

3GPP Advances Towards Transport

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Date: 04./05. July 2018

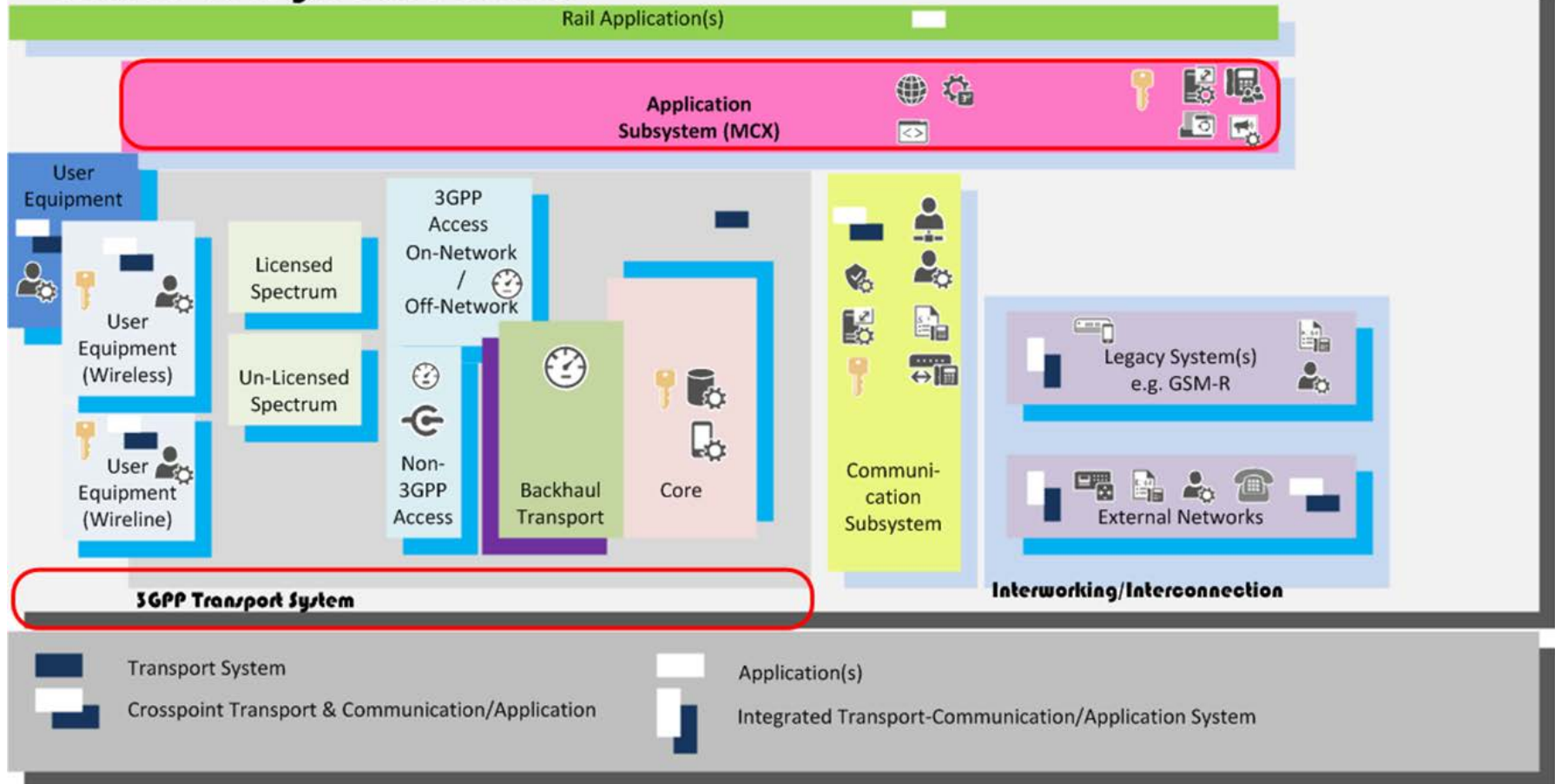
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Version: 1.1.1

