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Digital Transformation via 5G: Deployment Plans

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Session 3: Wireless infrastructure and digital transformation

Paper S3.1

Outline

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- **IMT-2020 Use Cases and Requirements**
- **5G Deployment Challenges**
- **5G Core Network Deployment**
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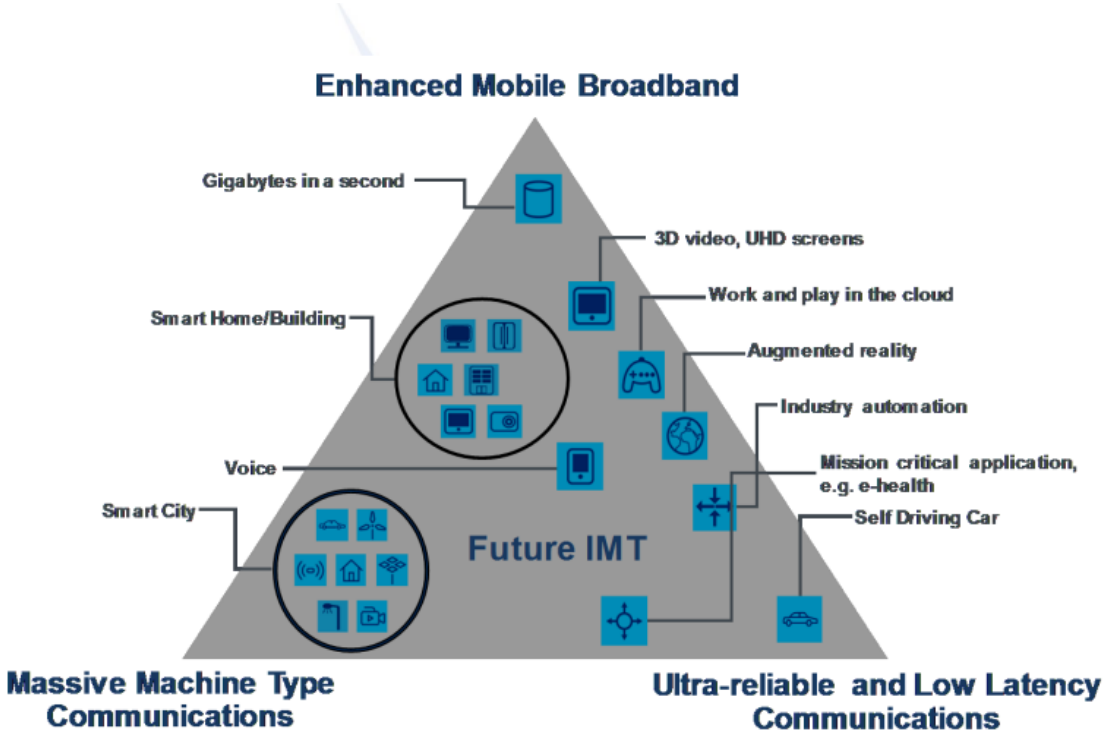
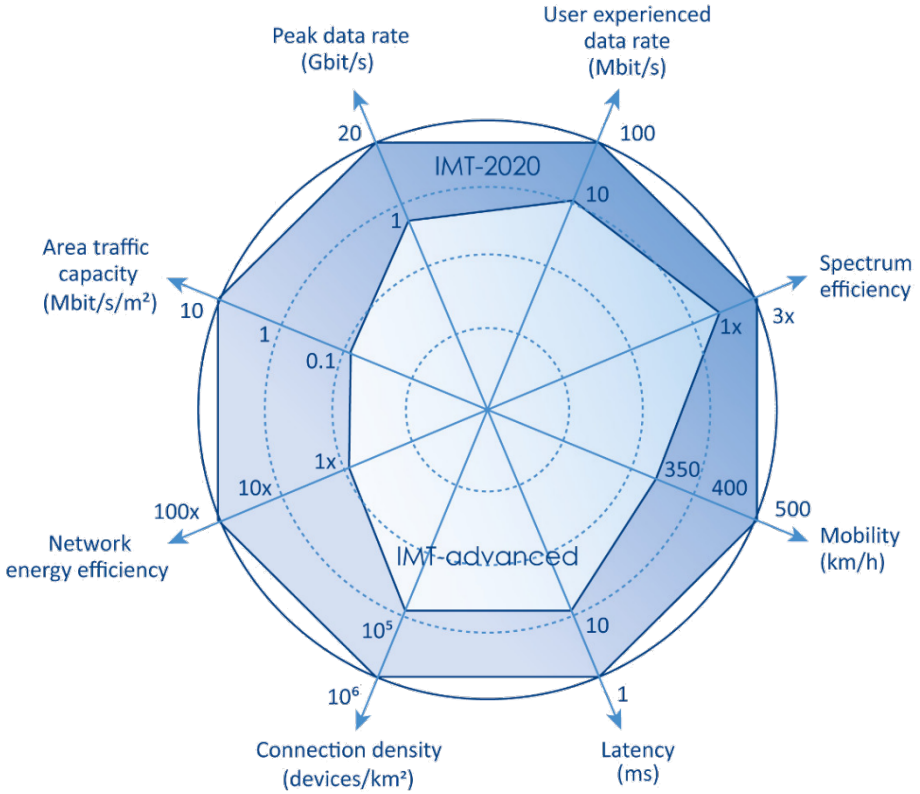
Digital Transformations and 5G

