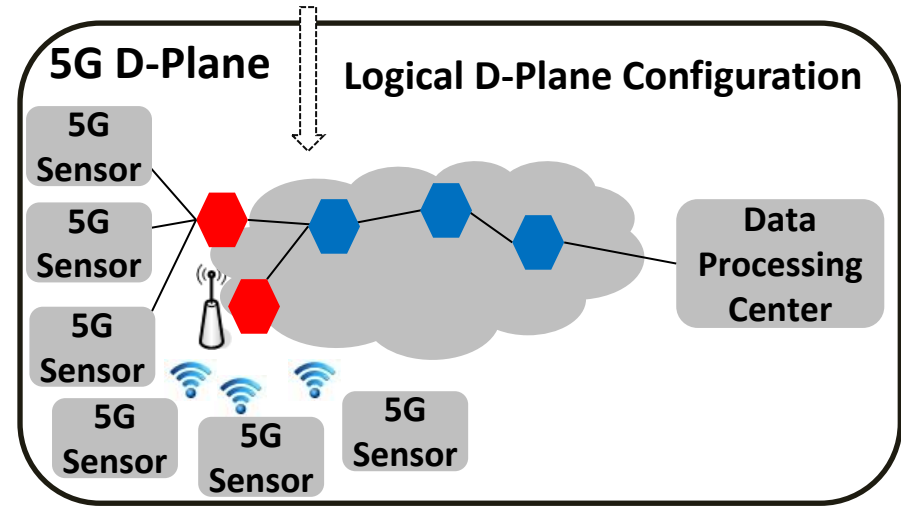**ERLEBEN, WAS VERBINDET.**

11

EXAMPLE WITH LOW COMPLEXITY
STATIC/NOMADIC FIXED AND WIRELESS SENSOR NETWORK

5G C-Plane

Authentication

Addressing

② ③

Forwarding Path Management

①

5G Network Infrastructure Controller

Logical C-Plane

- 5G Logical Network Core Function
- 5G Logical Network Access Function
- ① 5G NF-Controller interface
- ② ③ Inter-5G NF interface

5G D-Plane   Logical D-Plane Configuration

5G Sensor
5G Sensor
5G Sensor
5G Sensor
5G Sensor
5G Sensor

Data Processing Center

Logical D-Plane

- 5G Logical NF – Logical Access Points
- 5G Logical NF – Logical forwarding nodes
- 5G Logical NF – Logical D-Plane endpoints
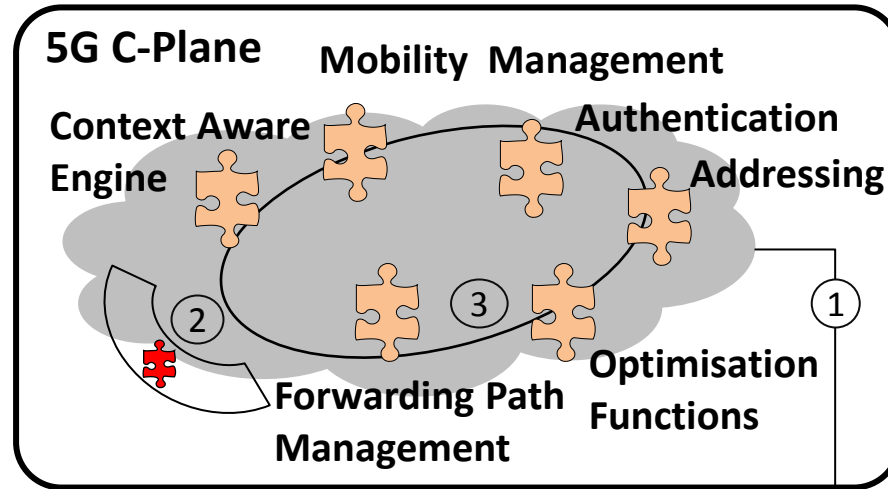- 5G Logical NF – Other Logical Network functions

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12

EXAMPLE WITH HIGH COMPLEXITY
MULTIMEDIA MOBILE BROADBAND

5G C-Plane
Mobility Management
Context Aware Engine
Authentication Addressing
② ③
Forwarding Path Management
Optimisation Functions
①

5G D-Plane
Logical D-Plane Configuration
5G Mobile Devices
Content Provider

5G Network Infrastructure Controller

Logical C-Plane
- 5G Logical Network Core Function
- 5G Logical Network Access Function
- ① 5G NF-Controller interface
- ② ③ Inter-5G NF interface

Logical D-Plane
- 5G Logical NF – Logical Access Points
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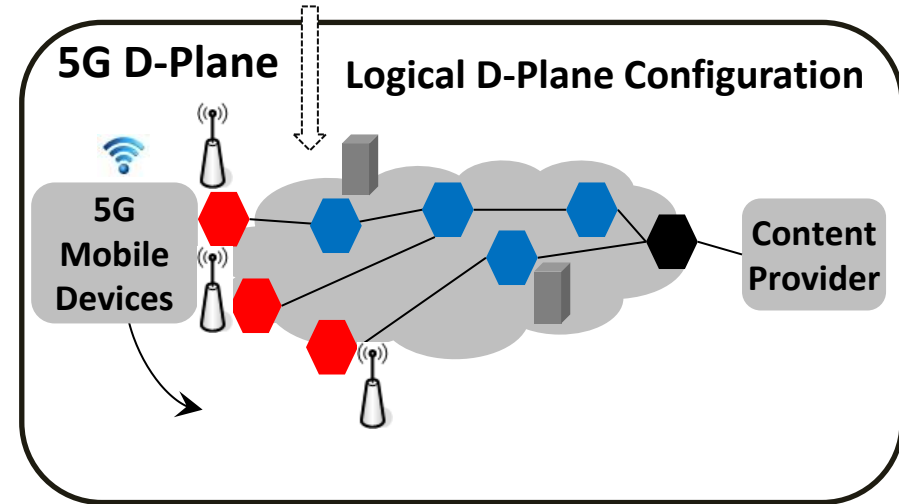© CONFIG consortium

