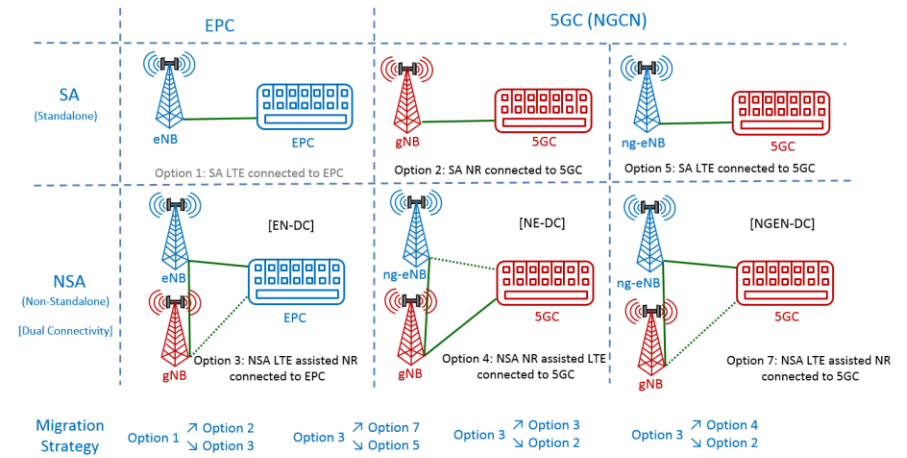


5G Network Architecture Options

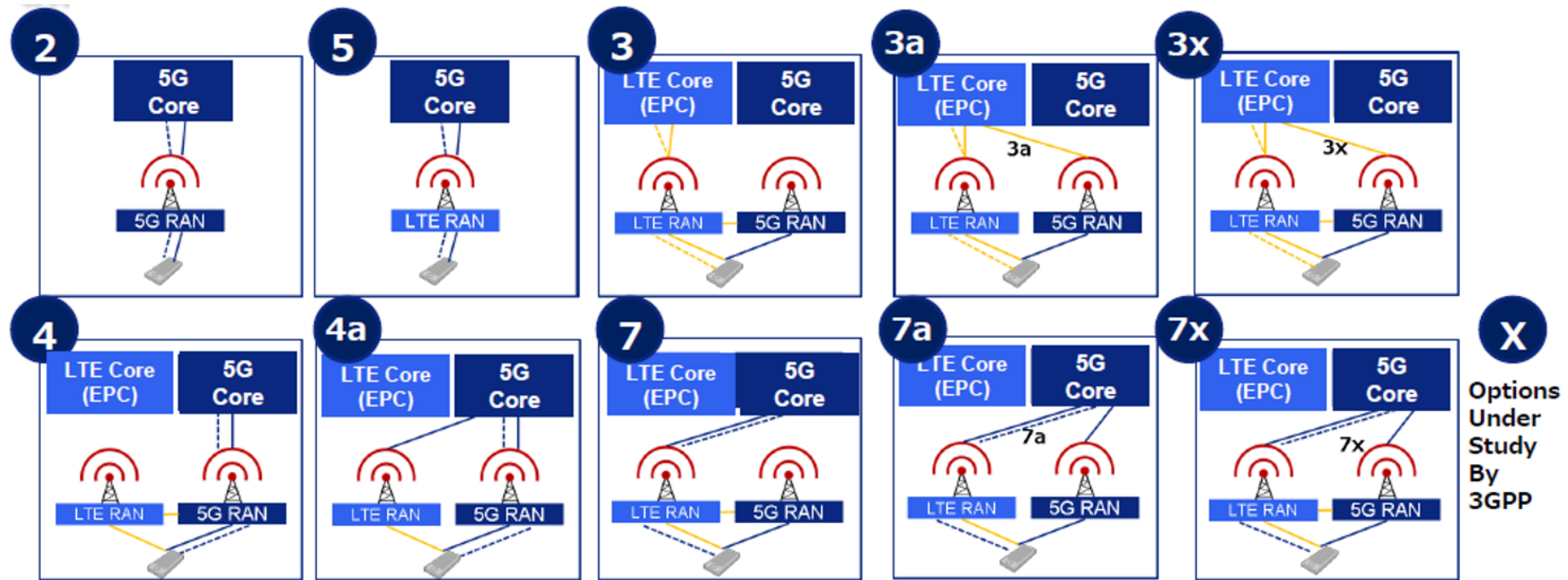
(Updated)



5G Network Architecture Options



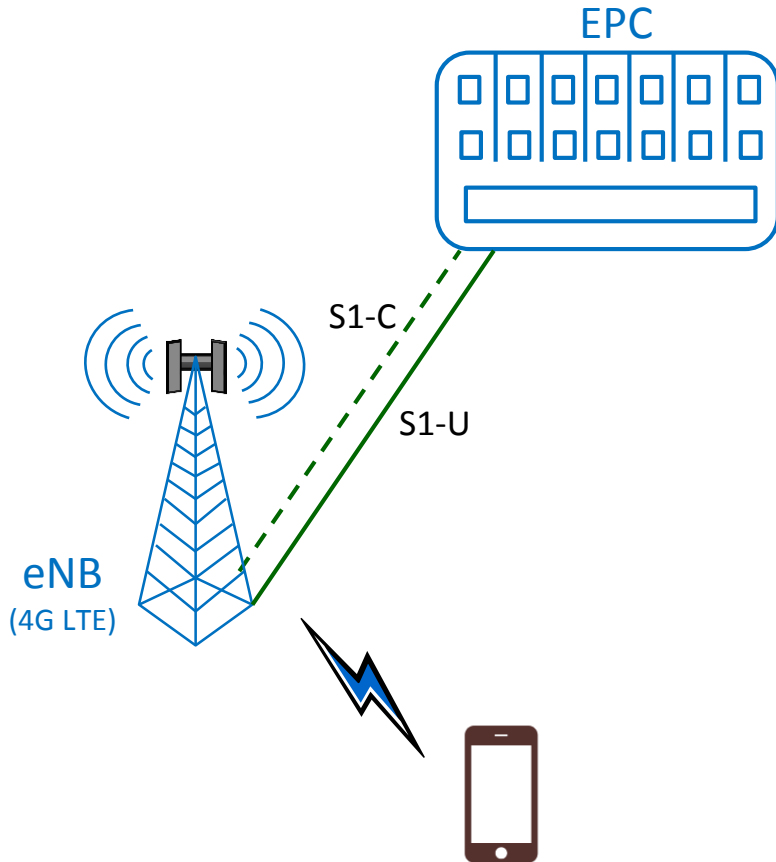
How did it all start?



- Back in 2016, Deutsche Telekom proposed 5G architecture options that can be used to move to 5G from LTE
 - The option numbers they proposed have been adopted in all discussions
- The above picture from KDDI, summarises them nicely

