5G INTERCONNECT AND ROAMING

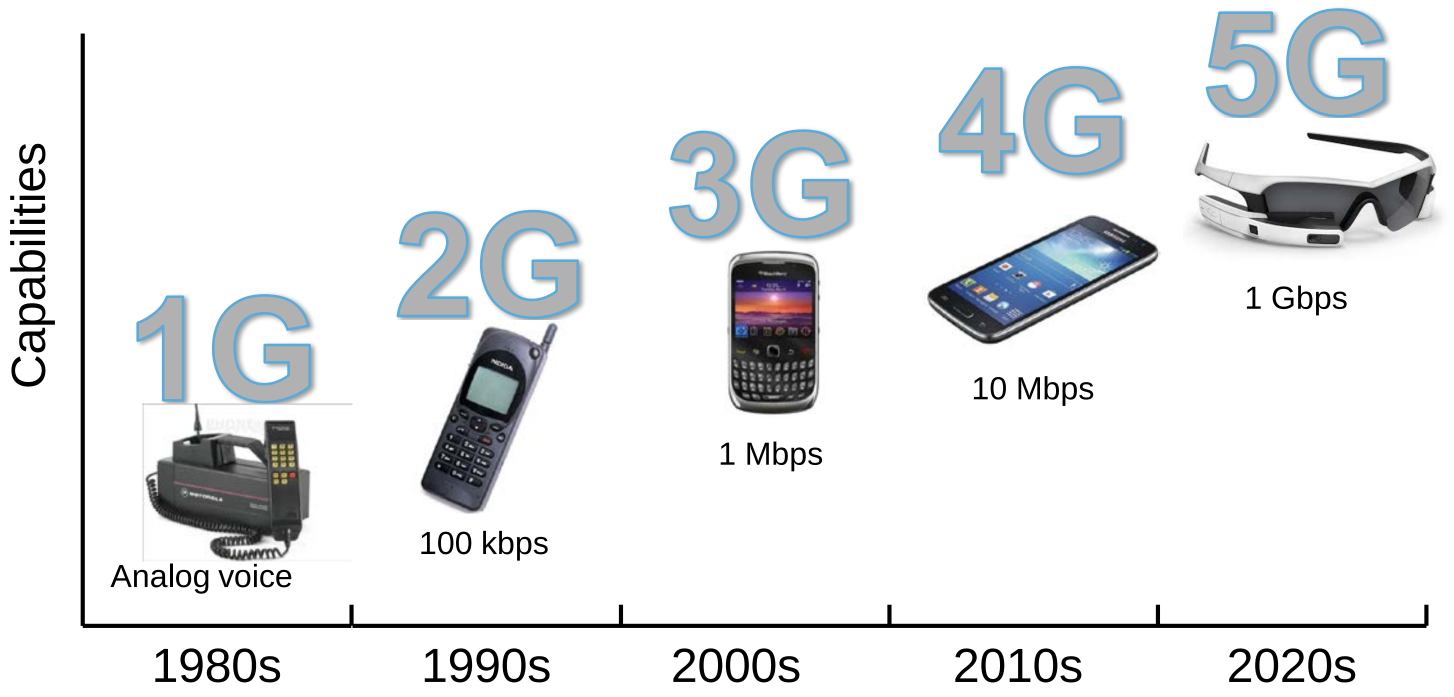
How can we make network slicing and edge computing work across networks?

Pieter Nooren

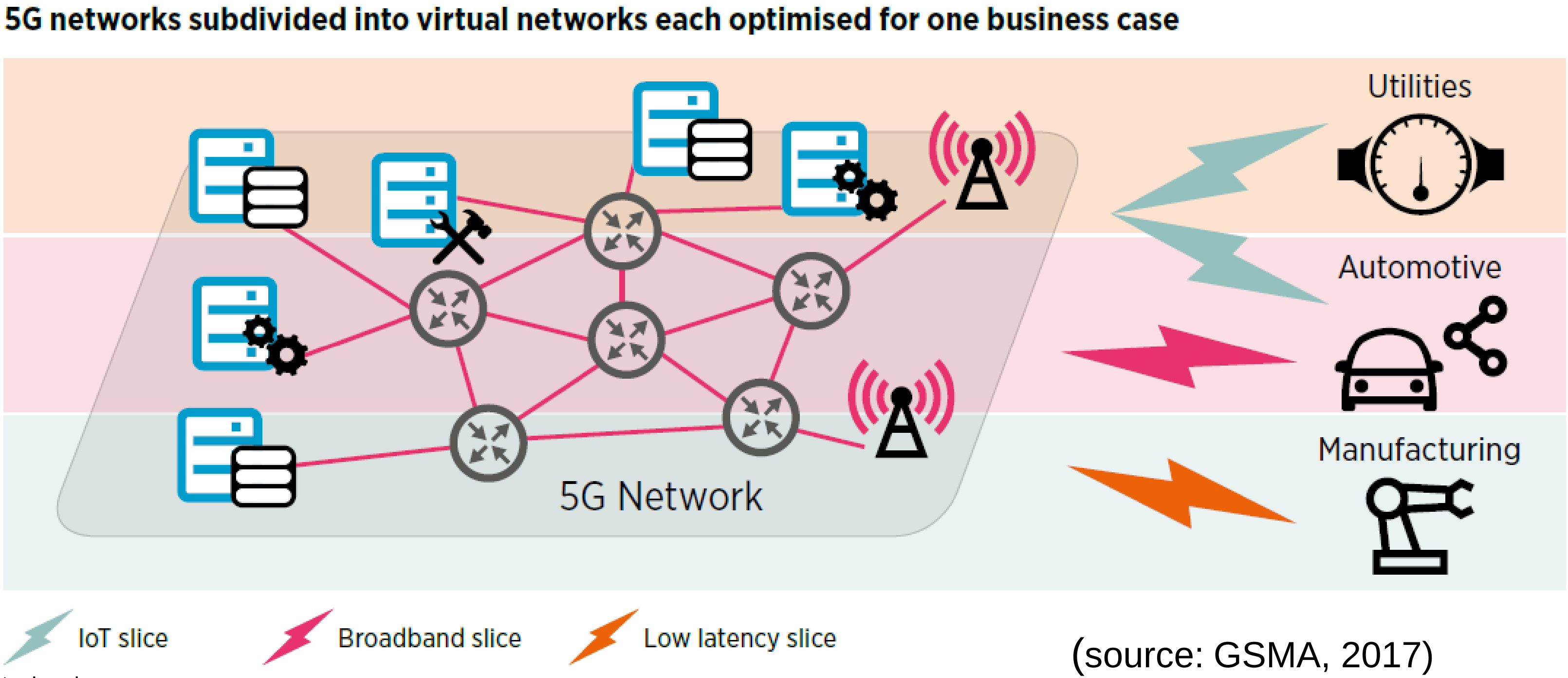
WIK Conference “New Code, new challenges for the Gigabit society”,
Brussels,15-16 October 2019