- **Digital transformation**: Use of digital technologies to solve problems, to offer services, and to address constraints with a view to achieving **sustainable development** in **many sectors of the economy**.
- **Three Pillars** of Digital Transformation:
  - **People**
  - **Processes**, and
  - **Tools**.
- **5G is a vital tool for digital transformation,** as it is an essential enabler for novel solutions and new platforms for sustainable development in all sectors of the economy**.**

IMT-2020: 5G Use Cases and Requirements





Source: https://www.etsi.org/technologies/mobile/5g

5G Deployment Challenges

- **5G Core** Network
- **5G Transport** Network
- **5G Radio Access** Network (RAN)

5G Core Network (CN) Deployment

Choice	Virtualization	Separation	Year	Notes
EPC	Optional	Disabled	Rel. 8-13 (2008-2016)	• Reference point interfaces (Sx interfaces) • Proprietary protocols (e.g., Diameter, eGTP, S1AP, and PFCP) for each interface • Possibility of deploying DECOR • Some nodes/NFs should be upgraded prior to 5G NSA deployment
EPC+	Mandatory	3GPP CUPS	Rel. 14-16 (2016-2019)	• Reference point interfaces (Sx interfaces including Sxa, Sxb, and Sxc depending on CUPS) • Proprietary protocols (e.g., Diameter, eGTP-C, eGTP-U, S1AP, and PFCP) for each interface • Possibility of deploying DECOR • Some nodes/NFs should be upgraded prior to 5G NSA deployment
5GC	Mandatory	Designed separately from the beginning	Rel. 15-17 (2016-2021)	• Service-based interfaces for CP function group (Nx naming for interfaces (e.g., Nsmf, Namf)), using HTTP/2-based REST APIs • Reference point interfaces for UP NFs and their interconnections (e.g., N1, N2, N4, and N9), using proprietary interfaces such as EPC • Supports network slicing (slice-based session establishment)

