



5G & IoT: emerging technologies and spectrum implications

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We are GSMA

The GSMA represents the interests of mobile operators worldwide, uniting nearly



800
MOBILE OPERATORS



300+
COMPANIES
IN THE BROADER MOBILE ECOSYSTEM

OUR MEMBERSHIP REACH SPANS MORE THAN



220
countries and territories



7.6
BILLION+
MOBILE CONNECTIONS
WORLDWIDE



CONNECTING **27,000+**
INDUSTRY EXPERTS



GSMA WAS
FOUNDED IN
1987



Connecting everyone and everything to a better future

Industry Purpose

- UN Sustainable Development Goals
- Big Data for social good

Convene the industry

- Mobile World Congress events
- Mobile 360 events

Regulation & Public Policy

- Spectrum
- Mobile for Development

Technology Development

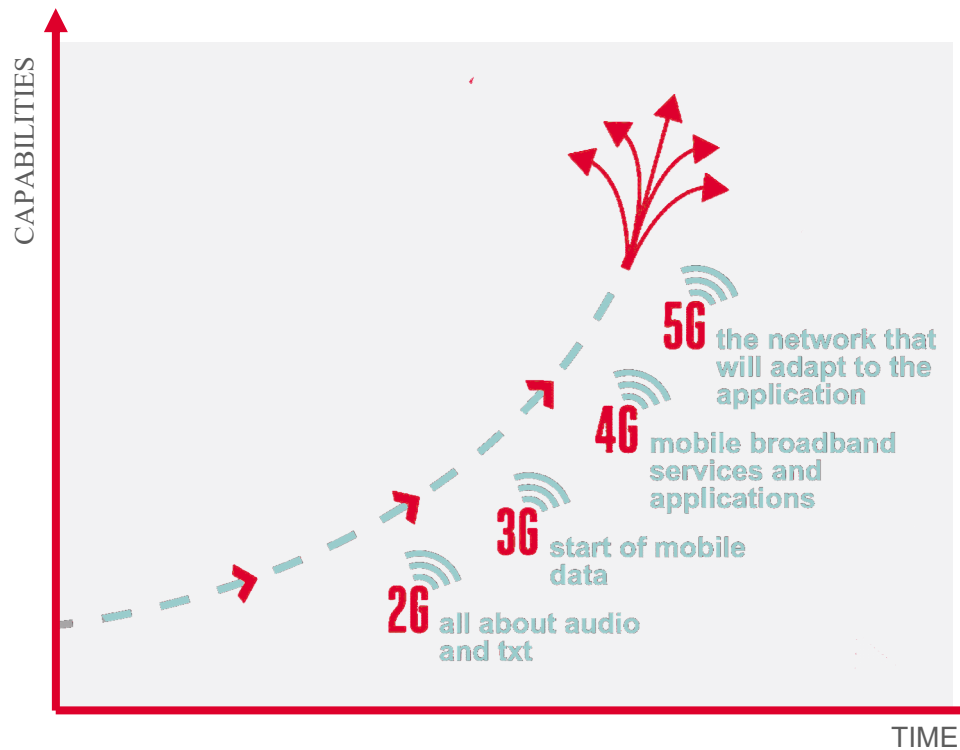
- Security, Terminals, Networks, Internet, Wholesale, SDO Engage.

