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5G – Enabling technology for web integration?

… or not? Is this déjà vu all over again?

Dan Warren, Head of 5G Research, Samsung

Starting point - ‘5G is different’

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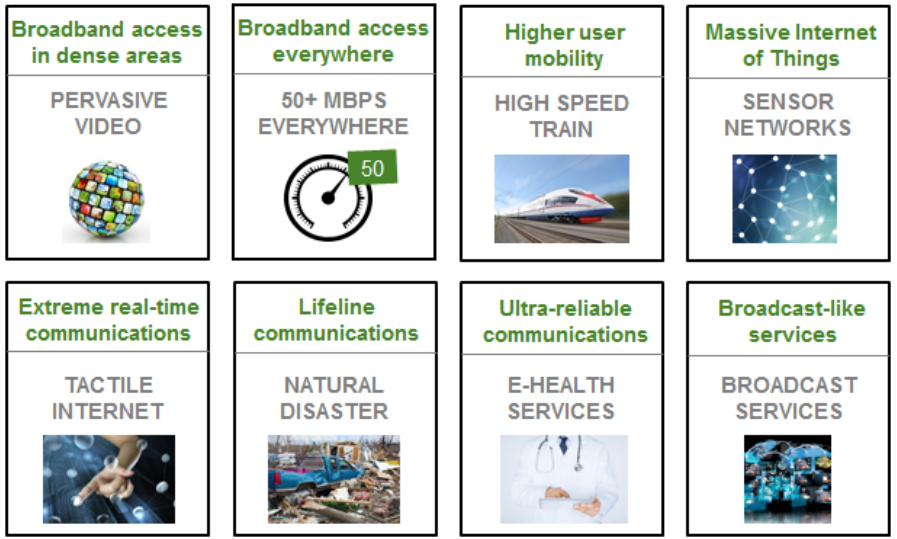
- Service, application and business case-led definition

Source – NGMN White Paper, 2015 https://www.ngmn.org/de/5g-white-paper/5g-white-paper.html

5G Vision defined around Business Context, and Characterisation based on Use Cases, Business Models and Value Creation



5G Service Scenarios

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- Key Scenarios to be Addressed throughout the Multiple Stages of 5G Development

Requirements

- 10x bandwidth per connection
- Low-ms latency
- Five 9's reliability
- 100% coverage
- >10x connections
- 50Mbps per connection everywhere
- 1000x bandwidth/area
- 10 year battery life
- Reduction in TCO

Different contexts of the same environment

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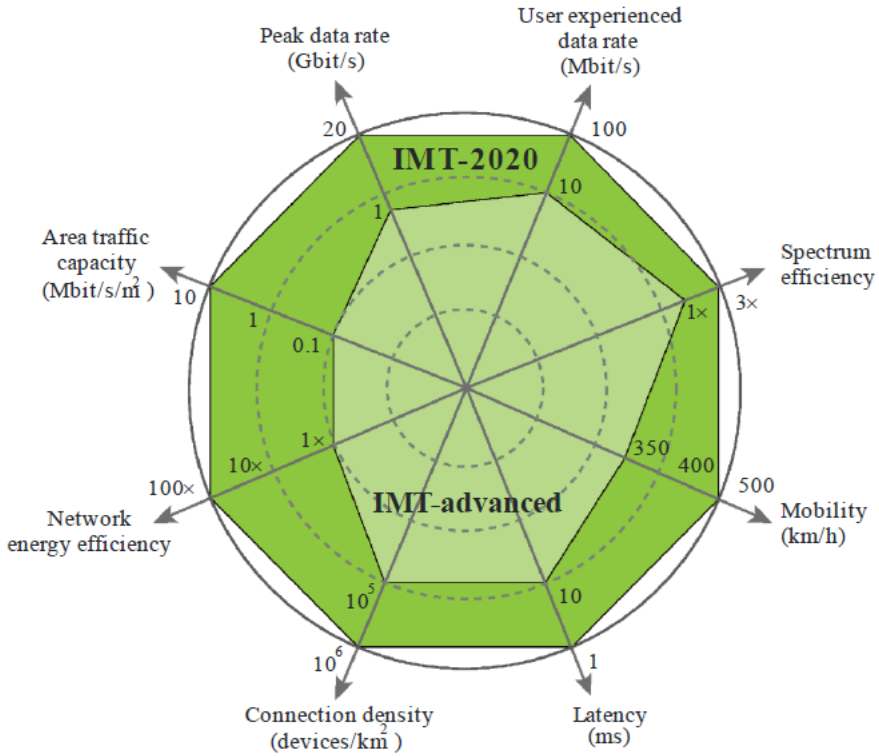
Requirements	Applications	Customer segments	MNO biz model
• 10x bandwidth per connection • Low-ms latency • Five 9's reliability • 100% coverage • >10x connections • 50Mbps per connection everywhere • 1000x bandwidth/area • 10 year battery life • Reduction in TCO	• Enhanced Mobile BB • Connected vehicles • AR/VR • S-UHD/3D Video • Haptics/Sensing • Massive IoT • Remote machine control • Mission critical services • Fixed-wireless access • …	• Consumer • Auto industry • Health • Industry 4.0 • Agriculture • Smart City/Public sector • Smart building • Utilities • Education • Transport • …	• B2C • B2B • B2B2C

Faux requirements – Five 9's and 100%



Source – ITU-R M.2083 'IMT Vision – Framework and overall objectives of the future development of IMT for 2020 and beyond

What's Missing?

