

Coordinated Control and Spectrum Management for 5G Heterogeneous Radio Access Networks Coherent

Towards a 5G Mobile Architecture
Standardisation Update

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Key requirements for architecture

- **Network Function Virtualization.**
- **C-plane/U-plane separation.**
- **Operation of Network Slicing.**
- **Sharing of the RAN between multiple operators.**

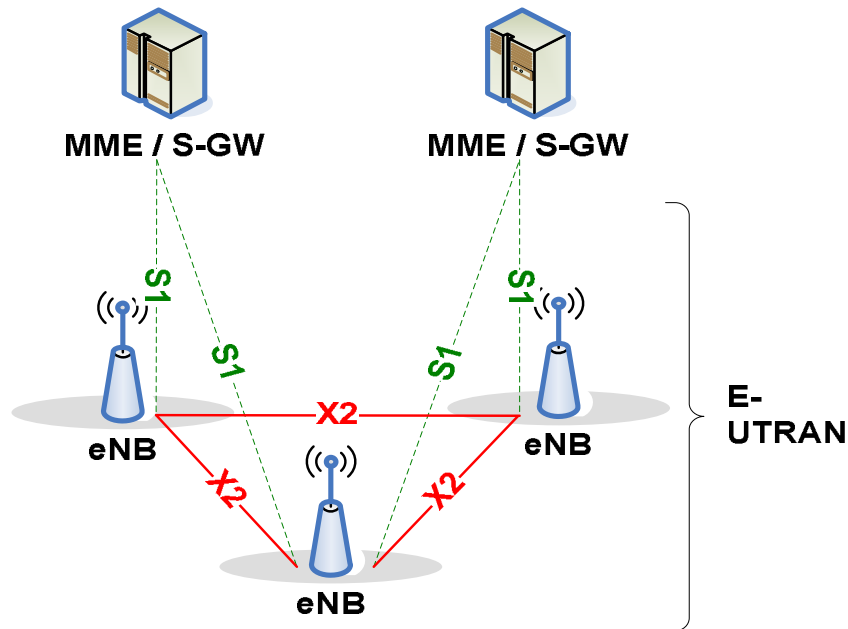
Tight interworking between the new RAT and LTE.

The design of the RAN architecture shall enable lower CAPEX/OPEX

- **RAN-CN interfaces and RAN internal interfaces shall be open for multi-vendor interoperability.**

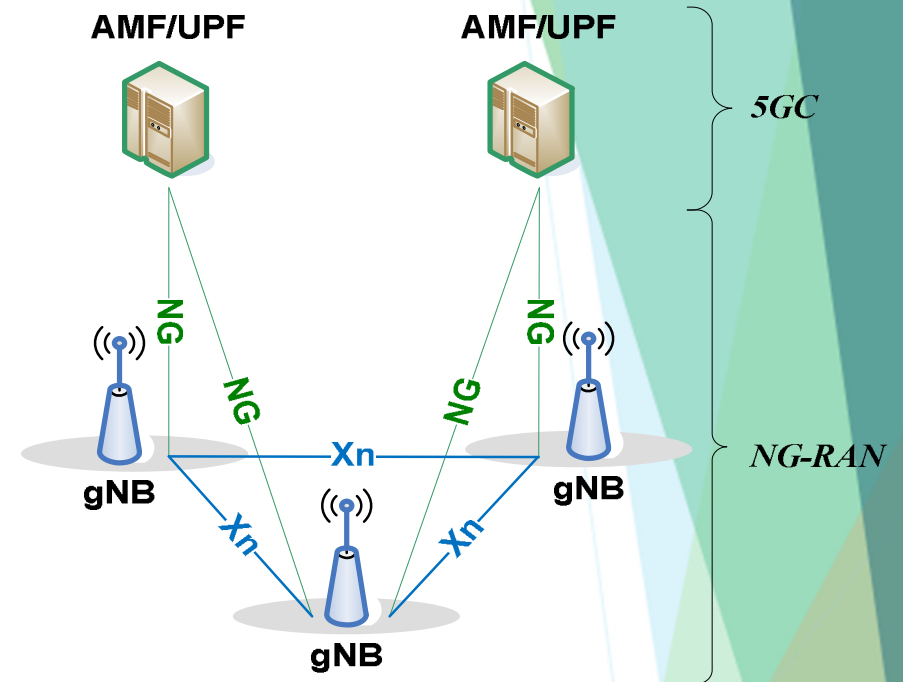
Same architecture as in LTE?

