4TC-ARM, An introduction to 5G

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Agenda

- 5G motivations
- What remains?
- Key concepts and new features
- Evolution of the radio part
- Virtualization and network function virtualization
- Network slicing
- 5G Core Network
- 5G NG RAN

Note: all the figures come from http://blogs.univ-poitiers.fr/f-launay/

5G motivations

- To look for more flexibility, a better scalability, to provide elasticity
- To reduce CAPEX/OPEX
- To support new applications: low latency, IoT, etc.
- To be able to support easily new applications and to allow new evolution

What remains? 5G is a cellular network!

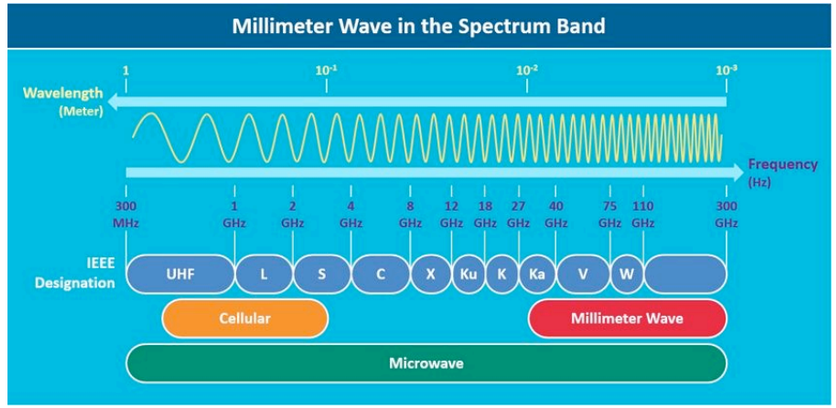
- Logical channels
- Data plane *vs* control plane
- Non access stratum *vs* access stratum
- Mobility management mechanisms
- GTP Tunnel
- As in 4G:
  - Full IP
  - Resource sharing using OFDM

Key (new) concepts

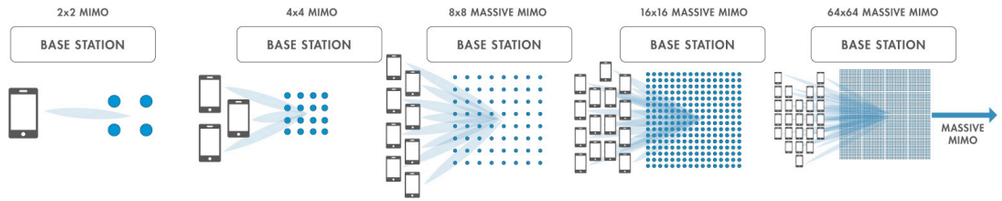
- Evolution of the radio part
- Service oriented architecture
- Virtualization, Network function virtualization
- Micro-services, middleware
- Network slicing
- IoT support

Evolution of the radio part

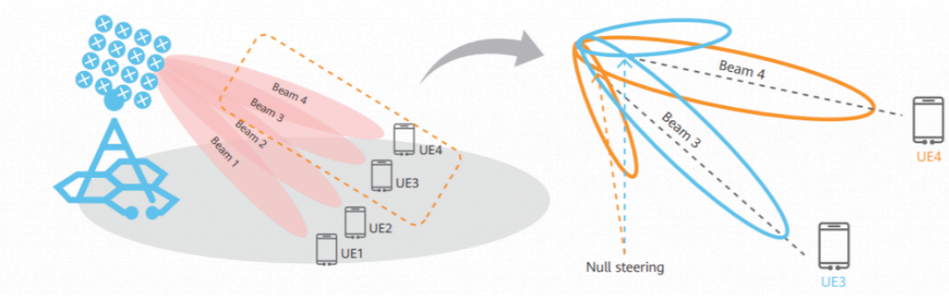
- mmWave
  (and also: 700MHz, 2.1GHz, 3.5GHz, 26GHz
  + the frequency bands used in 2G/3G/4G)