Option 1: SA LTE connected to EPC - Legacy

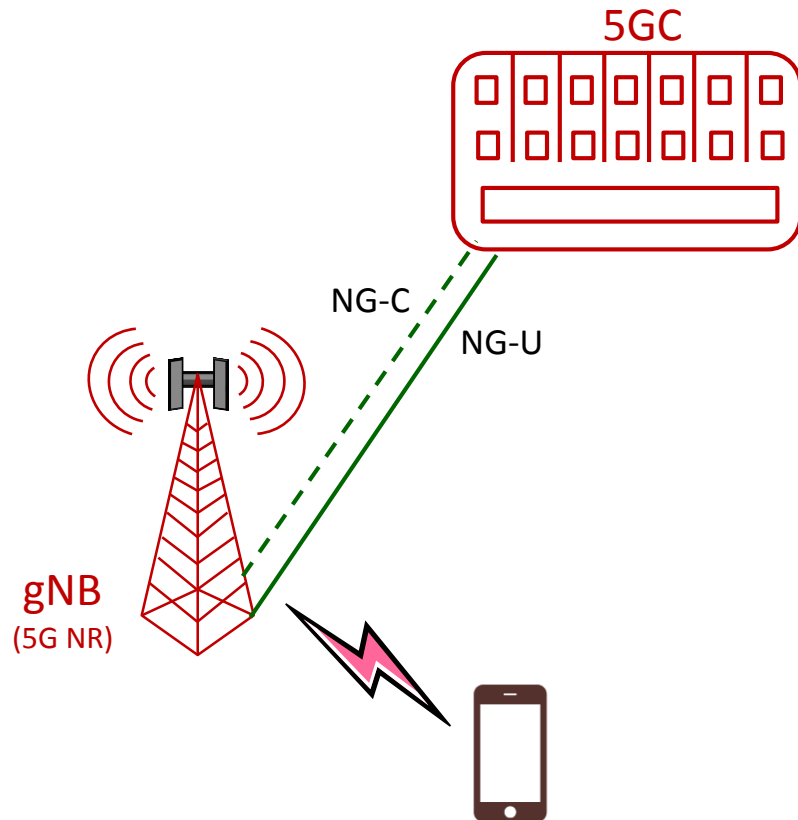
Option 1



SA = Standalone
NSA = Non-standalone

Option 2: SA NR connected to 5GC

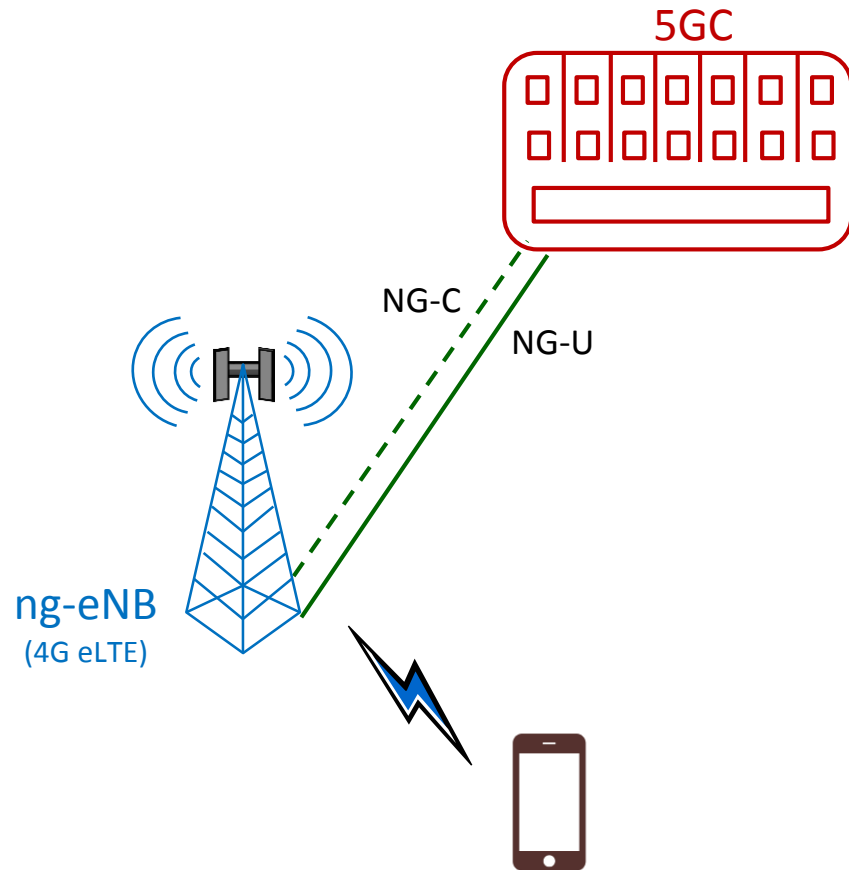
3GPP SA Option 2



- Only option for greenfield 5G operators
- Full support for new 5G applications and services including:
 - Enhanced Mobile Broadband (eMBB)
 - Massive Machine-Type Communications (mMTC)
 - Ultra-reliable and Low Latency Communications (URLLC)
- Needs multiple spectrum to provide all above cases and also to provide ubiquitous 5G coverage

Option 5: SA LTE connected to 5GC

3GPP SA Option 5



- Long term vision
- Deployed in conjunction with Option 2
- Can provide some of the benefits that 5G NR provides in conjunction with 5G Core.

Non-standalone Terminology

- MR-DC: Multi-RAT Dual Connectivity
 - 2 RATs (e.g. LTE and/or 5G NR) simultaneously providing connectivity to a device or UE
- MN: Master Node
- SN: Secondary Node

3GPP TS 36.300: Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2

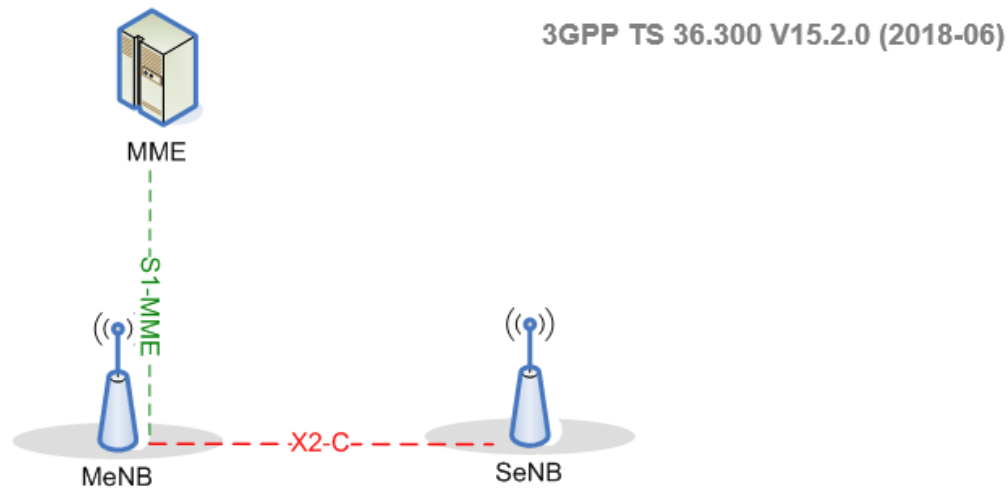


Figure 4.9.3.1-1: C-Plane connectivity of eNBs involved in Dual Connectivity

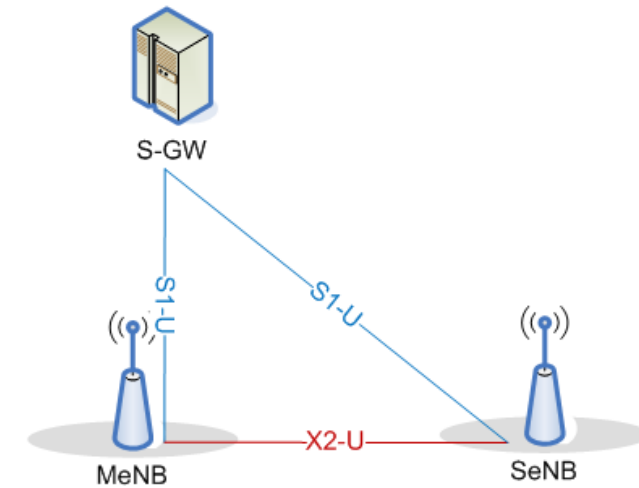


Figure 4.9.3.2-1: U-Plane connectivity of eNBs involved in Dual Connectivity

Master and Secondary nodes with LTE & NR

3GPP TS 37.340: Evolved Universal Terrestrial Radio Access (E-UTRA) and NR; Multi-connectivity; Stage 2
3GPP TS 38.300: NR; NR and NG-RAN Overall Description; Stage 2