LTE Architecture



- Fig.4-1 in 3GPP TS 36.300
 - MME - Mobility Management Entity
 - S-GW - Serving GW
 - eNB – evolved Node B - Base Station
 - S1 – Interface to Core
 - X2 – Inter-base stations interface

NR Architecture



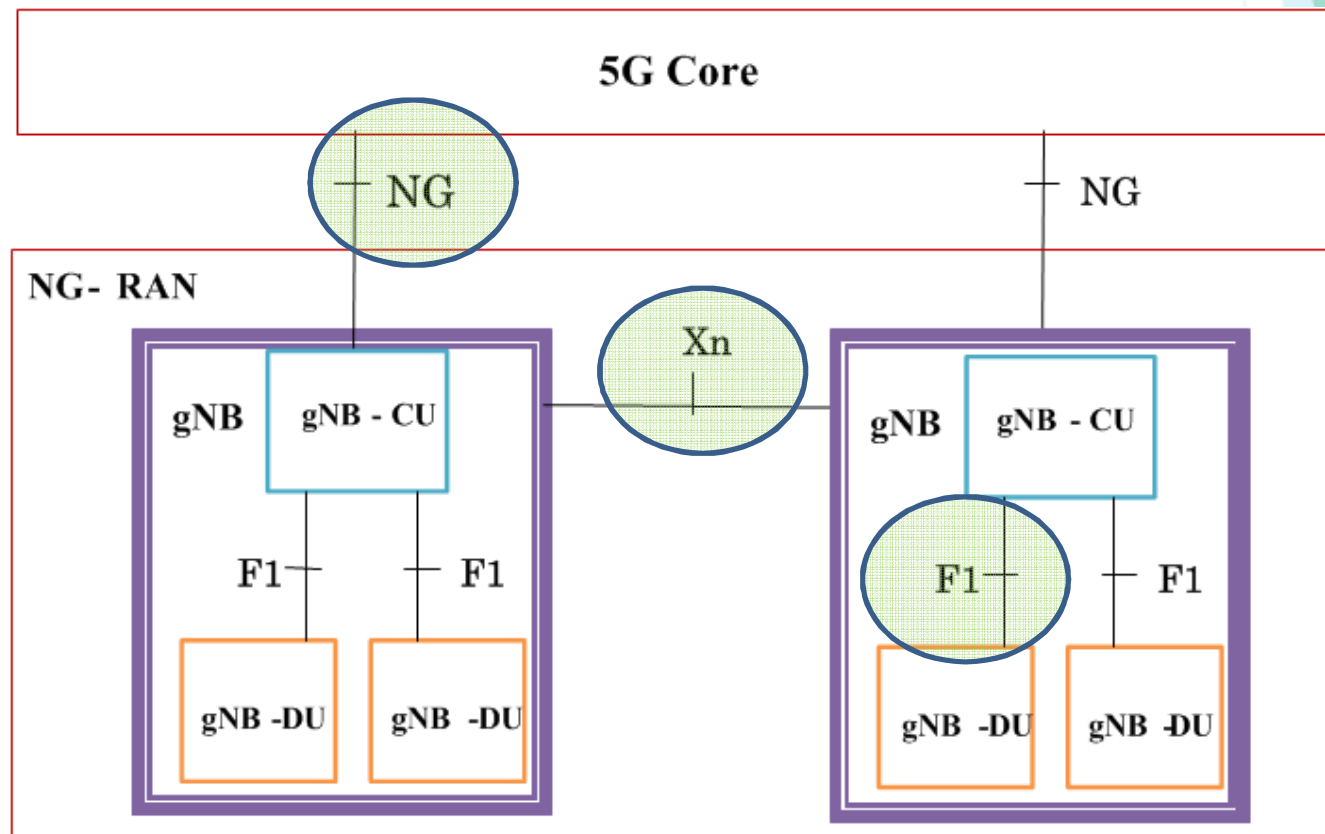
- Fig.4-1-1 in 3GPP TS 36.800 June 2017, Release 15
 - AMF - Access and Mobility Management Function
 - UPF - User Plane Function
 - gNB - NR Node B – Base Station
 - NG – Interface to Core; **supports Slice, PDU Session and 5QI (QoS)**
 - Xn – Inter-base stations interface
 - NR – New Radio

Any difference between LTE and NR Base Stations?

