Business model-driven 5G deployment

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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

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

GSMA GOALS

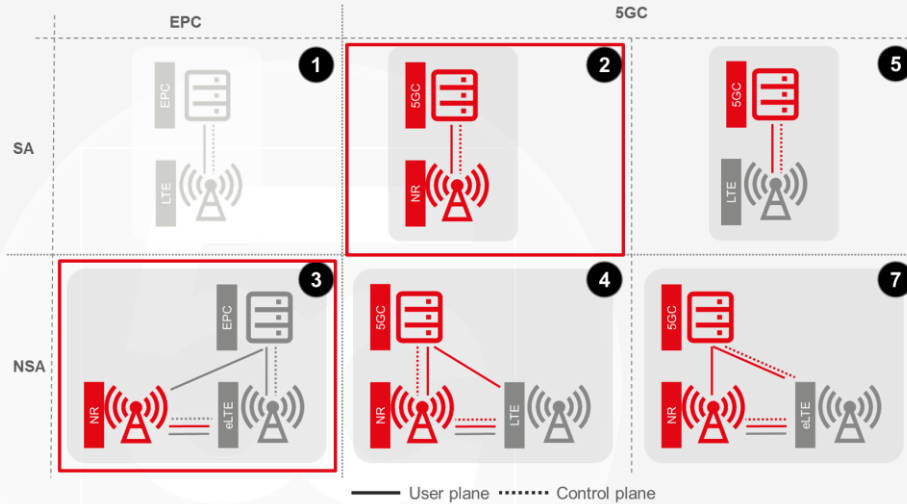|	
1	BOUNDLESS CONNECTIVITY FOR ALL
2	INNOVATION & NETWORK ECONOMICS
3	TRANSFORMATION OF VERTICAL INDUSTRIES
4	REVOLUTIONIZE THE MOBILE BROADBAND EXPERIENCE
5	HELP TO GROW NEW USE CASES

The Role of GSMA in the 5G Era
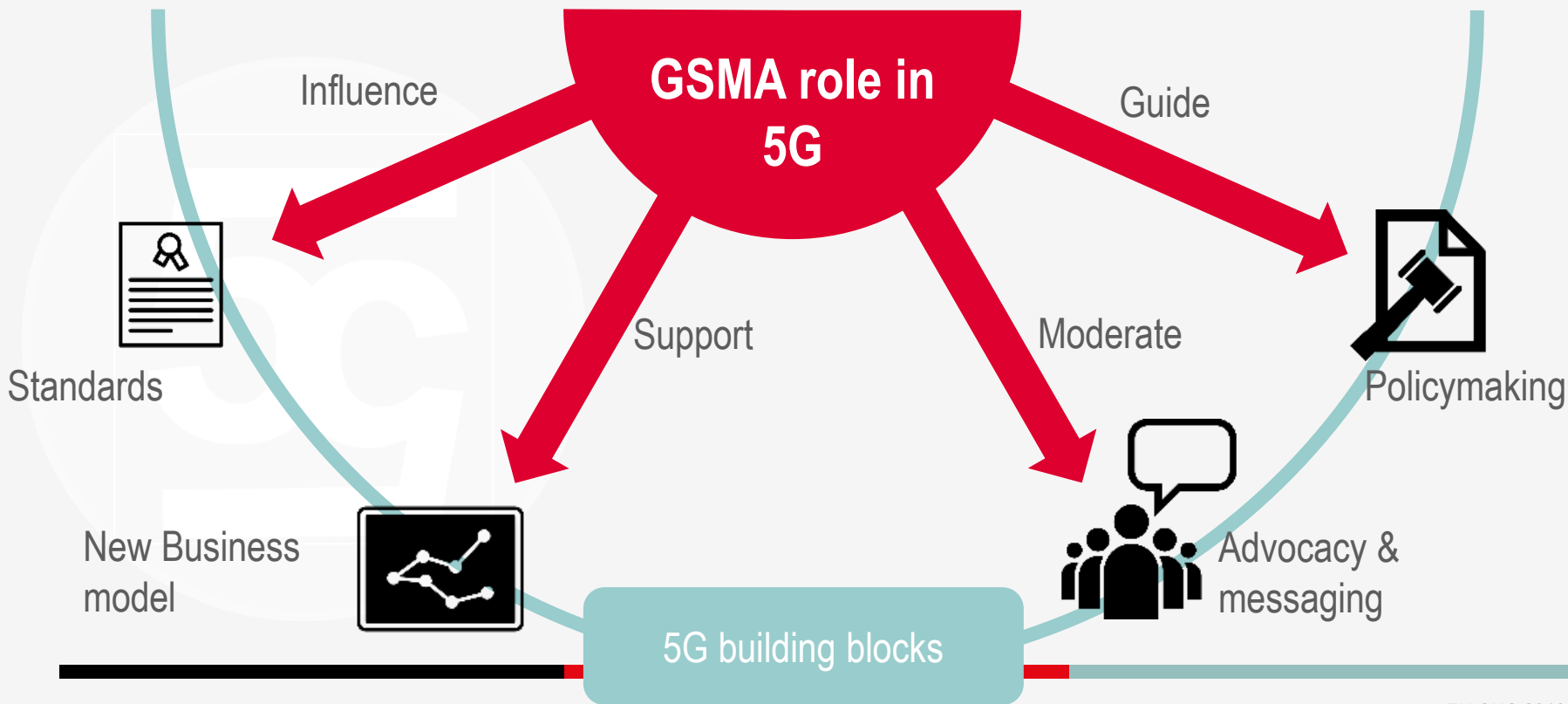
Unlocking business innovation