Release 15

3GPP TS 37.340 V15.2.0 (2018-06)

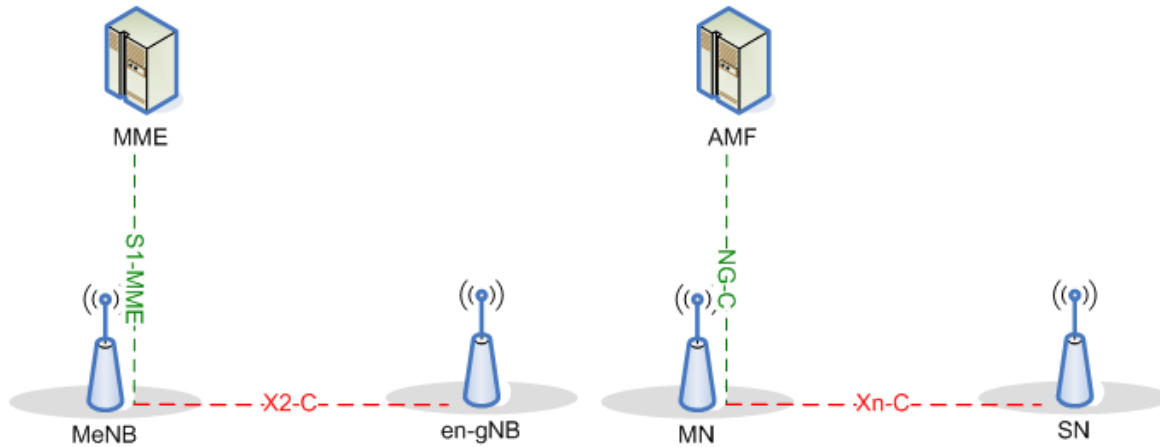


Figure 4.3.1.1-1: C-Plane connectivity for EN-DC (left) and MR-DC with 5GC (right).

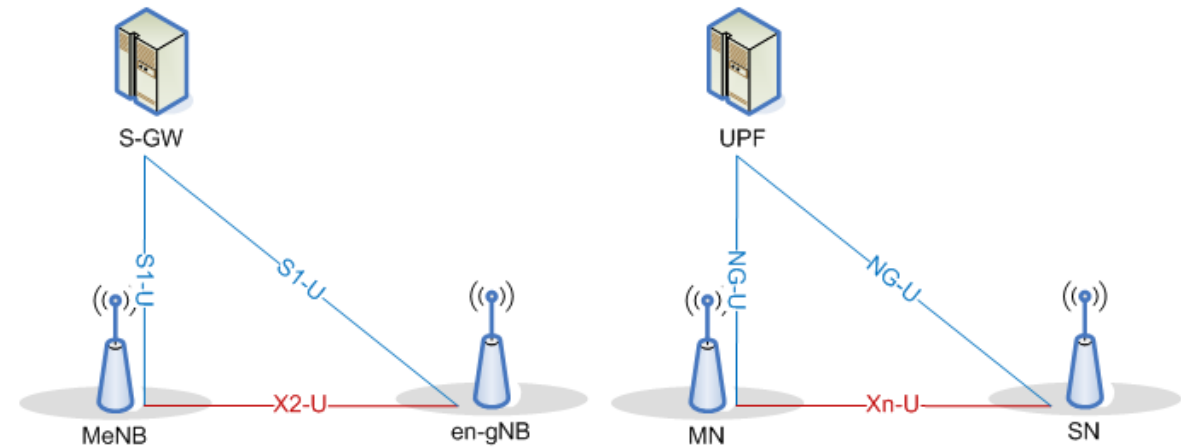
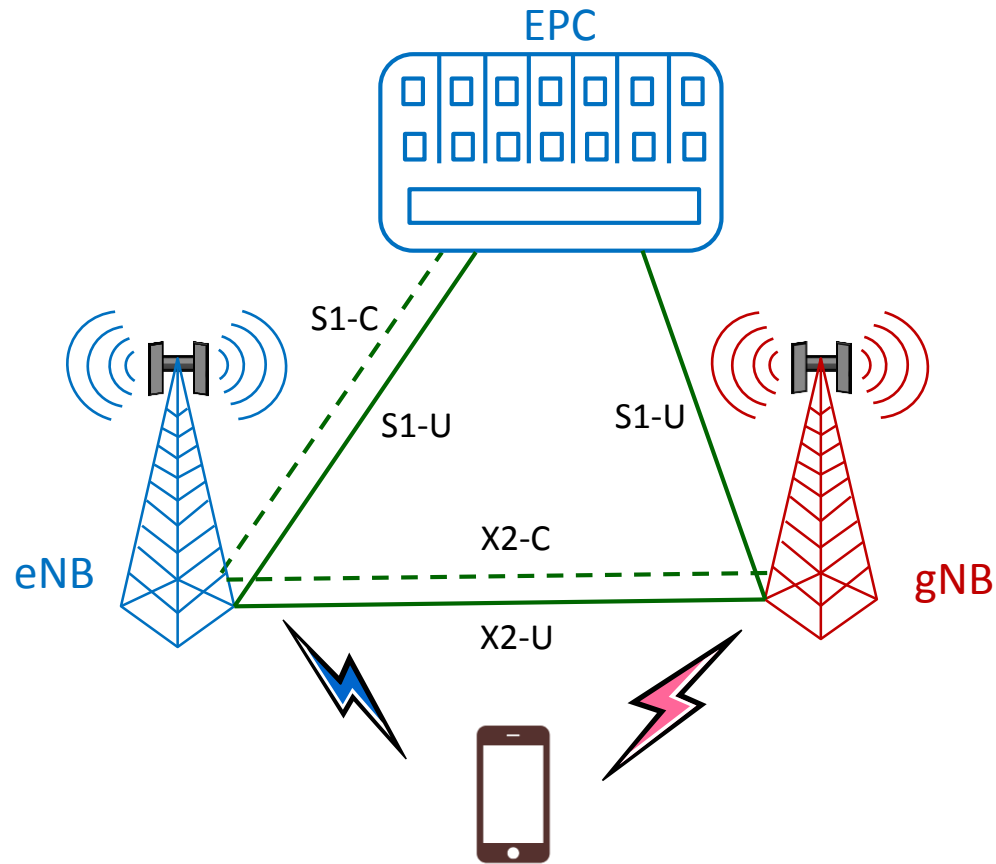


Figure 4.3.2.1-1: U-Plane connectivity for EN-DC (left) and MR-DC with 5GC (right).

- Note that while the secondary node control plane goes to the master node, the secondary node user plane can go via master node or can be connected directly

Option 3: NSA LTE assisted NR, connected to EPC

3GPP NSA / “LTE Assisted” Option 3 / 3A / 3X
a.k.a. EN-DC = E-UTRA-NR Dual Connectivity



3GPP TS 37.340: Evolved Universal Terrestrial Radio Access (E-UTRA) and NR; Multi-connectivity; Stage 2
3GPP TS 38.300: NR; NR and NG-RAN Overall Description; Stage 2