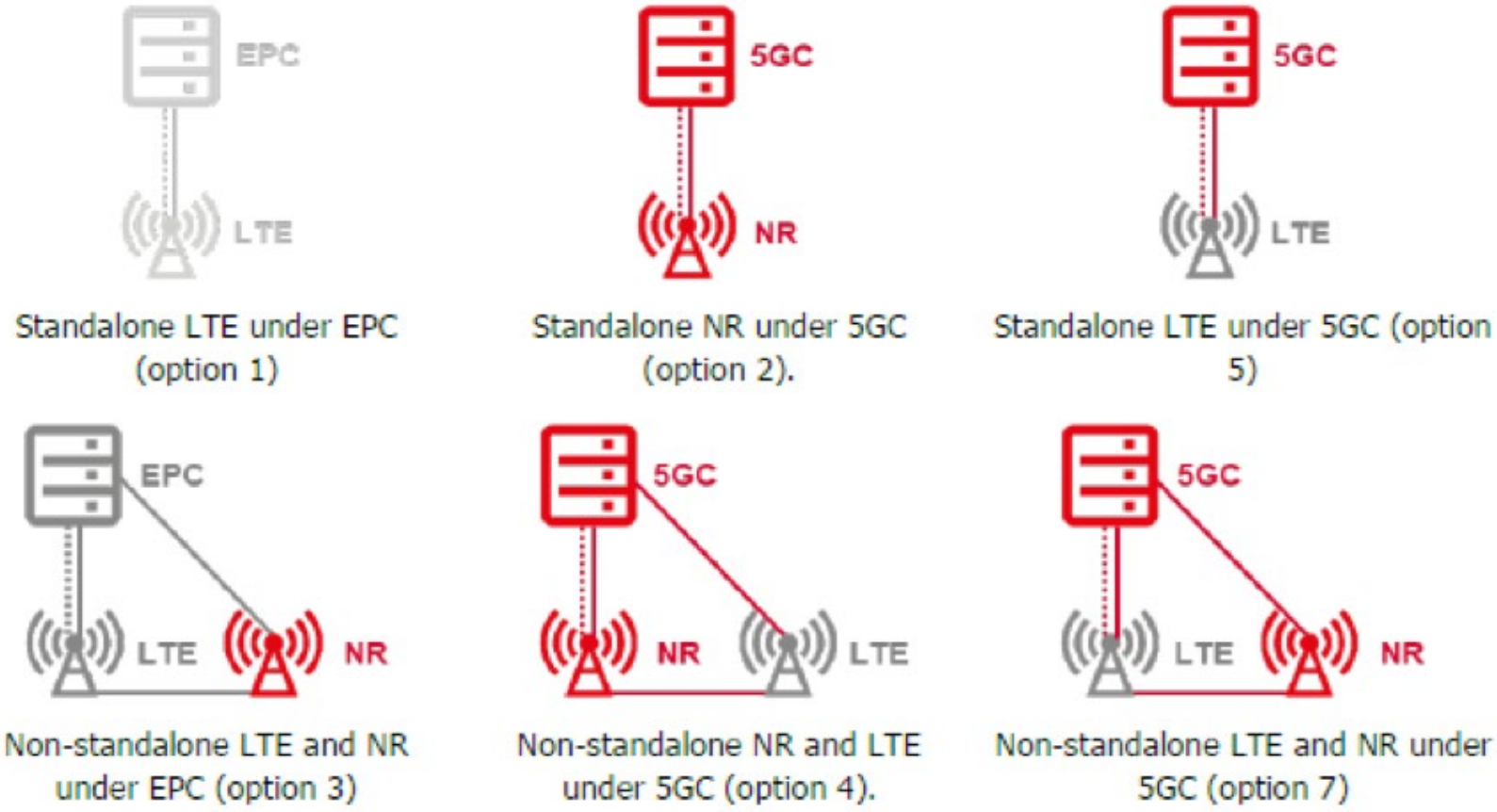
5G Core Network Deployment

State	State#	Description	3GPP Option
Initial (2017-2020)	ini1	Physical EPC	Option 1
	ini2	Virtual EPC	Option 1
	ini3	Physical and virtual EPC (both serving 4G)	Option 1
Intermediate (2019-2023)	int1	EPC+ (serving both 4G and 5G Option 3)	Option 3
	int2	Virtual EPC (serving 4G) interworking with EPC+ (Serving 5G Option 3)	Option 3
	int3	Virtual EPC (serving both 4G and 5G Option 3 (with less capacity))	Option 3
	int4	Physical EPC (serving 4G) interworking with virtual EPC (serving 5G Option 3)	Option 3
	int5	Physical EPC (serving 4G) interworking with EPC+ (serving 5G Option 3)	Option 3
Final (2020-2025)	fin1	Physical EPC (serving 4G) interworking with 5GC (Serving 5G Options 2/4)	Options 2/3/4
	fin2	Virtual EPC (serving 4G) interworking with 5GC (Serving 5G Options 2/4)	Options 2/3/4
	fin3	EPC+ (serving 4G) interworking with 5GC (serving 5G Options 2/4)	Options 2/3/4
	fin4	Unified 5GC (serving both 4G and 5G Options 2/4)	Options 2/4