TNO innovation for life

FIVE GENERATIONS MOBILE COMMUNICATION



5G AIMS TO PROVIDE TAILORED CONNECTIVITY TO A VARIETY OF APPLICATION AREAS

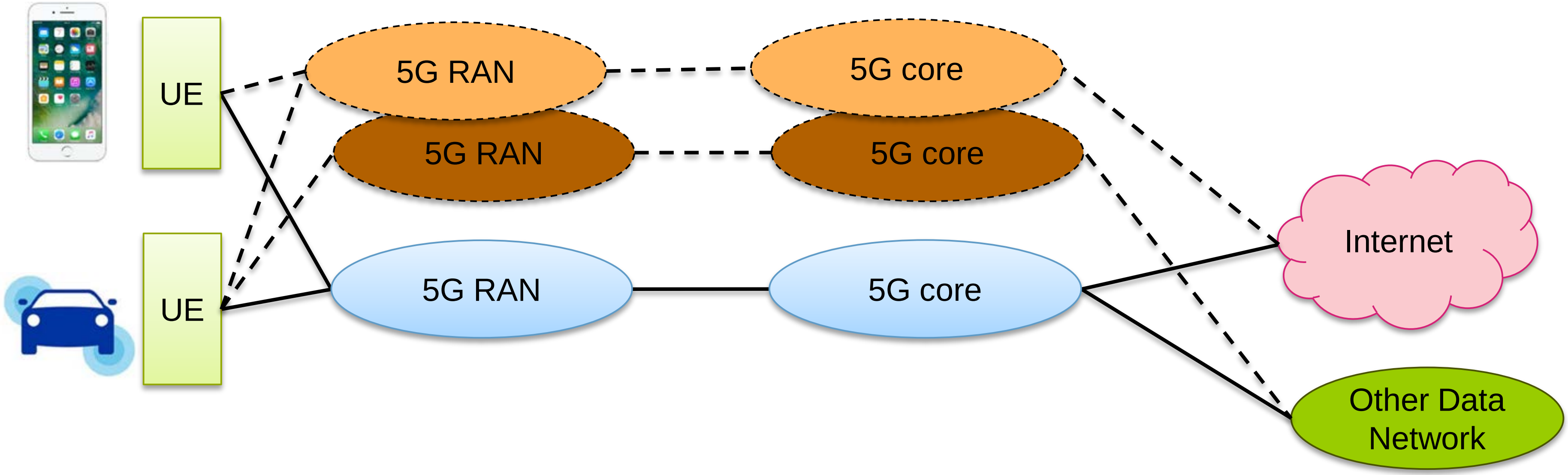


(source: GSMA, 2017)

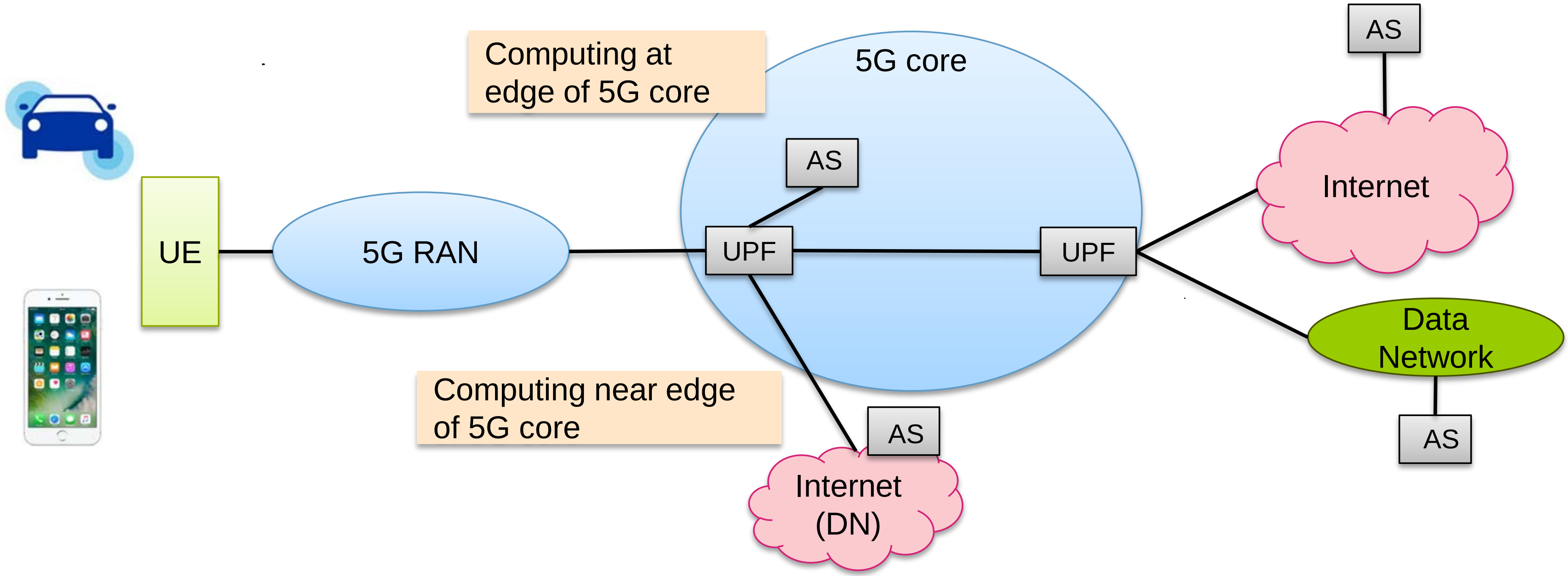
IN THIS PRESENTATION

- 5G builds on several new technology ingredients for providing tailored connectivity, computing and storage to digital society domains
  - Slicing
  - Edge computing
- The new technologies make 5G more powerful and flexible than 4G but also introduce new interconnect and roaming challenges
  - Network slices provided by different operators
  - Edge computing provided by different operators or service providers
- The growth of the 5G ecosystem depends on adequate interoperability to achieve network effects
  - This has worked well in 2G, 3G and 4G
  - How can we make it work for network slicing and edge computing in 5G?

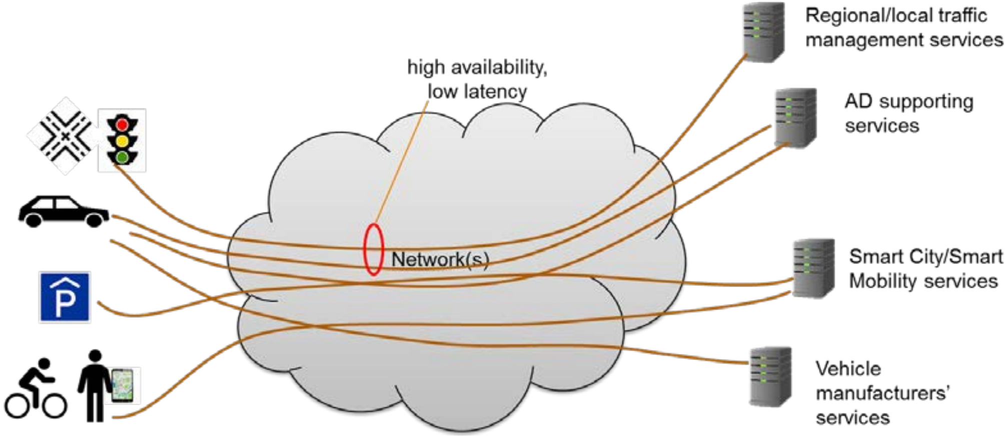
SLICING GIVES SEPARATED VIRTUAL NETWORKS ON TOP OF ONE PHYSICAL NETWORK INFRASTRUCTURE