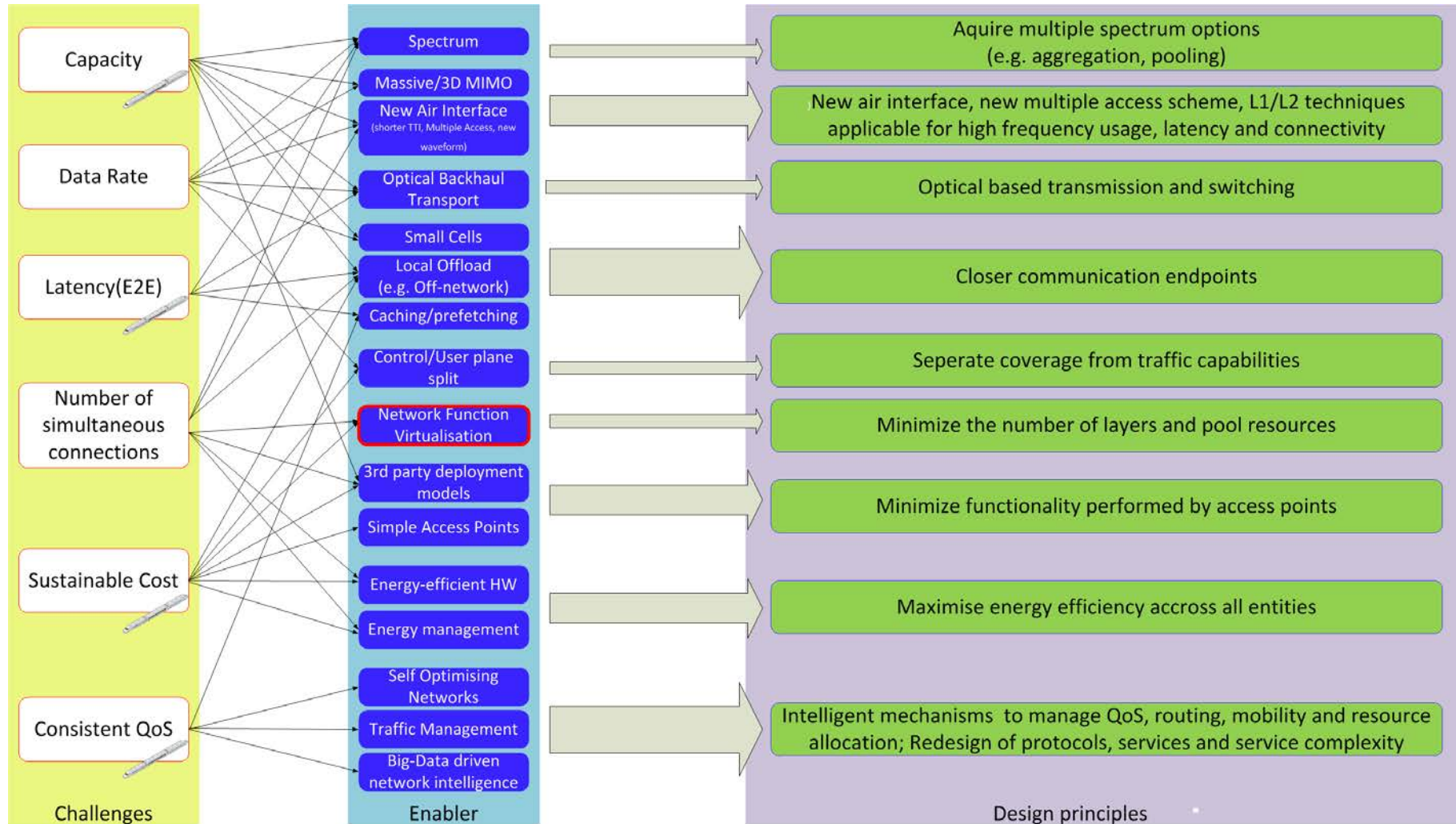


(1) Focus subject

FRMCS in a global context



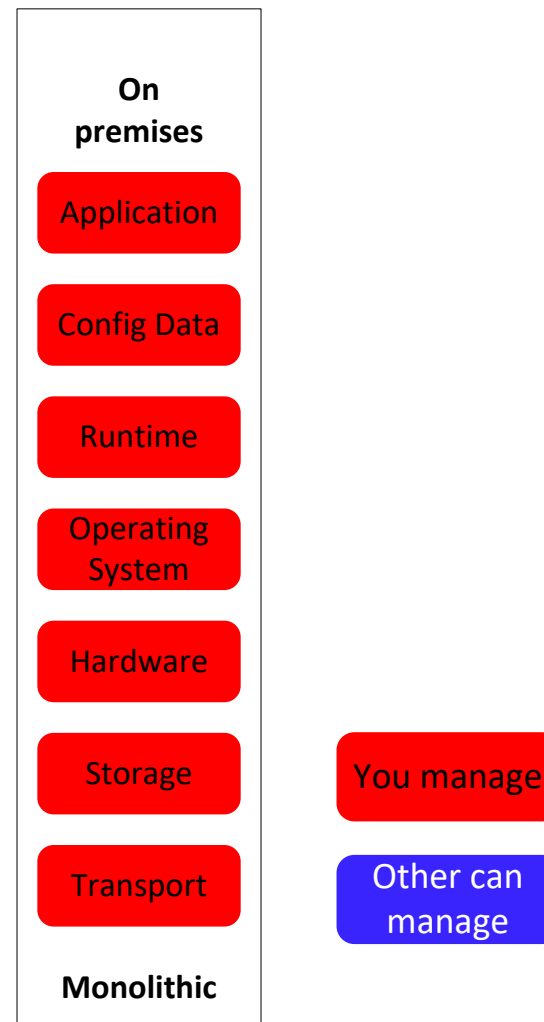
(2) Design principles 5G System



(3) System Principles: Traditional infrastructure – Monolithic Approach

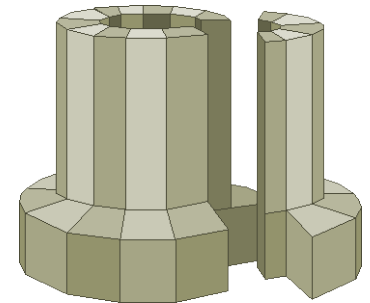
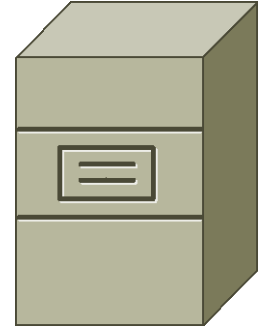
- Each subsystem of GSM-R system consists of:
 - specific piece of hardware (network, storage, computing entity);
 - Specific operating system;
 - Specific configuration data;
 - Specific applications for control and user plane;

→ This monolithic approach cannot easily follow the evolution of services nor the technology.