- LTE: eNB **coverage limited by the physical parameters of the system gain**
- NR: coverage limited by the deployment approach
 - **Centralized deployment Coverage limited by the allocated computing resources in a data center**
 - **Could cover an entire country!**
 - **Non-centralized deployment coverage:**
 - **Classical physical limitations**
 - Mixed deployment possible

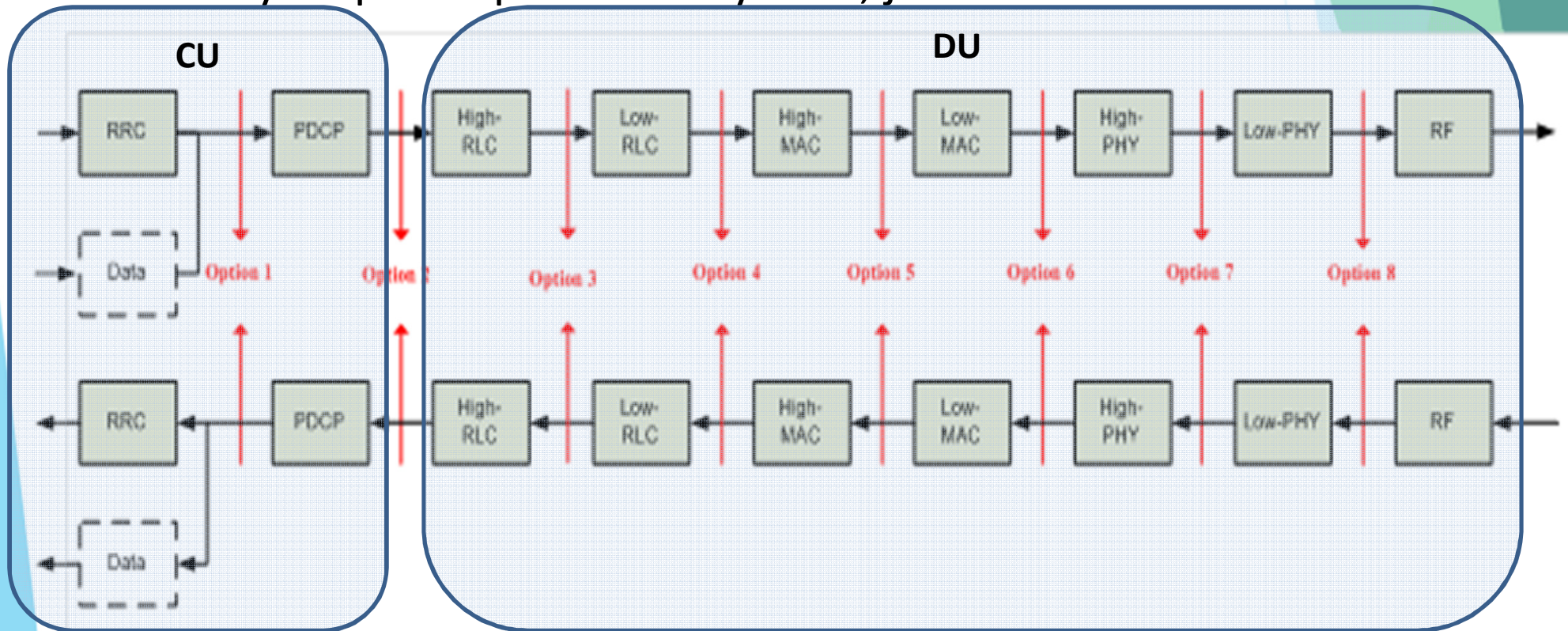
Centralized deployment

- gNB split between a CU – Central Unit and DUs – Distributed Units
- **F1** is the interface between CU and DU – **its standardisation enables competition in DU offering!**



