5G & NET NEUTRALITY

A functional analysis to feed the policy discussion

Pieter Nooren, Bram van den Ende, Iko Keesmaat and Toon Norp

April 16, 2018

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THE COMBINATION OF 5G AND NET NEUTRALITY LEADS TO DEBATE

- TOPICS / NET NEUTRALITY

Ericsson CEO: Net Neutrality Threatens 5G

BARCELONA -- MWC 2018 -- Ericsson CEO Börje Ekholm has urged European regulators to relax rules on net neutrality when it comes to 5G services, arguing that legislation could hinder the rollout of mission-critical applications.

Digital Single Market policy – Open Internet

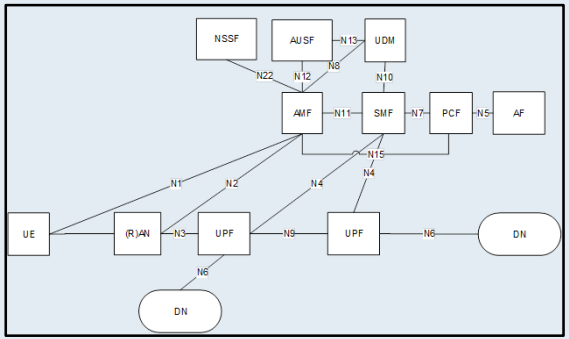
throttling or prioritisation. At the same time, the EU net neutrality rules allow reasonable traffic management and, with the necessary safeguards, "specialised services"; those are services which assure a specific quality level, required for instance for connected cars or certain 5G applications.

5G Manifesto for timely deployment of 5G in Europe

In this context we must highlight **the danger of restrictive Net Neutrality rules**, in the context of 5G technologies, business applications and beyond. 5G introduces the concept of “Network Slicing” to accommodate a **wide-variety of industry verticals’ business models** on a common platform, at scale and with services guarantees.

TNO HAS INITIATED A STUDY ON 5G AND NET NEUTRALITY TO FEED THE POLICY DISCUSSION

5G technology



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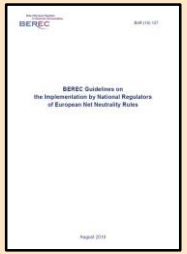
Regulation and Guidelines

Body of European Regulators for Electronic Communications
BEREC



Rijksoverheid

Authority for Consumers & Markets

kpn

ERICSSON

NOKIA

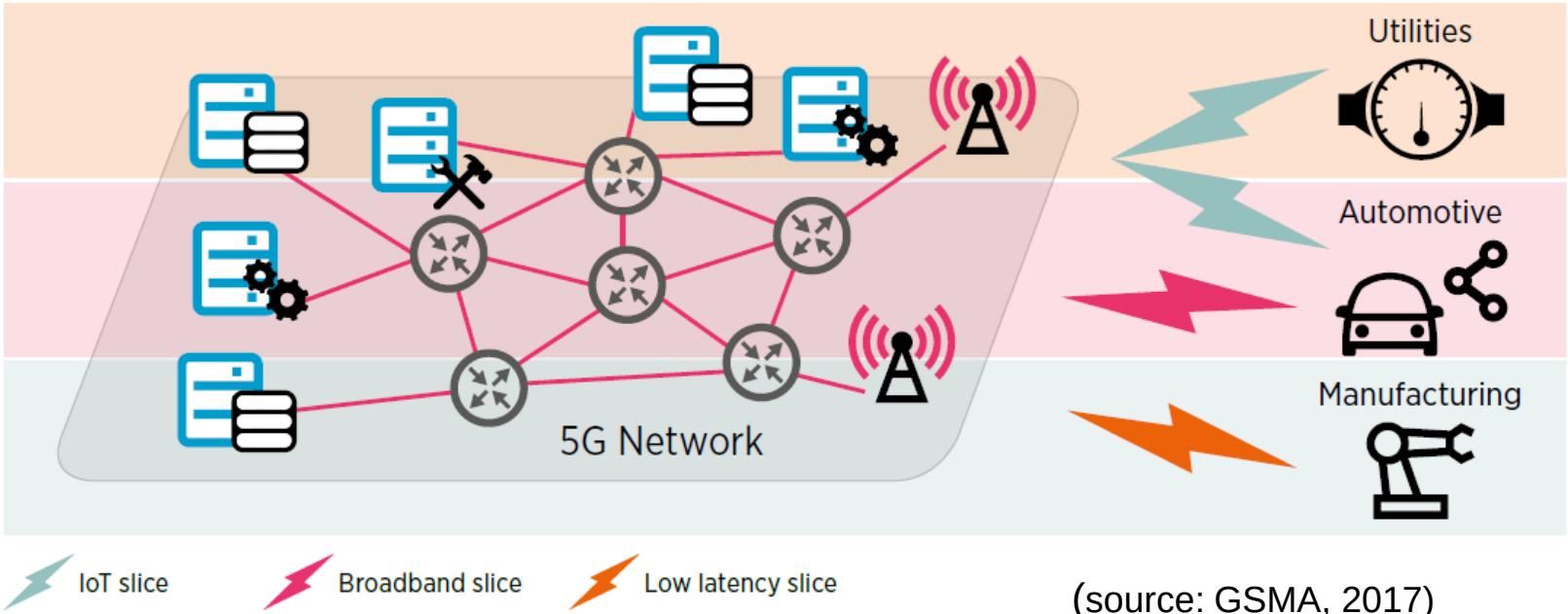
HUAWEI

FME

POWERED BY DUTCH TECHNOLOGY

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

5G networks subdivided into virtual networks each optimised for one business case



(source: GSMA, 2017)

IN THIS PRESENTATION

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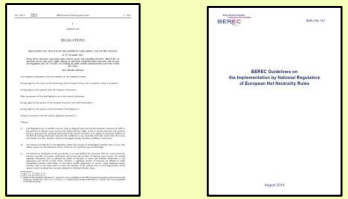
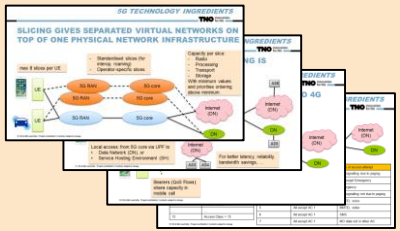
Use cases with tailored connectivity

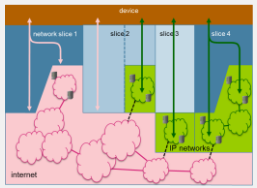
Rules for net neutrality



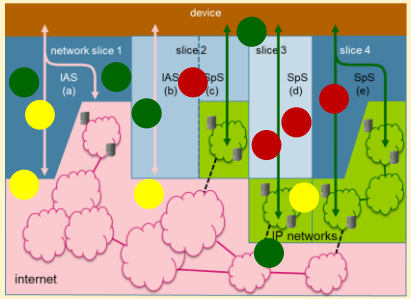
5G technology ingredients



5G consolidated architecture



Assessment of alignment of 5G and NN



SCOPING AND SOURCES

Scope of study

Factual technical description of:

- mobile connectivity required in emerging applications and
- the mapping of net neutrality rules to this connectivity

Out of scope

- Business model and commercial considerations (e.g., zero rating)
- Policy recommendations

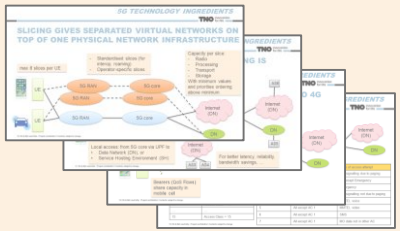
Sources

- 5G architecture based on 3GPP Release 15 specifications (5G Phase 1).
- Net Neutrality rules from EU Regulation 2015/2120 and BEREC Guidelines (August 2016)
- Interviews with experts on use cases and Net Neutrality policies

Use cases with tailored connectivity

Rules for net neutrality

5G technology ingredients



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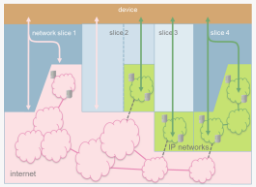