(4) System Principles : Servers and Virtualisation

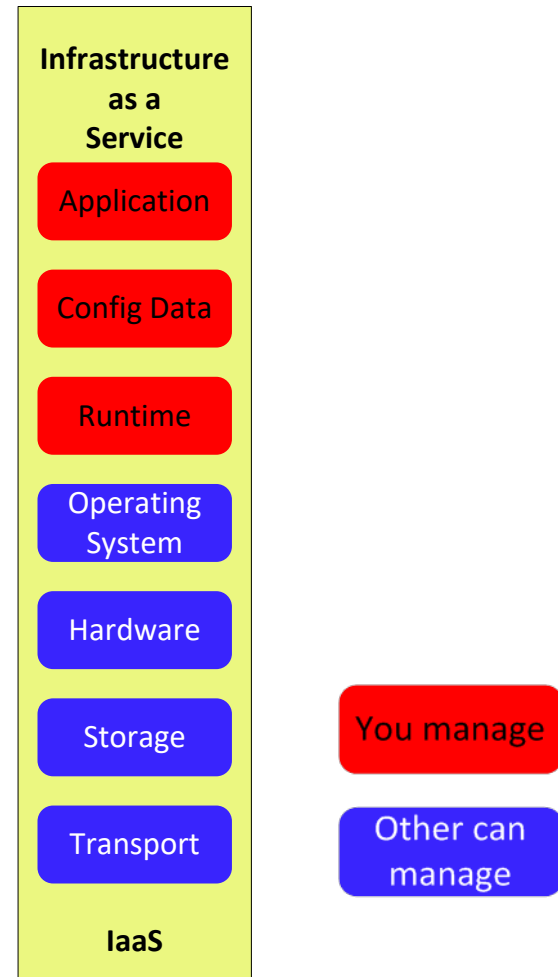
- **Servers:**
 - Powerful and configurable;
 - Low failure rate;
 - Engineered to avoid failures;
 - Never fully utilised → lead to waste;
 - Difficult to run multiple applications on the same server;
- **Hardware virtualisation can solve these problems:**
 - Virtualisation emulates physical server's hardware in software → entirely programmable in software;
 - Creation on demand;
 - Run multiple virtual machines on a physical server;
 - Portable → move a virtual machine from one server to another
 - Requires detailed capacity planning



(5) System Principles : Infrastructure as a Service (IaaS)

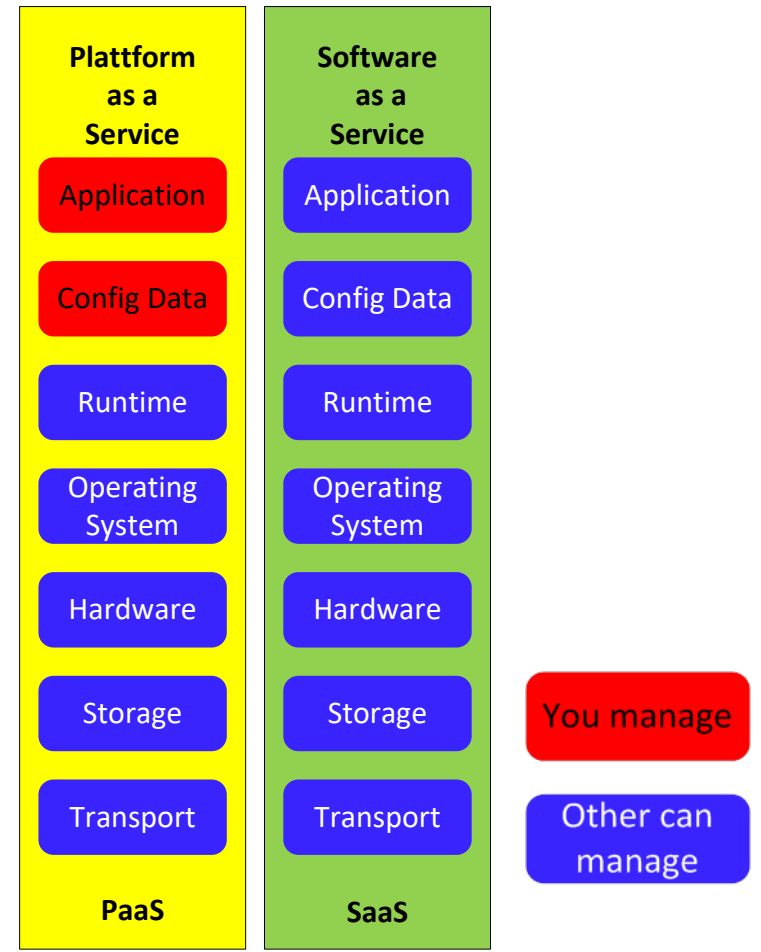
- Raw networking and storage;
- application is able to consume computing capabilities as needed;
- Application Programming Interface provides management and creation of infrastructure on demand;