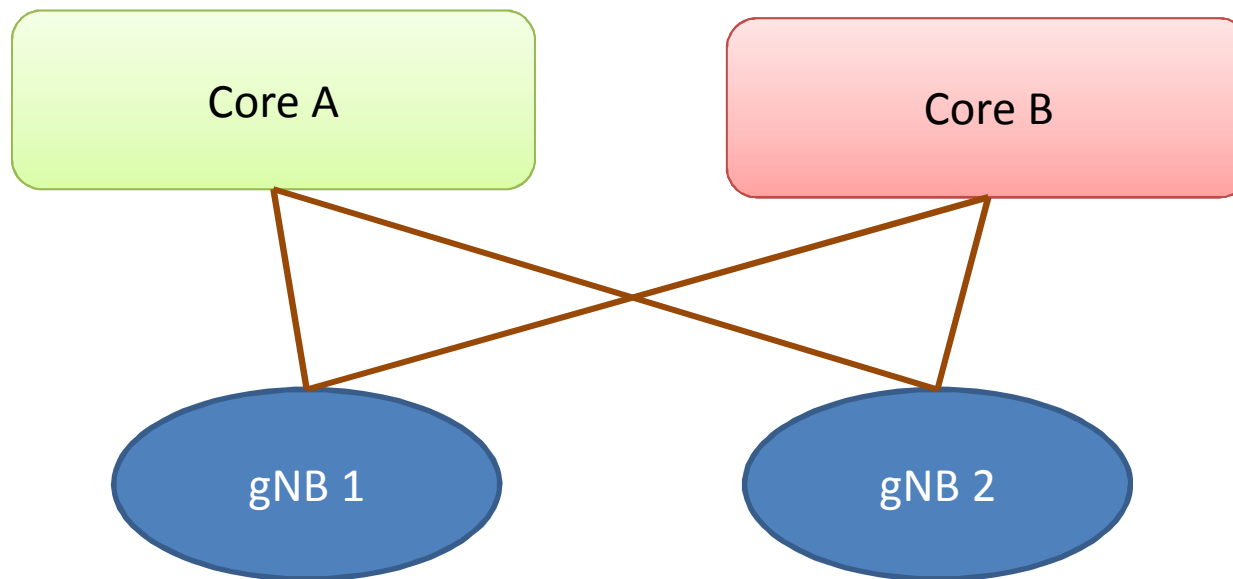
Functional split in centralized deployment

- High layer split: between PDCP (Packet Data Convergence Protocol) and RLC (Radio Link Control), as shown below
- Low layer split: separate study item, just started



Shared RAN deployment

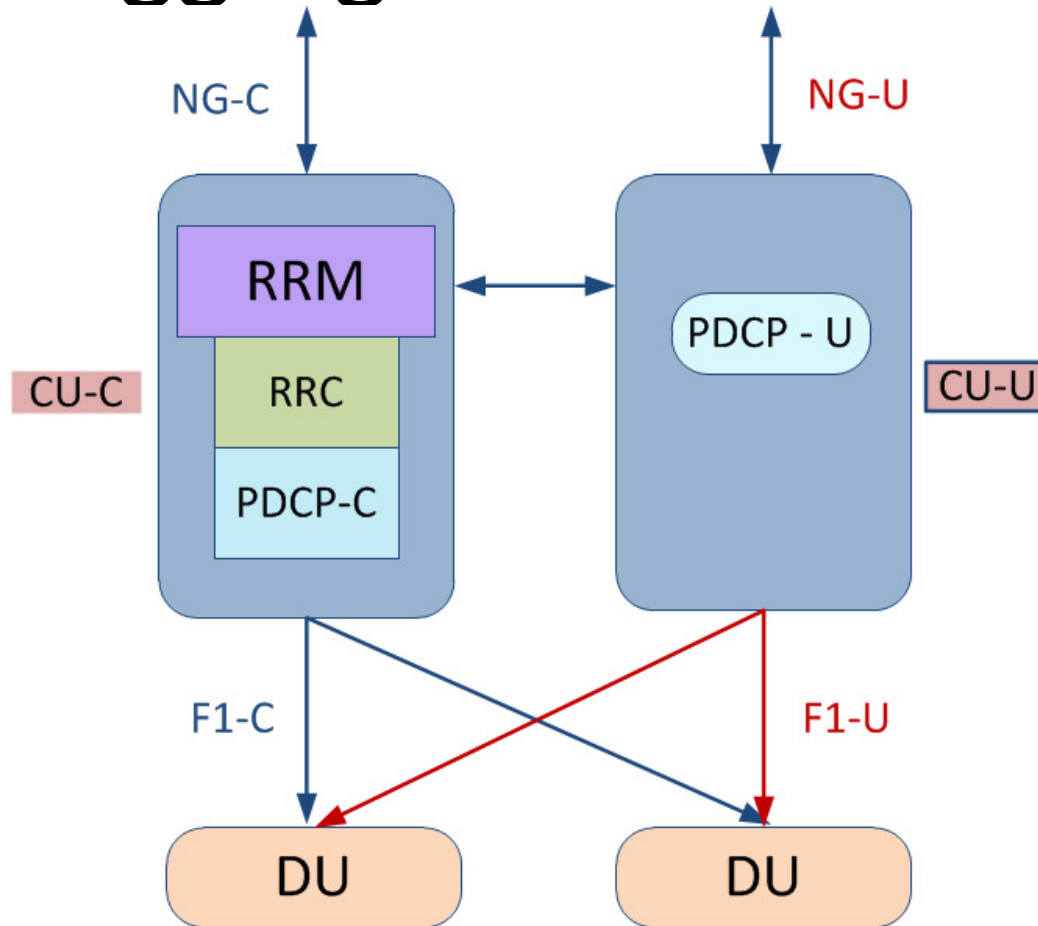
- Some operators seem keen to share RAN infrastructure, while keeping a separated Core
 - **To lower the deployment costs**
 - **The Slice ID (end to end) can be used to this end**