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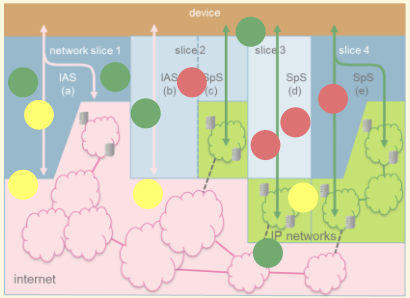


MAIN RULES FOR INTERNET ACCESS SERVICE (IAS)

Traffic management

1. "*providers of internet access services … shall treat all traffic equally … irrespective of …the content accessed or distributed, the applications or services used or provided*"
2. "*The first subparagraph shall not prevent providers of internet access services from implementing reasonable traffic management measures.*"

   … such measures shall be transparent, non-discriminatory and proportionate… not be based on commercial considerations but on objectively different technical quality of service requirements of specific categories of traffic. …
3. (additional stipulations related to *exceptional or temporary network congestion*)

Sub-internet Services and limited number of reachable end points

"'internet access service' means a publicly available electronic communications service that provides access to the internet, and thereby connectivity to virtually all end points of the internet, irrespective of the network technology and terminal equipment used."

MAIN RULES FOR SPECIALISED SERVICES (SPS)

Specialised Services only if optimisation is necessary for specific quality

"*Providers … shall be free to offer services other than internet access services which are optimised for specific content, applications or services, or a combination thereof, where the optimisation is necessary in order to meet requirements of the content, applications or services for a specific level of quality.*"

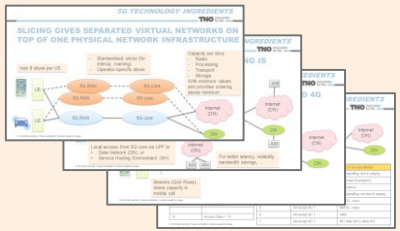
and only if they do not replace IAS or degrade the quality of IAS

Providers … may offer or facilitate such services only if the network capacity is sufficient to provide them in addition to any internet access services provided. Such services shall not be usable or offered as a replacement for internet access services, and shall not be to the detriment of the availability or general quality of internet access services for end-users

Use cases with tailored connectivity

Rules for net neutrality

5G technology ingredients



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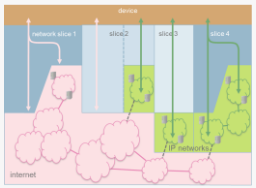

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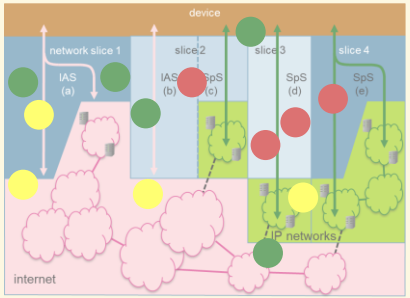
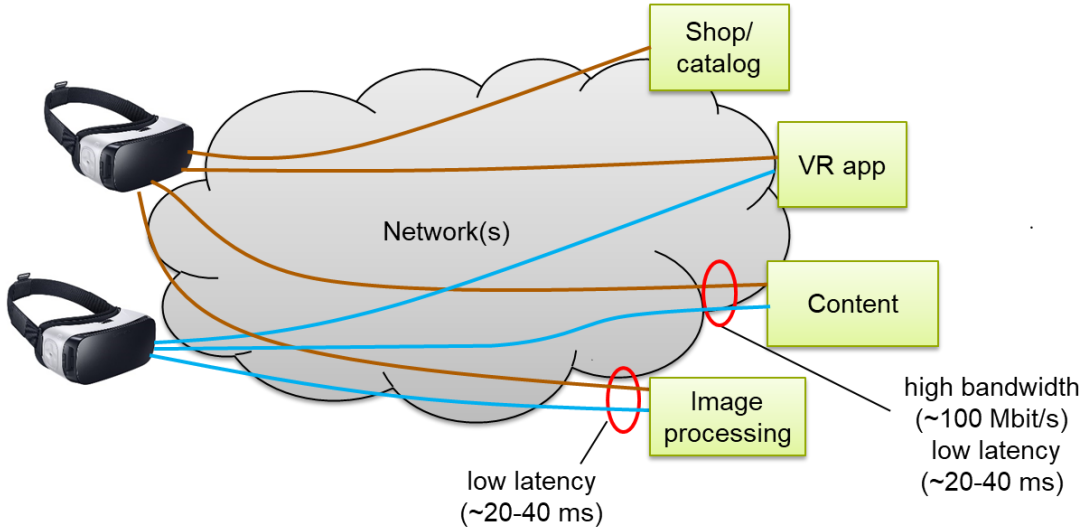
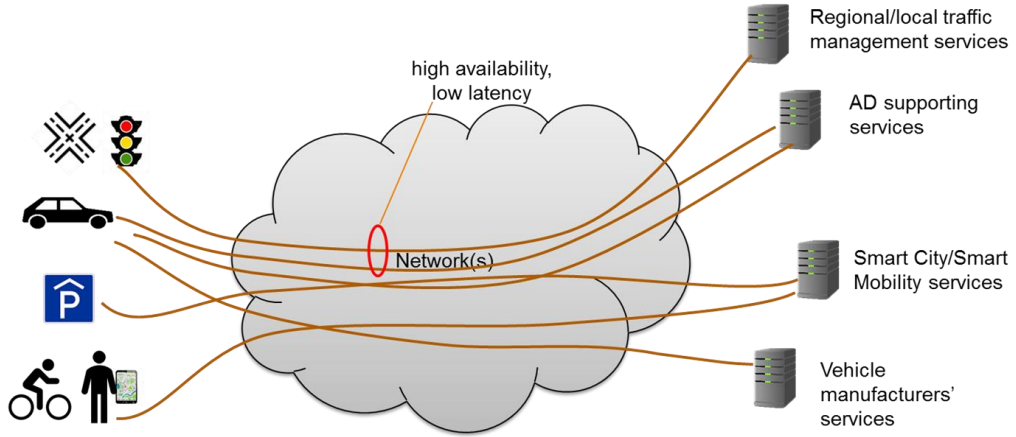


USE CASE: VR IN MEDIA



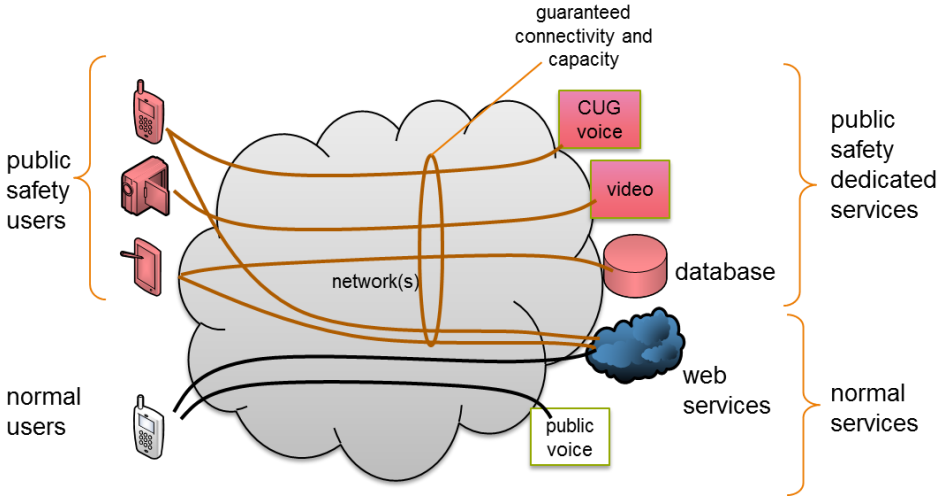
- Low latency and high bandwidth
- Potential for large impact on network load in case of mass market adoption