→ Requires infrastructure management



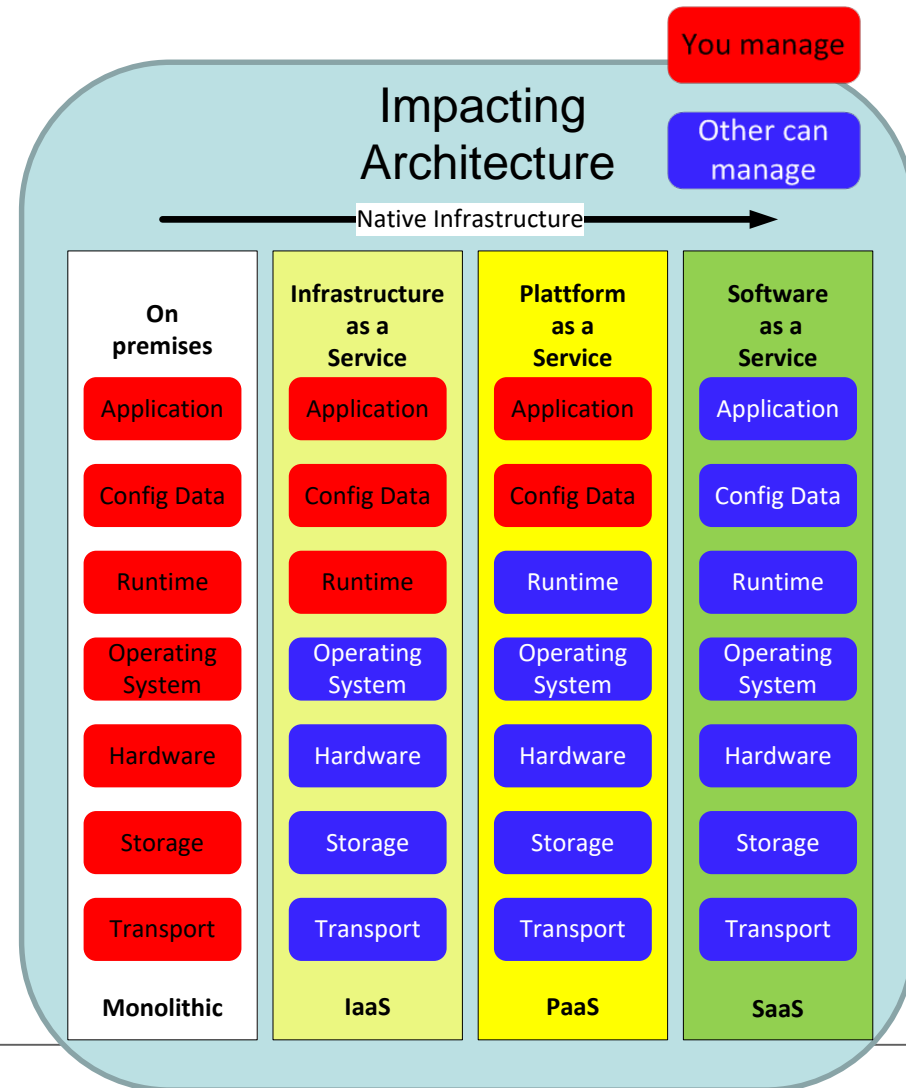
(6) System Design: Platform as a Service (PaaS) and Software as a Service (SaaS)

- Hides physical server like IaaS does;
- Hides operating systems from applications;
- Application code takes into account platform dependencies.
- IaaS requires infrastructure management, if PaaS platform is managed by the provider.
- Applications include features that allows them to be managed by the platform without access to the underlying operating system.
- Applications embraced running on a platform are called «cloud native applications».
- Runs applications on a PaaS or consume applications through software as a service (SaaS).



(7) Native infrastructure benefits

- Infrastructure is software and hardware that supports applications and encompasses:
 - operating systems, configuration management and any system or software needed to support the life cycle of applications;
 - Native infrastructure allows to run native applications.
- Scaling your infrastructure the same way as scaling your applications;
- Specific physical (communication) entities lead to waste, because of under-utilisation;
- Virtualisation promises to solve these problems
- Virtualisation emulates physical hardware → virtual machines.
- Application Programming Interface (API) to create and manage infrastructure on demand