- ITU-R has no requirement for 100% coverage* or for 99.999% availability

So why does everyone keep talking about them?

- Because they are included in everyone's marketing, but no one knows why they were put there.
- NGMN's white paper mentions 'availability close to 100%'.

**ITU-R M.2083 does state 'Achievable data rate that is available ubiquitously across the coverage area', but in a foot note clarifies that 'The term "ubiquitous" is related to the considered coverage area and is not intended to relate to an entire region or country'*

... or in other words, when they say ubiquitous, they don't actually mean ubiquitous

5G Service Enablers – meeting requirements

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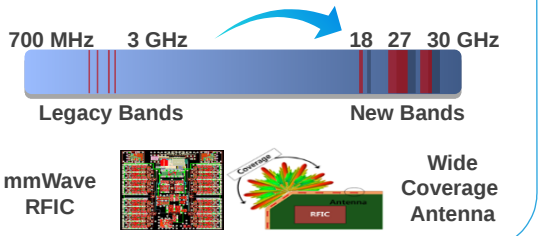
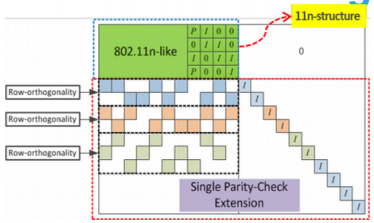
mmWave System/RFIC/Ant.

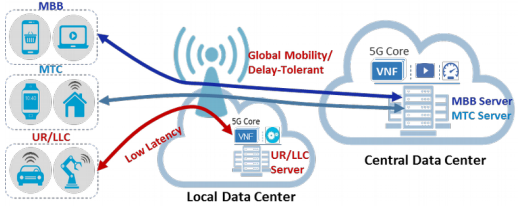


New Channel Coding

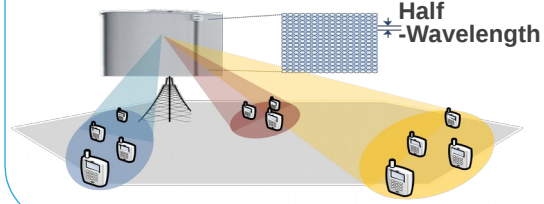


LDPC (Low-Density Parity-Check)

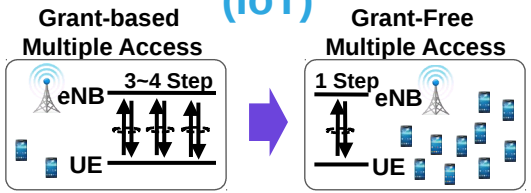
Network Slicing



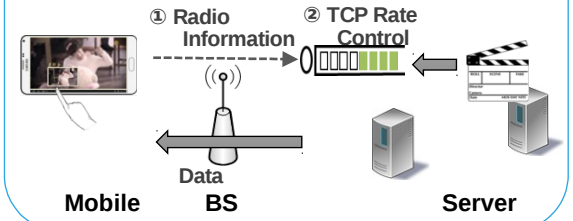
< 6 GHz Massive MIMO



Massive Connectivity (IoT)



Low Latency NW



New for 5G – RAN architecture extensions

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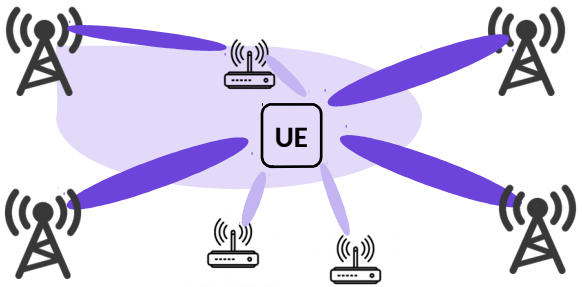

New Air Interface

- **CP-OFDM** – to introduce flexibility in OFDM and mitigate Inter Symbol Interference
- **Massive MIMO** – large numbers of bearers to increase bandwidth in sub-6GHz bands
- **mmWave** – provides access to broad frequency bands for higher bandwidths
- **Beam Forming** – extends range/cell size for mmWave bands
- **Shortened TTI** – reduces latency
- **Flexibility in band sizing** – allows previously unavailable bands to be used