USE CASE: ITS WITH AUTOMATED DRIVING



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

USE CASE: CRITICAL COMMS IN PUBLIC SAFETY

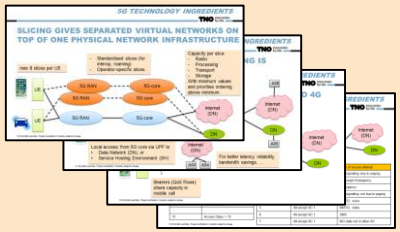


- Extremely high reliability of connectivity

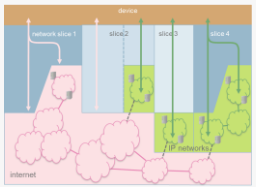
Use cases with tailored connectivity

Rules for net neutrality

5G technology ingredients



5G consolidated architecture



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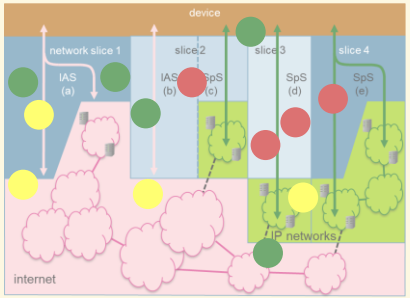
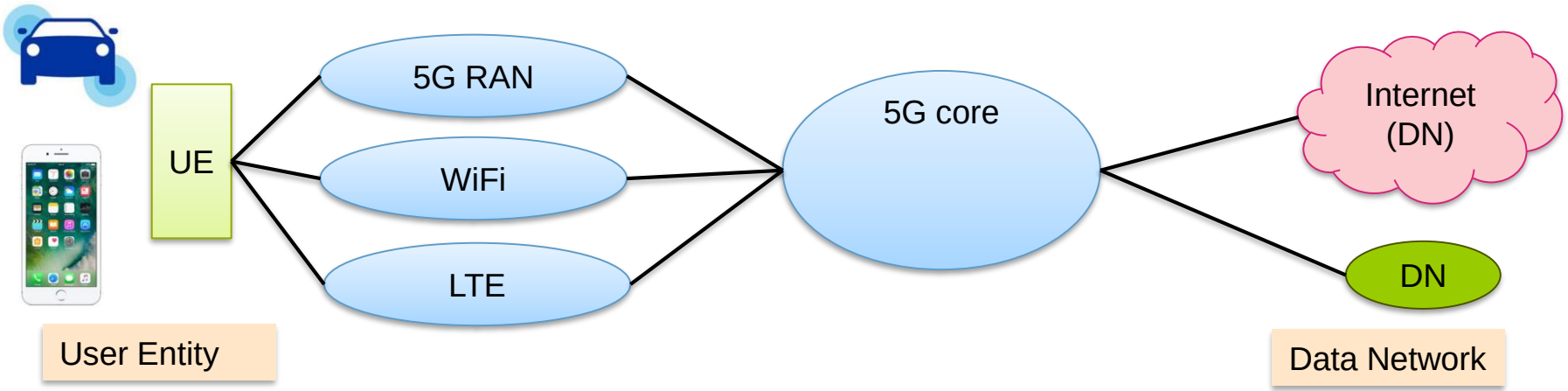


OVERALL 5G ARCHITECTURE



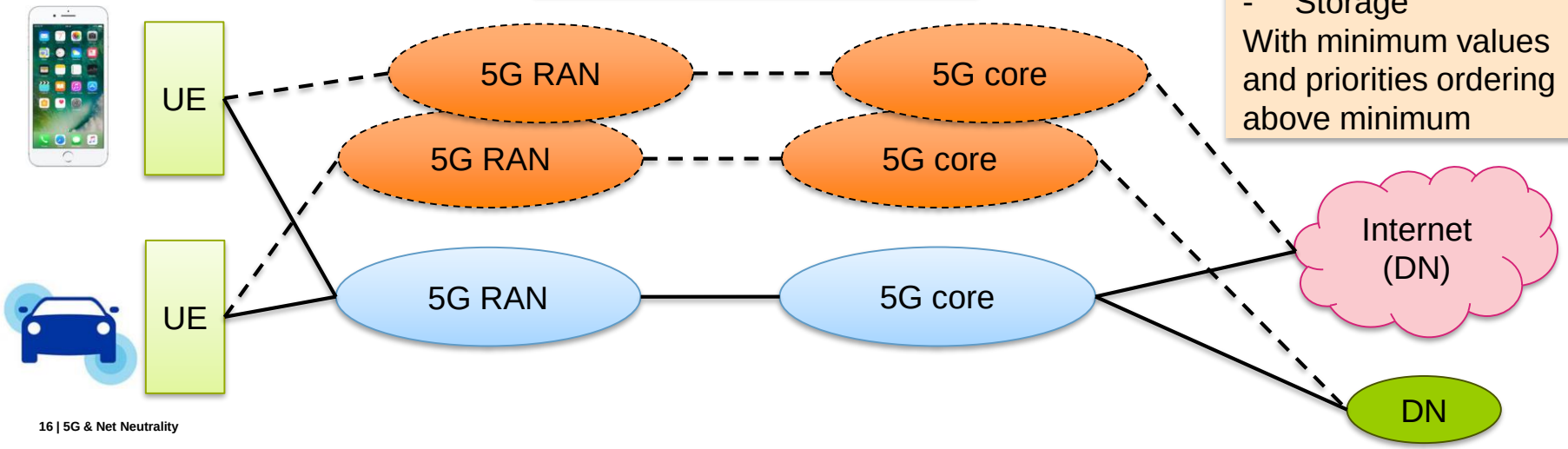
SLICING GIVES SEPARATED VIRTUAL NETWORKS ON TOP OF ONE PHYSICAL NETWORK INFRASTRUCTURE

max 8 slices per UE

- Standardised slices (for interop, roaming)
- Operator-specific slices

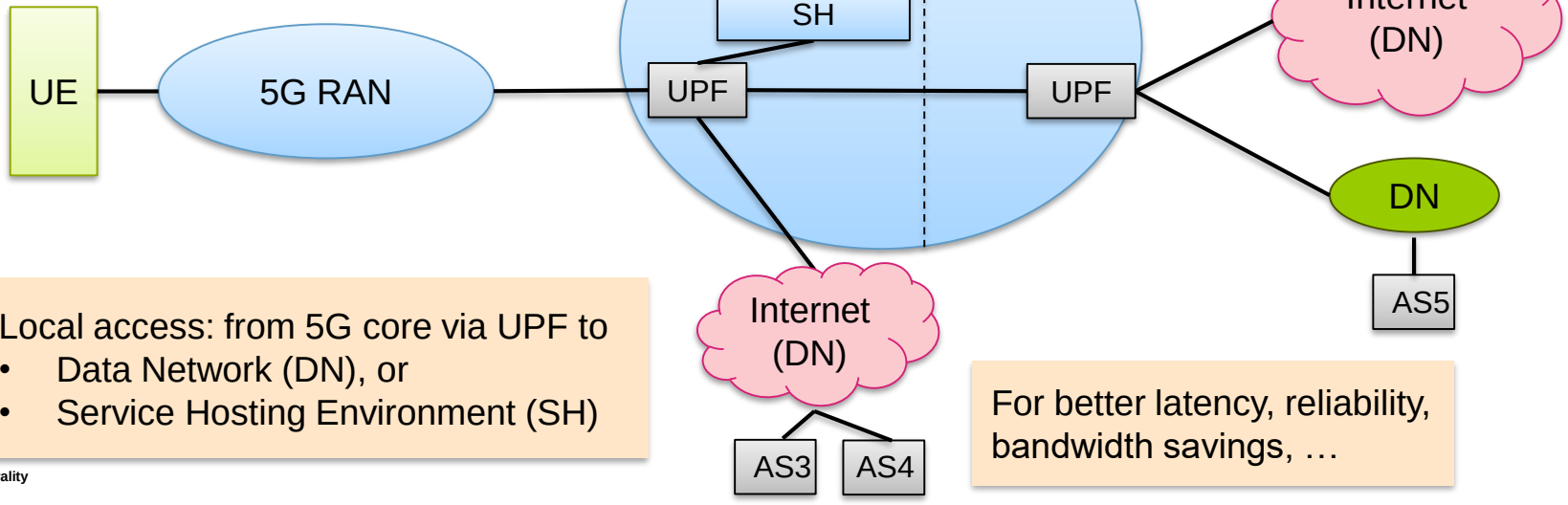
Capacity per slice:
- Radio
- Processing
- Transport
- Storage