Programmes

- Identity, IoT (including Remote SIM provisioning), Future Networks



From purpose built to a flexible generation

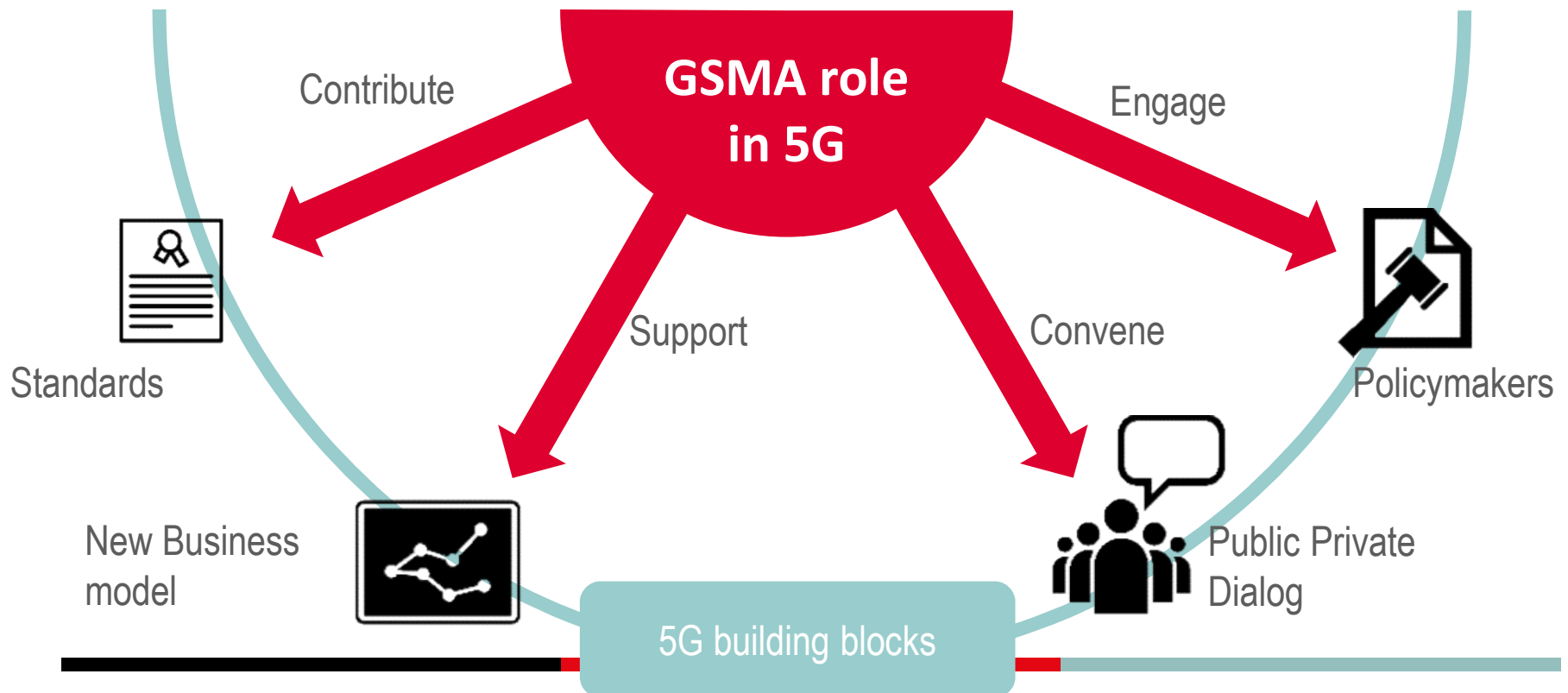


Evolution towards 5G

- The fifth generation of mobile technology is expected to be deployed in large scale in the 20s decade
- As for the previous generation leaps it will produce a leap in performance:
- Speed in the Gbit/s
- Latency below 5ms
- 5G will be adaptable to serve a variety of use cases and integrate existing networks



The Role of GSMA in the 5G Era





We sought our members views to develop a vision for the 5G Era...



In October 2016 we asked the CEOs of our 750+ mobile operator members 20 questions (CEO 5G Survey)

And derived 10 insights...

1	5G will transform the mobile broadband experience in early deployments and drive new intelligent automation use cases later.	6	Competition and collaboration between operators and other ecosystem players to provide services will intensify in the 5G era.
2	5G as a technology will evolve over time and leverage a variety of spectrum ranges, plus robust security, to support new use cases.	7	New models for infrastructure ownership, competition and partnerships will be required for the 5G era.
3	Enterprise services and solutions will drive 5G's incremental potential.	8	Regulation, licensing and spectrum policy will make or break the 5G opportunity.
4	5G will start as an urban-focused technology and integrate with 4G to provide boundless connectivity for all.	9	The industry should strive to avoid spectrum and technology fragmentation for 5G.
5	5G will deliver revenue growth to mobile operators, with a 2.5% CAGR in the early 5G era.	10	Interoperable and interconnected IP communication services, including device-to-device, supported as default in the 5G era.