Other RAN innovations

- **CoMP** – UE attached to multiple cells to provide greater reliability
- **Small cell support** – greater indoor coverage, increased cell density, self-backhauling
- **5G-NR in unlicensed bands** – extension of mobile ecosystem
- **Session management split from mobility management** – enabler for RAN slicing
- **D2D, V2X** – devices connecting directly, with no network

(not so) 5G – topology flexibility

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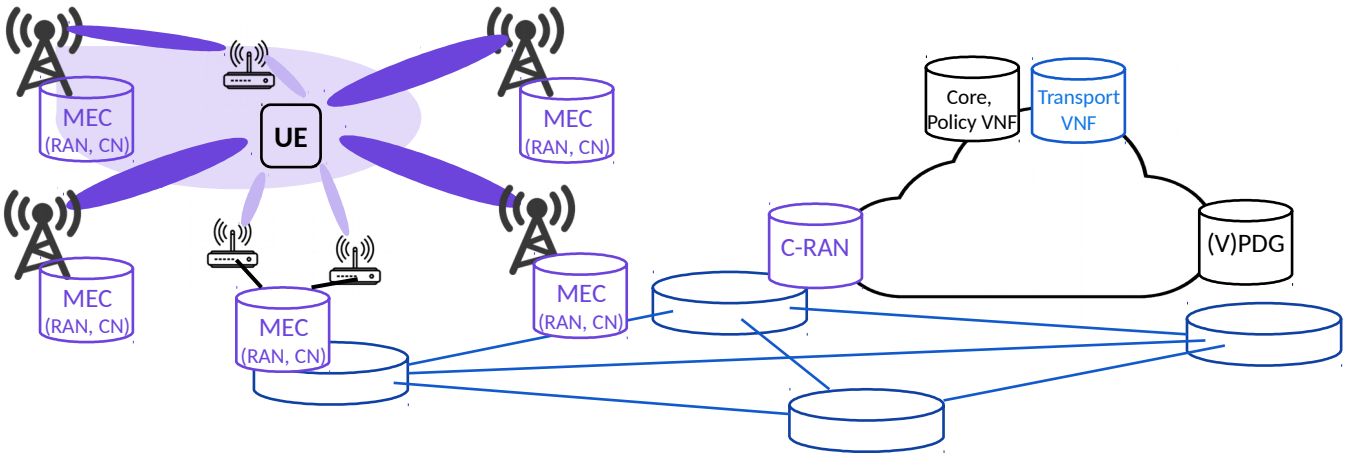

‘Softwarisation’ of the network

C-RAN – removal of functionality from cell sites to consolidation point in the network

NFV and SDN – enabling flexibility in where functions are deployed and scaled

MEC – pushing Core Network functions and content ingress to cell sites

CP/UP split – decoupling of user plane traffic from control plane functions

Meeting the goals

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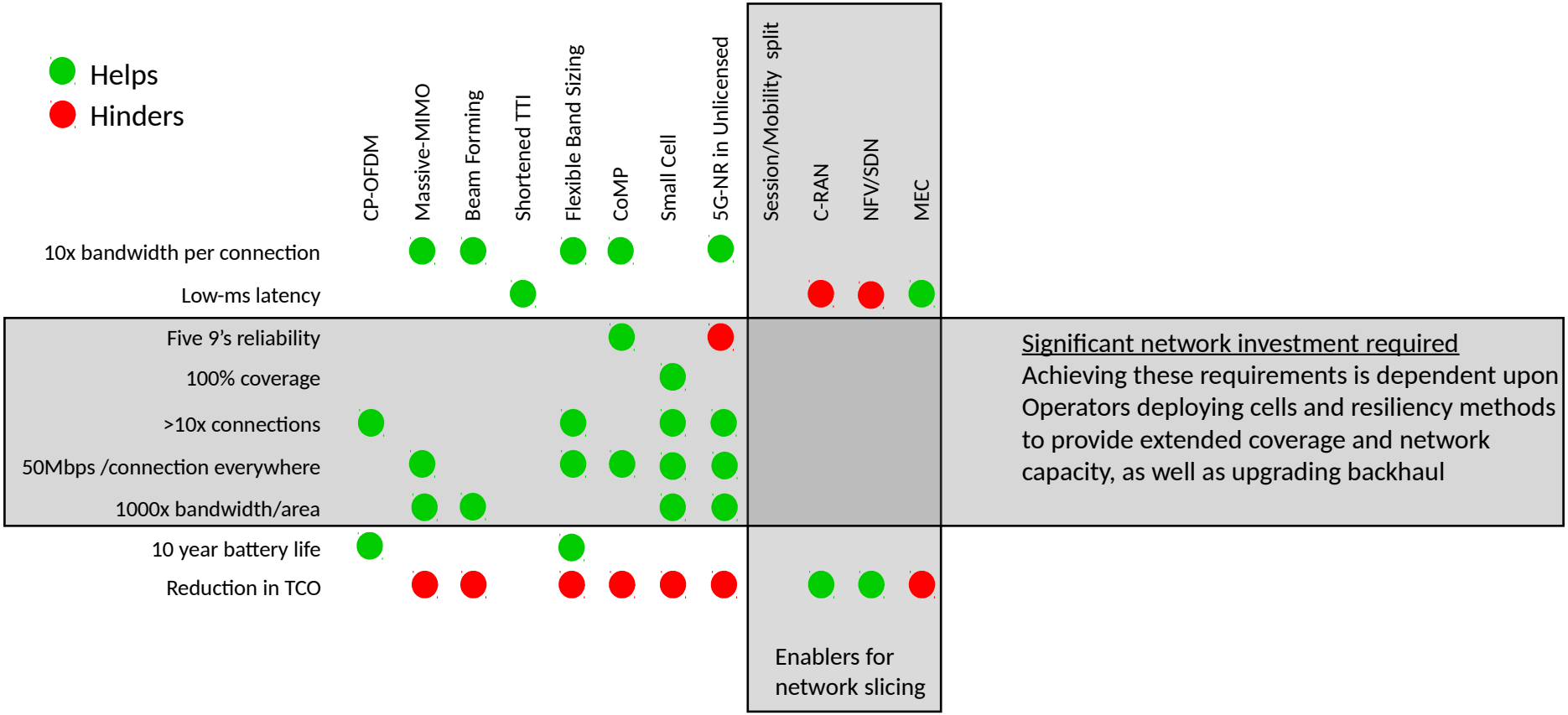