With minimum values and priorities ordering above minimum



LOCAL ACCESS AND/OR SERVICE HOSTING IS AIMED AT DEMANDING APPLICATIONS

Service Hosting (SH) of
- operator services (e.g. AS1) or
- 3rd party services (e.g. AS2)

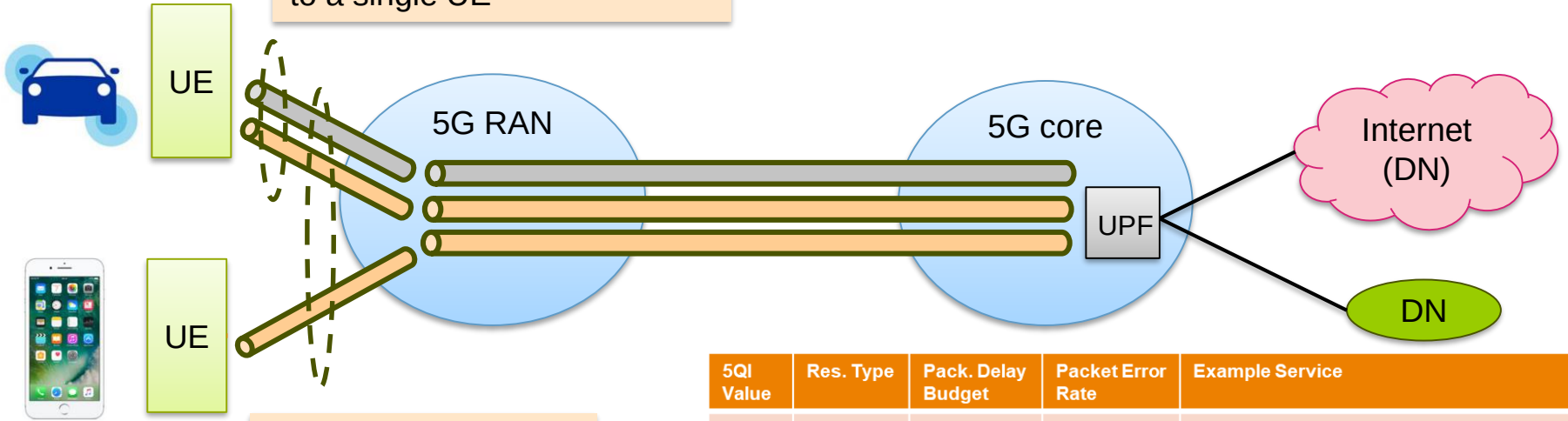


Local access: from 5G core via UPF to
- Data Network (DN), or
- Service Hosting Environment (SH)

For better latency, reliability, bandwidth savings, …

QOS DIFFERENTIATION IN 5G IS SIMILAR TO 4G

Multiple bearers (QoS Flows) to a single UE



Bearers (QoS Flows) share capacity in mobile cell

5QI Value	Res. Type	Pack. Delay Budget	Packet Error Rate	Example Service
B	Delay Critical GBR	5ms	10^{-5}	Remote control
C		10ms	10^{-6}	Intelligent transport systems
D		20ms	10^{-5}	
1	GBR	100ms	10^{-2}	Conversational Voice
2		150ms	10^{-3}	Conversational Video (Live Streaming)
3		50ms	10^{-3}	Real-time Gaming, V2X messages, …

Use cases with tailored connectivity

Rules for net neutrality

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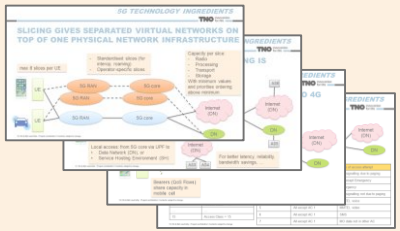
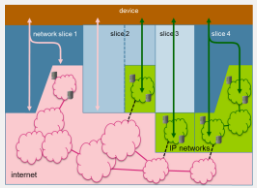