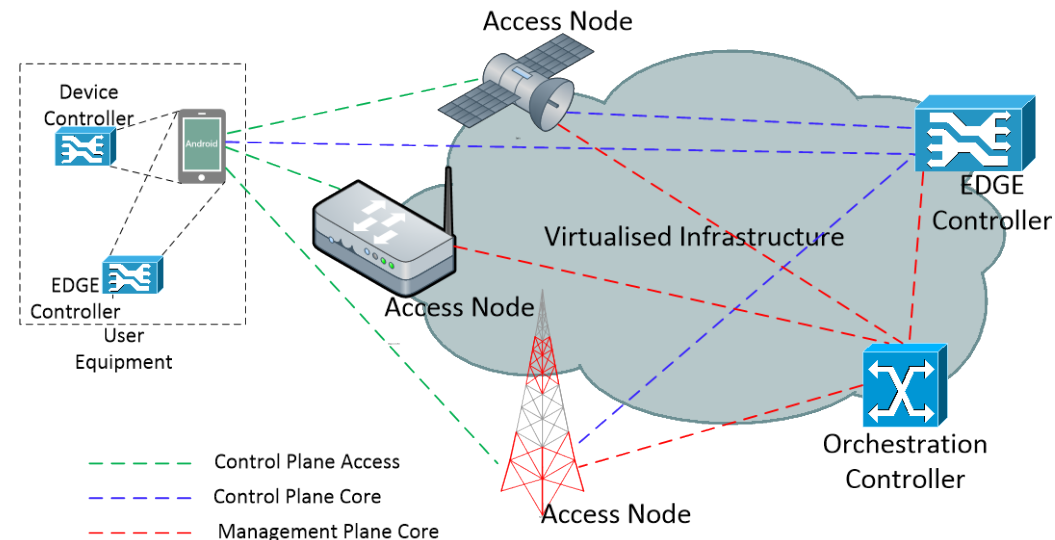
--> Virtualisation is an enabler for Soft Defined Networks (SDN).

(8) High level architecture of 5G System

- Network flattening;
 - Separation Control & User Plane;
 - Network functions implementation centralised or distributed (EDGE) depending on performance requirements;
 - Logical network elements decomposed into sets of applications or modules with dynamic instantiation in the virtual infrastructure;
 - Unified control plane: Device Controller, EDGE Controller and Orchestration Controller;
 - Maximise reuse of control plane transactions;
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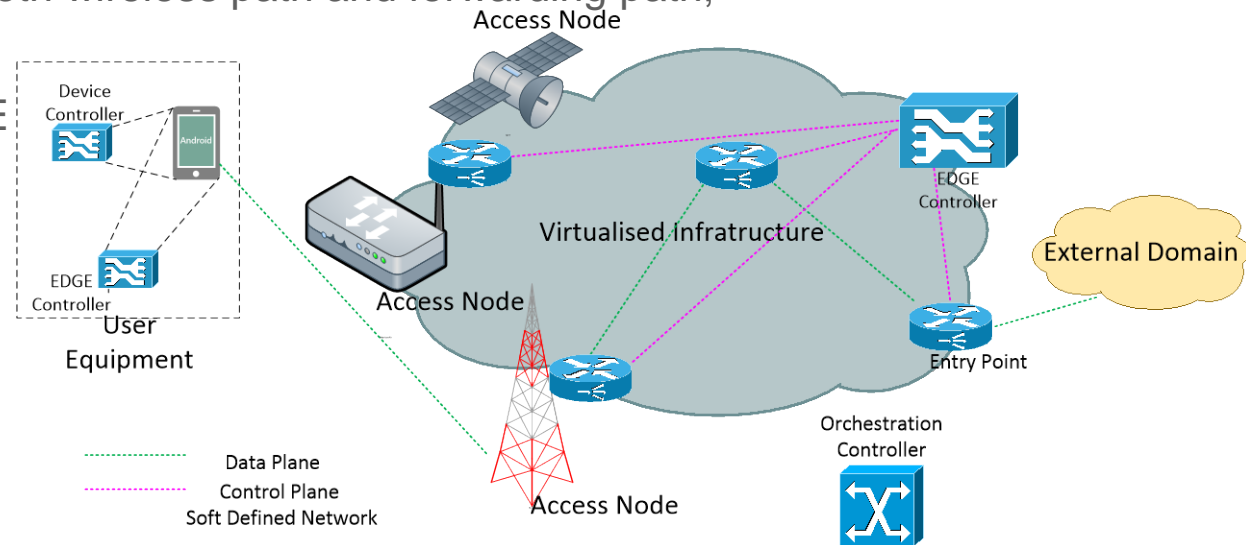
(9) 5G System approach –Control Plane

- **Device Controller (DC)**
 - Physical Layer connectivity;
 - Handles the plurality of wired and radio access → Access & network selection;
- **EDGE Controller (EC)**
 - Inherits Access and Core functions;
 - Distributed via a set of interconnected Control Applications;
 - C-Applications are dedicated to a subset of network control functions e.g. Mobility or Flow Management, Radio Access (RA) App;
 - Radio Access Application split into RA^D and RA^C;
 - UE EDGE Controller provides for Off-network a subset of Access and Core Functions;
- **Orchestration Controller (OC)**
 - coordinates cloud resources (RO) and topology management (TM);
 - RO determines virtual control and data planes inside the virtual infrastructure;
 - TM handle virtual machines and virtual links required to instantiate and connect EDGE Controller;