5G Transport Network (TN) Deployment

- **Capacity Considerations**
  - Replacing Wireless with Fiber in TN
  - Upgrading Wireless TN
  - Expanding Fiber-based TN
- **C-RAN Deployment and TN**
- **Software-Defined TN**
  - Upgrading TN Equipment
  - Evolution of TN Architecture

From 4G to 5G: End-to-End Deployment Options



Source: GSMA

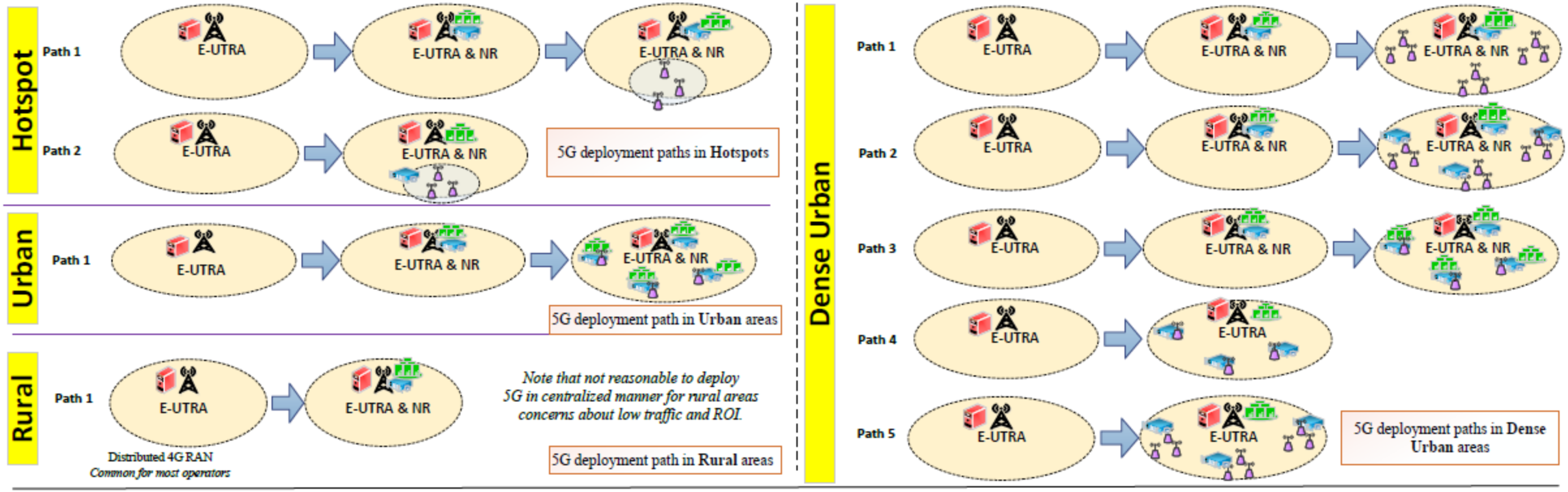
From 4G to 5G: End-to-End Deployment Paths

Path	Main Factors and Features	Considerations for Network Operators
1→ 3→7→4/2	• 5G early deployment with minimum CapEx • 5G eMBB services can be provisioned • 5G devices are available to support Options 3/3A/3X • 4G is utilized for longer periods	• There is a need to estimate 5G early customers • Ideal when 4G is widely available and the aim is to smoothly reach SA 5G before E5G/6G • Not recommended when the aim is fast provisioning of 5G services to vertical customers • Suitable when the aim is to smoothly prepare for 5GC, NFV, and SDN • Suitable for Tier 2/3 operators
1→3→4/2	• 5G early deployment with minimum CapEx • 4G spectrum can be refarmed after Phase 1 • 4G facilities can be leveraged to start and gradually expand 5G	• Switching from NSA to SA is costly • Recommended for rapid growth of 5G traffic and customers (after 2022) • Recommended for Tier 1 operators and rapid expansion of 5G
1→4/2	• 5G full-scale deployment • Long TTM • Provisioning all 5G services by enabling NS • NR works in SA mode and CN is 5GC (all modified from 4G)	• High CapEx • Need mature SDN, NFV, and E2E orchestrator in short time • Initial revenue may not be satisfactory • Forward compatibility with Rel. 16-17 should be considered • Recommended for special use cases (e.g., delay-sensitive applications) and hotspots
1→7→4/2	• Supports both 5GC/EPC NAS in initial deployment • Offers 5GC and NR capabilities • Utilizes 4G RAN and its spectrum in initial phase	• High CapEx • Suitable when 4G coverage is extensive with high traffic • Suitable when NFV and SDN are implemented • Not Recommended when the aim is quick 5G deployment