Pain points for commercial slicing

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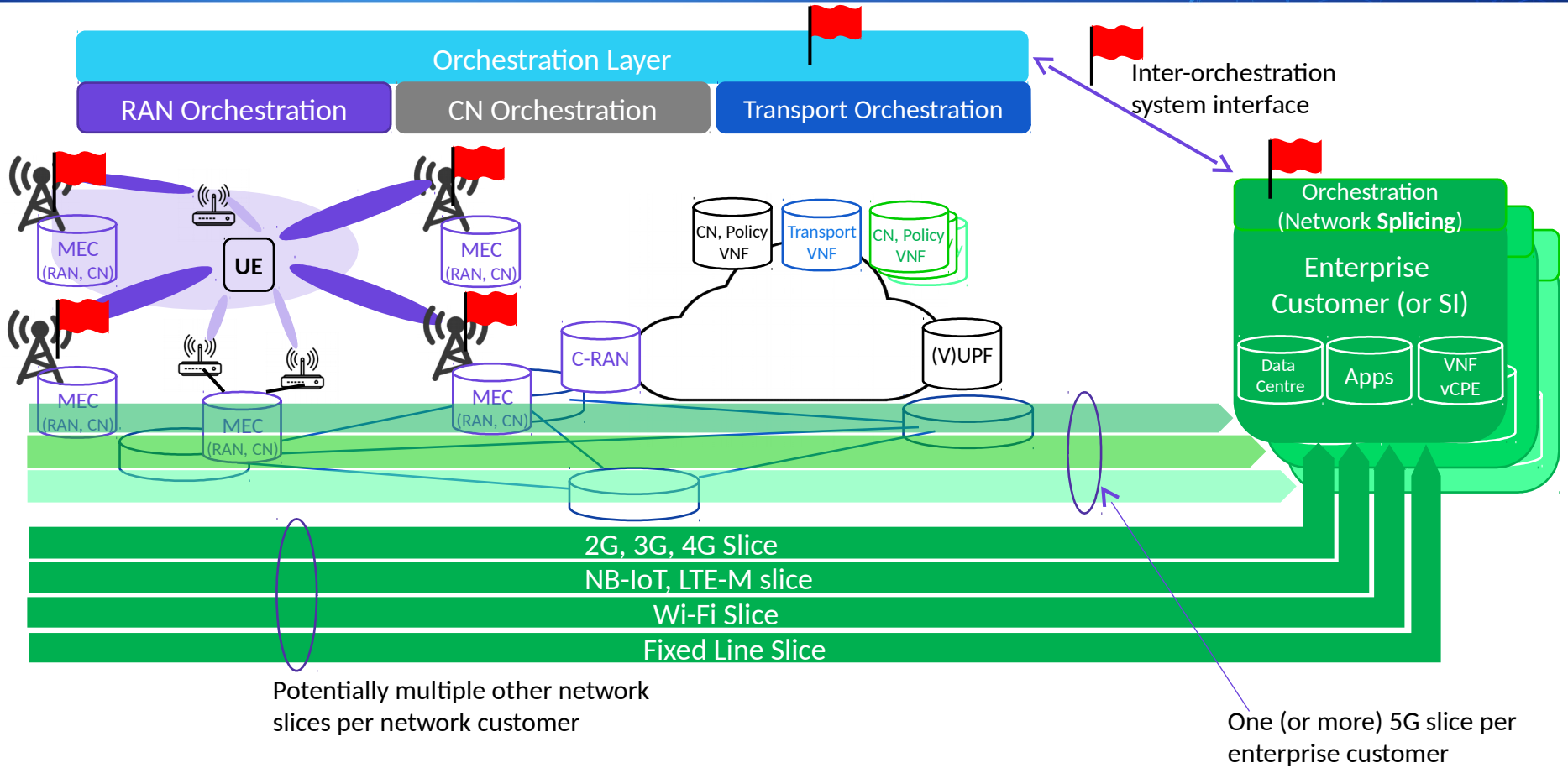
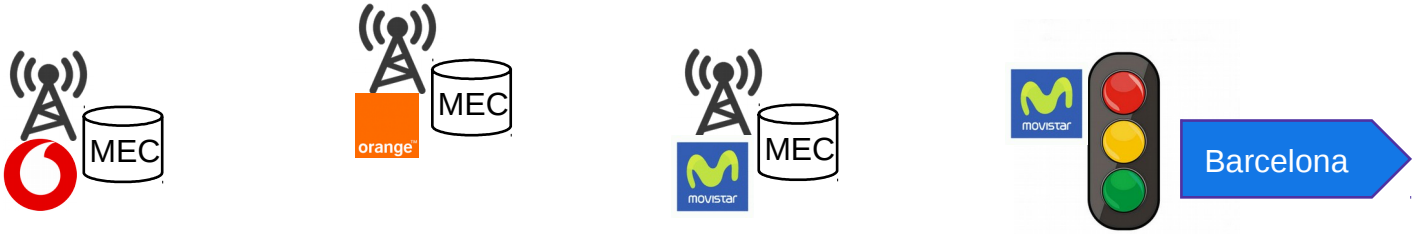
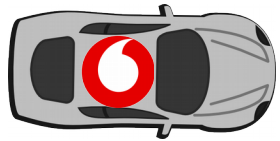