The 5 GSMA goals for the 5G era



1 BOUNDLESS CONNECTIVITY FOR ALL

2 INNOVATION & NETWORK ECONOMICS

3 TRANSFORMATION OF VERTICAL INDUSTRIES

4 REVOLUTIONIZE THE MOBILE BROADBAND EXPERIENCE

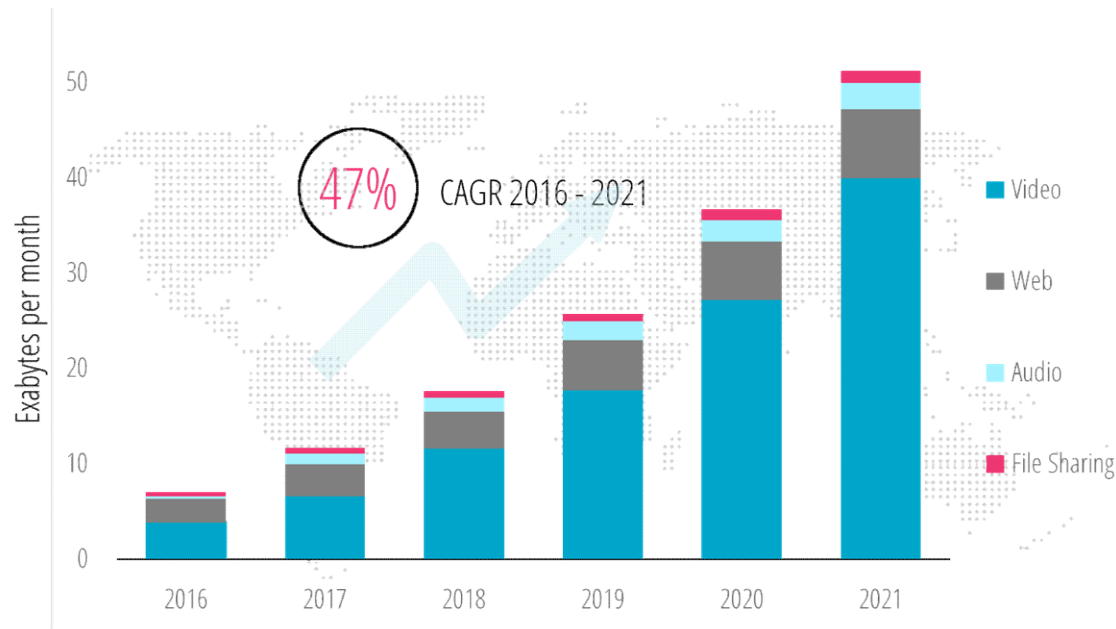
5 HELP TO GROW NEW USE CASES



Addressing the data demand



Relentless growth of mobile data



Graphics: GSMA | Source: Cisco VNI 2017

Data usage set to grow

- Consumers appetite for data, especially video still on the rise
- Millions of “things” also expected to add to mobile data traffic
- Some estimations suggest that capacity of mobile networks will need to grow by a factor of 1,000,000



Available tools for extending the capacity



SPECTRAL EFFICIENCY

- How many bits of information can be sent every second for each hertz of bandwidth
- No major improvements expected compared to already efficient LTE
- Target is **x3** efficiency over LTE



NETWORK DENSIFICATION

- More smaller cells can dramatically improve capacity
- Physical limitation due to interference between adjacent cells
- With mmWave very high capacity multiplier possible (x1000)