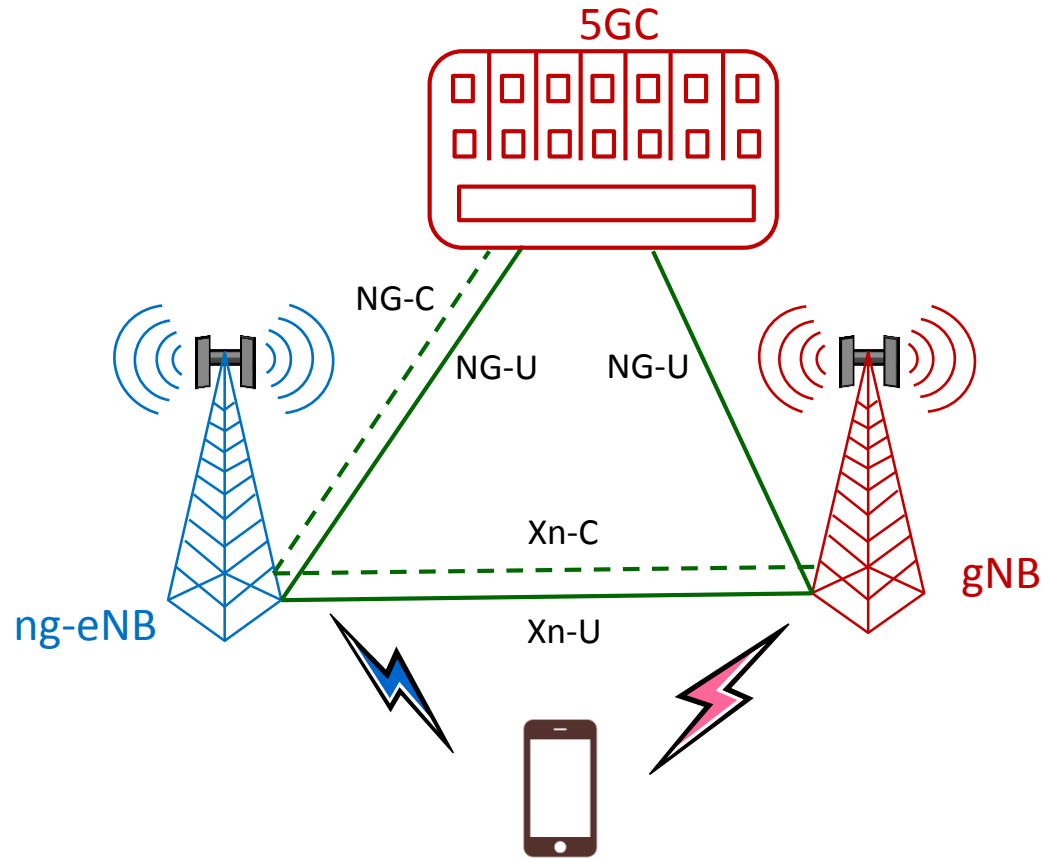
- Leverages existing 4G deployments
- Capable of creating 5G hotspots quickly
- New 5G applications and services creation possible

Difference between 3/3A/3X

- In option 3, there is no connection from gNB to EPC – eNB hardware upgrade is probably required
- In option 3A, gNB has S1-U interface to EPC but no X2. New services can be handled by NR and X2 backhaul is easy to meet
- Option 3X is a combination of 3 & 3A. S1-U is available from gNB and X2 interface is available too

Option 7: NSA LTE assisted NR, connected to 5GC

3GPP NSA / "LTE Assisted" Option 7 / 7A / 7X a.k.a.
NGEN-DC = NG-RAN E-UTRA-NR Dual Connectivity



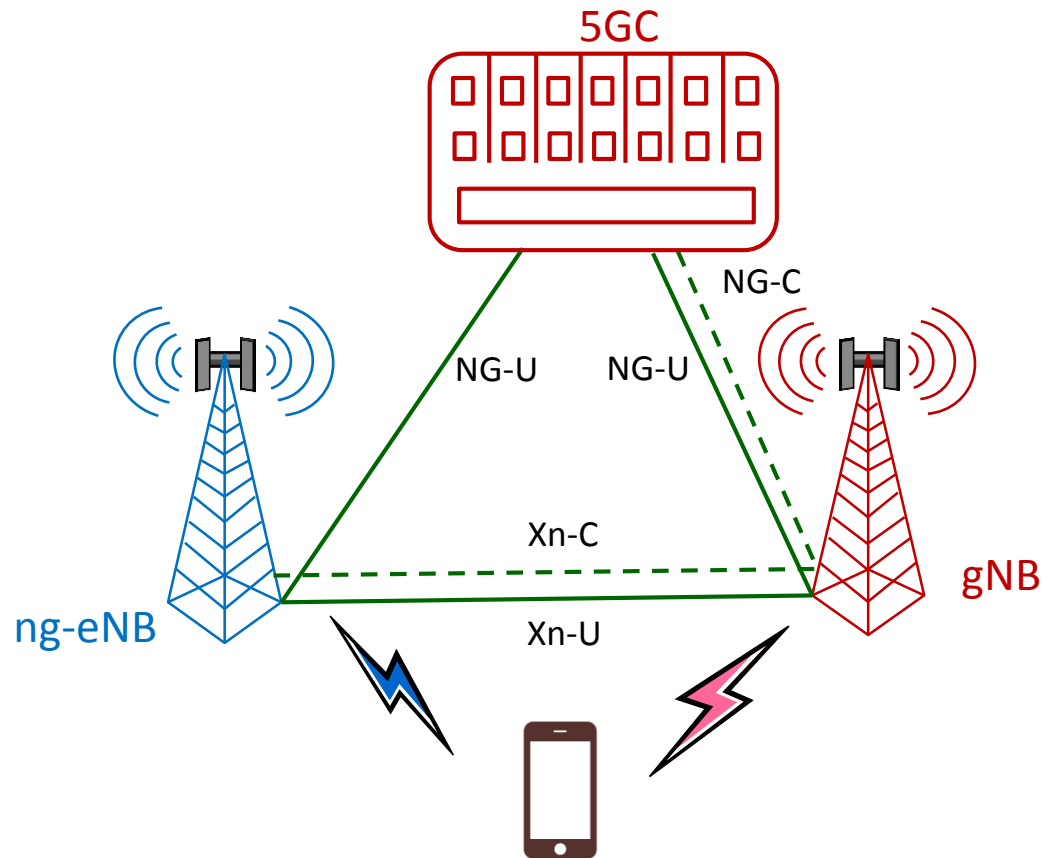
- In this case ng-eNB is the master and gNB is secondary node.
- Next Generation CN (NGCN) has replaced EPC
- Evolved eNB and gNB connect via Xn interface
- 5G driven by capacity needs, rather than just coverage
- New 5G applications and services creation possible

Difference between Option 7 / 7A / 7X

- In option 7, there is no interface between gNB and 5GC. Information flows via Xn
- In option 7A, there is no Xn interface and gNB is connected to 5GC via NG-U interface
- Option 7X is a combination of option 7 & 7A

Option 4: NSA NR assisted LTE, connected to 5GC

3GPP NSA / "NR Assisted" Option 4 / 4A
a.k.a. NE-DC = NR-E-UTRA Dual Connectivity