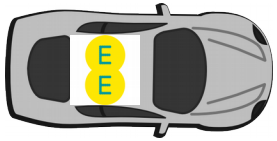
An example of Secondary implications

~~V2N2X~~ ~~V2N2N2X~~ ~~V2N2multi-N2X~~ V2vN2hN2multi-N2X??

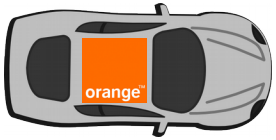




Very localised interconnect

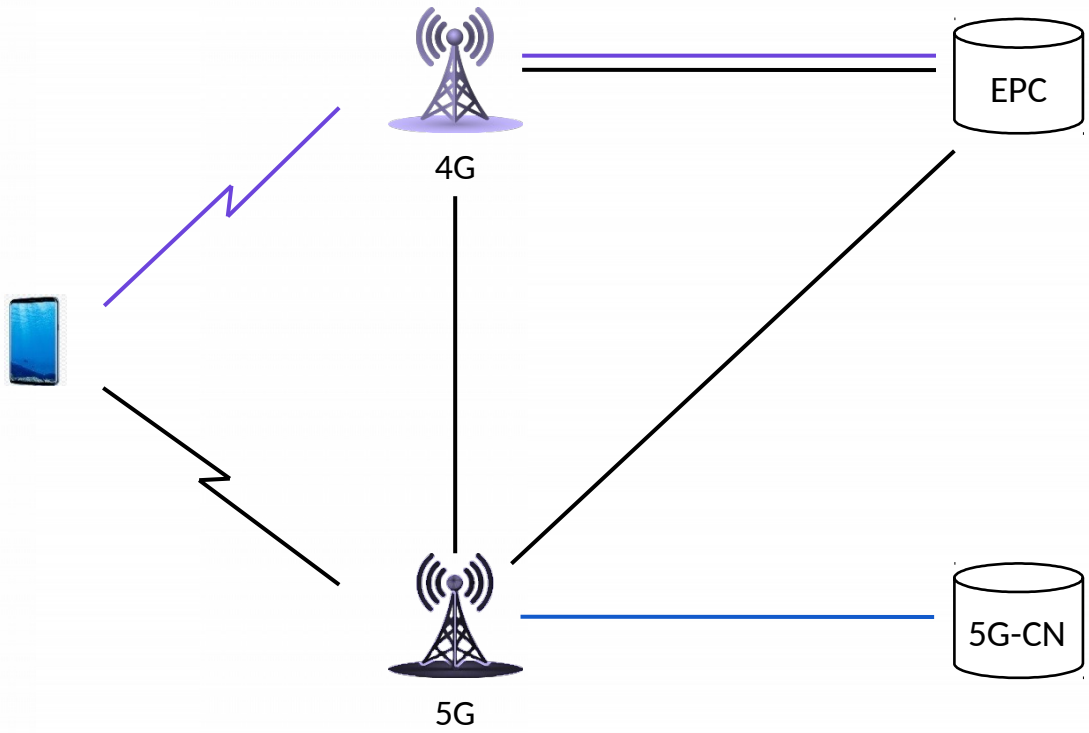


Completely new Roaming model



Technical and commercial challenges

5G – Standalone vs Non-Standalone



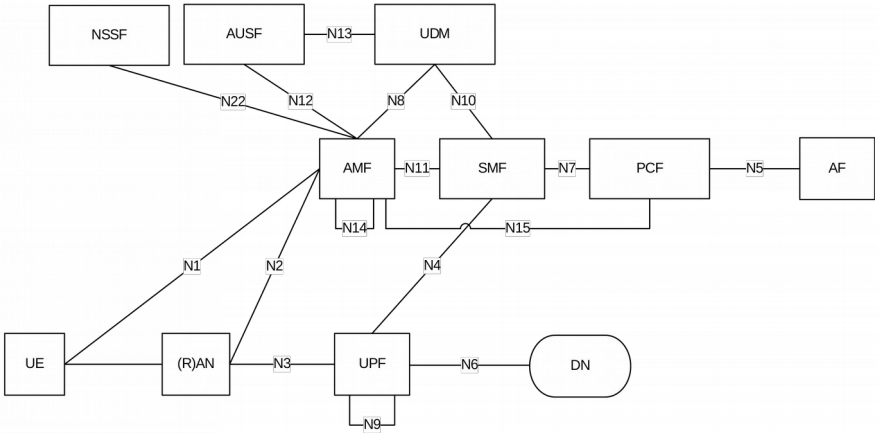
Today – 4G Access
Device attaches to LTE/4G radio and Evolved Packet Core (EPC)

Early 5G – Non-Standalone
Device attaches to 5G-NR, which routes either via 4G Base Station to EPC, or direct to EPC

5G Standalone
Device attaches to 5G-NR and 5G Core Network.

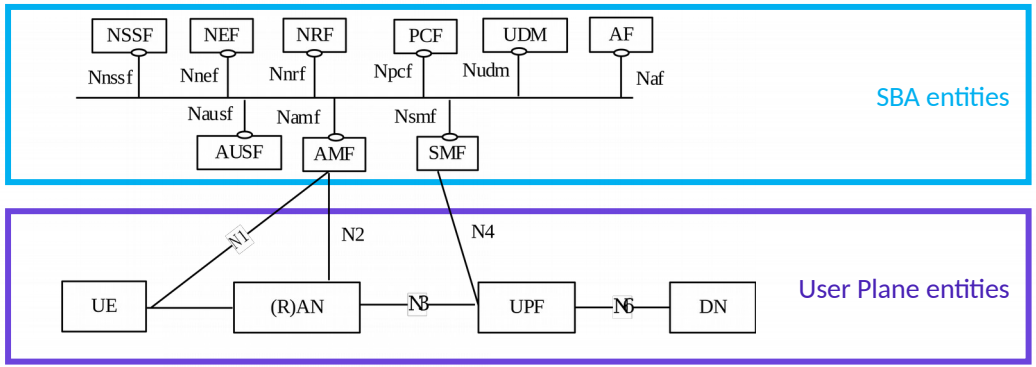
5G CN Architecture

- Traditionally 3GPP has documented the architecture of the system (in Stage 2 Working Groups) using Reference Points and Network Functions
- In principle there is one Reference Point between each pair of Network Functions
- The functionality of each Reference Point is then defined in terms of the messages exchanged between the Network Functions, as shown in call flows in the Technical Specifications
- The Stage 3 Working Groups take these call flows and translate them into protocols
- Different protocols can, and often are, used for different Reference Points
- Here is the 5G system architecture depicted in this Reference Point style (from TS 23.501)



CN redefined as Service-Based Architecture (SBA)

- Here is the 5G system architecture depicted in the SBA style (from TS 23.501)



Authentication Server Function (AUSF)
Access and Mobility Management Function (AMF)
Session Management Function (SMF)
Network Slice Selection Function (NSSF)
Network Exposure Function (NEF)
NF Repository Function (NRF)
Policy Control Function (PCF)
Unified Data Management (UDM)
Application Function (AF)