- Massive MIMO



- Beamforming

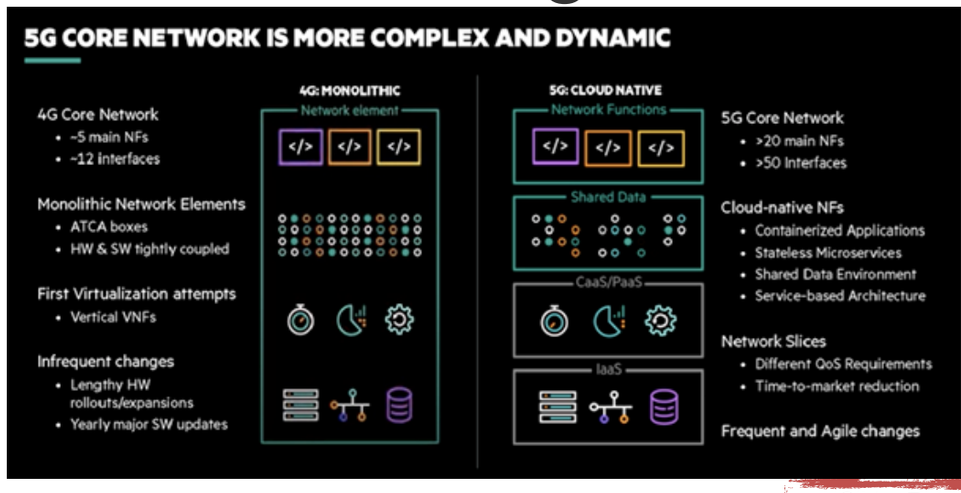


Virtualization

- From a dedicated hardware provided by telecom suppliers…

  to…

  Data center, cloud and dedicated software running on basic servers
  (*Service Oriented Architecture*)



Network function virtualization

- Instead of having one EPC running on a server, the functions are divided into independent softwares (aka micro-services) running on virtual machines
  - Flexibility, Scalability, Elasticity

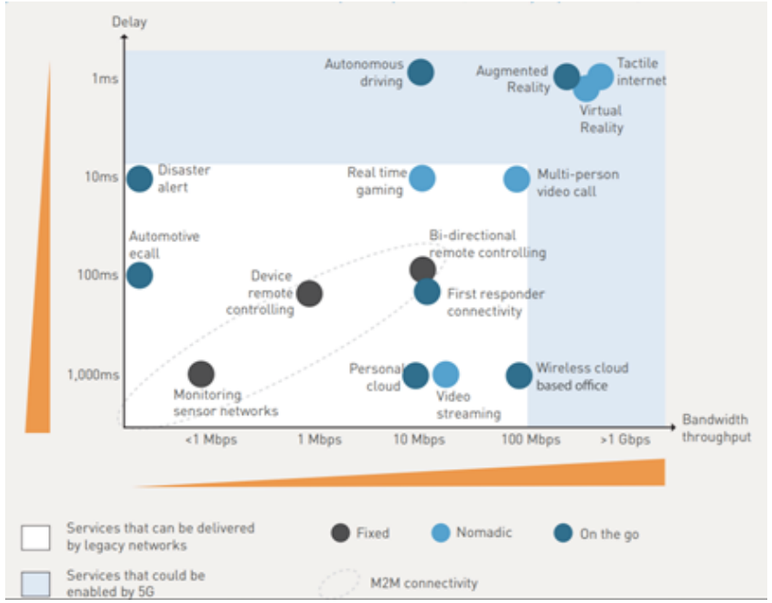
- Network deployment and optimization:
  - Where to locate the network functions (*e.g.* MME) to reduce the signaling load, to decrease the latency, to optimize the throughput, etc.
  - How to adapt dynamically the architecture to the requests?

Network slicing

- To provide efficient support for quality of service and *Service Level Agreement* (SLA)
- In 5G, several heterogeneous applications:
  - mMTC: massive Machine Type Communications
  - eMBB: enhanced Mobile Broadband
  - URLLC: Ultra-Reliable Low Latency Communications
  - V2X: Connected Vehicles
- Heterogeneous QoS requirements and heterogeneous KPIs