EDGE COMPUTING IS AIMED AT APPLICATIONS REQUIRING LOW-LATENCY NETWORKED COMPUTE

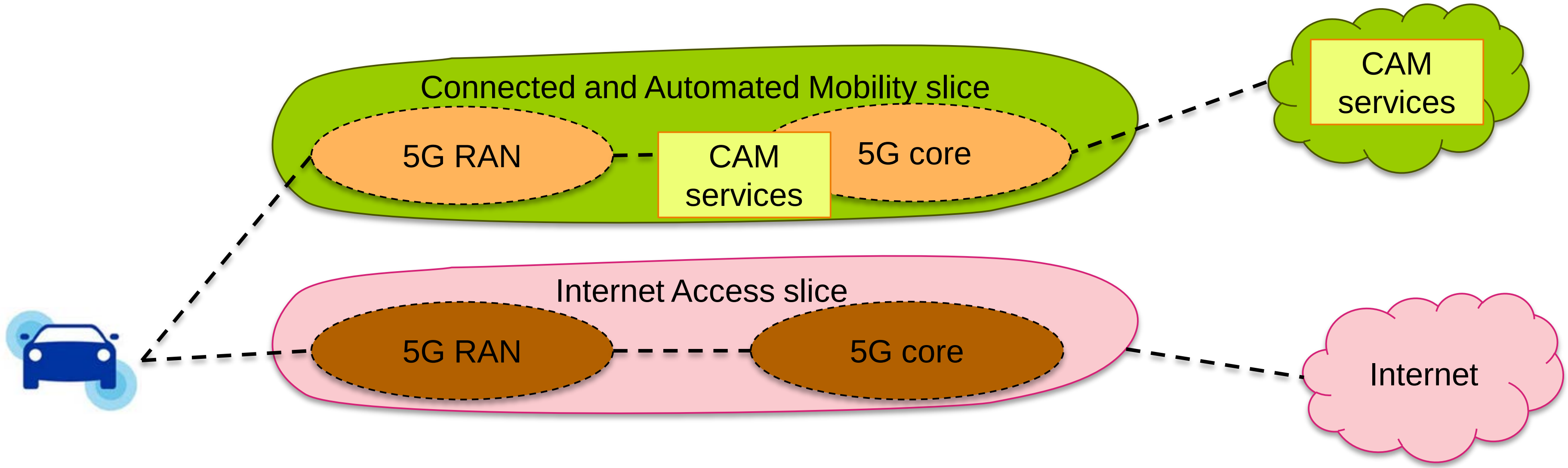


EXAMPLE USE CASE FOR 5G: CONNECTED AND AUTOMATED MOBILITY (CAM)

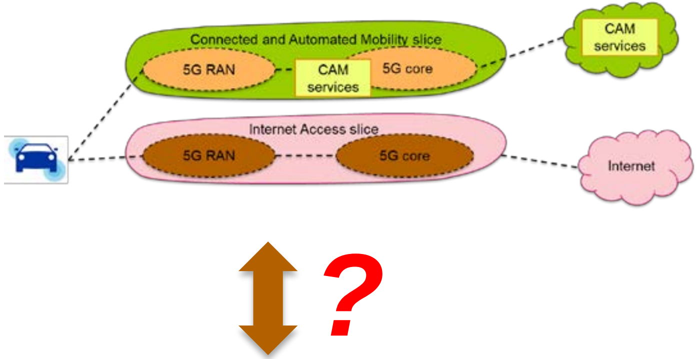


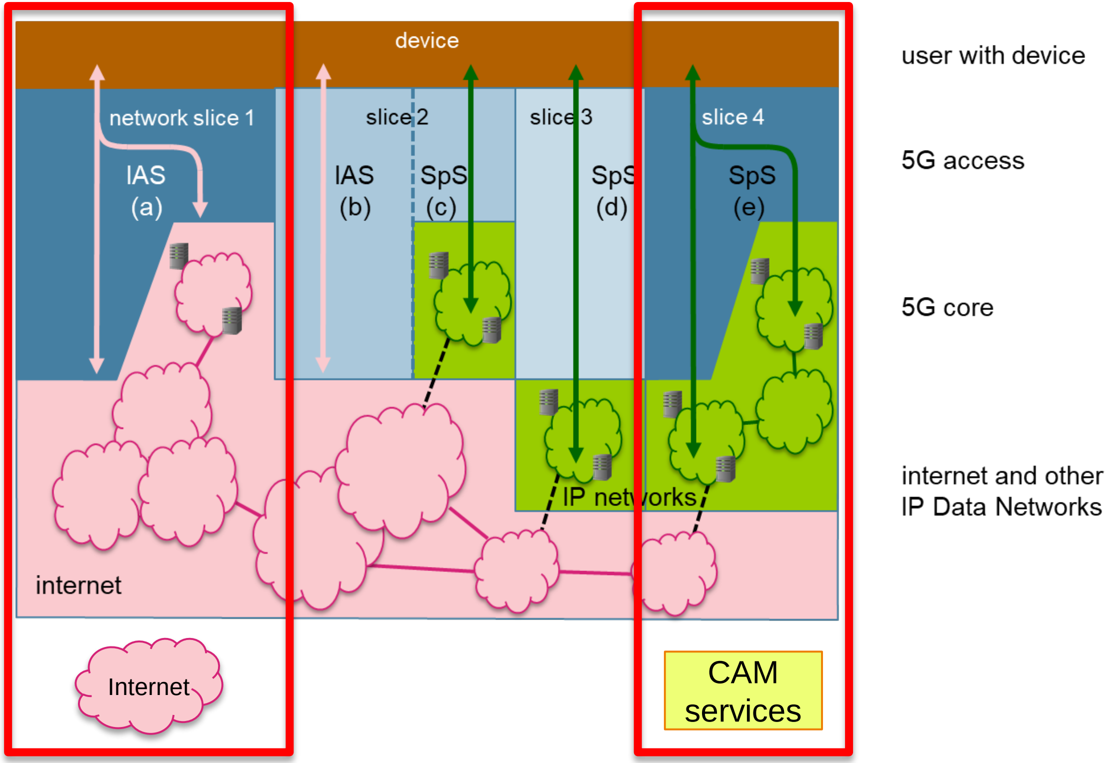
- Low latency, depending on application
- High reliability of connectivity