5G consolidated architecture



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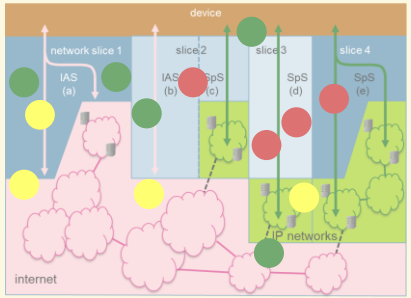
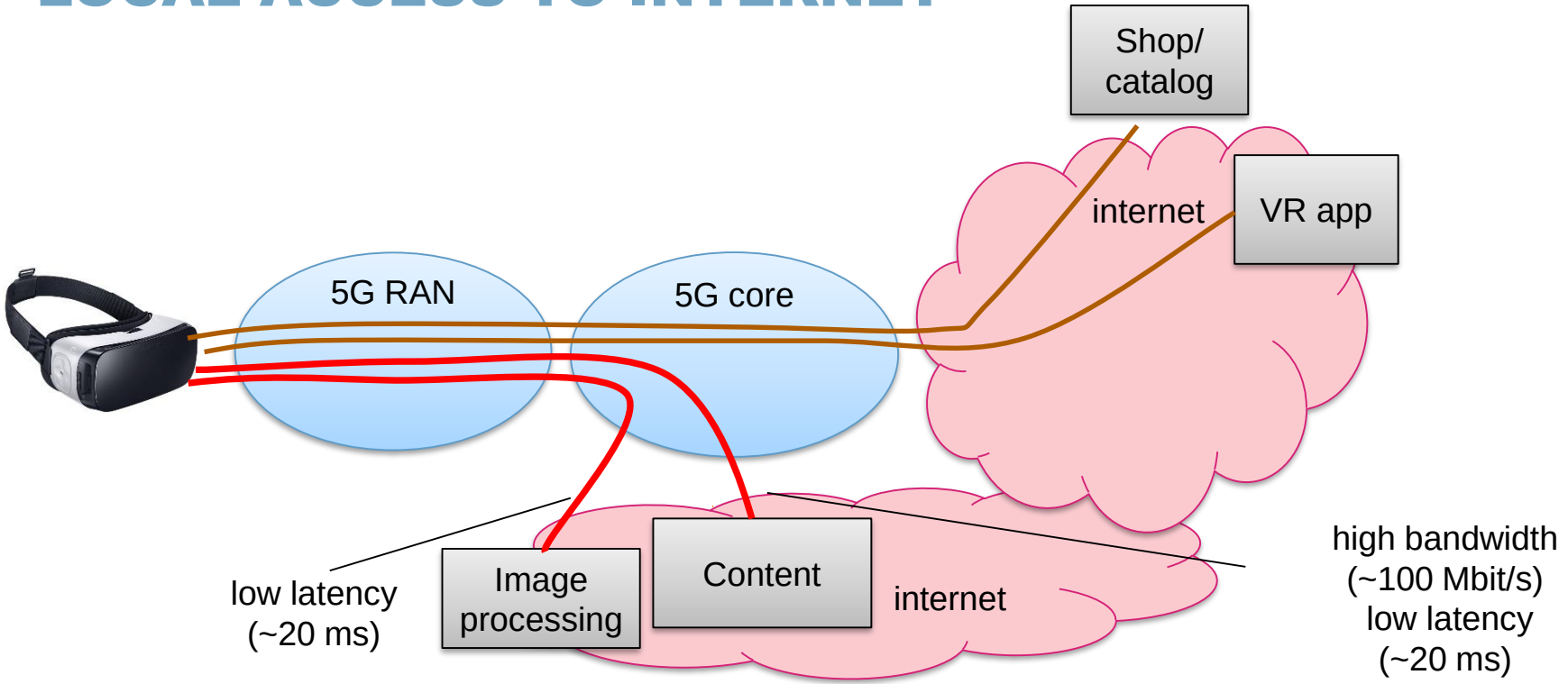
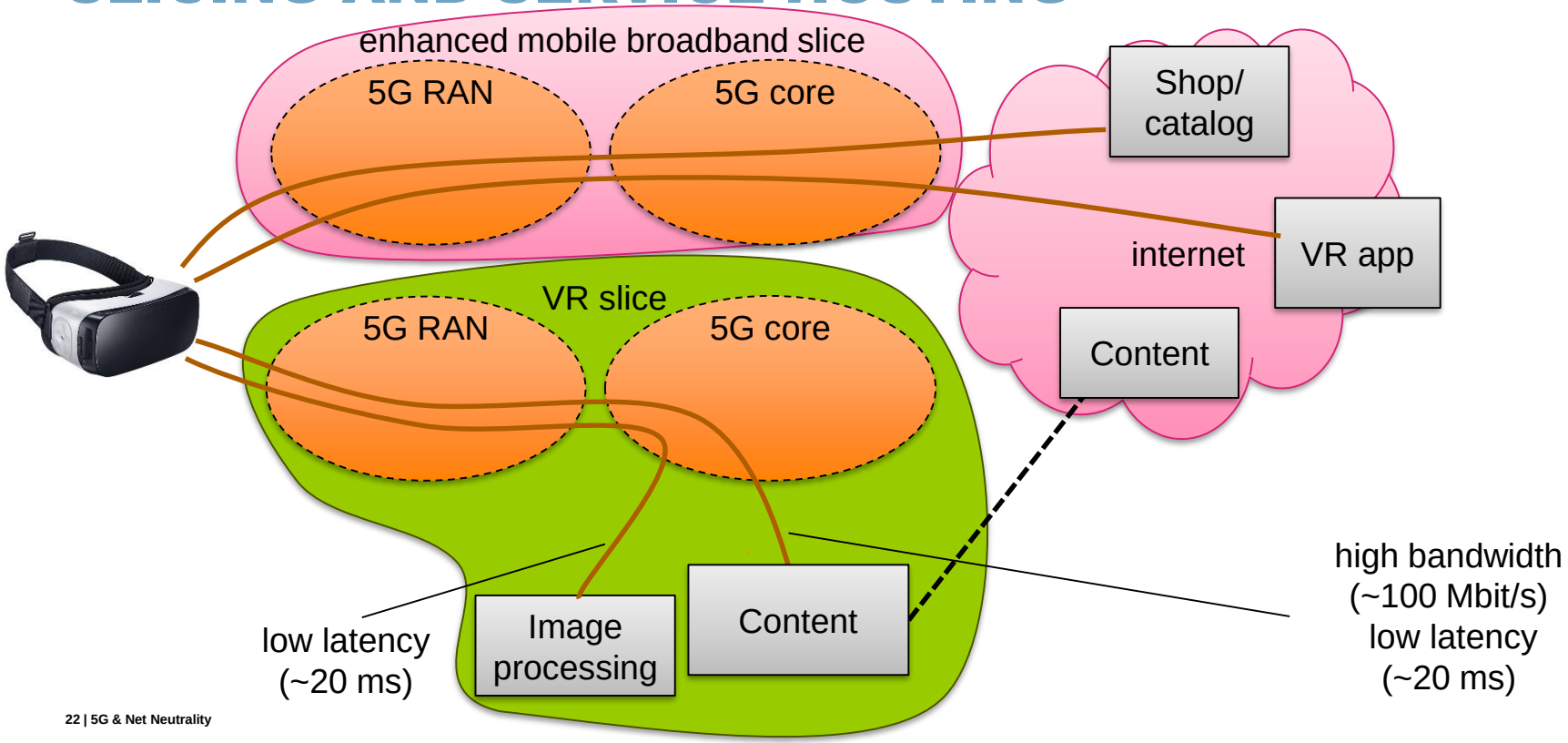