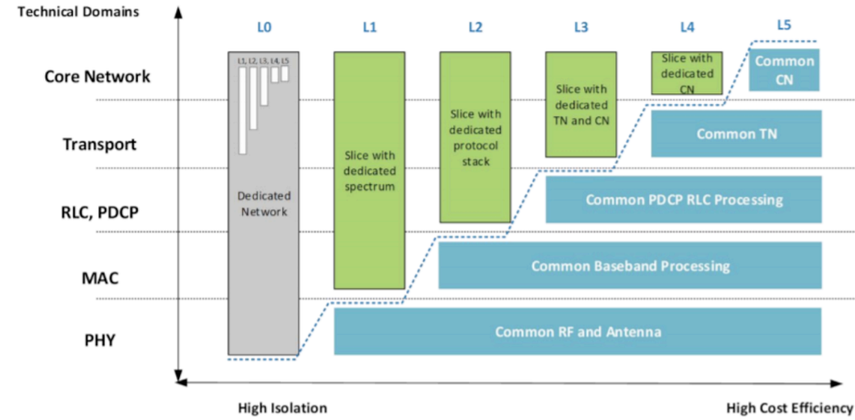
Network slicing (cont'd)

- To build logical networks w.r.t KPI on a single physical network
- Isolation of the different slices to allow independent monitoring, management, etc.
- Typically:
  - A slice for mobile broadband
  - A slice for V2X trafic
  - 1 slice for a MVNO
  - 1 slice for first responders
  - etc.



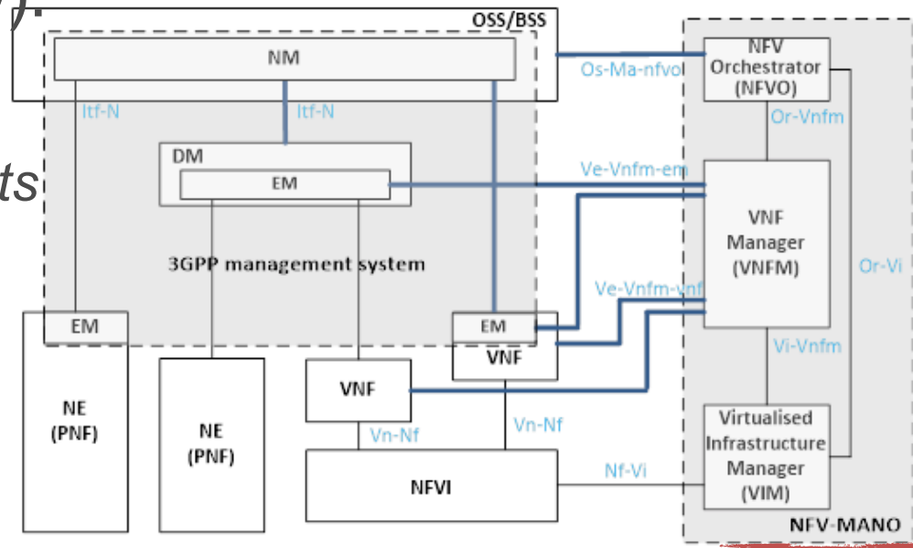
Network slicing (cont'd)

- Network slice template
  - List of virtual functions required,
  - Hardware needed for each function,
- Network slice instance
  - Entities (e.g. RAN, server, software component) w.r.t. KPIs
  - Physical network function (PNF) and virtual network function (NFV)
- Network slice
  - Management and monitoring of NSI
  - Monitor the provided QoS