5G and E5G Spectrum for Radio Access Network

	Phase 1		Phase 2		Phase 3		
Choices	Carrier Frequency	BW	Carrier Frequency	BW	Carrier Frequency	BW	Characteristics
Choice 1	3.5 (3.3-4.2) GHz	100 MHz	Low band (e.g., 800 MHz)	20 MHz	mmWave 3.5 (3.3-4.2) GHz	1 GHz 100 MHz	Phase 1: Provisioning 5G data rates to end-users Phase 2: Provisioning 5G services in deep areas Phase 3: Provisioning all 5G services reliably (including data rate hungry services and in deep areas)
Choice 2	3.5 (3.3-4.2) GHz	100 MHz	mmWave Low band (e.g., 800 MHz)	1 GHz 20 MHz	3.5 (3.3-4.2) GHz	100 MHz	Phase 1: Provisioning 5G data rates to end-users Phase 2: Provisioning all 5G services reliably (including data rate hungry services and in deep areas) Phase 3: Increasing 5G capacity and coverage
Choice 3	2.6 (2.496-2.69) GHZ	100 MHz	3.5 (3.3-4.2) GHz	100 MHz	mmWave Low band (e.g., 800 MHz)	1 GHz 20 MHz	Phase 1: Provisioning 5G data rates to end-users Phase 2: Provisioning 5G services in deep areas (e.g., for IoT devices/sensors in blind spots) Phase 3: Provisioning all 5G services reliably (including data rate hungry services and in deep areas) Although 2.6 GHz is an important band in 4G, it can be used for 5G when 3.5 GHz band is not available.
Choice 4	2.6 (2.496-2.69) GHZ	100 MHz	mmWave Low band (e.g., 800 MHz)	1 GHz 20 MHz	3.5 (3.3-4.2) GHz	100 MHz	Phase 1: Provisioning 5G data rates to end-users Phase 2: Provisioning all 5G services reliably (including data rate hungry services and in deep areas) Phase 3: Increasing 5G capacity and coverage Although 2.6 GHz is an important band in 4G, it can be used for 5G when 3.5 GHz band is not available
Choice 5	mmWave Low band (e.g., 800 MHz)	1 GHz 20 MHz	3.5 (3.3-4.2) GHz	100 MHz	3.5 (3.3-4.2) GHz	100 MHz	Phase 1: Provisioning 5G services in hotspots and deep areas Phase 2: Provisioning 5G broadband services to end-users Phase 3: Increasing 5G capacity and coverage

5G Radio Access Network Deployment: Traffic-Based Options



Note 1: Depending on traffic/location, there are different 5G deployment choices (hotspots, dense urban areas, urban areas, and rural areas)
Note 2: In practice, choosing a 5G deployment plan depends on the availability of capital, service affordability, expected traffic, locations of existing eNB sites, and availability of spectrum

Conclusion

- **5G deployment is done in different steps:**
  - **First**: **Core network** should be **5G ready**. This can be done mostly by hardware/software upgrades
  - **Second**: **Transport network** should be upgraded to handle new excessive traffic and avoid **bottlenecks**
  - **Third**: **Radio access** network should be upgraded to connect **5G devices** and applications
- **5G deployment is time consuming and requires careful planning**
- **5G deployment requires hardware/software upgrades in existing 4G networks for 5G compatibility**
- **5G deployment requires new hardware/software for 5G sites**
- **5G deployment requires new spectrum**

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Thank you!