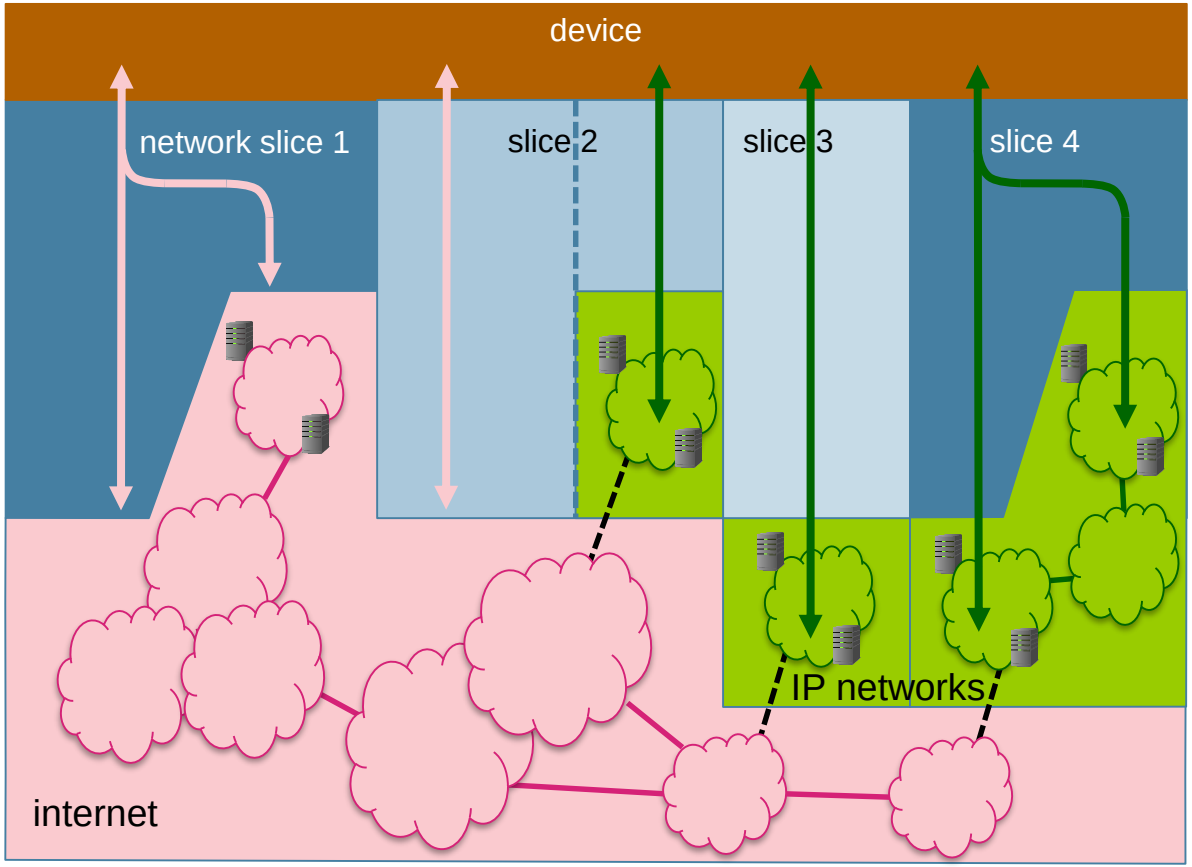
ARCHITECTURE IMPLEMENTATION OPTION VR#2 – LOCAL ACCESS TO INTERNET



ARCHITECTURE IMPLEMENTATION OPTION VR#5 – SLICING AND SERVICE HOSTING



ONE MAP THAT CONSOLIDATES ALL ARCHITECTURE OPTIONS FROM THE USE CASES



user with device

5G access

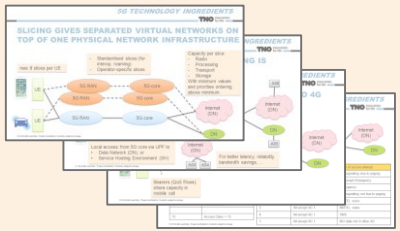
5G core

internet and other
IP Data Networks

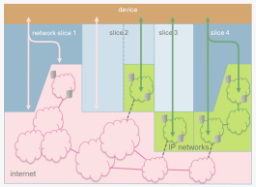
Use cases with tailored connectivity

Rules for net neutrality

5G technology ingredients



5G consolidated architecture



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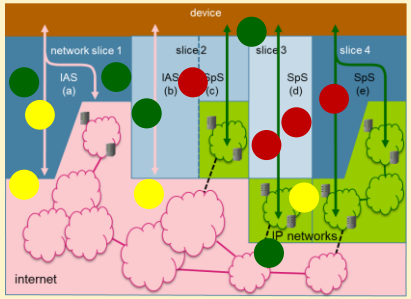
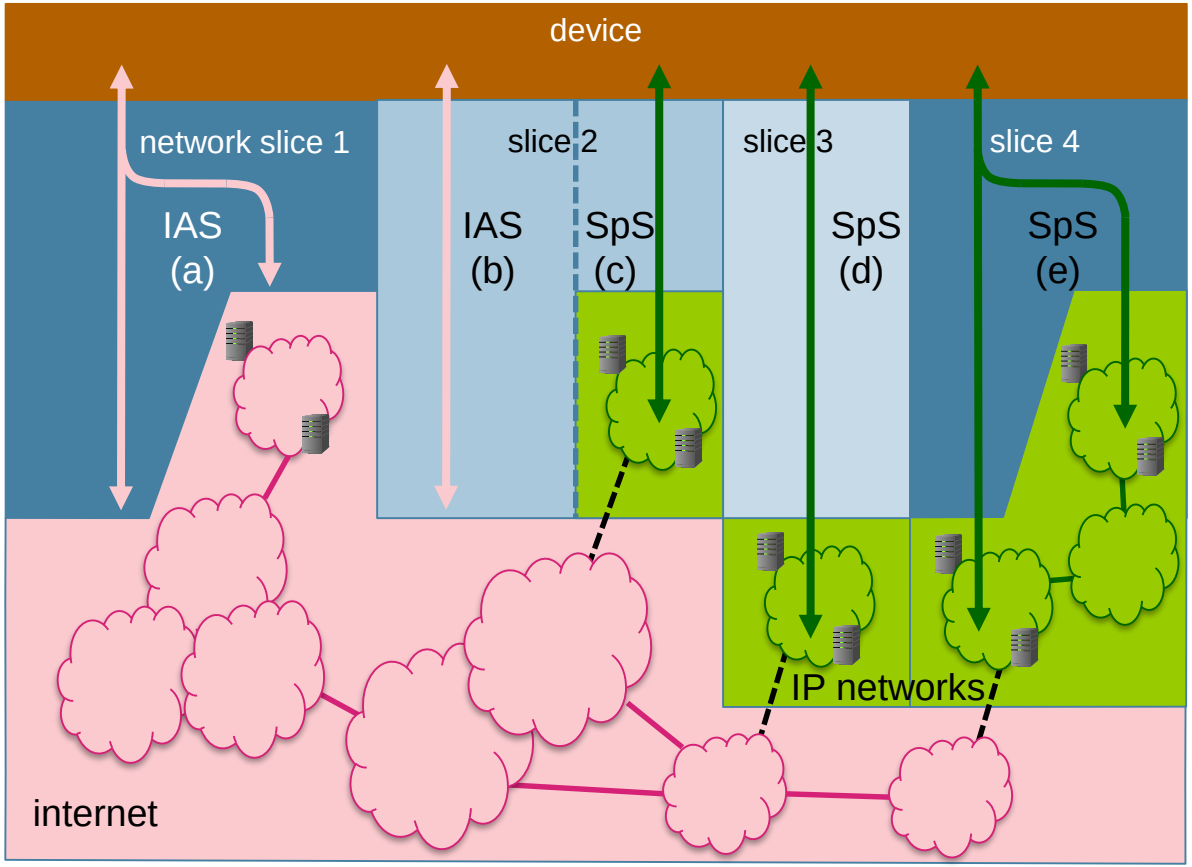


THE ARCHITECTURE SUPPORTS SERVICES THAT NEED TO COMPLY WITH THE RULES FOR IAS AND FOR SPS



user with device

5G access

5G core

internet and other
IP Data Networks

IT IS CRUCIAL TO DISTINGUISH BETWEEN 5G TECHNOLOGY AND NET NEUTRALITY CONCEPTS

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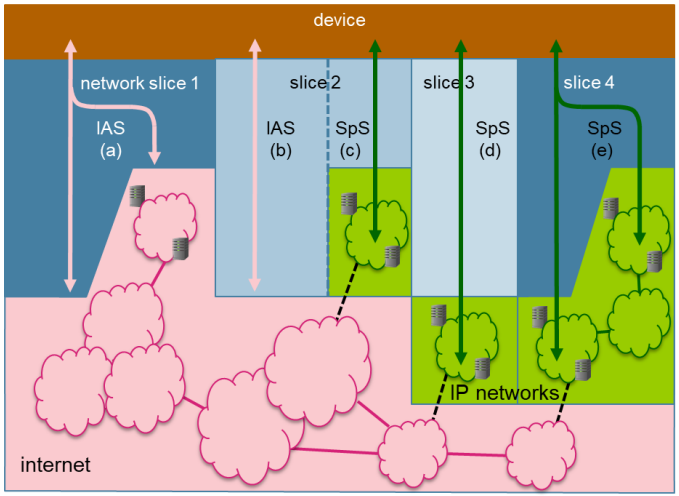
What matters is how the 5G technologies and architectures are used, not the technologies themselves



A slice is not the same as a specialised service

- An IAS is always in a slice if the network uses 5G slicing
- A slice can be used to build an SpS
- An IAS and an SpS can be provided through the same slice

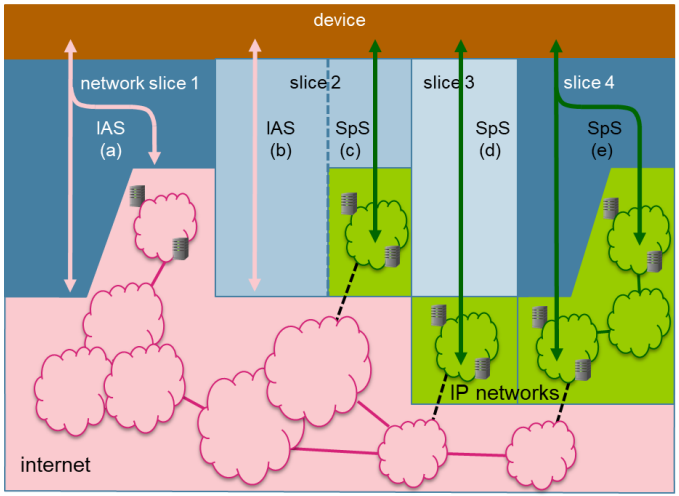
QoS differentiation can be applied inside and outside an IAS

- QoS differentiation can be used within an IAS
- QoS differentiation can be used to provide an SpS (cf VoLTE in 4G/LTE)

IT IS CRUCIAL TO DISTINGUISH BETWEEN 5G TECHNOLOGY AND NET NEUTRALITY CONCEPTS

What matters is how the 5G technologies and architectures are used, not the technologies themselves

The rules do not introduce an a priori ban on any 5G technology ingredient



It is not possible to come to an overall assessment with a single outcome on the alignment of 5G technology with net neutrality rules.