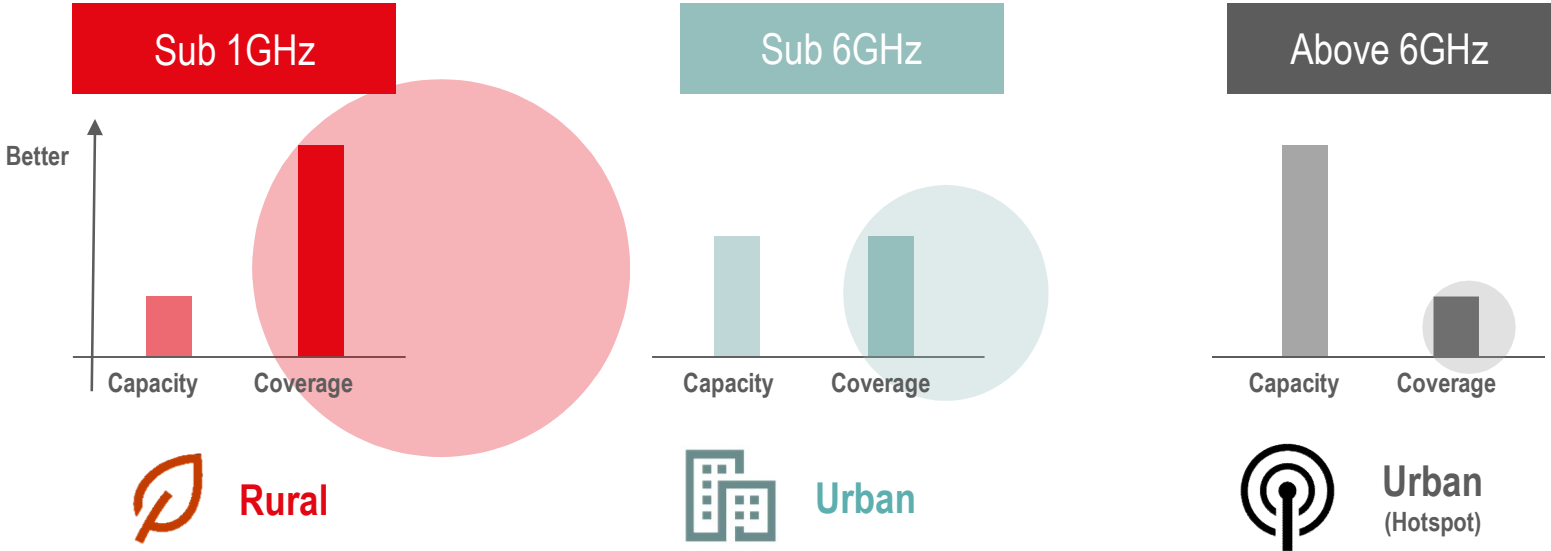
Frequency Band

NEW SPECTRUM

- Capacity is directly proportional to the bandwidth (see spectral efficiency)
- Licensed spectrum preferred due to possibility of controlling quality and maximizing potential



Different spectrum to fulfil different deployment needs



CAPACITY MORE BANDWIDTH ALLOWS FOR MORE INFORMATION TO BE SENT BY THE SYSTEM


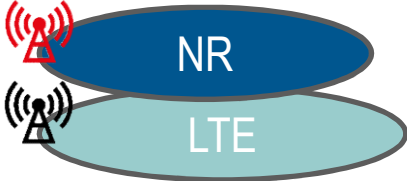
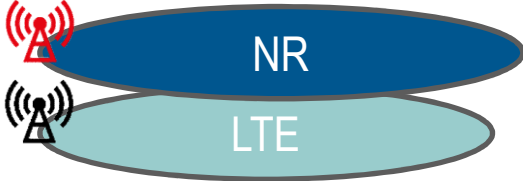
COVERAGE MORE FAVOURABLE PROPAGATION OF RADIO SIGNALS ALLOWS FOR LARGER CELLS





Coverage comparison

Notes

- LTE not suited for deployment in mmWave
- Higher propagation loss at 3.5GHz compensated by
 - Massive MIMO
 - Beamforming
- Limited availability of spectrum below 1GHz limits the performances

RAT/Band	Illustrative coverage comparison	Scenario
NR mmWave		Local coverage Peak data rate: 10Gbps
NR 3.5GHz mMIMO LTE 1800		Reuse of 1800 grid possible for Downlink Peak data rate: 1Gbps
NR 700MHz LTE 800 MHz		Deep indoor penetration Peak data rate: 100Mbps