5G Radio: Non-standalone (NSA) vs. Standalone (SA)

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

Option-4 and Option-7 will also be part of Release 15 in a "late drop" expected in December 2018

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

5G Core Network: a new paradigm
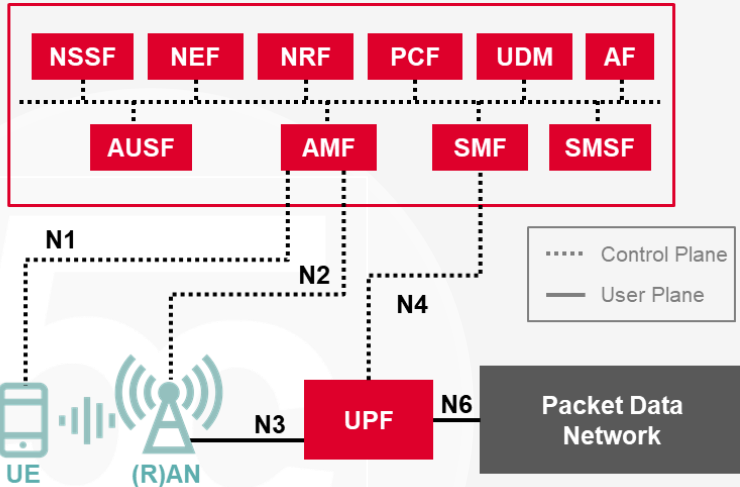
Advantages

- Decomposed functional elements offering specific network services (authentication, mobility management, etc)
- Common message bus using RESTful APIs. HTTP/2 over TCP transport
- Enables network capabilities exposure for fast service creation
- Control plane and user plane separation
- Supports network slicing
- Designed to leverage virtualisation principles

Disadvantages

- Further work required in some areas (e.g. roaming/interworking)
- Update on skills of operator's workforce required
- Potential latency issues
- Multivendor deployment analysis required
- No CS interworking defined for Release 15

NEF	Network Exposure Function	AMF	Access & Mobility Management Function
NRF	Network Repository Function	SMF	Session Management Function
PCF	Policy Control Function	UE	User Equipment
UDM	Unified Data Management	(R)AN	(Radio) Access Network
AF	Application Function	UPF	User Plane Function
AUSF	Authentication Server Function	DN	Data Network

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)