EXAMPLE IMPLEMENTATION OF CONNECTED AND AUTOMATED MOBILITY IN A *SINGLE* 5G NETWORK

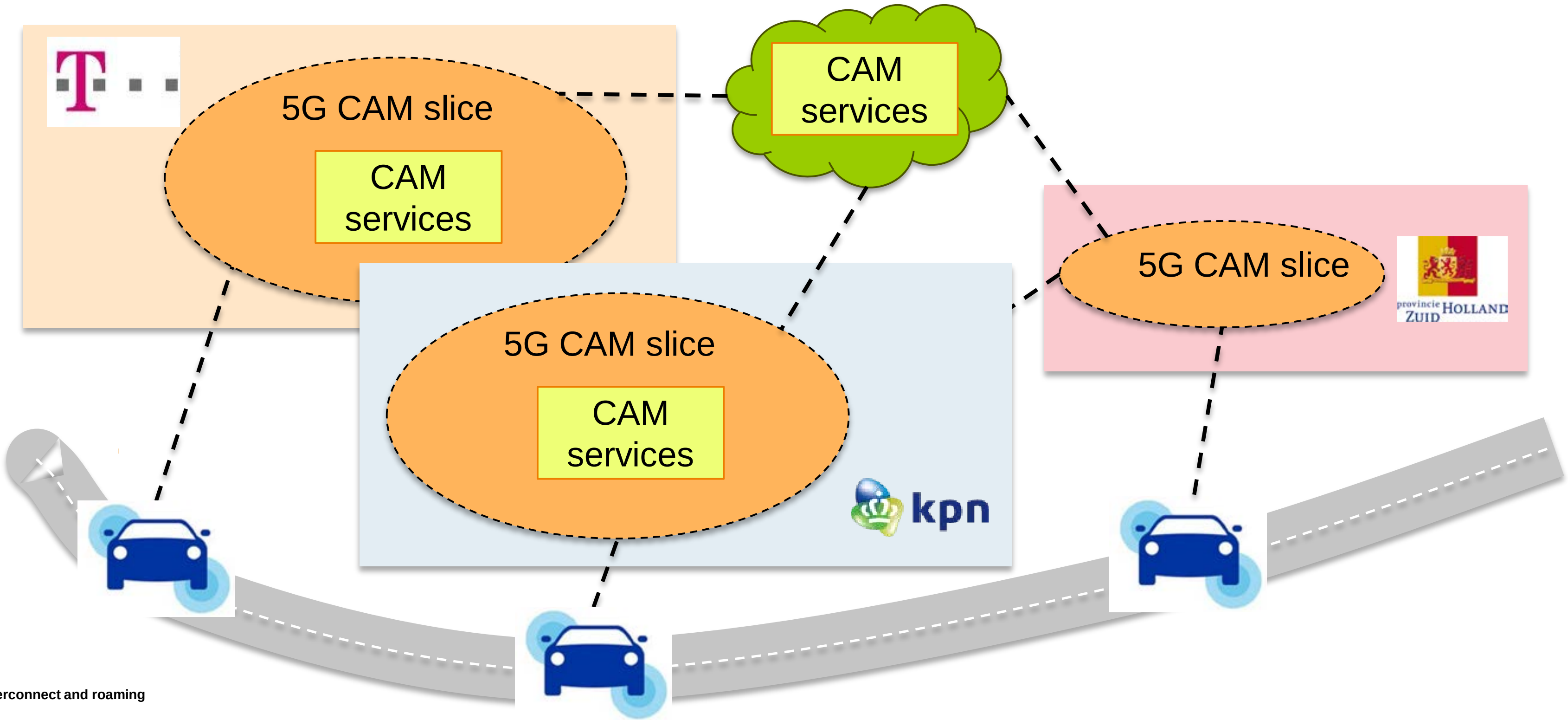


SERVICES DEPLOYED OVER 5G NEED TO COMPLY WITH THE EU NET NEUTRALITY RULES





IN PRACTICE, CAM SERVICES WILL NEED TO WORK ACROSS *MULTIPLE* 5G NETWORKS



x-Border corridors

Greece – Turkey

The Greece – Turkey cross-border corridor is located in the South-Eastern borders of Europe.

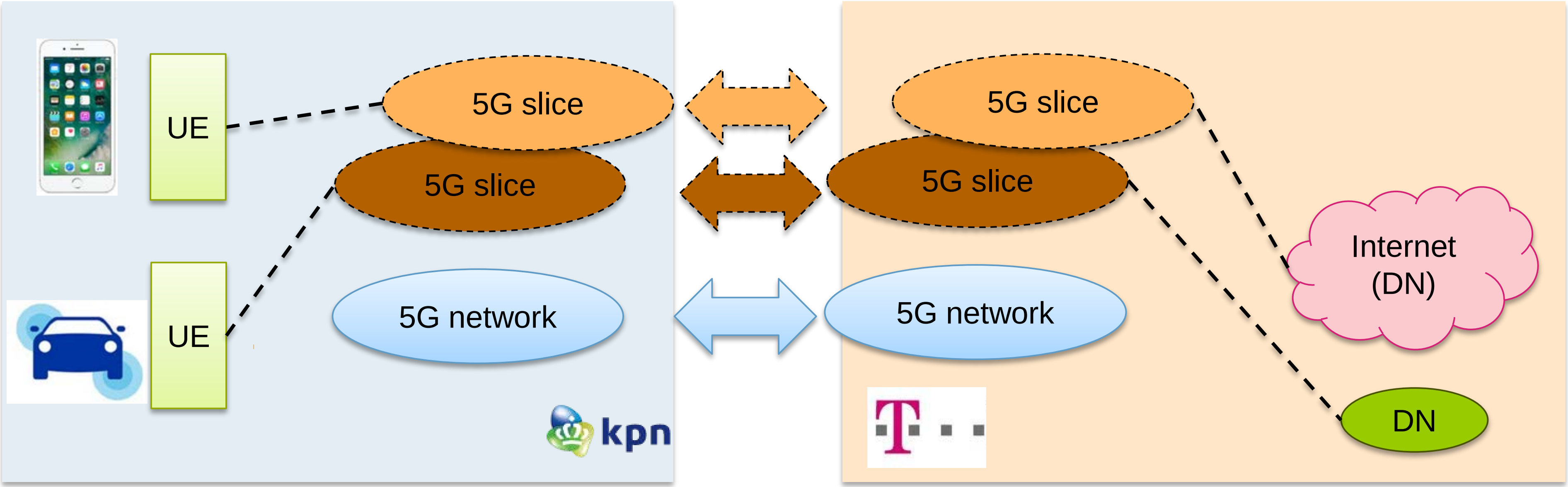
Spain – Portugal

The Spain-Portugal cross-border corridor connects the cities of Vigo and Porto.