 NR gNodeB
  LTE eNodeB



Fixed Wireless Access in 5G



Source: Samsung Electronics

FWA role

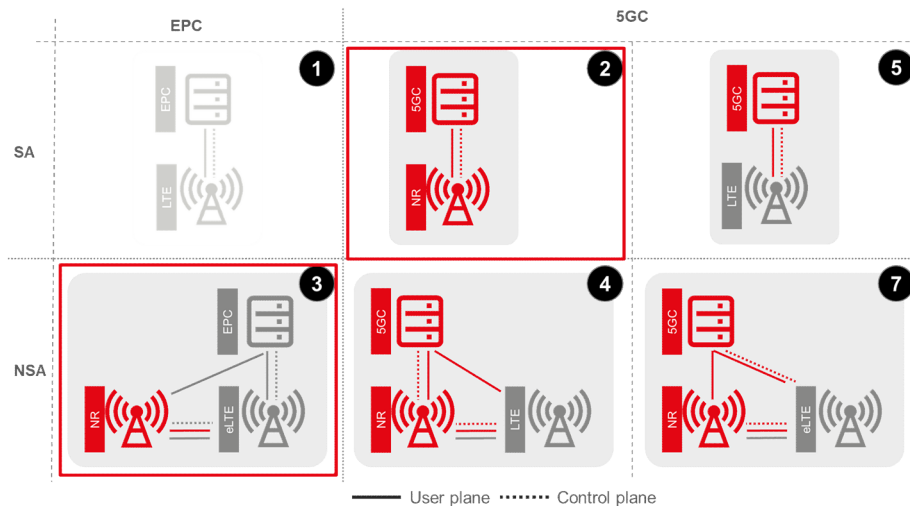
- 5G radio evolution designed to operate also in mmWave(*) where large bandwidths are available
- Fixed Wireless Access combined with 5G radio technology is a relevant fibre substitute
- Falls into consumer focussed category but has enterprise applications too
- May be initially fragmented (several technical specifications)



State of the deployment



Non-standalone (NSA) vs. Standalone (SA)



- ### Option 3 (NSA)
- Quick time-to-market
 - Leverages existing 4G deployment
 - Minor modification to 4G network required
 - User plane provided over NR and LTE
 - Control plane provided over LTE
 - Legacy 4G devices still supported
 - “5G devices” only need to support New Radio protocols

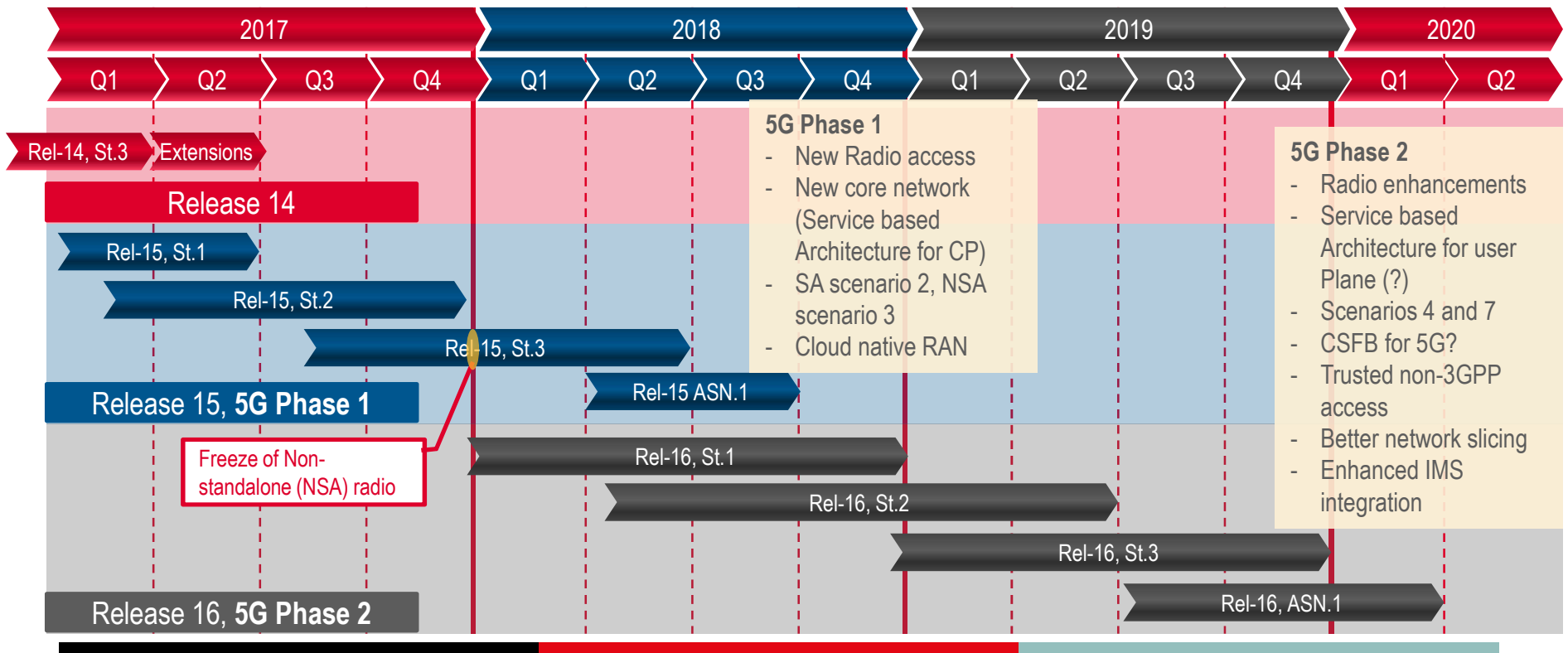
- ### Option 2 (SA)
- Requires both NR and new 5G core
 - No impact on LTE radio
 - May require interworking between EPC and 5GC
 - Full support for 5G services
 - Supports Network slicing
 - “5G devices” need to support New Radio and core network protocols