User Plane – Control Plane separation at CU (Disaggregated CU)

- COHERENT proposed UP/CP separation as requirement in TR 38.813
- Only COHERENT had contributions on this topic in many meetings starting with May 2016
- Finally in May and June 2017:
 - Was recognized that the **Central Control by CU cannot be 200km away from DU**
 - In addition **centralized RRM is beneficial**
 - A new study item was initiated in RAN June 2017 meeting
 - A new interface (E1?) was proposed

“Disaggregated” solution for CU



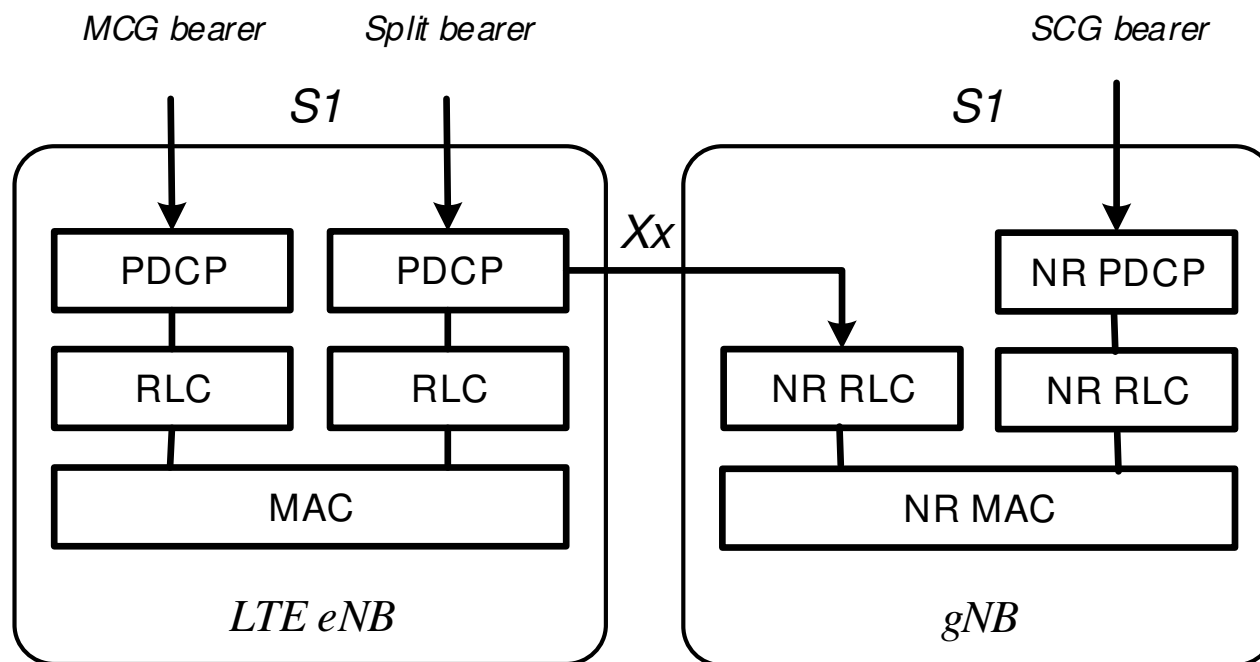
RRM – Radio Resource Management

RRC – Radio Resource Control

- A new interface is needed between CU-C and CU-D

Connection of NR base station to LTE Core

- First phase of NR deployment
 - (for more see the backup slides)
- Most support got Dual Connectivity of UE to both LTE and NR base stations (Figure 10.1.2.2-1: Radio Protocol Architecture for split bearer and SCG bearer in Option 3/3a in 3GPP TR 38.801)



MCG – Master Cell Group

SCG – Secondary Cell Group

Could LTE be deployed as CU, DU?