5GMOBIX

(source: www.5g-mobix.com)

THERE IS A NEED TO INTERCONNECT SLICES ON TOP OF INTERCONNECTION OF NETWORKS (1)



THERE IS A NEED FOR INTERCONNECTION OF SLICES ON TOP OF INTERCONNECTION OF NETWORKS (2)

Table 5.15.2.2-1 - Standardised SST values

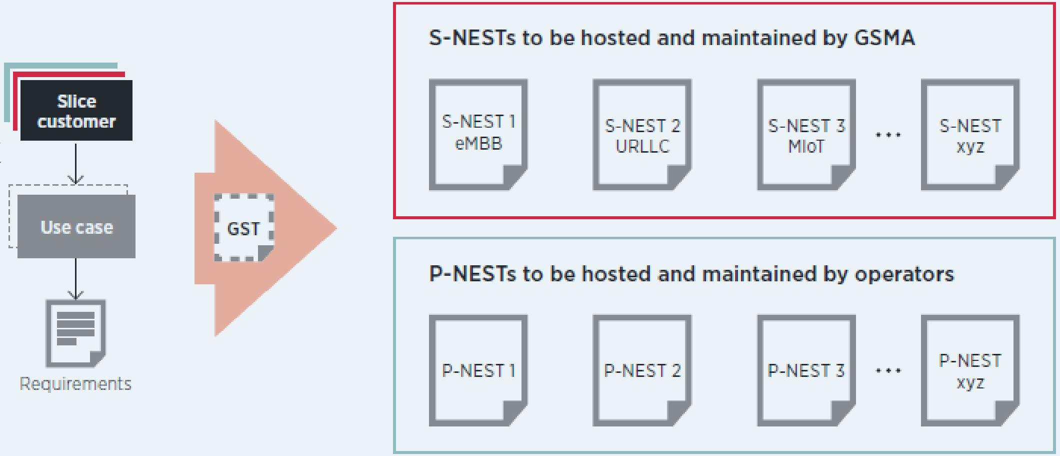
Slice/Service type	SST value	Characteristics.
eMBB	1	Slice suitable for the handling of 5G enhanced Mobile Broadband.
URLLC	2	Slice suitable for the handling of ultra- reliable low latency
MIoT		

NOTE: The suppo

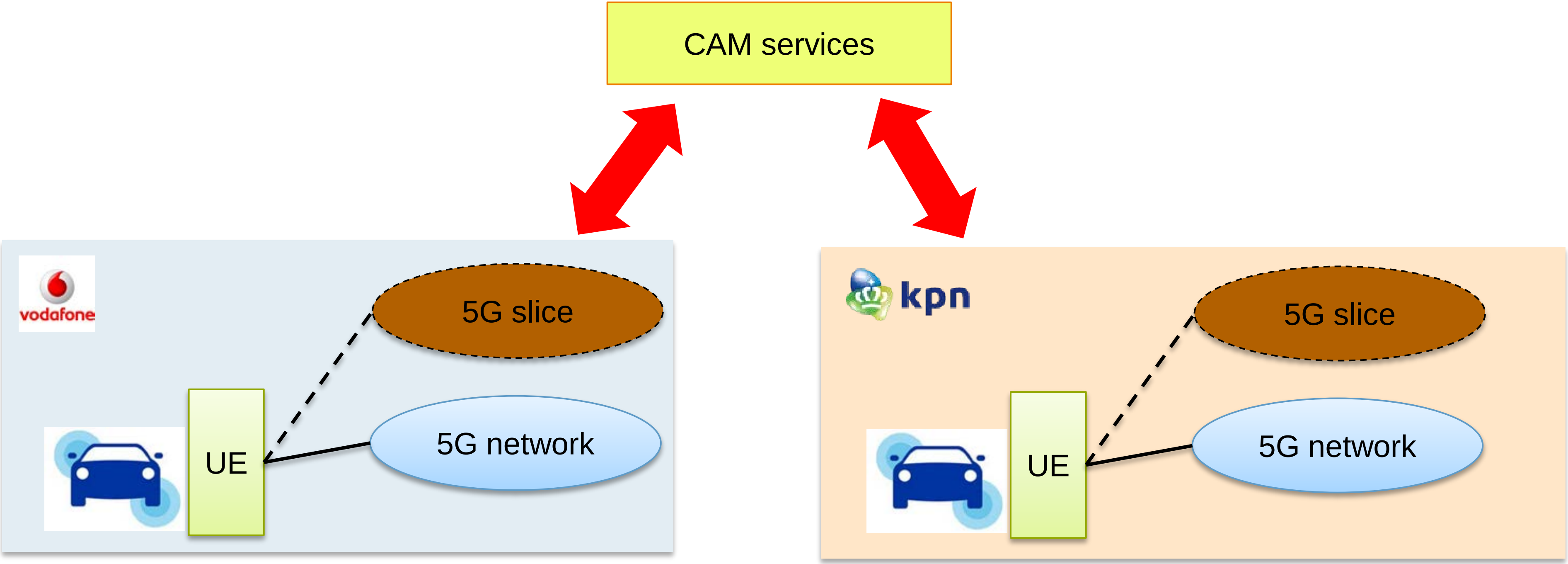
3GPP TS23.501

Figure 2: Standardised and private NESTs

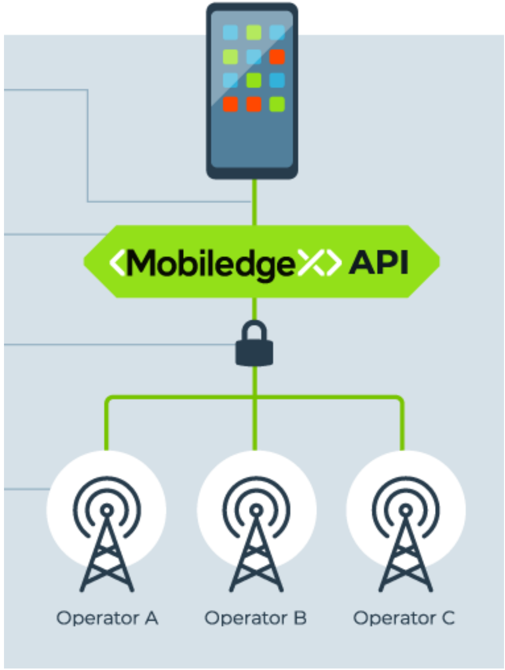
From Vertical Industry Requirements to Network Slice Characteristics, GSMA



VERTICAL INTEROPERABILITY CAN BE AN ALTERNATIVE FOR HORIZONAL INTERCONNECT (1)



VERTICAL INTEROPERABILITY CAN BE AN ALTERNATIVE FOR HORIZONAL INTERCONNECT (2)



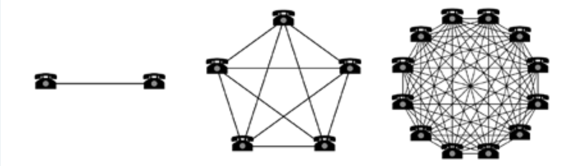
GSMA LAUNCHES NEW INDUSTRY-WIDE INITIATIVE TO SUPPORT DEVELOPMENT OF OPERATOR EDGE CLOUD AR/VR

November 21, 2018 | Press Release

"Both VR and AR are disruptive forms of immersive multimedia that, combined with operator edge cloud and 5G connectivity, will transform the cost structures of the enterprise and entertainment fields," commented Alex Sinclair, Chief Technology Officer, GSMA. "Mobile operators will play a key role in its development, but without a common approach and industry-wide collaboration we risk fragmenting the market from the beginning. ..."