Consumer-driven deployment

Consumer focused 5G introduction

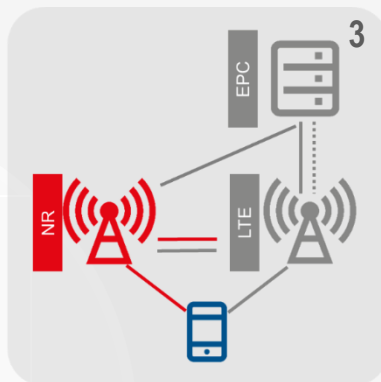| Element	Impact
EPC	Minor modifications
LTE	Minor modifications
UE using LTE	EPC stack
UE using NR	EPC stack

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

Voice over IMS continuity considerations

LTE and NR connected to EPC

From	To	Impact
NR	LTE	Yes (PS HO)
NR	CS	Yes* (SRVCC)
LTE	NR	Yes (PS HO)
LTE	CS	Yes (SRVCC)
CS Fallback		
NR	CS	Yes*
LTE	CS	Yes

* May have long interruption time

SRVCC · CS · SRVCC · CSFB · LTE · NR · PS Handover

LTE and NR connected to 5GC
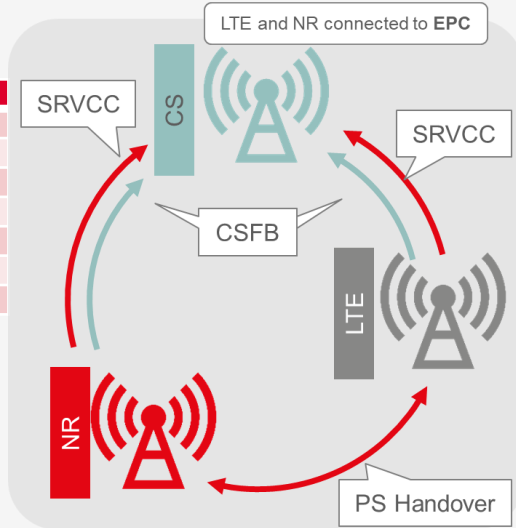
From	To	Impact
NR	LTE	Yes (PS HO)
NR	CS	No*
LTE	NR	Yes (PS HO)
LTE	CS	No
CS Fallback		
NR	CS	No*
LTE	CS	No*

* May be specified in Release 16

No SRVCC · CS · No CSFB · LTE · NR · PS Handover
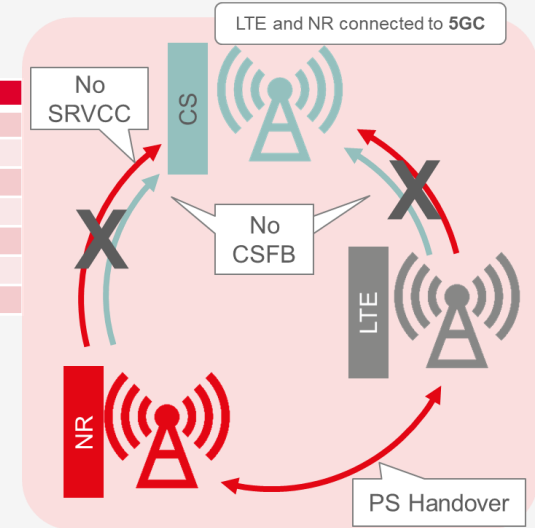
Impacts

- Some differences depending on whether EPC or 5GC is used to connect to the radio networks
- EPC continues to support CS Fallback and Single Radio Voice Service Continuity.

- **Use of voice over IMS over NR strongly recommended for best user experience**
- **CS Fallback not supported in first 5G release when 5GC is used**
  - 3GPP studying this for Release 16

Not all roaming scenarios are supported

Home CN ▶ ▼ Visited CN	EPC	5GC	EPC+5GC
EPC	✓	❗	✓
5GC	❗	✓	✓
EPC+5GC	✓	✓	✓

Commercial value vs complexity

- Two scenarios have been identified as potentially problematic by 3GPP:

  - Roaming agreement between two networks supporting different Core networks

- May require complex solution

- Problem will probably disappear over time
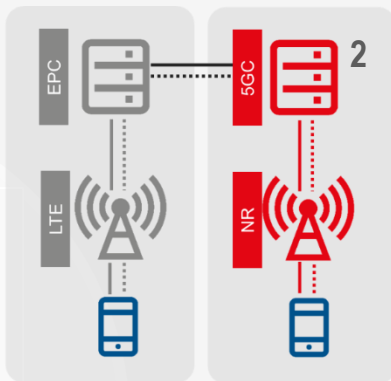
Enterprise-driven deployment