- A study for assessing the possibility of LTE centralized deployment is on-going in RAN3

Conclusions

- 3GPP makes evident progress in each meeting towards central CP-UP separation
 - COHERENT's Central Control and Coordination vision will come to life
- Significant standardization work ahead in RAN3
 - **At least EIGHT interfaces to be defined**
 - NG-C and NG-U between RAN and Core
 - Xn-C and Xn-U between NR base stations
 - Xx-C and Xx-U between LTE and NR base stations
 - F1-C and F1-U between CU and DU
 - Pending on the outcome of the study: E1?-C and E1?-U between CU-C and CU-U



Thank You!

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BACK-UP SLIDES



3GPP structure

| <u>Project Co-ordination Group (PCG)</u> | | |
|---|---|--|
| <u>TSG RAN</u> Radio Access Network | <u>TSG SA</u> Service & Systems Aspects | <u>TSG CT</u> Core Network & Terminals |
| <u>RAN WG1</u> Radio Layer 1 spec | <u>SA WG1</u> Services | <u>CT WG1</u> MM/CC/SM (Iu) |
| <u>RAN WG2</u> Radio Layer 2 spec Radio Layer 3 RRC spec | <u>SA WG2</u> Architecture | <u>CT WG3</u> Interworking with external networks |
| <u>RAN WG3</u> Iub spec, Iur spec, Iu spec UTRAN O&M requirements LTE S1, X2 | <u>SA WG3</u> Security | <u>CT WG4</u> MAP/GTP/BCH/SS |
| <u>RAN WG4</u> Radio Performance Protocol aspects | <u>SA WG4</u> Codec | <u>CT WG6</u> Smart Card Application Aspects |
| <u>RAN WG5</u> Mobile Terminal Conformance Testing | <u>SA WG5</u> Telecom Management | |
| <u>RAN WG6</u> Legacy RAN radio and protocol | <u>SA WG6</u> Mission-critical applications | |

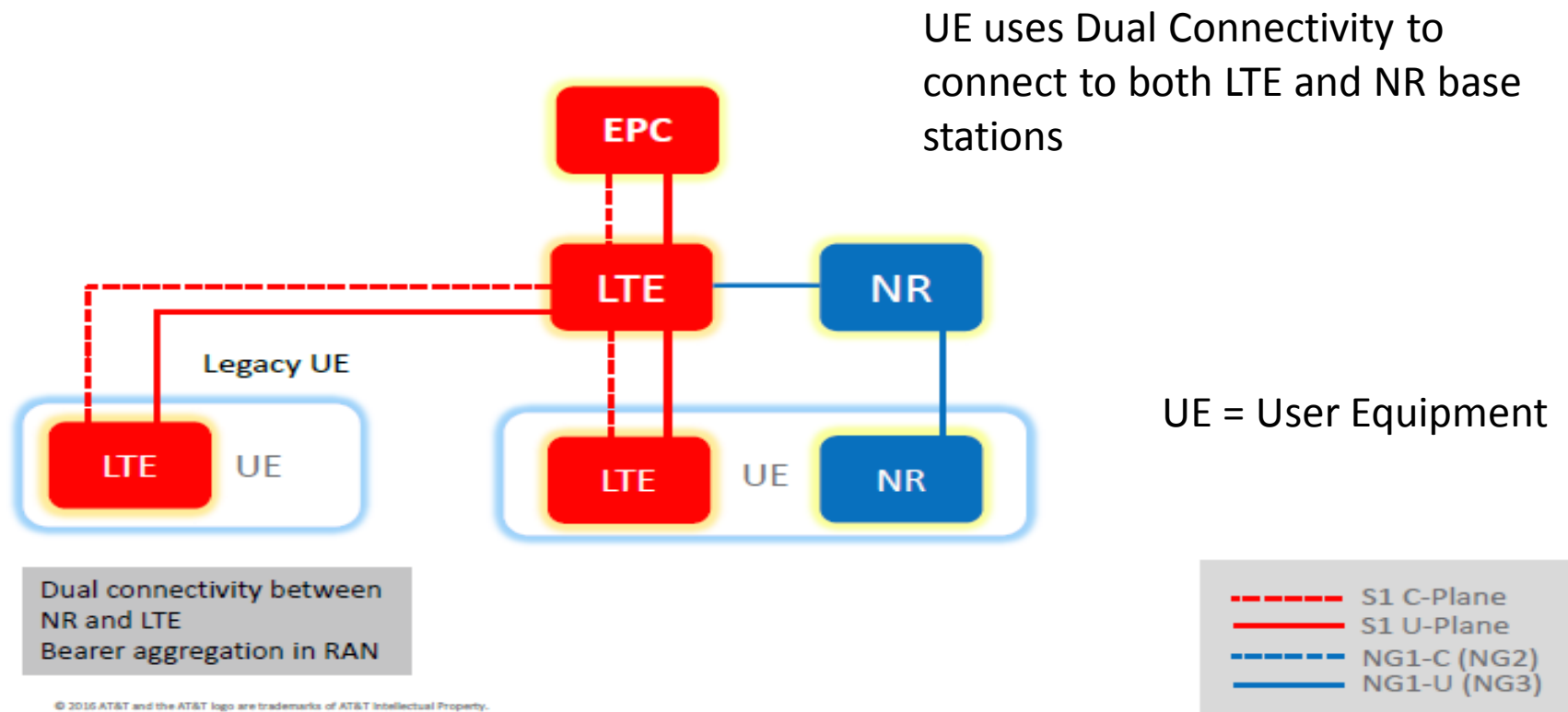
COHERENT participation in 3GPP towards the UP-CP separation