THE GROWTH OF THE 5G ECOSYSTEM DEPENDS ON OLD AND NEW TYPES OF INTEROPERABILITY

Strong network effects in mobile networking are achieved through interoperability
- For individual users and verticals/sectors
- Value for network providers and investors



MEMORANDUM OF UNDERSTANDING

ON

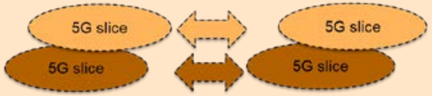
THE IMPLEMENTATION OF A PAN EUROPEAN 900 MHz DIGITAL CELLULAR MOBILE TELECOMMUNICATIONS SERVICE BY 1991

1987

5G interop

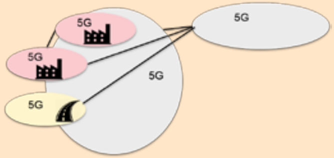
4G interop
- Across countries
- For voice and Internet data
- Across network providers of different sizes

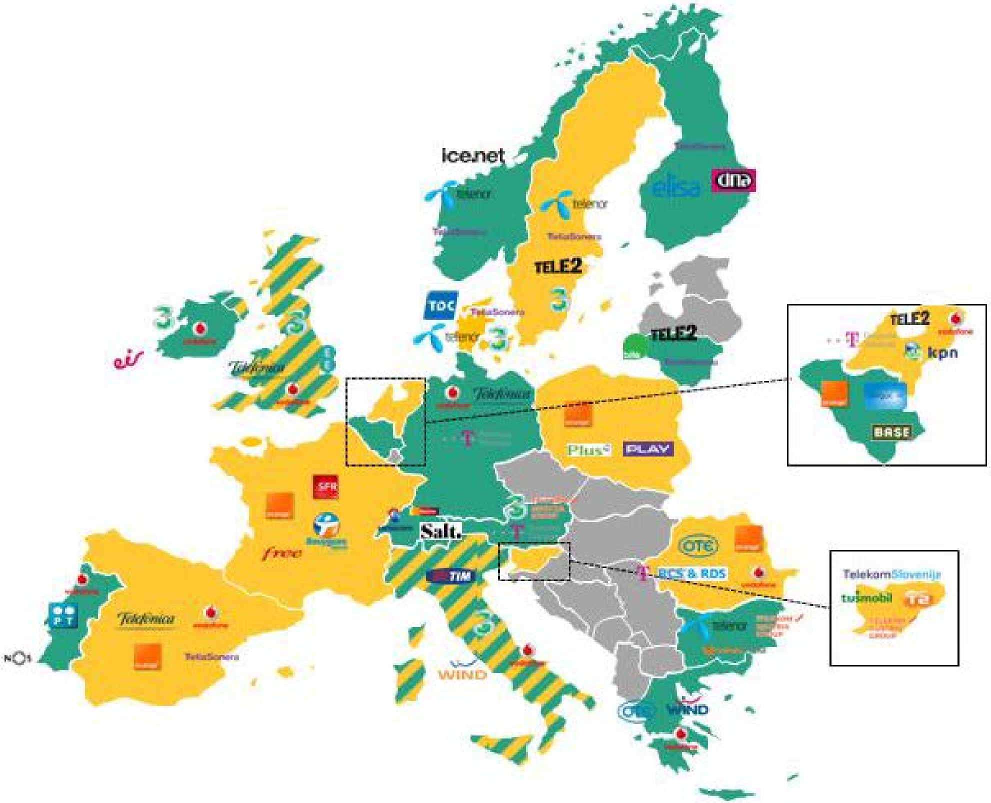
- Across slices carrying various applications



- Across vertical users and sectors

- Across classical operator networks and local “non-operator” networks

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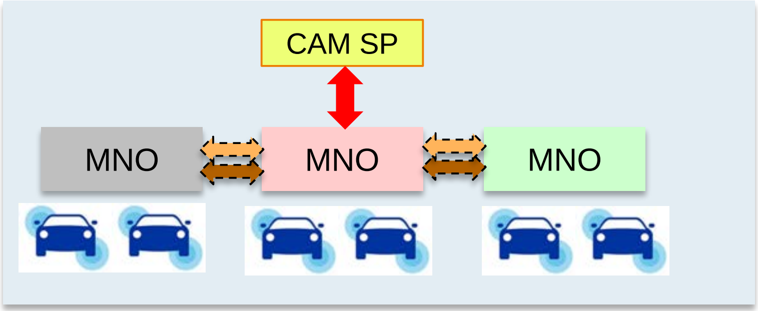
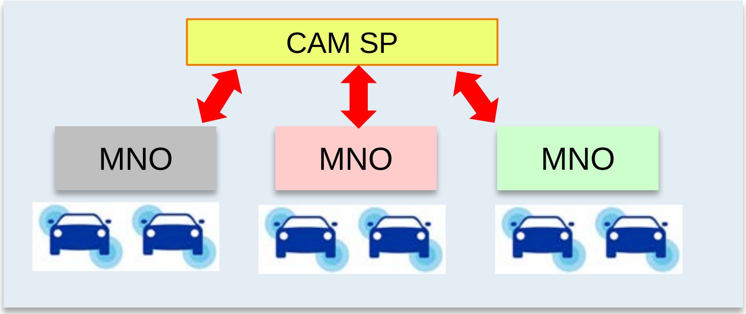
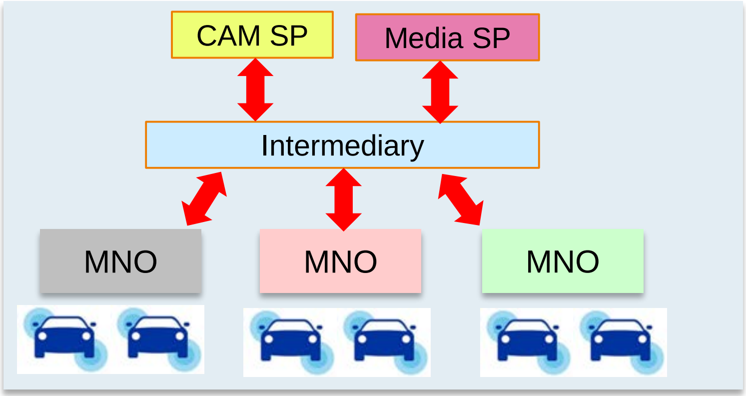
OBSERVATIONS ON WAY FORWARD TO 5G INTEROP (1) 5G TECHNOLOGY MEETS BUSINESS MODELS





New: vertical interfaces that support applications over 5G for verticals

Network effects: European operator groups, midsize operators, IPX providers



OBSERVATIONS ON WAY FORWARD TO 5G INTEROP (2) TIMING IS AN IMPORTANT FACTOR

Let's focus on deploying 5G infrastructure and sector services now and look at interop later

vs

Let's plan ahead to avoid fragmentation and benefit from network effects early on

Interop may slow down innovation

5G interop is more complex than 4G interop

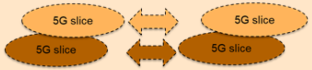
WRAP UP

5G interop

4G interop

- Across countries
- For voice and Internet data
- Across network providers of different sizes