Option 3 specification completed in December 2017
 Option 2 specification will be completed in June 2018

Until March 2018, 3GPP shall prioritize Option-3 stabilization and the Option-2 specification work.
 Migration to Option-4 and Option-7 starts as soon as Option-2 and Option-3 are stabilized



Standardisation Roadmap





5G use cases: a wide range of applications

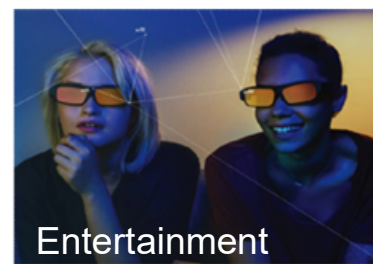
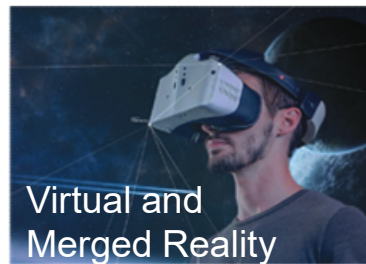
Ultra Reliability
and Low
Latency



Massive
M2M
Connectivity

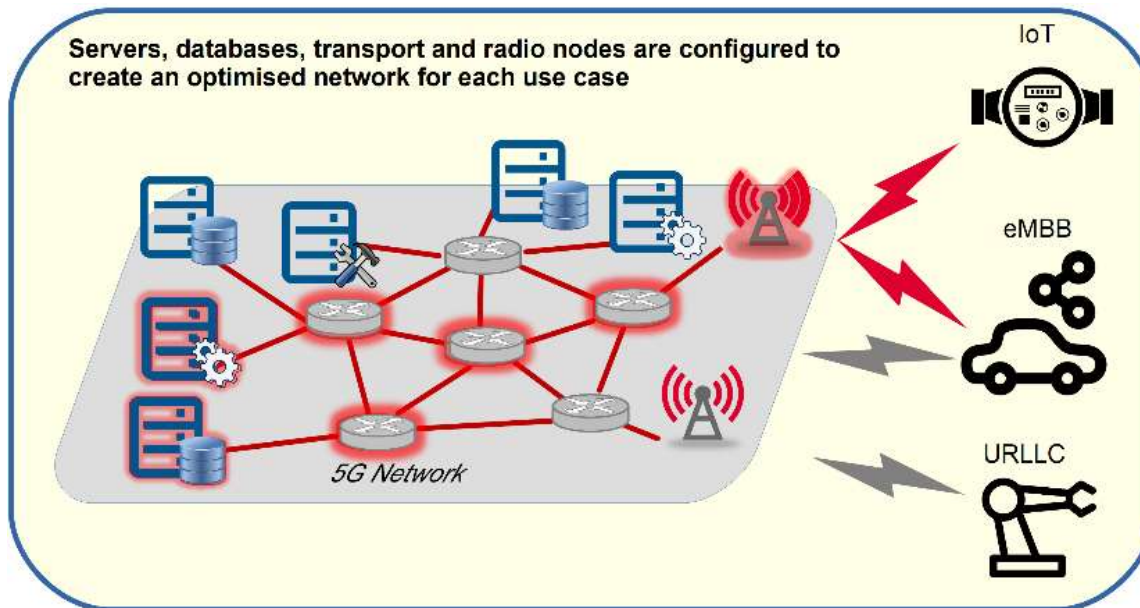