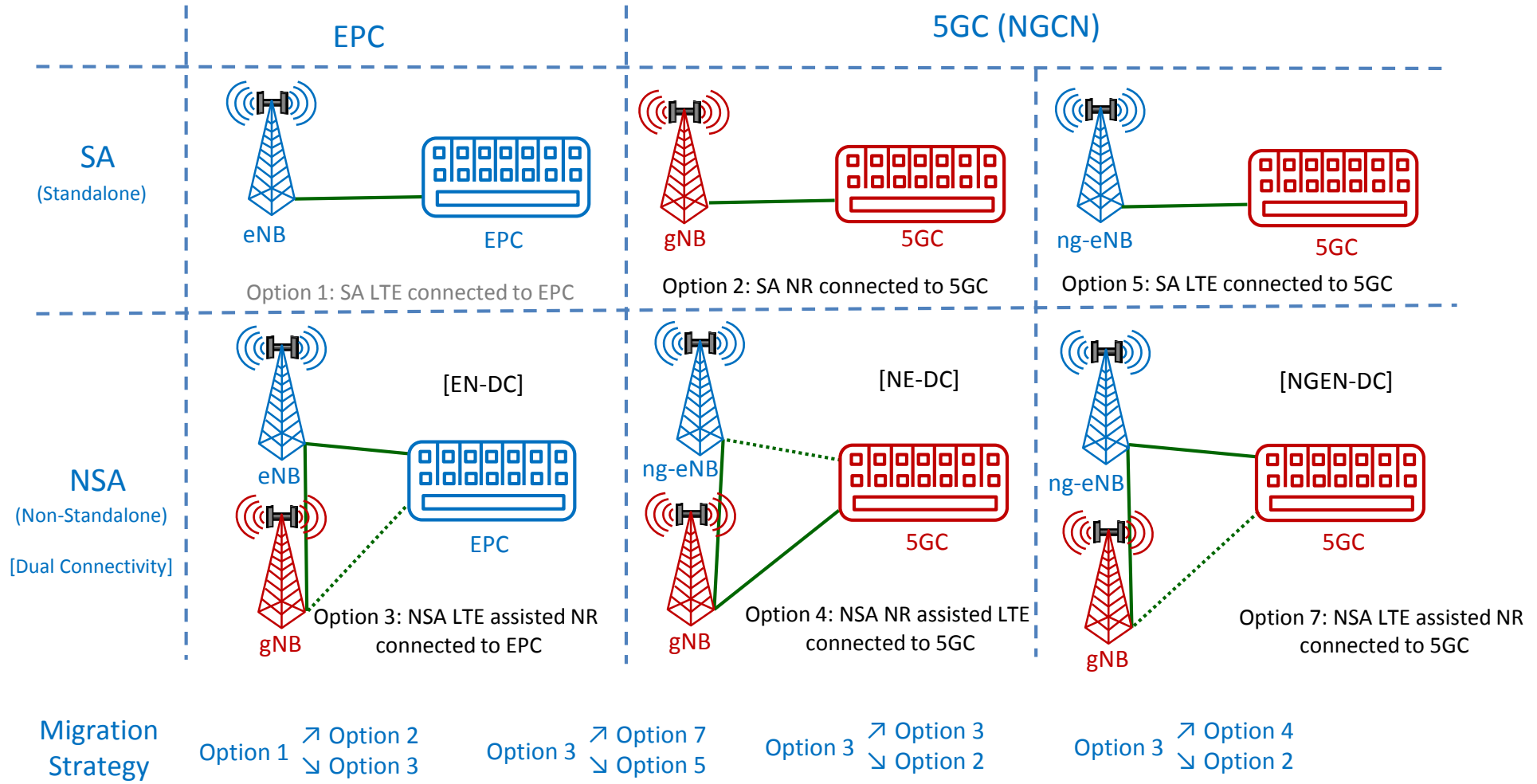


- Next Generation CN (NGCN) has replaced EPC
- 5G driven by capacity needs, rather than just coverage
- New 5G applications and services creation possible

Difference between Option 4 & 4A

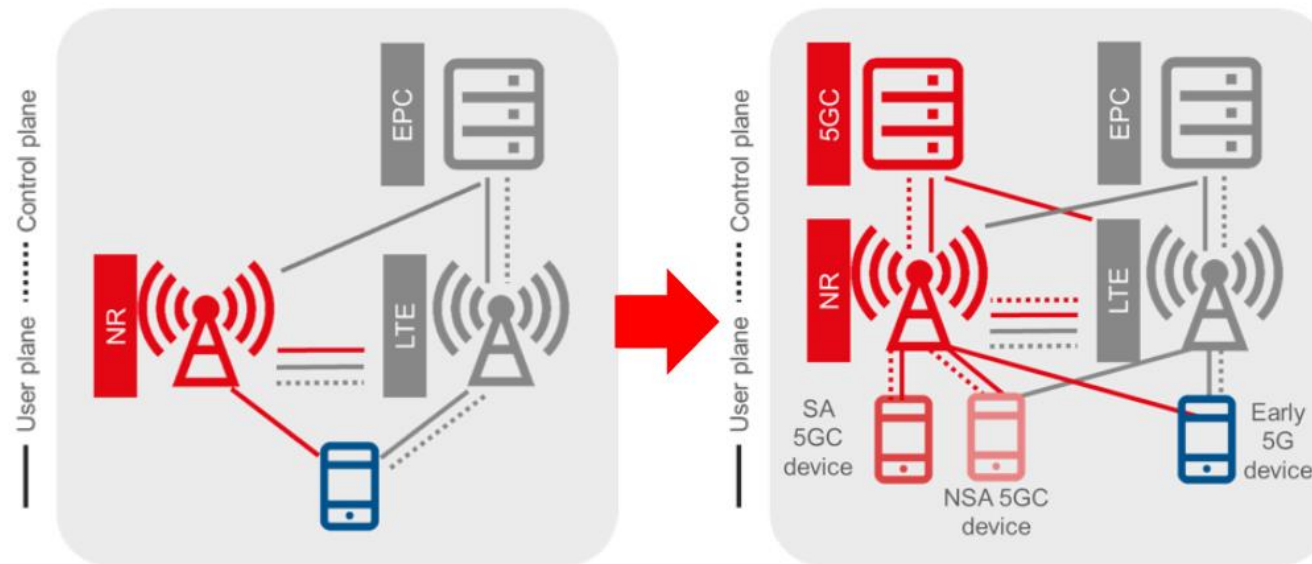
- In Option 4, there is no direct connectivity between ng-eNB and 5GC. All information flows via Xn interface
- In Option 4A, there is no Xn interface between ng-eNB and gNB. ng-eNB is connected to 5GC via NG-U interface.