EU CNC 2018

5G core takes centre stage

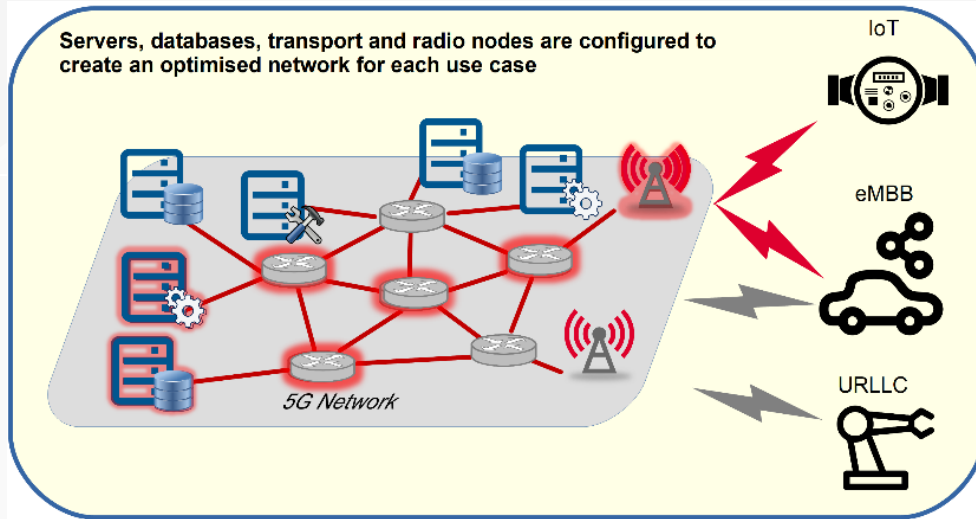| Element	Impact
EPC	IW with 5GC
LTE	No impact
UE using LTE	EPC stack
UE using NR	5GC stack

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

Unleashing the full potential of network slicing

Servers, databases, transport and radio nodes are configured to create an optimised network for each use case

IoT
eMBB
URLLC

5G Network

Device / Machine → Connectivity → Service enablement → Business solutions → Managed service

Hosted service

Integration at customer premises
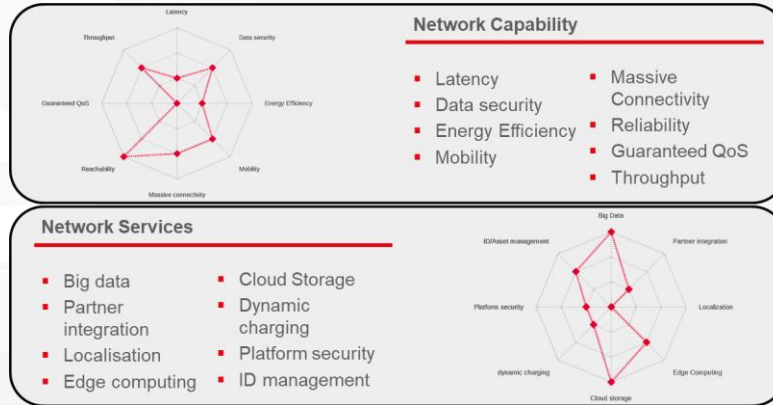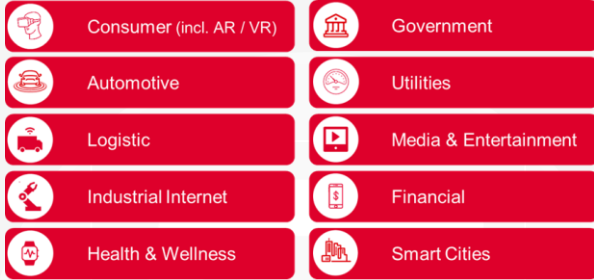
Capability exposure