- Across slices carrying various applications



- Across vertical users and sectors

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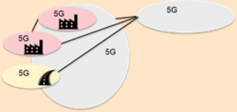
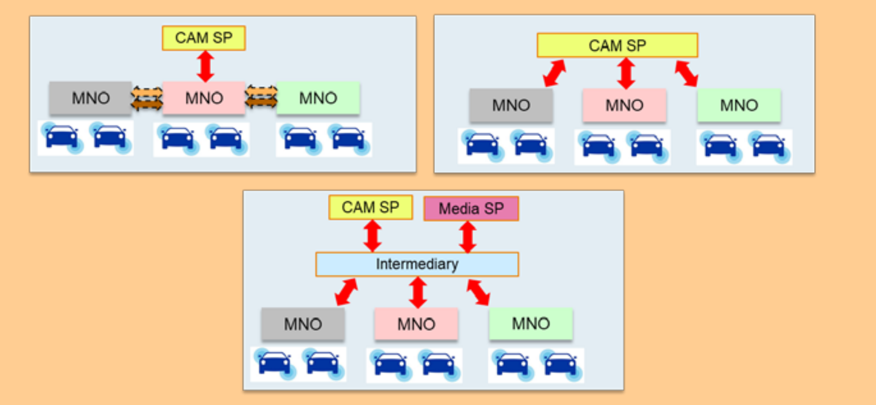


How?



When?

Let’s focus on deploying 5G infrastructure and sector services now and look at interop later

vs

Let’s plan ahead to avoid fragmentation and benefit from network effects early on

Interop may slow down innovation

5G interop is more complex than 4G interop

THANK YOU FOR YOUR ATTENTION

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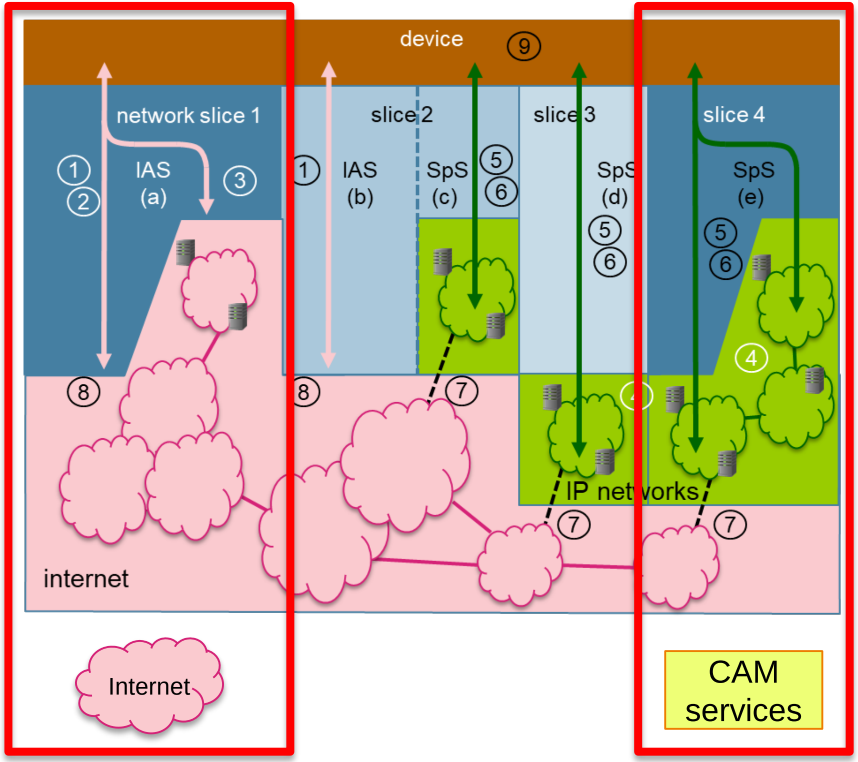
SEVERAL TOPICS IN THE DETAILED COMPLIANCE ANALYSIS ARE FURTHER DEVELOPED BY BEREC

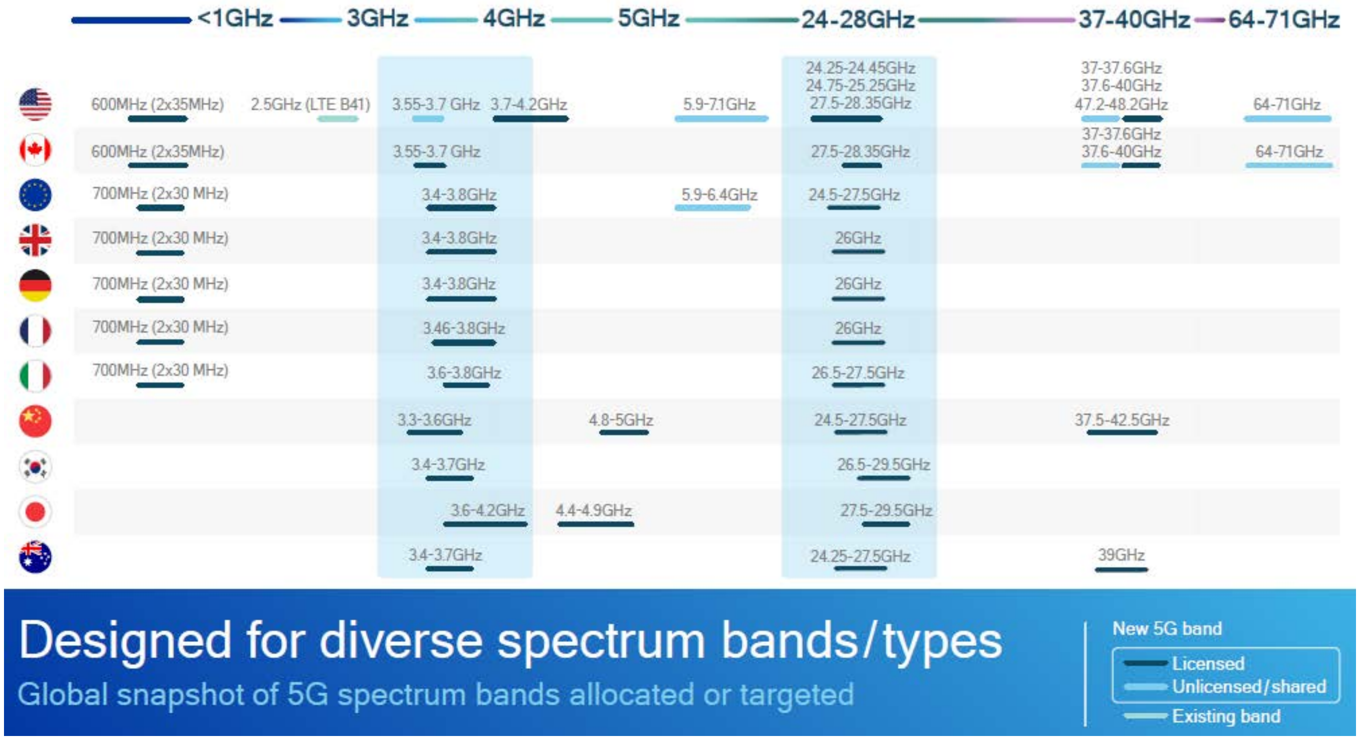


1. Multiple IASs with different traffic management settings in one network
2. QoS differentiation within IAS
3. Local access to the internet
4. Public and private services and associated networks
5. Objective need for optimisation in SpS
6. Impact of SpS on IASs
7. SpS and connections to the internet
8. Connectivity to limited number of internet end points
9. Access control