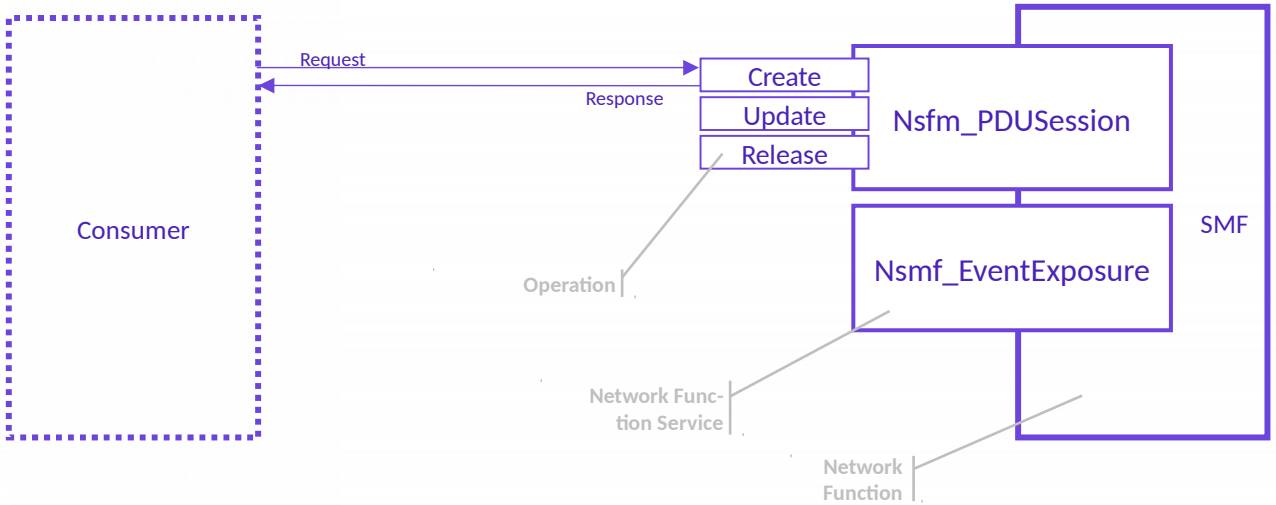
Unified Data Repository (UDR)
Unstructured Data Storage Function (UDSF)
5G-Equipment Identity Register (5G-EIR)
Security Edge Protection Proxy (SEPP)
Network Data Analytics Function (NWDAF)

User Plane Function (UPF)
Data Network (DN), e.g. operator services, Internet access or 3rd party services
User Equipment (UE)
(Radio) Access Network ((R)AN)

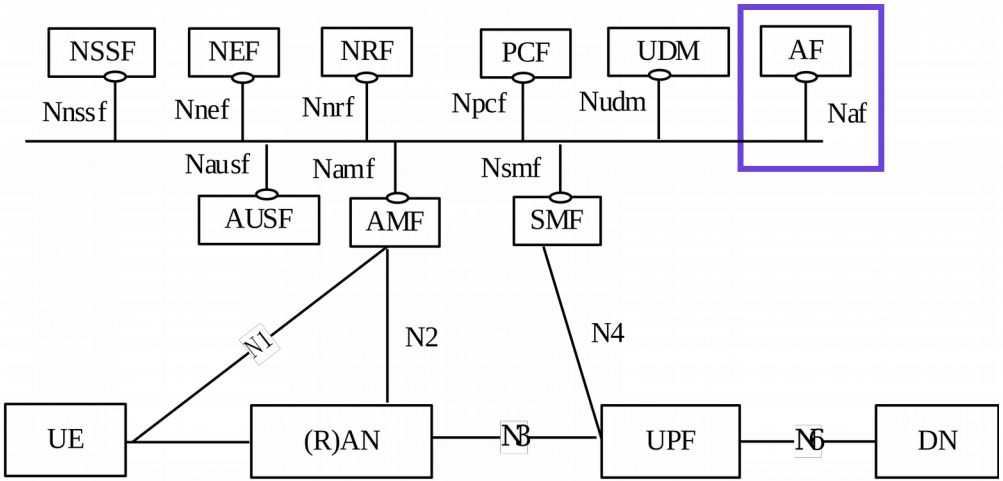
- Note that the User Plane functions, and their direct interactions with the Control Plane, are still depicted as Reference Points
- However, all of the other Control Plane functions are connected by http2-based service-based interfaces
- In principle any service-based interface exposed by a Network Function can be used (consumed) by any other Network Function

Functions, Services, Operations

- **Each entity in the architecture is (still) called a Network Function**
- **For those entities that are part of the Service Based Architecture**
  - Each of the interfaces to the Network Functions is a Service Based Interface (eg Nsmf)
  - Each Network Function supports one or more Network Function Services exposed via its Service Based Interface
  - Each Network Function Service supports one or more Operations
- **Operations can be invoked by other entities (Consumers)**



An AF with an http2 interface



- **The Application Function (AF) can be a mutually authenticated third party.**
  - Could be a specific 3rd party with a direct http2 interface or a interworking gateway exposing alternative API's to external applications.
- **Enables applications to directly control Policy (reserve network resource, enforce SLAs), create network Slices, learn device capabilities and adapt service accordingly, invoke other VNF's within the network…**
- **Can also subscribe to events and have direct understanding of how the network behaves in relation to the service delivered.**

- **Because the SBA is made up of VNFs, the AF could be deployed on a MEC server, in a network Cloud, on dedicated hardware. It could be dynamically brought into the network, or a specific network slice, and then removed when no longer in use.**

The de ja vu bit

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OMTP OPEN MOBILE TERMINAL PLATFORM APPROVED

OMTP OPEN MOBILE TERMINAL PLATFORM BONDI

oma Open Mobile Alliance For a Connected World

GSMA OneAPI

The Parlay Group

Parlay-X

WAC

OSA/Parlay

So where does that take us?