(10) 5G System approach –User Plane

- **Soft Defined Network (SDN)** technology;
- Neither data plane network elements nor unique logical elements like gateways or mobility anchor points are required;
- Last Hop Routing Element provide address allocation to the User Equipment and chains the radio access point of the User Equipment towards the backhaul;
- **Forwarding path** routes the data packets of the UE towards the **Entry Point**;
- (Network) Entry Point neither controlled by Orchestration Controller nor by the EDGE Controller;
- Wireless connection is managed by Radio Access (RA) App in the network; At service request, QoS is enforced for both wireless path and forwarding path;
- Off-network only mode is managed by the device EDGE controller on the UE;
- Combination of Off-/On-network, UE EDGE controller and network EDGE controller are involved;



(11) Conclusion(s) 5G 3GPP transport

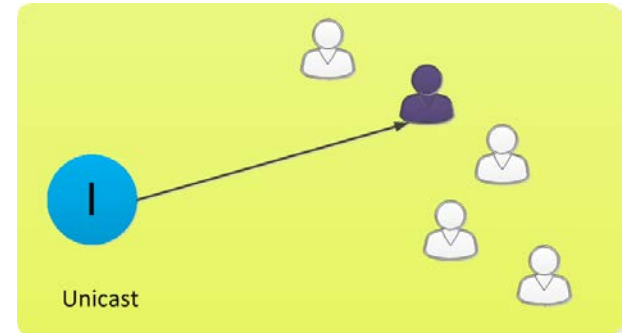
- Soft Defined Network (SDN) allows the location of functions where required to achieve the QoS requirements.
- No specific hardware → Applications are hardware native;
- SDN requires at least an «Infrastructure as a Service» approach;
- New functions can be implemented much faster.
- SDN is a candidate for an on-board communication system.



(12) Service Basics: Information Transport Modes

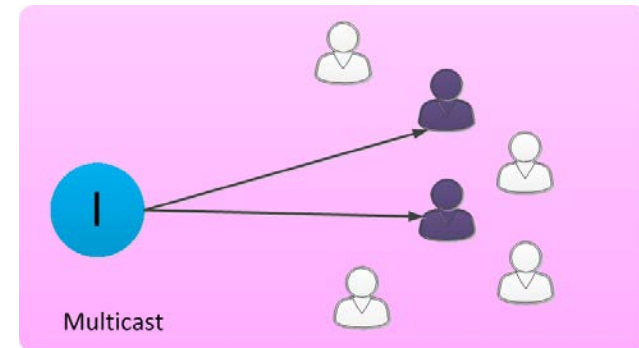
▪ Unicast

- Information are sent to exactly one recipient on a specific network;
- Encompasses also multiple unicast messages, each information is addressed to a specific recipient.



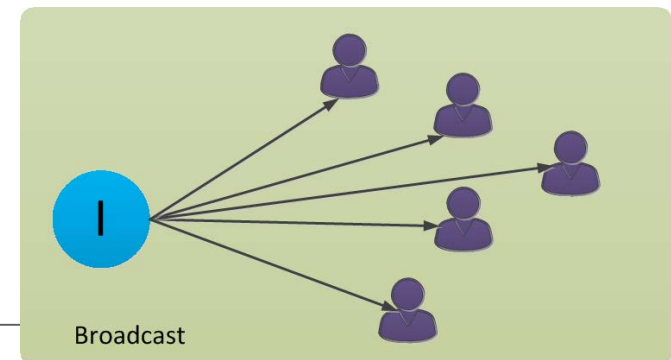
▪ Broadcast

- Information are sent to all recipients on a specific network. It is addressed towards a specific broadcast address.
- Use of broadcast depends on the number of concurrent users.