Enhanced
Mobile
Broadband





Technology overview: Slicing

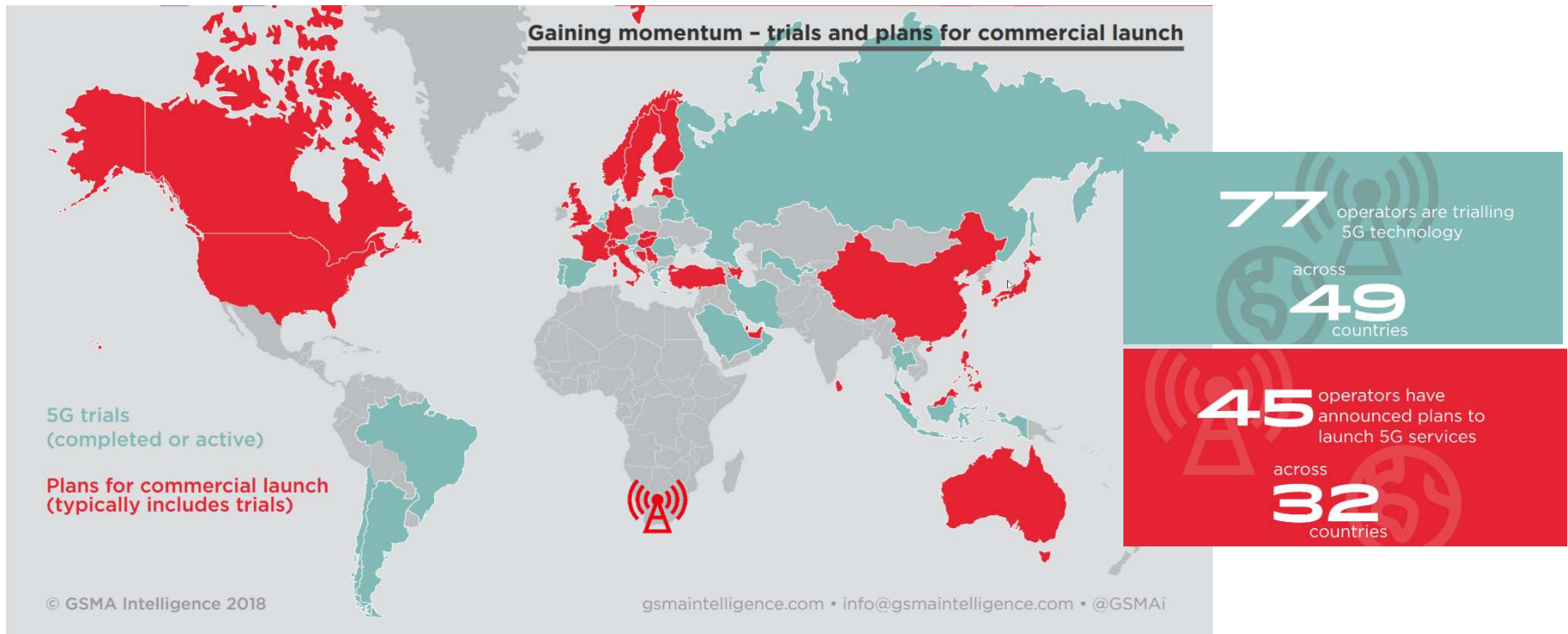


Adapting to the use case

- Network Slicing allows designing the network to adapt to the requirements of each use case
- Needs 5G Core to realize its full potential
- Enables new types of business models depending on level of control granted to customer
 - hosted solutions
 - Integration with customer's system



5G Trials Regionally



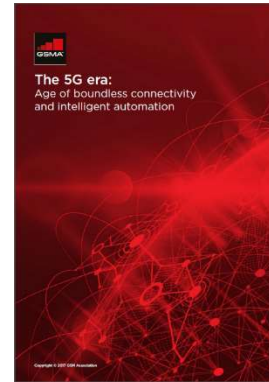
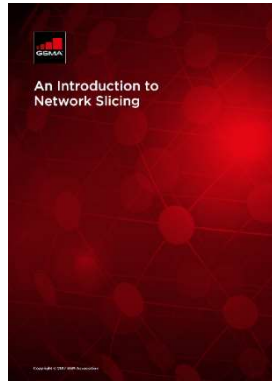


Any question?