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13

EXAMPLE WITH HIGH COMPLEXITY
MULTIMEDIA MOBILE BROADBAND

5G C-Plane

Mobility Management

Context Aware Engine

Authentication Addressing

② ③

Optimisation Functions

Forwarding Path Management

①

5G Network Infrastructure Controller

5G D-Plane   Logical D-Plane Configuration

Context awareness – context information is the source to optimize:

- **Network control/network services**
- **Network management (slices)**
- **Service offering (applications and services for the users)**

Logical C-Plane

5G Logical Network Core Function

5G Logical Network Access Function

① 5G NF-Controller interface

② ③ Inter-5G NF interface

Logical D-Plane

5G Logical NF – Logical Access Points

5G Logical NF – Logical forwarding nodes

5G Logical NF – Logical D-Plane endpoints
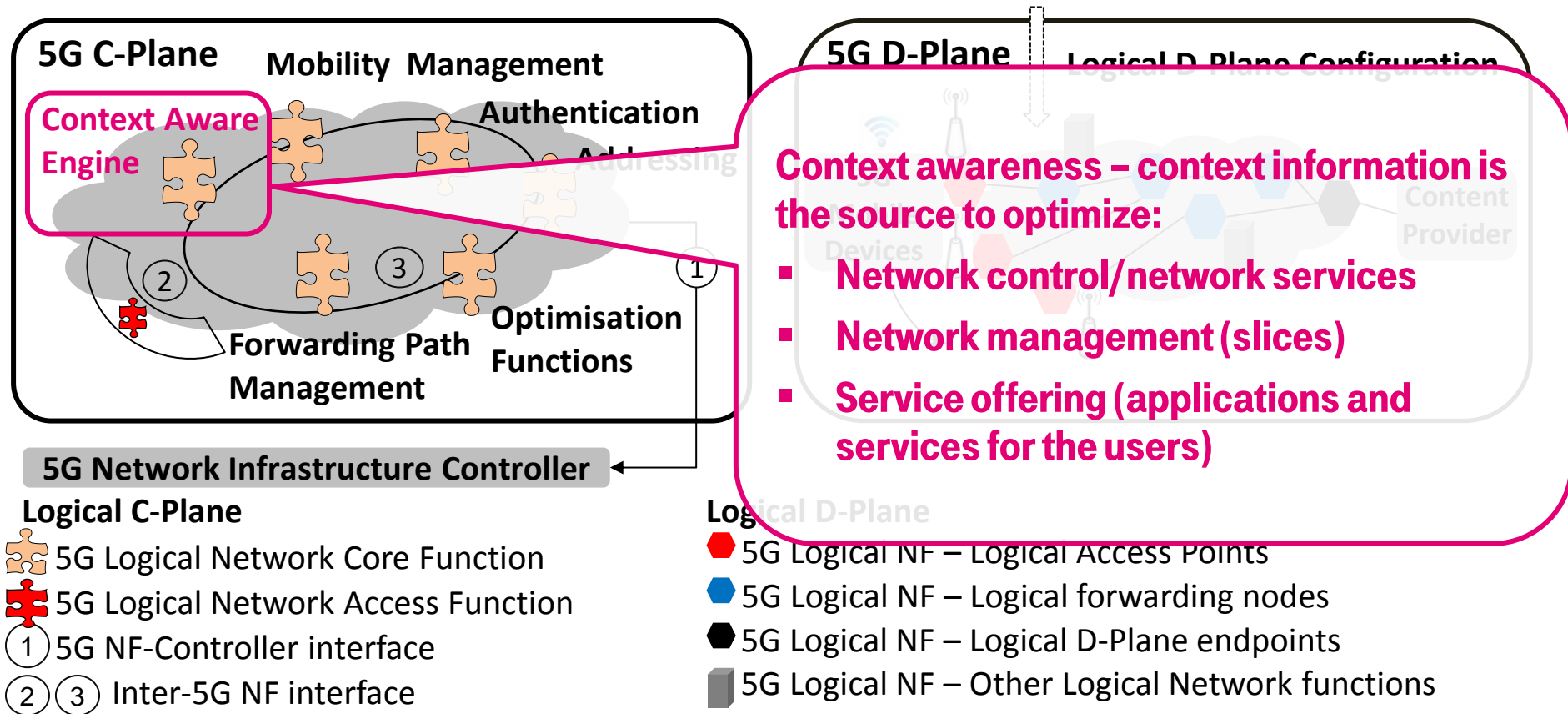
5G Logical NF – Other Logical Network functions

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14

CONCLUSION
5G WILL BE PLUG AND PLAY INFRASTRUCTURE

- **Paradigm Shift: 5G is about more than a new air interface - and it will be access agnostic**

- **Modular and flexible network architecture: No one-size-fits-all approach**

- **Virtual networks/network slices depending on use case requirements**

- **Context awareness will offer the possibility to optimize the infrastructure and the services**

- **If we agree on a common addressing/ID management and QoS interfaces/resource management for the heterogeneous access technologies within a slice, Fixed-Mobile Convergence will come for free**

➔ **Future telecommunication infrastructure will be**

  - **software driven,**

  - **access agnostic,**

  - **virtualized, and**

  - **sliced**

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Current participants

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THANK YOU!