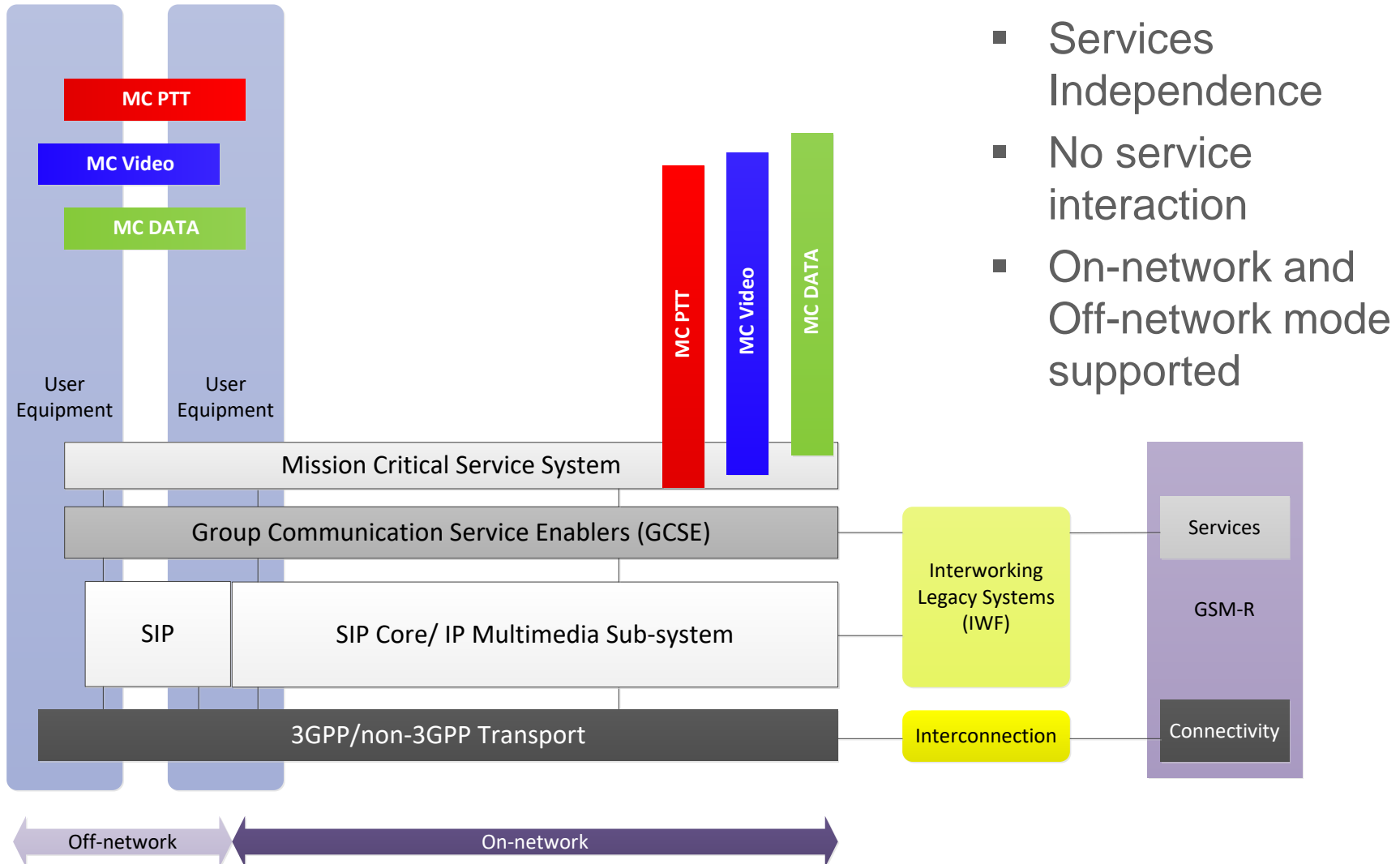


▪ Multicast

- Information are sent to a group of recipients on a network. Group members are affiliated to a group and are identified by its individual address.