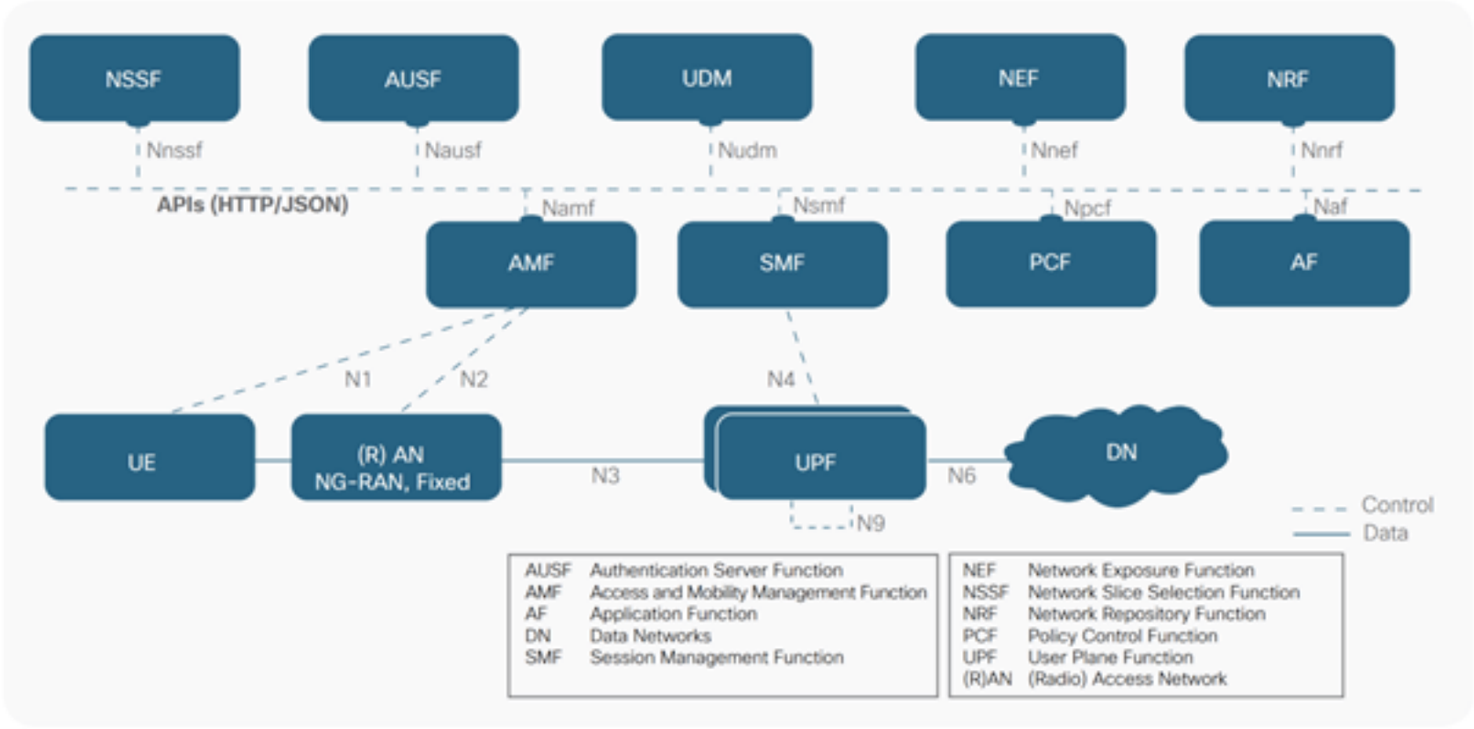


Network slicing (cont'd)

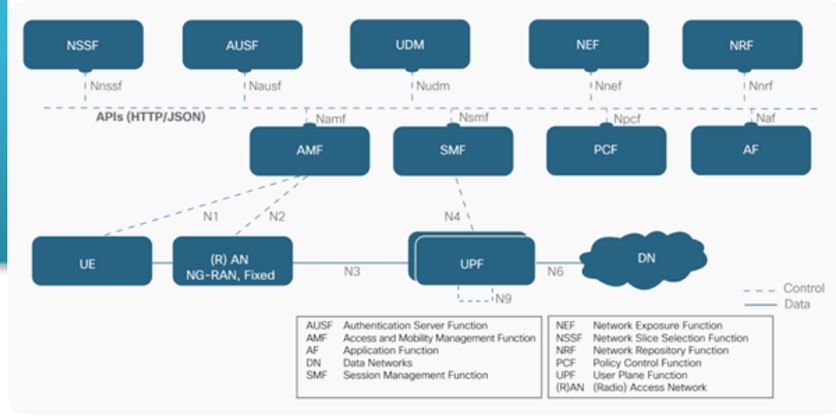
- New components are defined
  - Management system (OSS/BSS):
    - *Operation Support System: management, service provisioning, configuration, resource supervision*
    - *Business Support System: adapt the service deployment to the user demand*
  - Management and orchestration (NFV-MANO):
    - *Virtual function deployment*
    - *Monitoring virtual functions and hardware components*
    - *Virtual machines deployment & monitoring*
    - *Used & available resources*