5G Deployment Options and Migration Strategy



More in-depth study of 5G Architecture Options

Figure 8: Description of NSA Option #3 to NSA Option #4 and SA Option #2

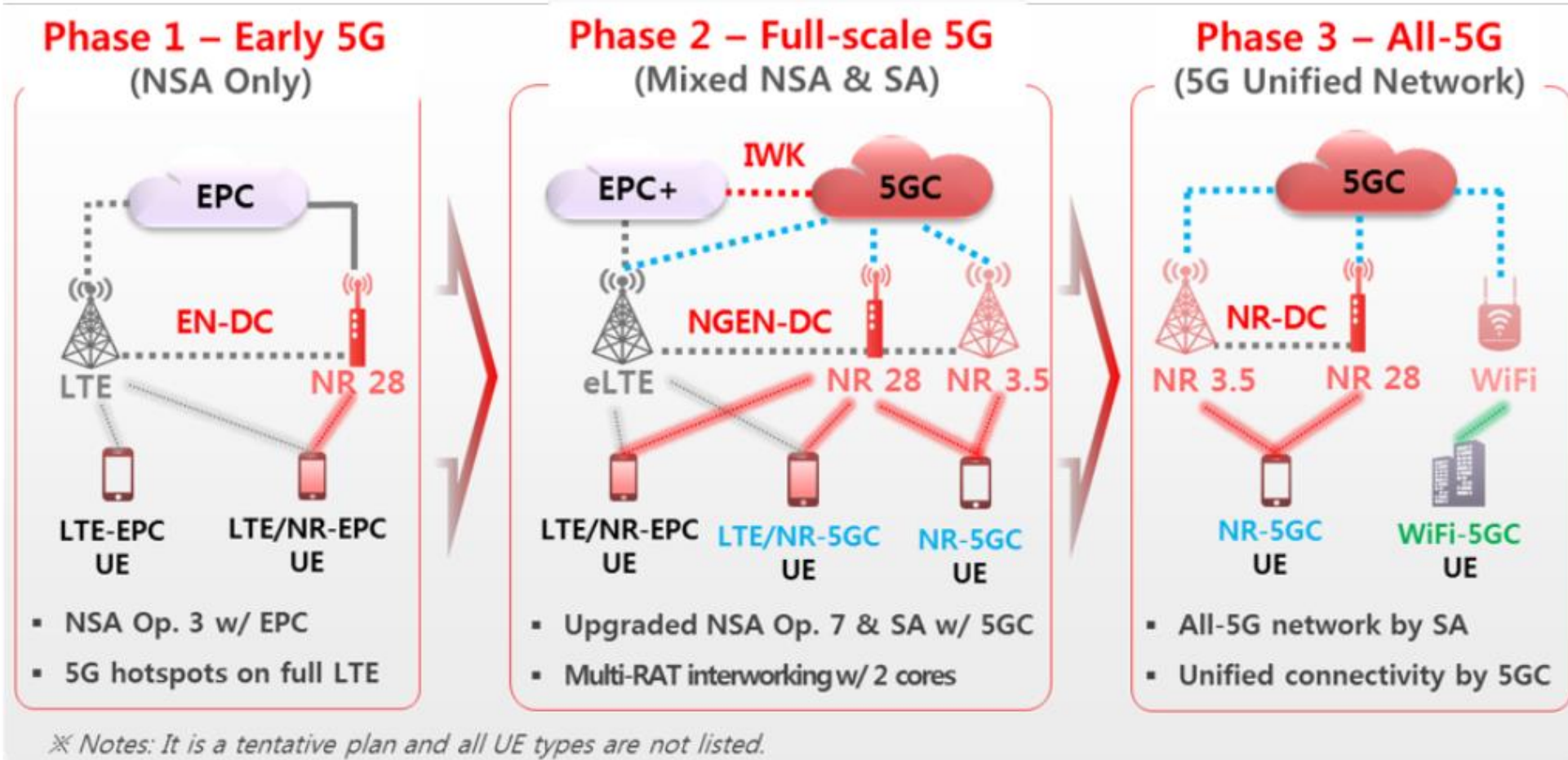


NOTE 1: Early 5G device refers to devices that support only NSA Option #3 5G deployment option

NOTE 2: NSA 5GC device refers to devices that support NSA Option #4

NOTE 3: SA 5GC device refers to devices that support SA Option #2

KT's 5G Network Migration Plan, Aug 2018

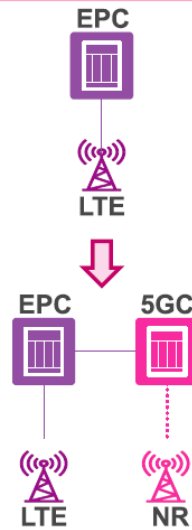


LGU+ 5G Migration Strategy, May 2018

5G Migration Scenario

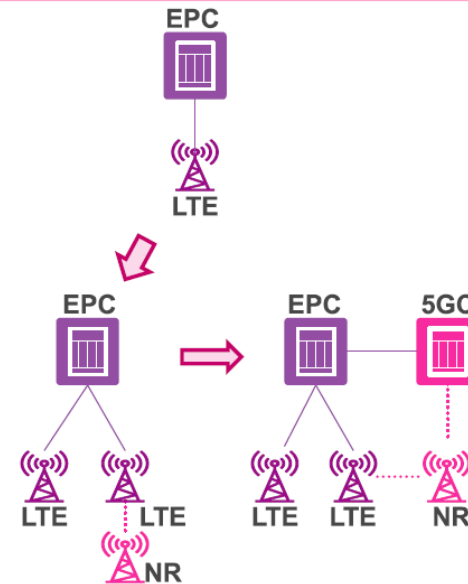
Smooth Migration through NSA to SA

Direct migration to SA



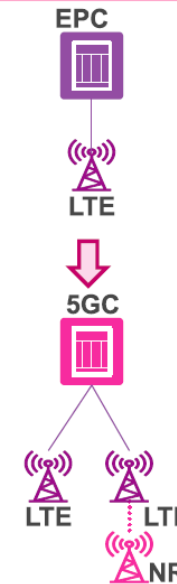
- Simple scenario
- Small sized UE
- Good for nation wide 5G coverage
- Voice performance issues

Indirect migration through NSA to SA



- NSA as an interim because of tough competition
- Better RF performance and T-put (aggregation)
- Early option3 UE need long term support
- Long term coexistence of EPC and 5GC
- **LG U+**