THE TOPICS ENCOUNTERED IN OUR FURTHER ANALYSIS ARE OF VARYING COMPLEXITY

Topic	Key points identified in analysis	Relative regulatory complexity
1. Multiple IASs with different traffic management settings	• Interpretation of *sender and receiver* in Art 3.3 of the Regulation • Note: assumption needed in remainder of analysis - it is allowed to have multiple IASs with different traffic management settings for a given end user	low
2. QoS differentiation within IAS	• Applications with multiple different traffic flows • Transparency through 5QI values or other methods • Dependency of ISP on other entities for assignment of traffic flows to traffic categories • Duration of QoS differentiation	medium to high
3. Local access to the internet	• (potentially:) IP interconnection of local networks	low
4. Public and private services and associated networks	• Size and scope of predetermined group of end users in private service	low to medium
5. Objective need for optimisation in SpS	• Determination of IAS for benchmark in case of multiple IAS offers • Variation of IAS performance between geographical regions and operators • Services comprising multiple traffic flows	high, except if SpS requirements are clearly much stricter than achievable over IAS.
6. Impact of SpS on IASs	• Multiple IASs affected by one SpS, within and outside the slice used for the SpS. • Isolation of the effect of the SpS on IAS from other effects occurring in mobile network at the same time • Complexity of network and capacity management in mobile network with many services and applications in general	high
7. SpS and connections to the internet	• Connectivity to internet from SpS through separate IAS • Connectivity between different legs between end user device and internet	low
8. Connectivity to limited number of internet end points	• Evaluation whether sub-internet service is acceptable for providing connectivity in specific situations	medium
9. Access control	(no issues if use is restricted to network congestion in emergency situations)	low

5G CAN USE A WIDE VARIETY OF FREQUENCIES



Source: Qualcomm

SOME OF THE 5G BANDS WILL BECOME AVAILABLE FOR LOCAL NETWORKS

Bundesnetzagentur 14 May 2018

The Chamber has ruled as follows:

Of the whole band at 3400 MHz – 3800 MHz, the Chamber will provide the spectrum from 3400 MHz to 3700 MHz (and therefore the majority of the 3.6 GHz band) for nationwide assignments. It will thus be possible to provide adequate spectrum for nationwide operators to realise their business models. This will ensure that the spectrum for nationwide assignments will be able to be used in full from 3400 MHz to 3700 MHz – and thus up to the upper edge at 3700 MHz. The future nationwide assignment holder will, therefore, not have to observe a guard band between the adjacent applications above 3700 MHz. Rather, the local and regional assignment holders will have to comply with a potential guard band with regard to the adjacent national usage.

It will nevertheless also be possible to provide adequate spectrum in the band at 3700 MHz – 3800 MHz for small and medium-sized enterprises to realise local and regional business models.

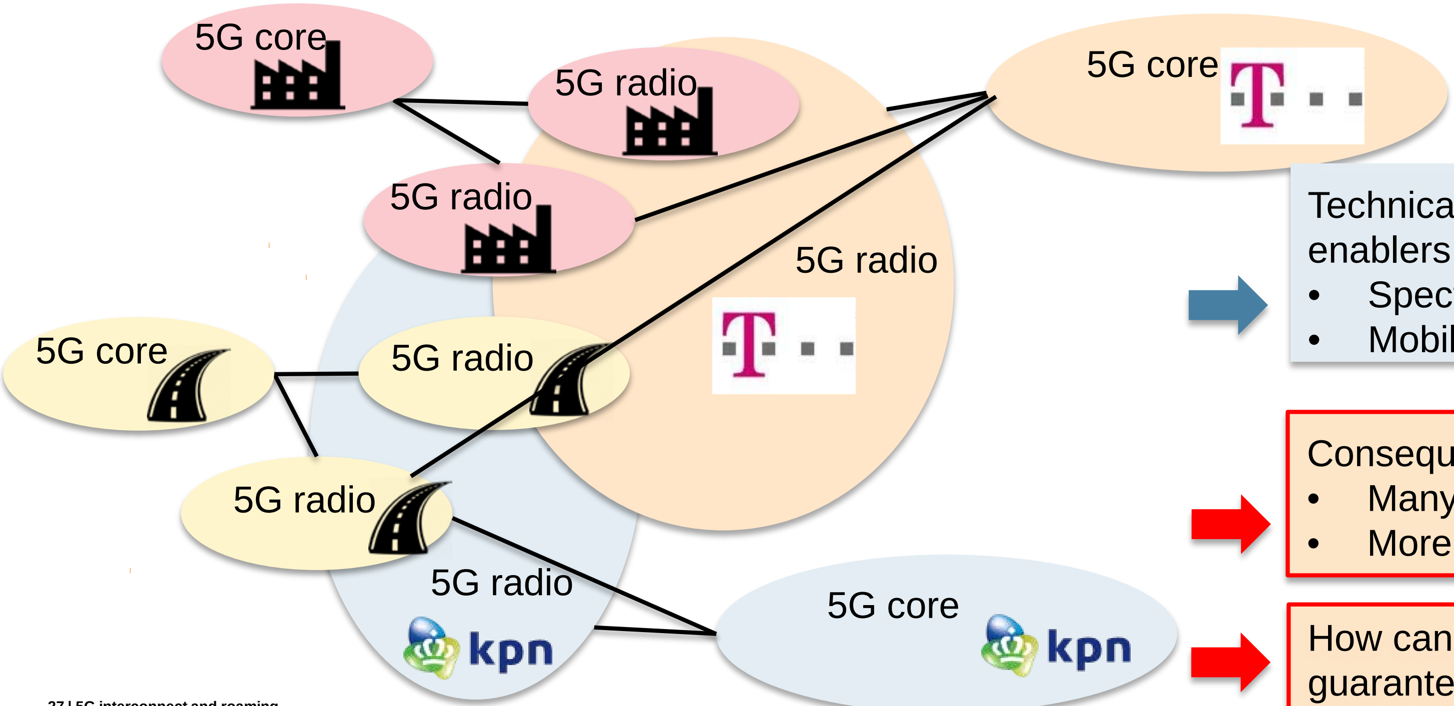
Ministerie van Economische Zaken

24 December 2018

Vanaf die datum is de 3,5 GHz-band in principe in zijn geheel beschikbaar. Agentschap Telecom beveelt aan om de band van 3700 – 3800 MHz op lokaal niveau te blijven uitgeven, zodat ook na afloop van de huidige vergunningen blijvend in de lokale behoefte van bestaande vergunninghouders kan worden voorzien.

TNO innovation for life

5G WILL BRING MULTIPLICITY AND VARIATION IN NETWORKS AND "OPERATORS"



Technical preconditions and enablers (in addition to 5G tech)

- Spectrum
- Mobile network codes

Consequences for ecosystem

- Many options and scenarios
- More participants and roles

How can end-to-end quality be guaranteed?