WE HAVE MADE A MORE DETAILED INVESTIGATION INTO NINE TOPICS IN THE ALIGNMENT OF 5G AND NN

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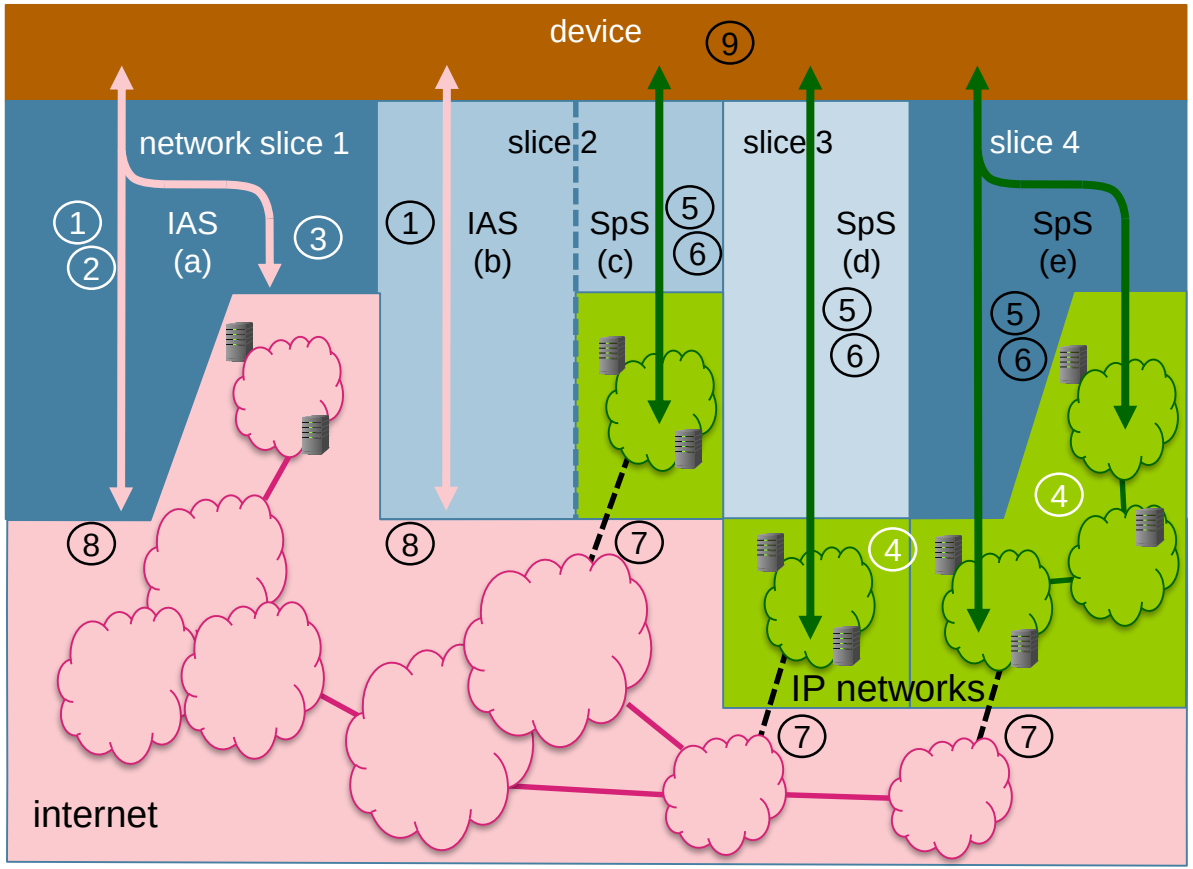

1. Multiple IASs with different traffic management settings in one network
2. QoS differentiation within IAS
3. Local access to the internet
4. Public and private services and associated networks
5. Objective need for optimisation in SpS
6. Impact of SpS on IASs
7. SpS and connections to the internet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

THE TOPICS ENCOUNTERED IN OUR FURTHER ANALYSIS ARE OF VARYING COMPLEXITY

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Topic	Key points identified in analysis	Relative regulatory complexity
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
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
Local access to the internet	• (potentially:) IP interconnection of local networks	low
Public and private services and associated networks	• Size and scope of predetermined group of end users in private service	low to medium
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.
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
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
Connectivity to limited number of internet end points	• Evaluation whether sub-internet service is acceptable for providing connectivity in specific situations	medium
Access control	(no issues if use is restricted to network congestion in emergency situations)	low

TOPIC 8. SPS AND CONNECTIONS TO THE INTERNET

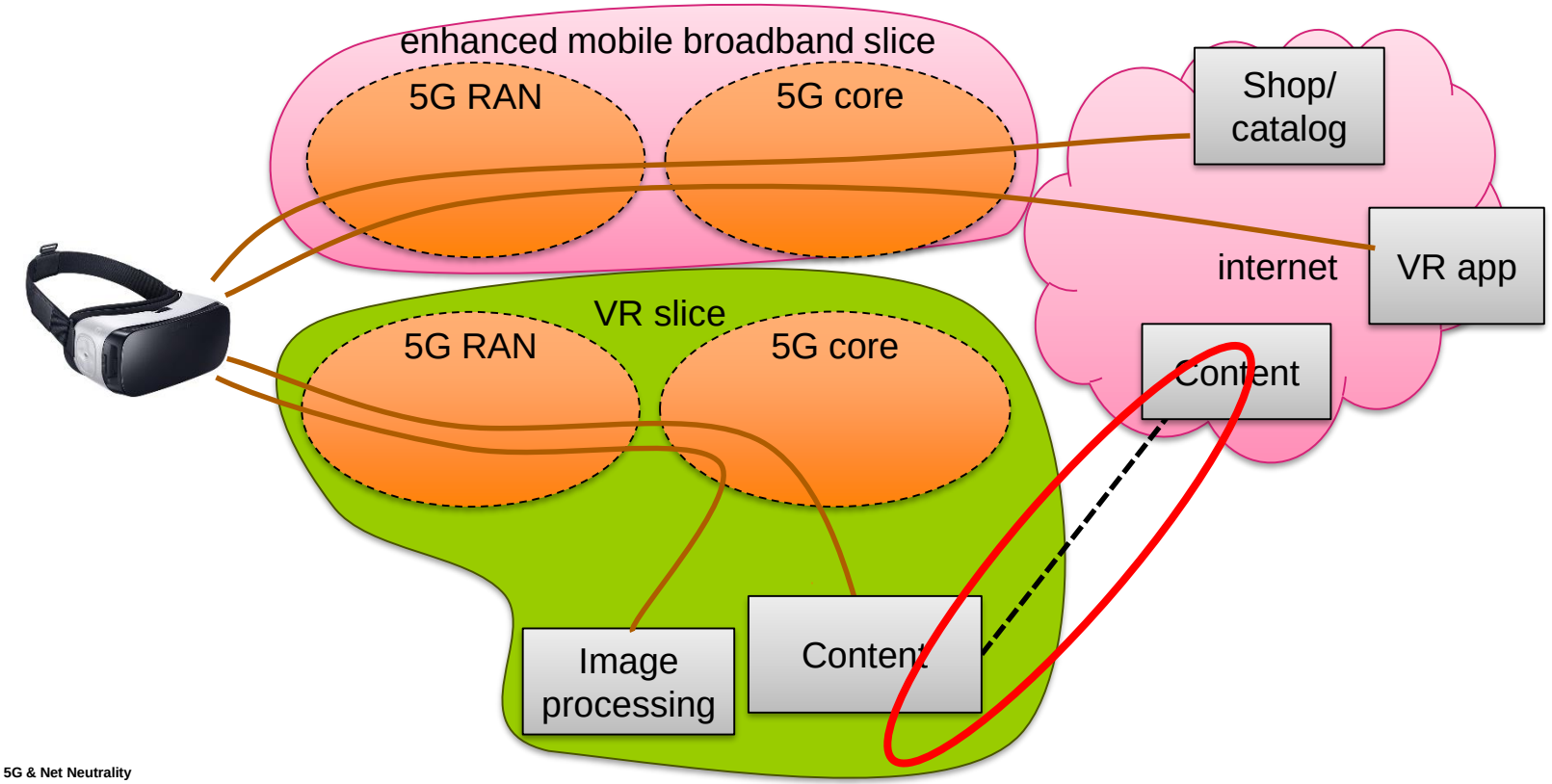
Regulation article 3(5)