Direct migration to NSA

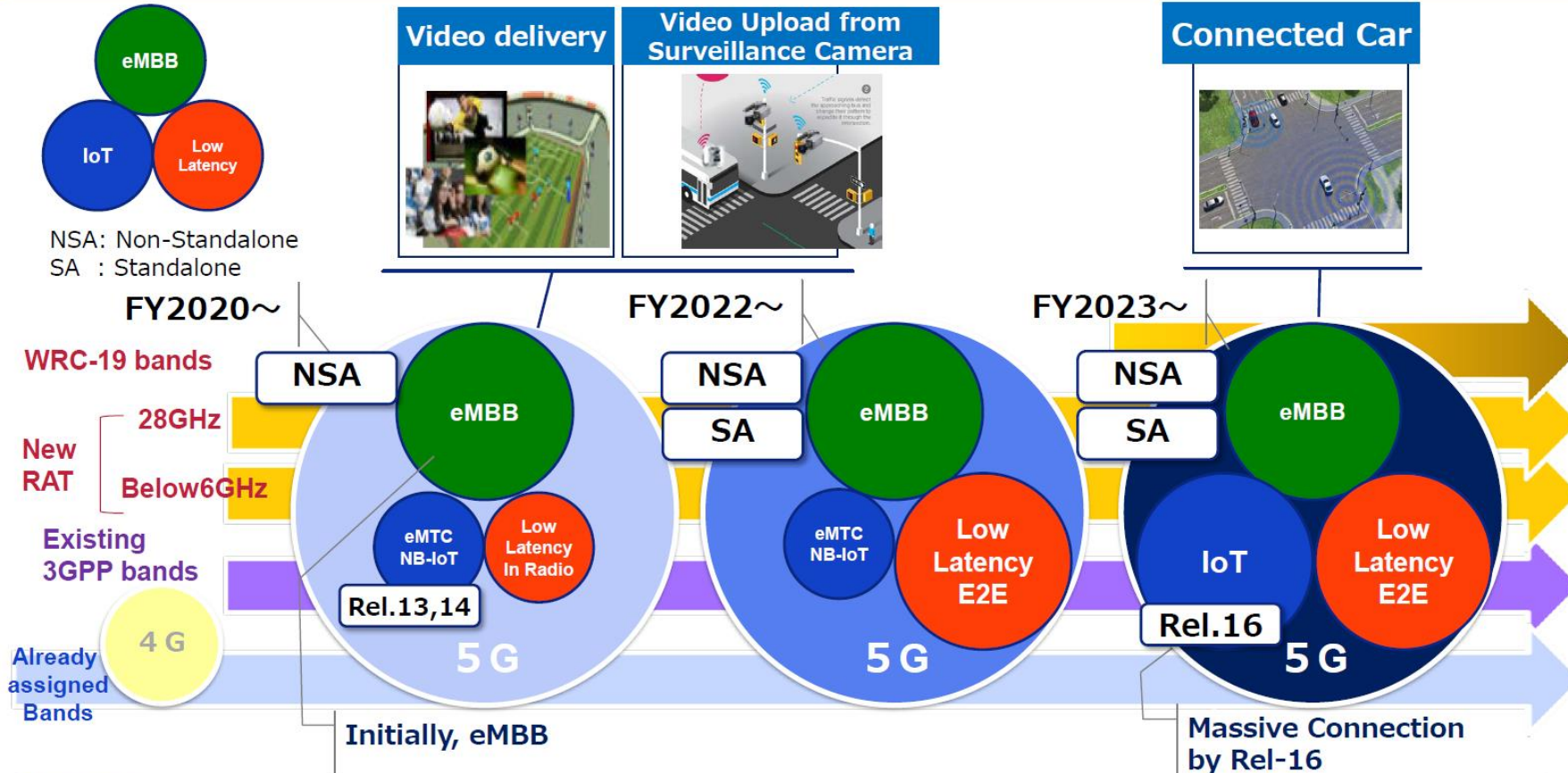


- Better RF and t-put with 5GC
- eNB SW upgrade to eLTE

KDDI's 5G Migration View, May 2018

Illustrative migration from 4G to 5G

au 5G

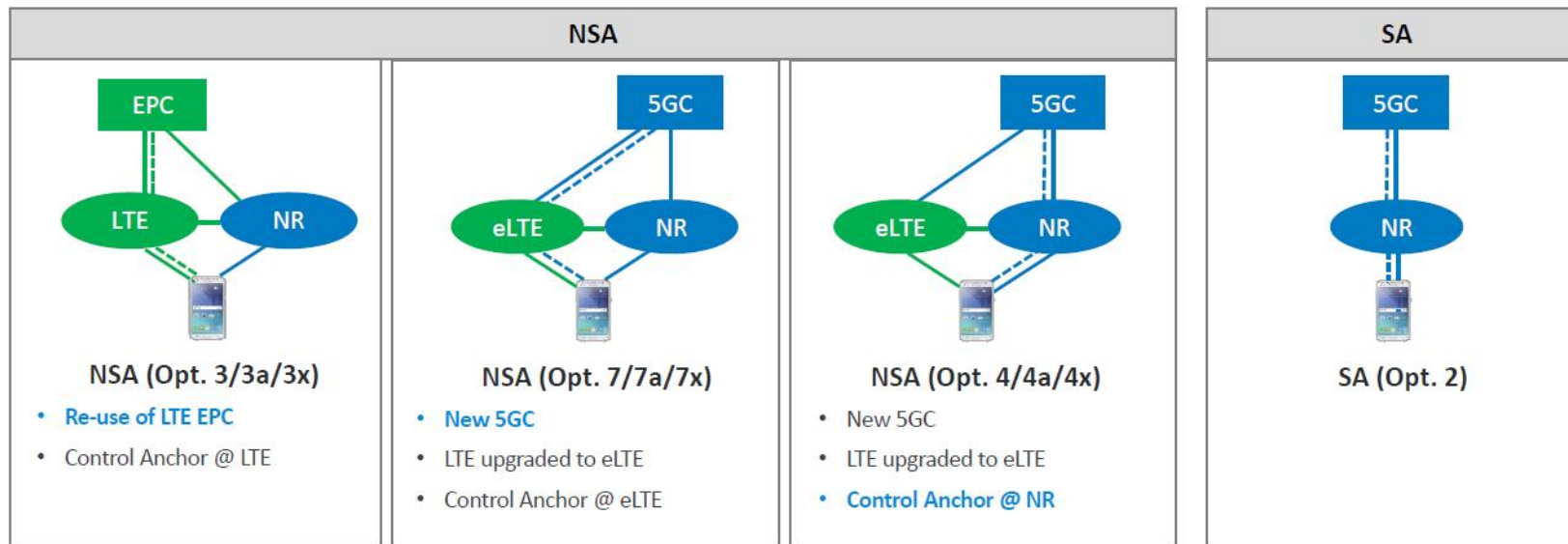


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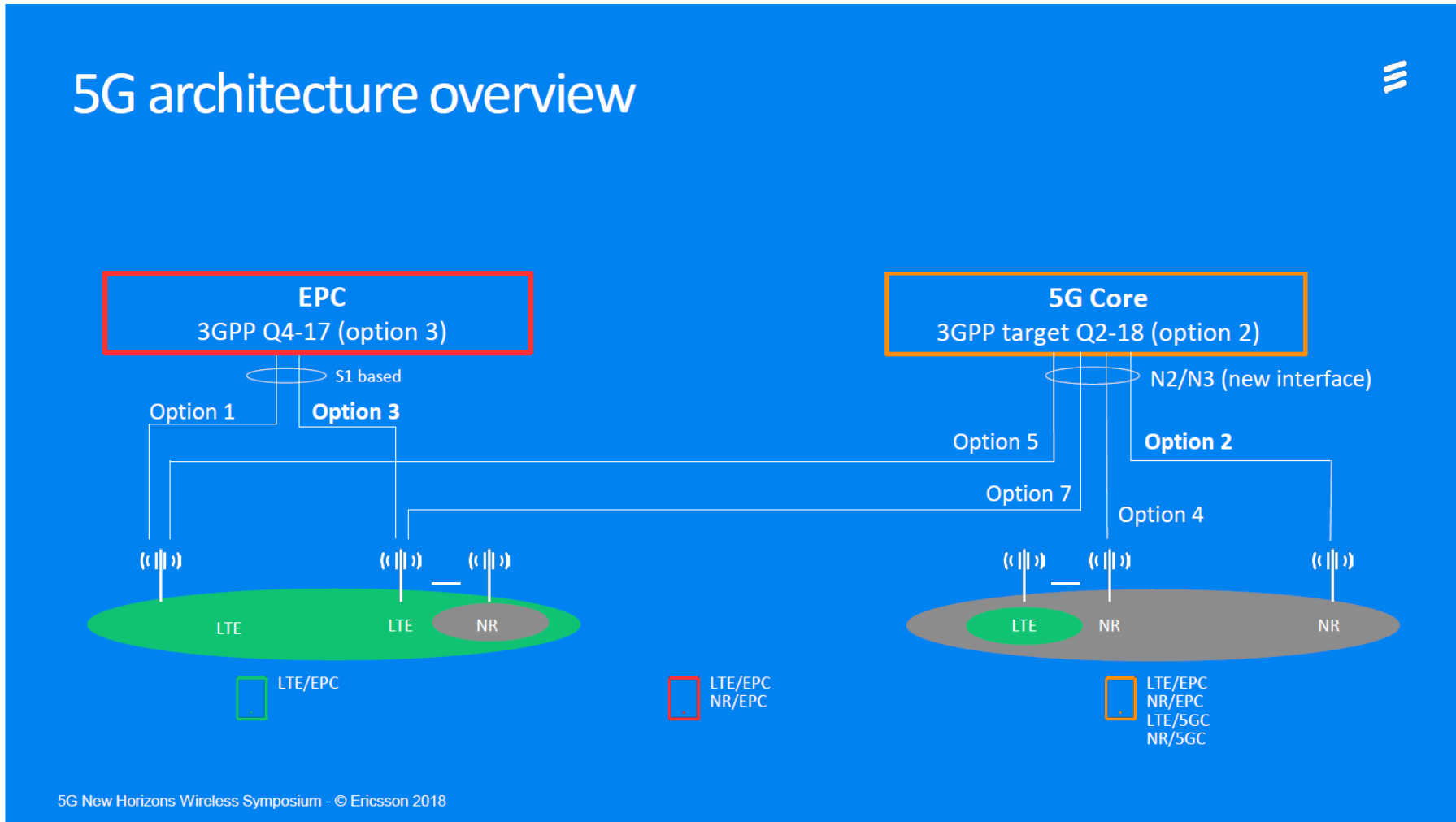
12