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
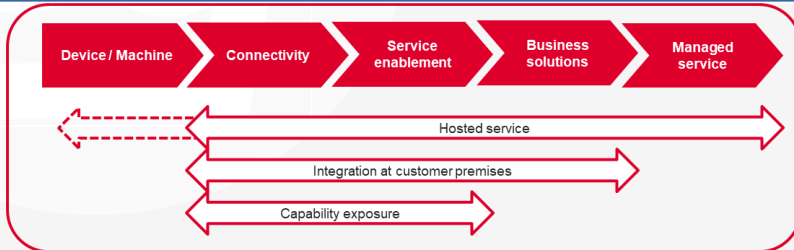
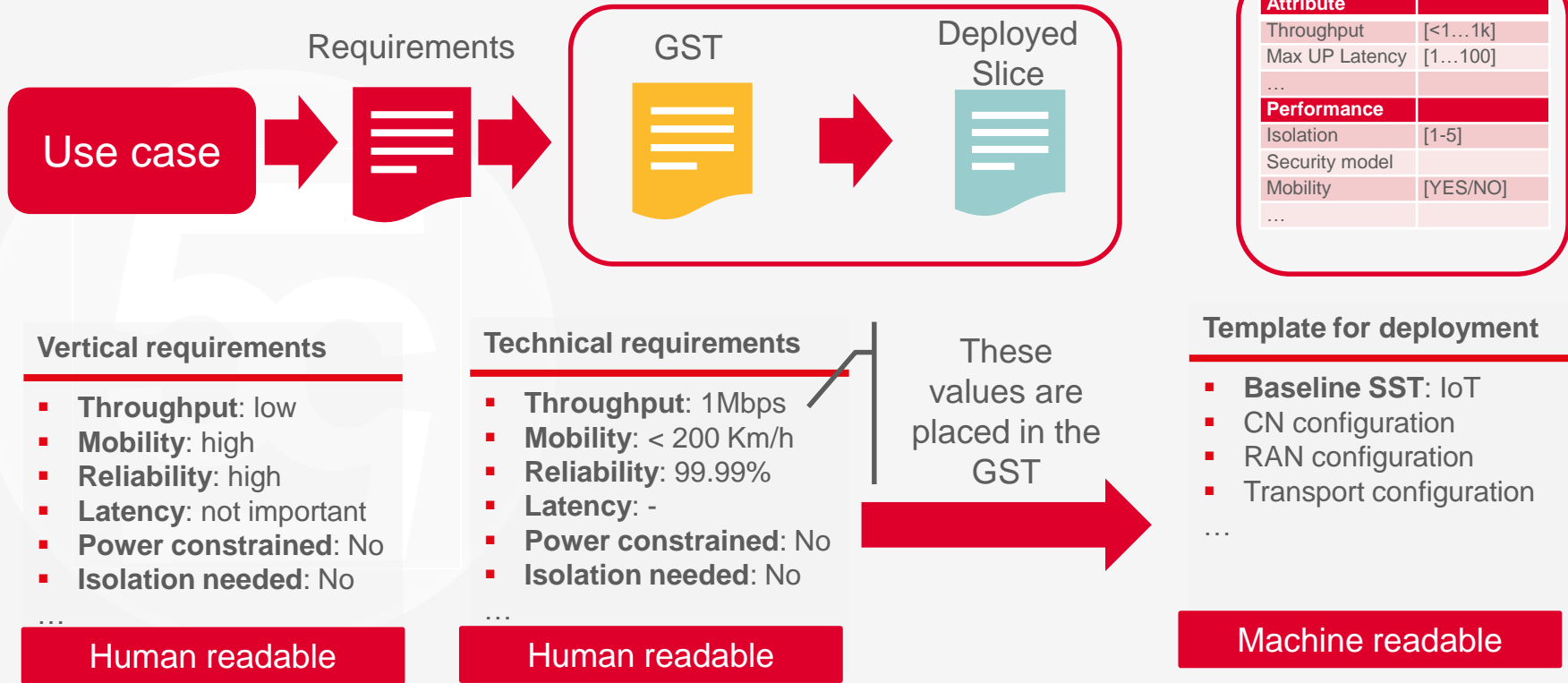# Industry use cases → capabilities → standardised slice type