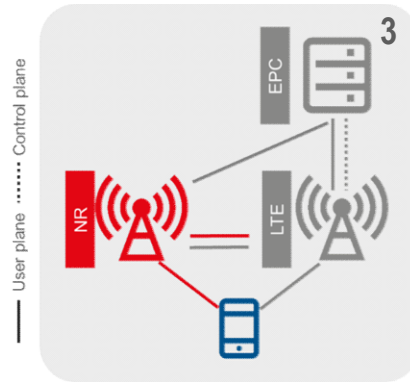
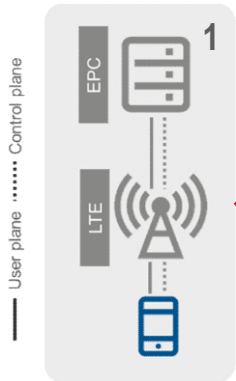
References





Consumer focused 5G introduction

Element	Impact
EPC	Minor modifications
LTE	Minor modifications
UE using LTE	EPC stack
UE using NR	EPC stack



Impacts

- Core Network
 - Minor impact on EPC to support NR
- Radio network
 - Minor Impact on LTE to support dual connectivity
- Devices
 - 4G-only devices will continue to operate normally
 - **5G capable device should support 5GC stack for forward compatibility**

Dual connectivity deployment

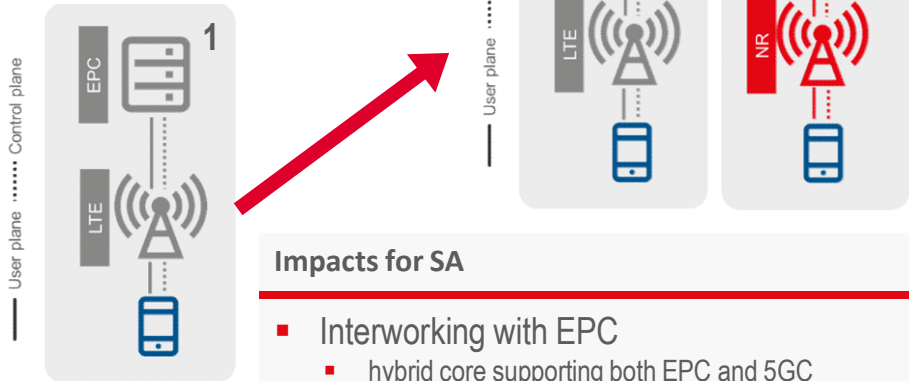
- This deployment option addresses the enhanced Mobile Broadband demand
- 5G is a capacity layer providing high data throughput initially in traffic hotspots
- Reliance on 4G for coverage
- Seamless usage of both LTE and NR

- Quite likely to be the deployment of choice where Data usage is high (e.g. >30Gbit/month per user), low WiFi penetration



Enterprise focused 5G introduction

Element	Impact
EPC	IW with 5GC
LTE	No impact
UE using LTE	EPC stack
UE using NR	5GC stack



Impacts for SA

- Interworking with EPC
 - hybrid core supporting both EPC and 5GC
 - Separate cores (standardised interface)
- Radio network
 - No impact on LTE
- Devices
 - Support of 5GC stack required
 - **Support of EPC stack highly desirable**

Impacts for SA

- New core network designed around service oriented paradigm will allow operators to leverage
 - low latency,
 - high reliability
 - Mobile network APIs
 - Network slicing
- Deployment focussed on enterprises and for exploring new horizons
- Through 5GC tailoring network behaviour to use case and acceleration of service creation become possible
- Focus on B2B