Samsung's 5G Architecture Options, May 2018

✓ LTE/5G Network Architecture Options & Evolutionary Path



Ericsson's 5G Architecture Vision, May 2018



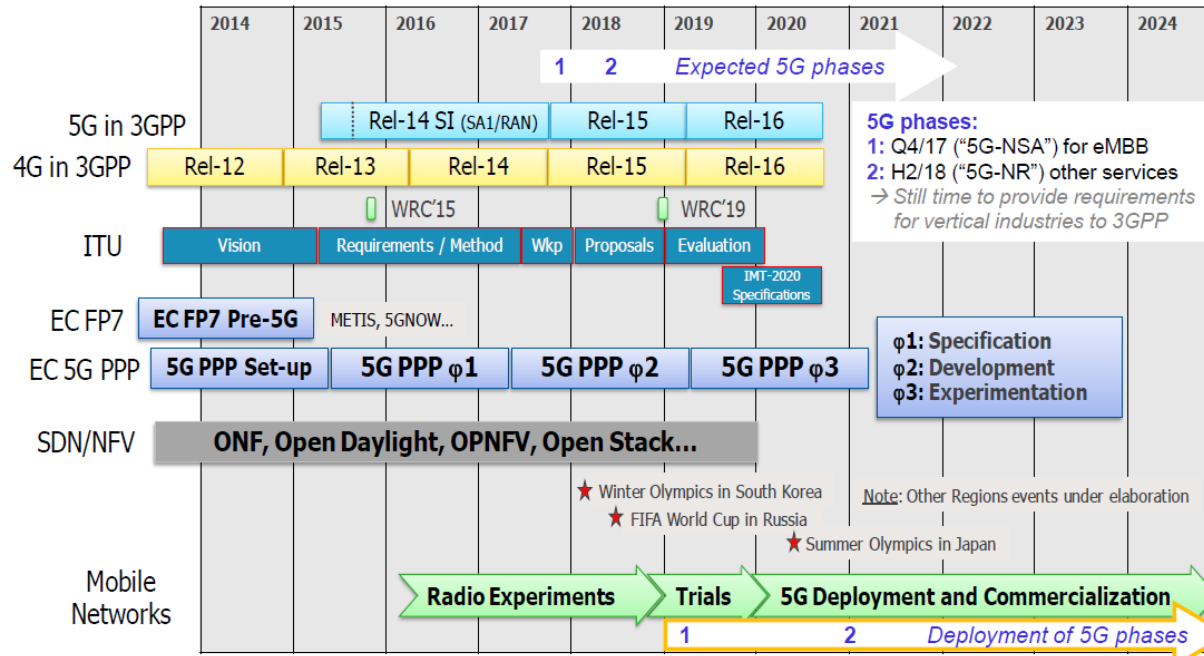
Telefonica's 5G plan, May 2018

5G Time Frame - Mapping to ITU / 3GPP etc.



ITU-R has provided and summarized the “Vision towards IMT-2020”

“5G-NR” hasn't been finally defined nor specified and hence good alignment of activities is necessary:



© by 5G Infrastructure Public Private Partnership (5G PPP)

Slide 11 09.05.2018
Uwe Löwenstein, TEF Germany

Andy Sutton, BT, May 2018

Summary

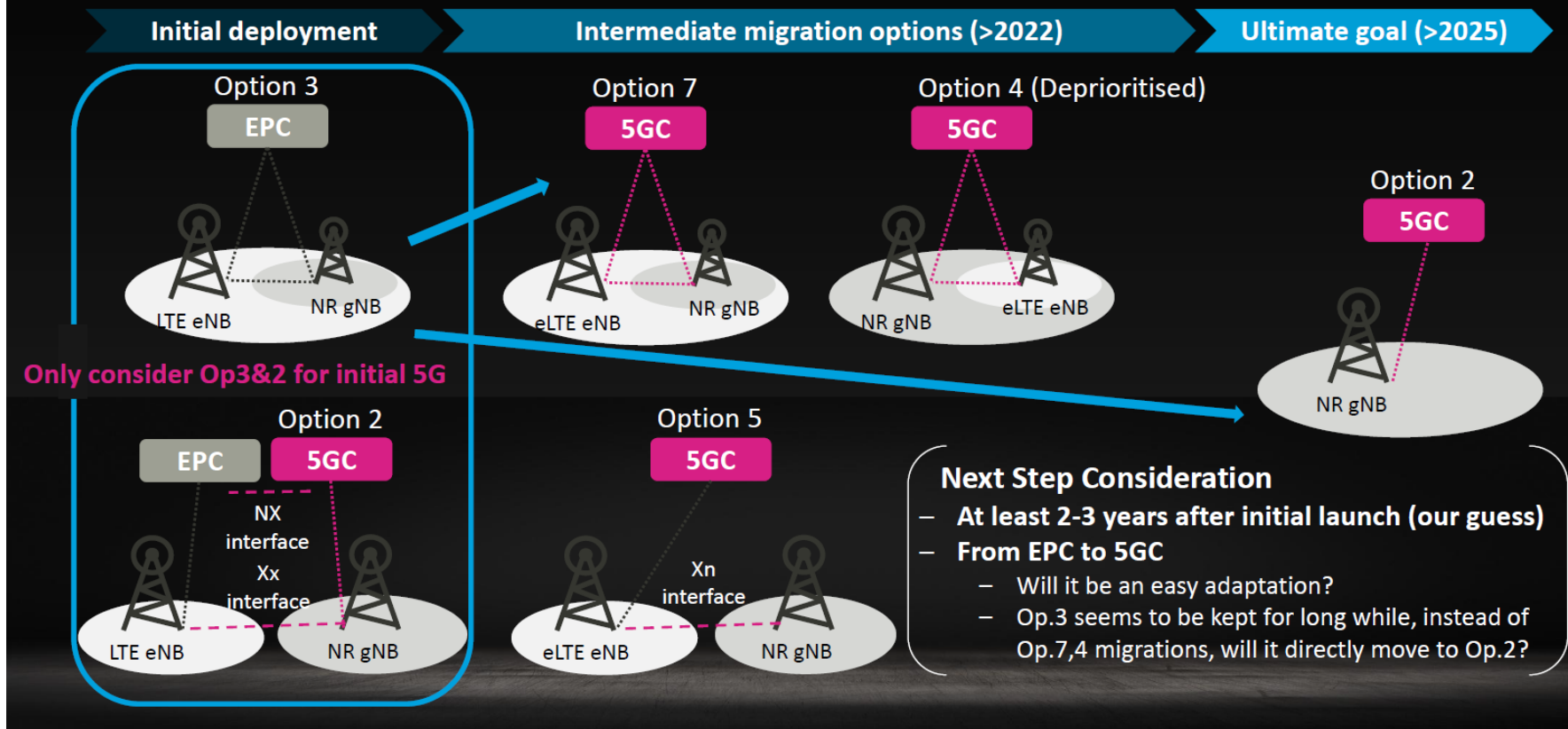
- 5G will address enhanced Mobile Broadband (eMBB), Ultra-Reliable & Low Latency Communications (URLLC) and massive Machine Type Communications (mMTC), use cases
- 5G requires a new network architecture
- Many operators will commence 5G service with an option 3x (EN-DC) network architecture
- The introduction of a Next Generation Core (NGC) will enable an evolution to an option 7x (NGEN-DC) network architecture
- NGC is the enabler for network slicing and 5G service innovation
- NGC network can be grouped into two functional blocks, CPF and UPF
- Once 5G NR coverage is comparable to 4G an operator may evolve to an option 4 architecture (NE-DC)
- An option 2 network will only be realised once all LTE spectrum is re-farmed to 5G NR (or standalone use case)

16 British Telecommunications plc 2017



MediaTek view, August 2018

5G: LTE-NR Inter-working – MediaTek view



Further Reading

- The 3G4G Blog: [5G New Radio \(NR\), Architecture options and migration from LTE](#)
- The 3G4G Blog: [5G Architecture Options for Deployments?](#)
- GSMA: [Road to 5G: Introduction and Migration Whitepaper](#)
- 3G4G Small Cells Blog: [Dual-connectivity, Bearer split and other Release-12 small cell enhancements](#)

Thank You

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