"*Providers … shall be free to offer services other than internet access services which are optimised for specific content, applications or services, or a combination thereof, where the optimisation is necessary in order to meet requirements of the content, applications or services for a specific level of quality.*"

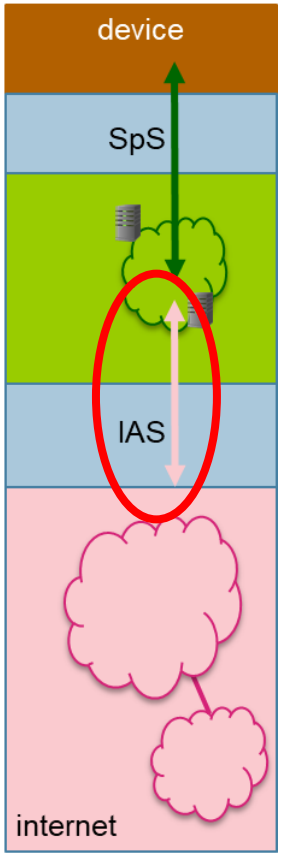
Guidelines par 110

"*Specialised services do not provide connectivity to the internet…*"

ARCHITECTURE IMPLEMENTATION OPTION VR#5 – SLICING AND SERVICE HOSTING



TOPIC 8. SPS AND CONNECTIONS TO THE INTERNET

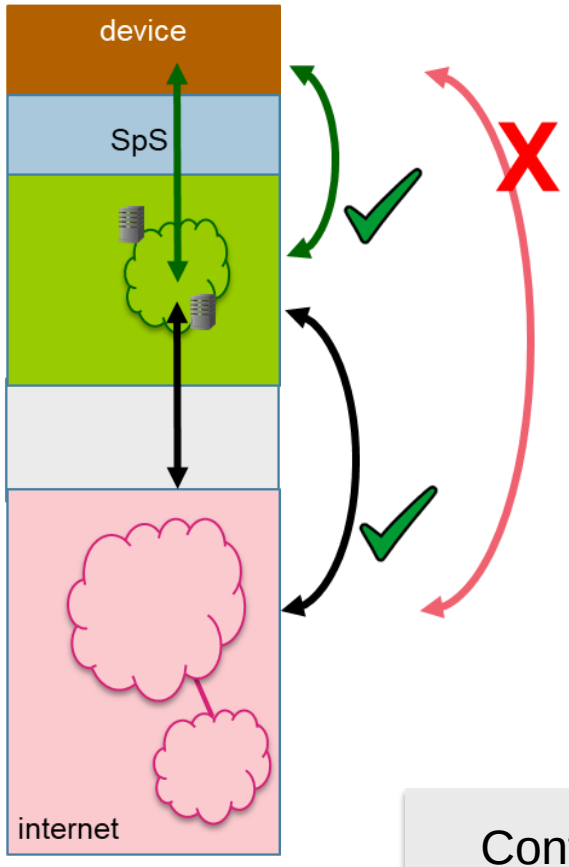


Guidelines par 115

"*VPNs could qualify as specialised services in accordance with … the Regulation. However, … to the extent that corporate services such as VPNs also provide access to the internet, the provision of such access to the internet by a provider of electronic communications to the public should comply with Article 3(1) to (4) of the Regulation.*"

Sequence of SpS and IAS seems to be allowed

TOPIC 8. SPS AND CONNECTIONS TO THE INTERNET



Guidelines par 102

"*specialised services are not usable or offered as a replacement for IAS*"

Guidelines par 126

"*It is of utmost importance that the provisions regarding specialised services do not serve as a potential circumvention of the Regulation. Therefore, NRAs should assess whether a specialised service is a potential substitute for the IAS …*"

Configuration with two unconnected legs seems to be allowed

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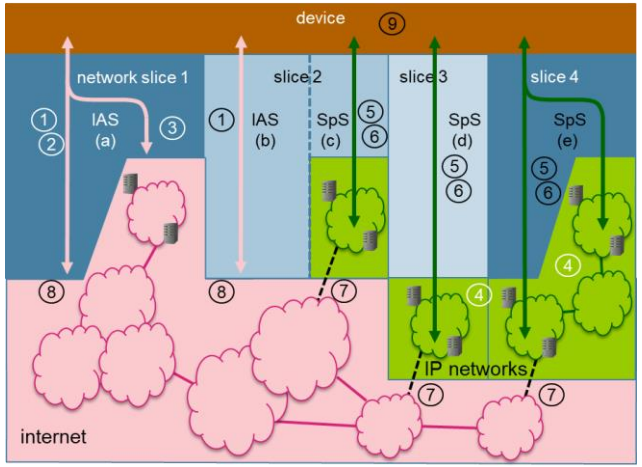
Public and private services and associated networks	• Size and scope of predetermined group of end users in private service	low to medium
Objective need for optimisation in SpS	• Determination of IAS for benchmark in case of multiple IAS offers • Variation of IAS performance between geographical regions and operators • Services comprising multiple traffic flows	high, except if SpS requirements are clearly much stricter than achievable over IAS.
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
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
Connectivity to limited number of internet end points	• Evaluation whether sub-internet service is acceptable for providing connectivity in specific situations	medium
Access control	(no issues if use is restricted to network congestion in emergency situations)	low

CONCLUSIONS

- It is not possible to come to an overall assessment with a single outcome on the alignment of 5G technology with net neutrality rules.
- The technological neutrality of the Regulation means that there is no a priori ban on any 5G technology ingredient.



Topic	Key points identified in analysis	Relative regulatory complexity
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
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
Local access to the internet	• (potentially:) IP interconnection of local networks	low
Public and private services and associated networks	• Size and scope of predetermined group of end users in private service	low to / medium
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.
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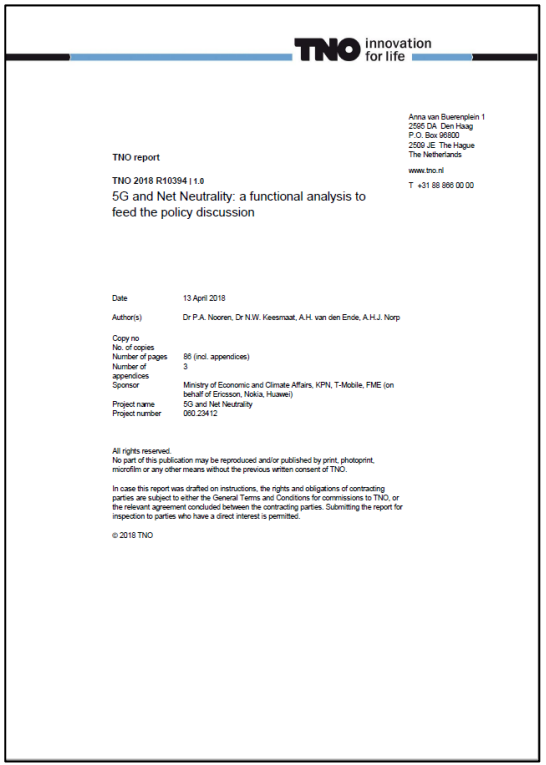
- The topics encountered in the assessment of the compliance have varying complexity.
  - The impact of Specialised Services on Internet Access Services and the objective need for optimisation in Specialised Services are expected to have the highest complexity.
- The topics encountered in the assessment are not exclusively related to 5G technology

RECOMMENDATIONS

Clearly distinguish between 5G architecture elements on the one hand and the net neutrality concepts of IAS and SpS on the other

We invite stakeholders to use the consolidated 5G architecture as a foundation for discussions on the alignment of 5G & net neutrality

1. Determine the specific connectivity demands from use cases
2. Develop the architecture options to support the connectivity in 5G networks
3. Evaluate the compliance of combination of application and architecture options with net neutrality rules



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5G and Net Neutrality: a functional analysis to feed the policy discussion

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THE FULL STUDY REPORT IS AVAILABLE AT TNO.NL


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