5G Core Network

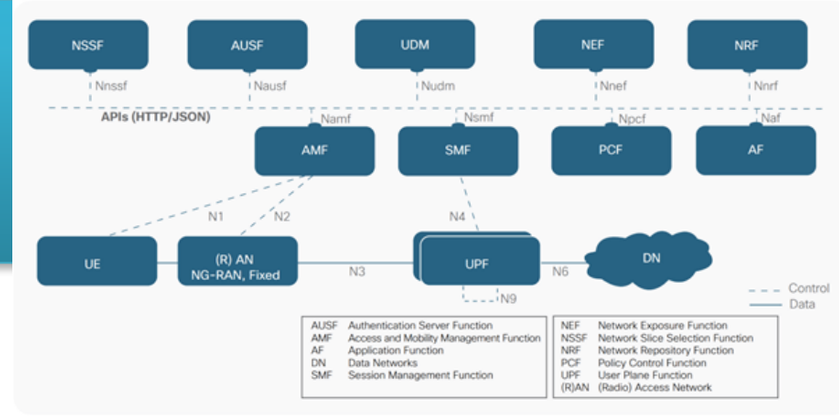


5G Core Network (cont'd)



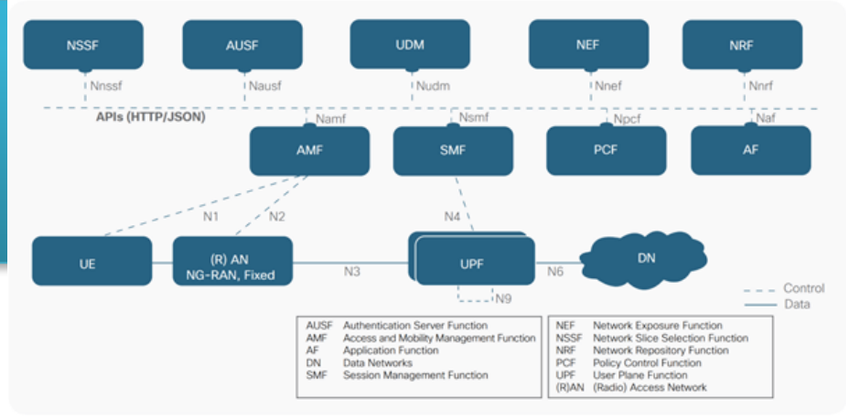
- Network slice selection function (NSS)
  - Selection of a slice considering the SLA
  - To provide the quality of experience required
- Authentication server function (AUSF)
  - Security functions
  - IMSI is always encrypted
  - Network can be authenticated

5G Core Network (cont'd)



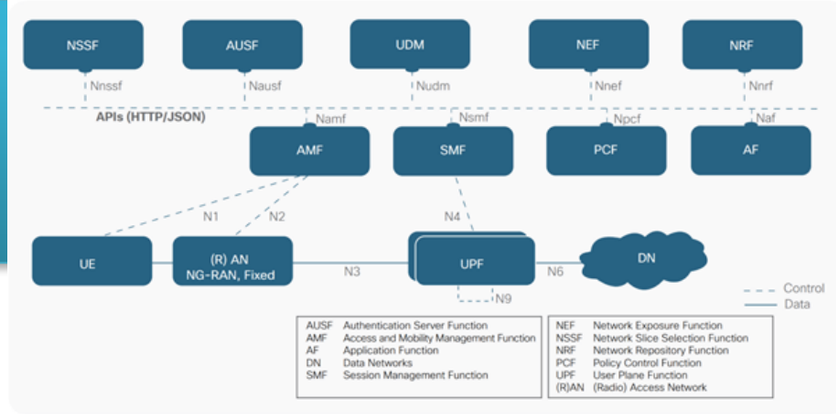
- Unified data management (UDM)
  - User session profile
  - Access to the UDR (*Unified Data Repository*) database
- Network exposure function (NEF)
  - To secure the service and capabilities provided by the network
  - RESTful APIs
- Network repository function (NRF)
  - List of virtual functions (available/used)
  - Control of the virtual function and re-configuration

5G Core Network (cont'd)



- Access and mobility function (AMF)
  - ~ MME in 4G
- Session management function (SMF)
  - Management and supervision of the PDN session
  - Control plane
- Policy control function (PCF)
  - Monitoring and control of the trafic in the network for AMF & SMF
- Application function (AF)
  - Provide the session related information to the PCF