Primary industry verticals under investigation

- Consumer (incl. AR / VR)
- Government
- Automotive
- Utilities
- Logistic
- Media & Entertainment
- Industrial Internet
- Financial
- Health & Wellness
- Smart Cities

- Telematics
- AR/VR
- Fleet Management
- CCTV surveillance
- Public Safety
- Agriculture drones
- Smart Grid
- Mobile banking
- Health monitor

Network Capability

- Latency
- Data security
- Energy Efficiency
- Mobility
- Massive Connectivity
- Reliability
- Guaranteed QoS
- Throughput

Network Services

- Big data
- Partner integration
- Localisation
- Edge computing
- Cloud Storage
- Dynamic charging
- Platform security
- ID management

Finding the "baseline" slices

- Extracted a multitude of use cases from the analysis of industry verticals, using relations with sectorial associations, interviews and desk research

- Mapped requirements into network capability requirements and network services requirements (Performance features, Operational features, Functional features)

- Will define a set of slice types that serve large portions of the use cases.

Example of configuration of a slice: telemetry

Requirements

GST

Deployed Slice

Use case

GST	
Attribute	
Throughput	[<1…1k]
Max UP Latency	[1…100]
…	
Performance	
Isolation	[1-5]
Security model	
Mobility	[YES/NO]
…	

Vertical requirements

- **Throughput**: low
- **Mobility**: high
- **Reliability**: high
- **Latency**: not important
- **Power constrained**: No
- **Isolation needed**: No

…

Human readable

Technical requirements

- **Throughput**: 1Mbps
- **Mobility**: < 200 Km/h
- **Reliability**: 99.99%
- **Latency**: -
- **Power constrained**: No
- **Isolation needed**: No

…

Human readable

These values are placed in the GST

Template for deployment

- **Baseline SST**: IoT
- CN configuration
- RAN configuration
- Transport configuration

…

Machine readable

Migration from initial deployment

Migration to long term configuration
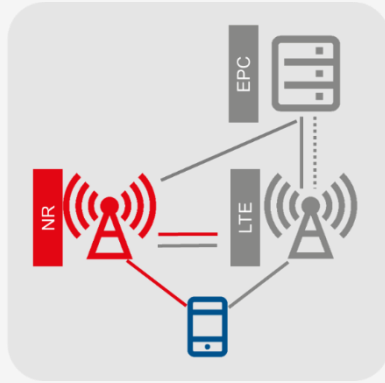
Element	Impact
EPC	Not in use
LTE	Upgrade
NR	Upgrade
UE using LTE	Need 5GC stack
UE using NR	Need 5GC stack

5G Core introduction
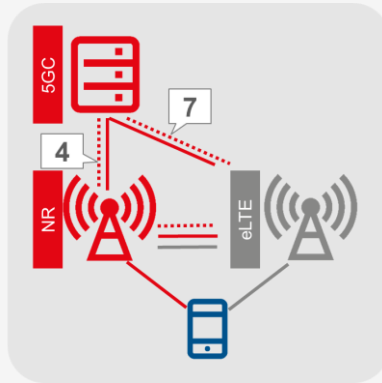
LTE integration

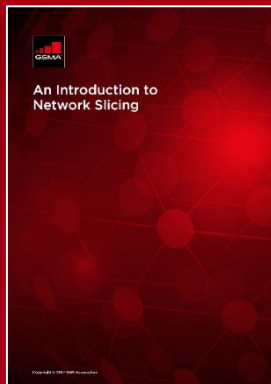| Element	Impact
EPC	Not in use
LTE	Upgrade
UE using LTE	5GC stack
UE using NR	5GC stack

Impacts of integrating LTE

- Integration of LTE with 5GC requires upgrades to LTE, NR and 5GC
- Roaming impacts
  - Roaming **not supported** between operators with different core networks. Fallback to 4G roaming
  - NG studying this issue
- Recommendation: EPC still useful
  - Support of legacy devices
  - Interworking with some roaming partners
  - LTE eNodeB can still be connected to EPC
- Benefits of LTE integration may be moderate
  - Network slicing extended to LTE coverage

All configurations can coexist in the same network

References