- Sept. 2015: RAN WORKSHOP ON 5G
- Dec. 2015: started the RAN work on Scenarios and Requirements for New Generation Access Technologies
 - COHERENT, focused on introduction of SDN concepts in wireless, introduces in TR 38.913 a requirement on User Plane-Control Plane separation
- COHERENT contributions to draft TR 38.801 on a hierarchical central control concept
- COHERENT contributions to draft TR 38.801 on Central RRM
- Most important outcome: New Study item proposed by Ericsson on separation of Control and User data processing in Central Unit, with strong COHERENT support

AT&T migration solution from LTE to NR

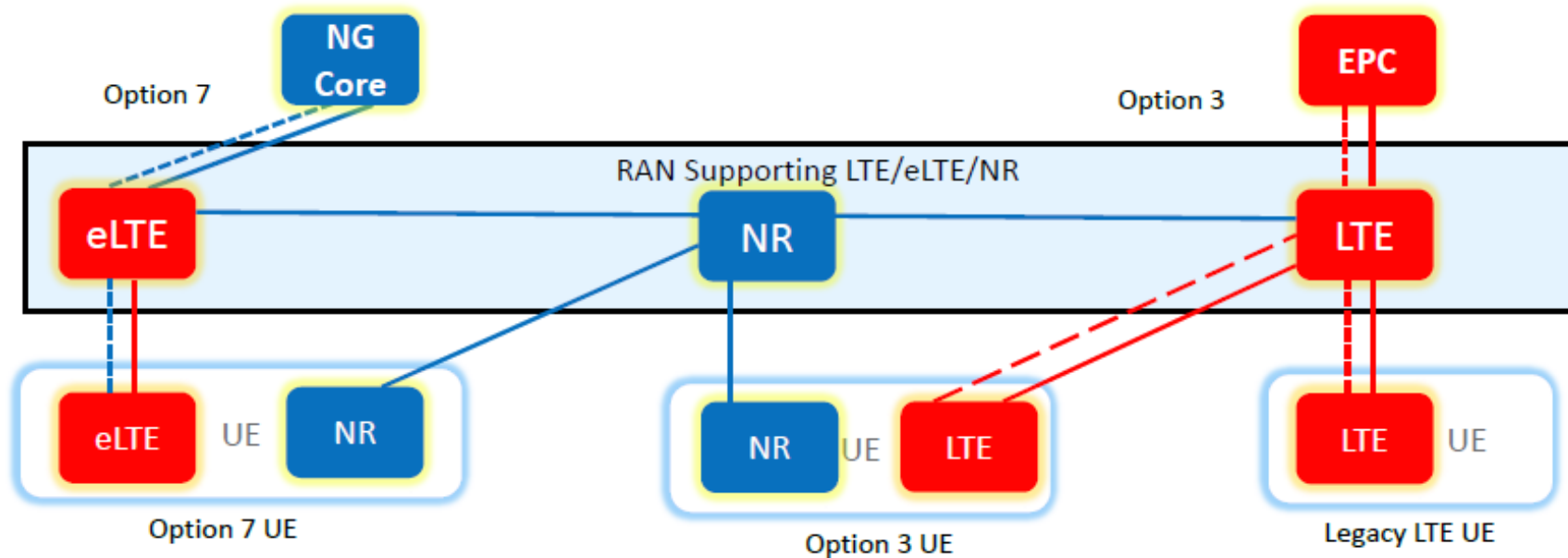
Step 1: NR base station connected through LTE eNB to LTE Core (EPC)