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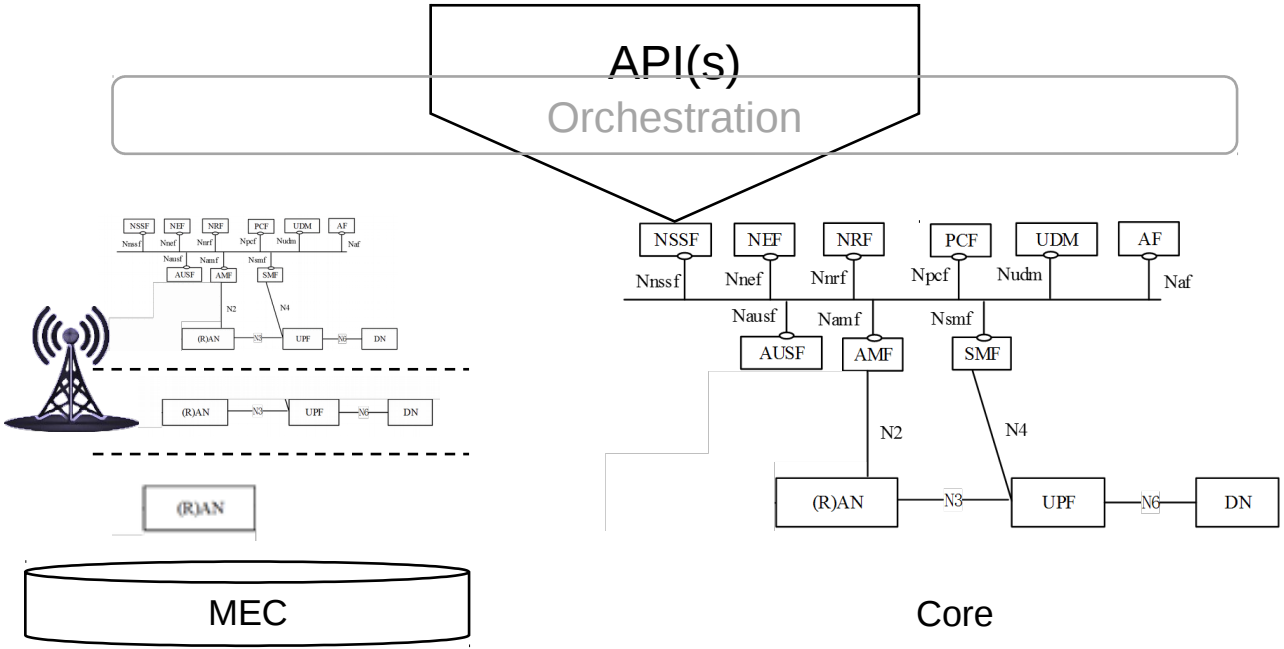
APIs

App, Dev, Web communities



Conclusions – This… but that…

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SBA, and the adoption of http2 is an opportunity for Web, App, Dev communities to access network capabilities	Not all networks will be 5G-SA day 1 (or Day N+1), so there is network-specific perspective to what will be available when and where
3GPP are in the process of defining the interfaces in the SBA architecture so there is an opportunity to work with the telecoms ecosystem to get this right	3GPP takes a looooong time, and adoption may take even longer – will web community wait? (You haven't in the past, particularly when device APIs get the job done)
URLLC and Massive IoT are the target use cases for 5G	eMBB is where initial launches will be targeted.
B2B, B2B2C business models drive 5G business case	No one actually knows what the business case is yet, and B2B, B2B2C come with different expectations from the customer around SLA, KPI and contractual penalties, liability

Set aside the radio – an SBA 5G Core network, with softwarisation, virtualisation, orchestration, MEC and slicing is going to take operators a while to get their heads around.

Consequences if we take all as read…

- 1ms latency for AR, VR, remote surgery is pointless without a video codec that runs signifi cantly faster than 1000 frames per second.
- TCP/IP is not fit for purpose. Packet loss handling will break a lot of 5G use cases
- …and neither is GTP. Internet of Things needs ‘Internet to the Thing’ without a proprietary connectivity network in the way.
- Telco networks have had to wait for common hardware platform performance to reach **curr ent** performance and availability requirements before NFV/SDN could happen. 5G perform ance and availability requirements are an order of magnitude harder and pushing the platf orm down into a more remote part of the network…
- ‘Driverless’ autonomous cars are great, as long as they are ALL autonomous. There is a m assive backward compatibility issue when some cars are driverless and others aren’t.
- Existing Roaming model won’t cut it… but we have been trying to change Roaming for yea rs. It is not technology that stops it changing.

Thank You

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