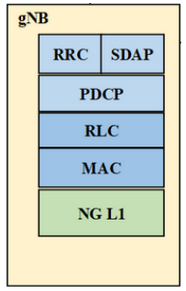
5G Core Network (cont'd)

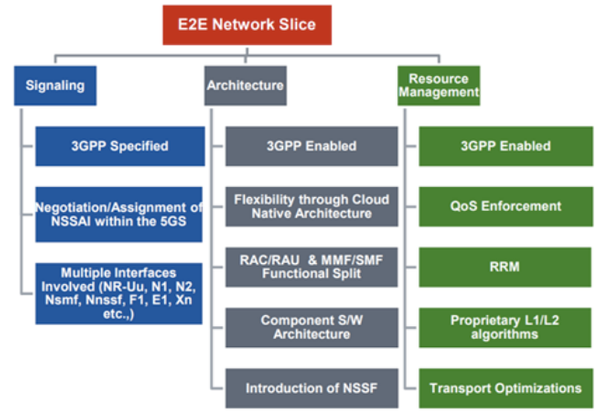


- User equipment (UE)
- New generation radio access network (NG-RAN)
- User plane function (UPF)
  - ~ PGW-C and SGW-C in 4G
  - User plane
  - Application classification
- Data networks (DN)
  - Internet access
  - Service providers

5G NG RAN

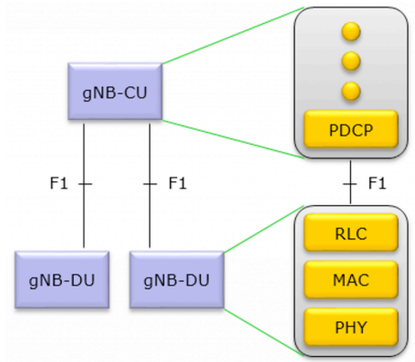
- End-to-end slice, including CN & RAN functions
- A 5G Base station:
  - *Radio resource management (monitoring, allocation, etc.)*
  - *Coding and modulation scheme,*
  - *Logical channels and SIBs,*
  - *MAC and scheduling*
  - *Ciphering,*
  - *Data plane (SDAP, Service adaptation protocol) / control plane (RRC)*
  - *IP Compression,*
  - *Session management,*
  - *QoS support,*
  - *Network slicing support*

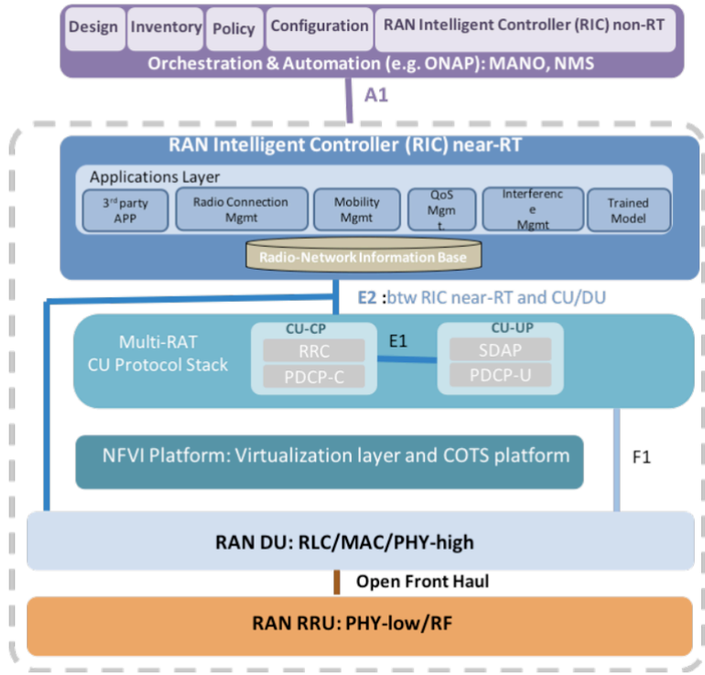




Base station (could be virtual)

- gNodeB:
  - 1 physical component (antenna)
  - 2 functions which could be virtual:
    - *gNB-CU*
    - *gNB-DU*
- From RAN to C-RAN (Cloud RAN)





Thanks for listening, reading and asking.

The end.