Step 1: Early 5G Deployment utilizing Phase 1 - Option 3



AT&T migration solution – Step 2

Step 2: Phase 1 Evolution to Option 7 – Plus Simultaneous Support for Option 3 & Option 7



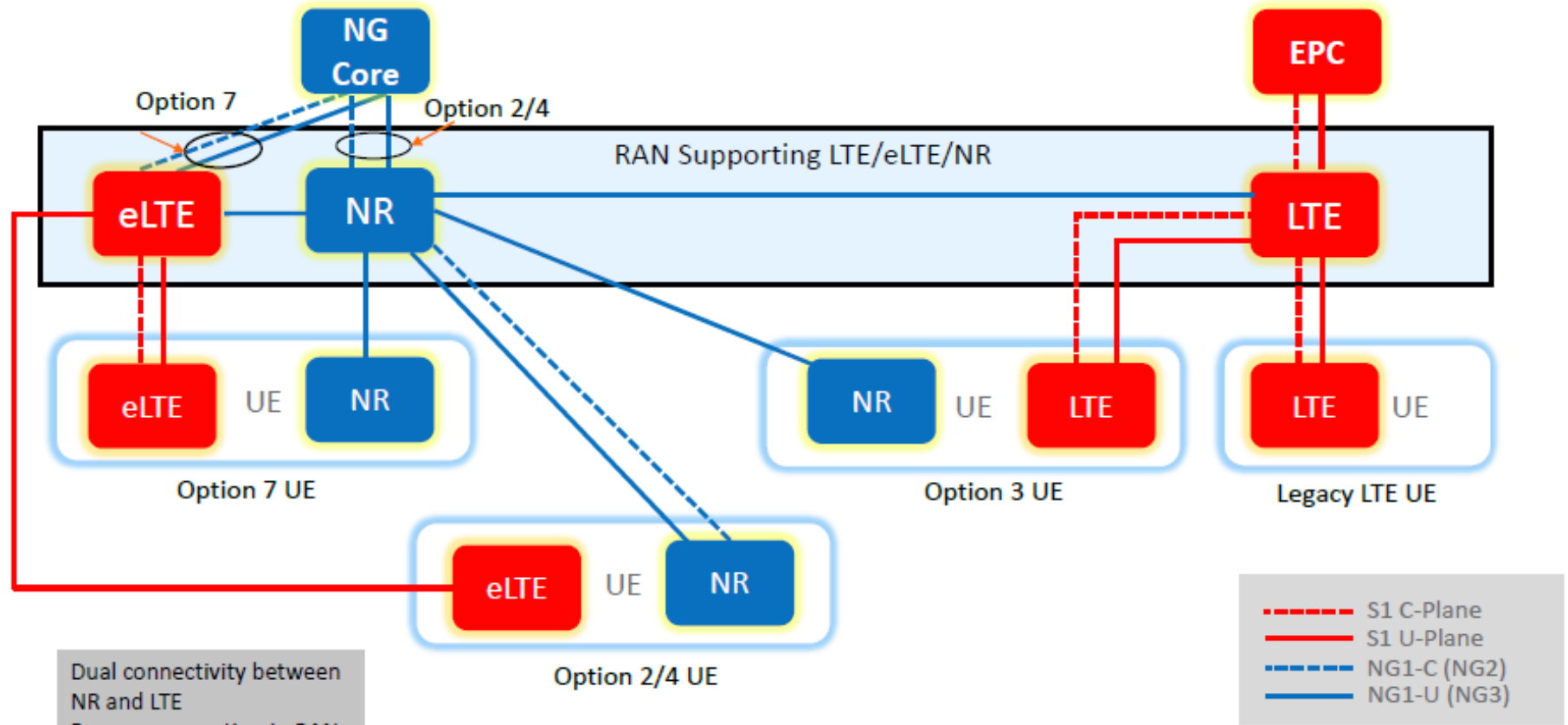
Dual connectivity between NR and LTE
Bearer aggregation in RAN

--- S1 C-Plane
— S1 U-Plane
--- NG1-C (NG2)
— NG1-U (NG3)



AT&T migration solution – Step 3

Step 3: Phase 2 Evolution to Option 2/4 – Plus Simultaneous Support Option 3 & Option 7



Dual connectivity between NR and LTE
Bearer aggregation in RAN

CORE Configurations for Options 3, 7 and 2/4 and legacy LTE will likely co-exist. The 3GPP specification work must support this.