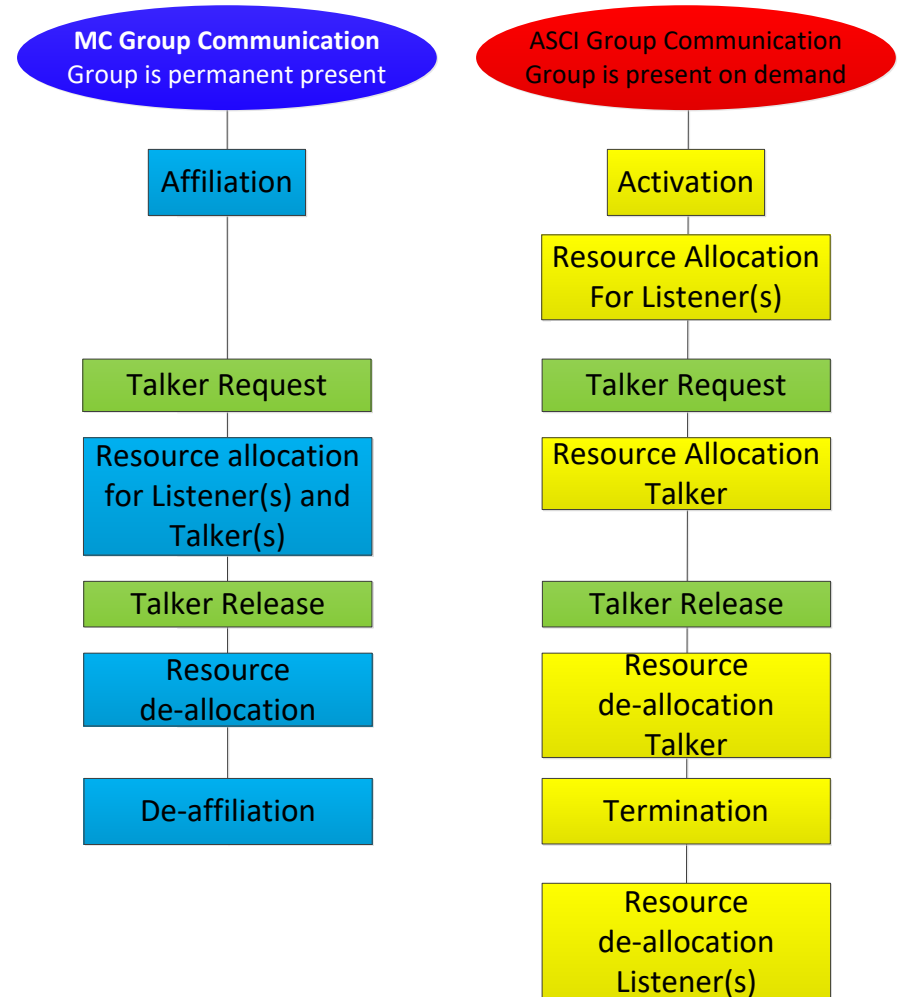


(13) Services: Mission Critical Service System High Level Approach



(14) Principle of Mission critical communications

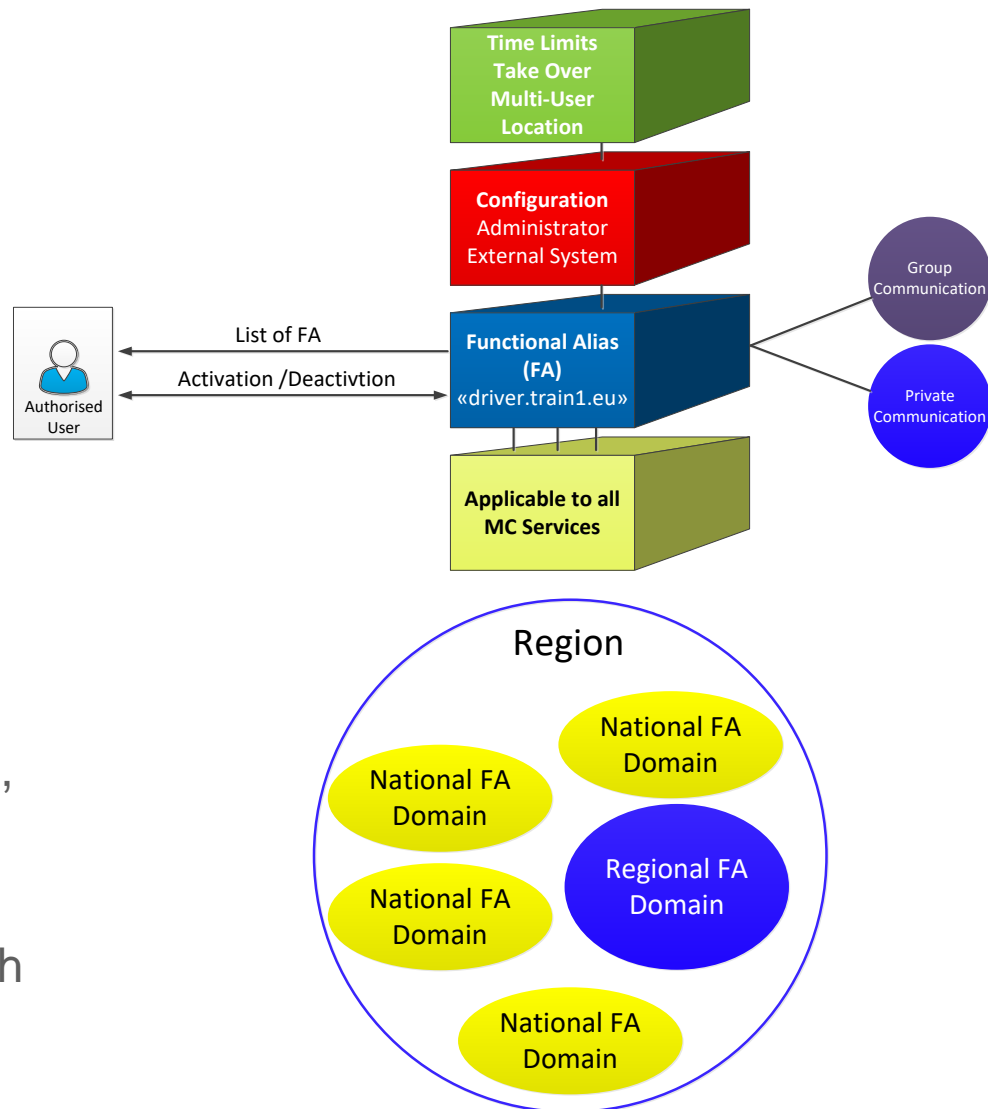
- Groups in MC framework are permanent available;
- MC User affiliates to a group and from a group automatically;
- Transport resources are only allocated when someone transmits;
- The number of concurrent users determines the use of broadcast architectural enhancements;



unity, solidarity, universality

(15) MC communications: Functional Alias (FA) High - Level behaviour

- Provides alternative user addressing scheme in contrast to MC Service identity; counterpart to Functional Number;
- FA provides alphanumeric characters;
- Only applicable for an authorised MC user.
- FA association with multiple MC users;
- Configuration by Administrator or external systems via Application Programming Interface;
- Activation/Deactivation of FA from a list, location or at MC user or log out;
- FA can be taken over if authorised;
- FA uniqueness requires association with an administrative realm;
- FA domains with national, regional or global designation possible;



(16) Next steps in 3GPP

- Continue Functional Alias;
- New focus area MC Data;
- Study the Multi MC User capabilities of one MC User Equipment ;
- Interworking between MC Service System and GSM-R;
- Requirements addressing transport system performance;
- Off-network mode requirements need to be more detailed;



(17) General 3GPP Benefits

- New concepts developed in 3GPP will help to advance railway operational concepts.
- 3GPP will provide a large variety of features from FRMCS project can select.
- 3GPP focus is on gaining flexibility in the use of communication system



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Thank You for Your Attention

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