Two-Level Fronthual Architecture and Requirements

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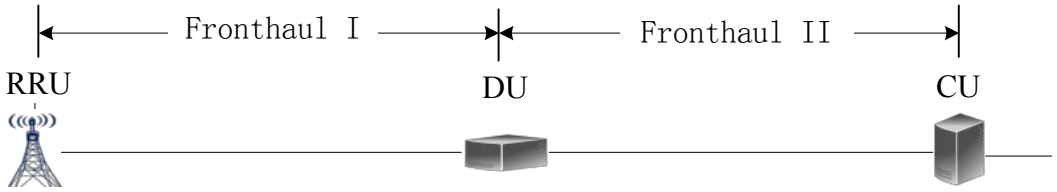
Outline

- Two-level fronthual architecture
- Discussions on delay requirement
- Discussions on synchronization requirement

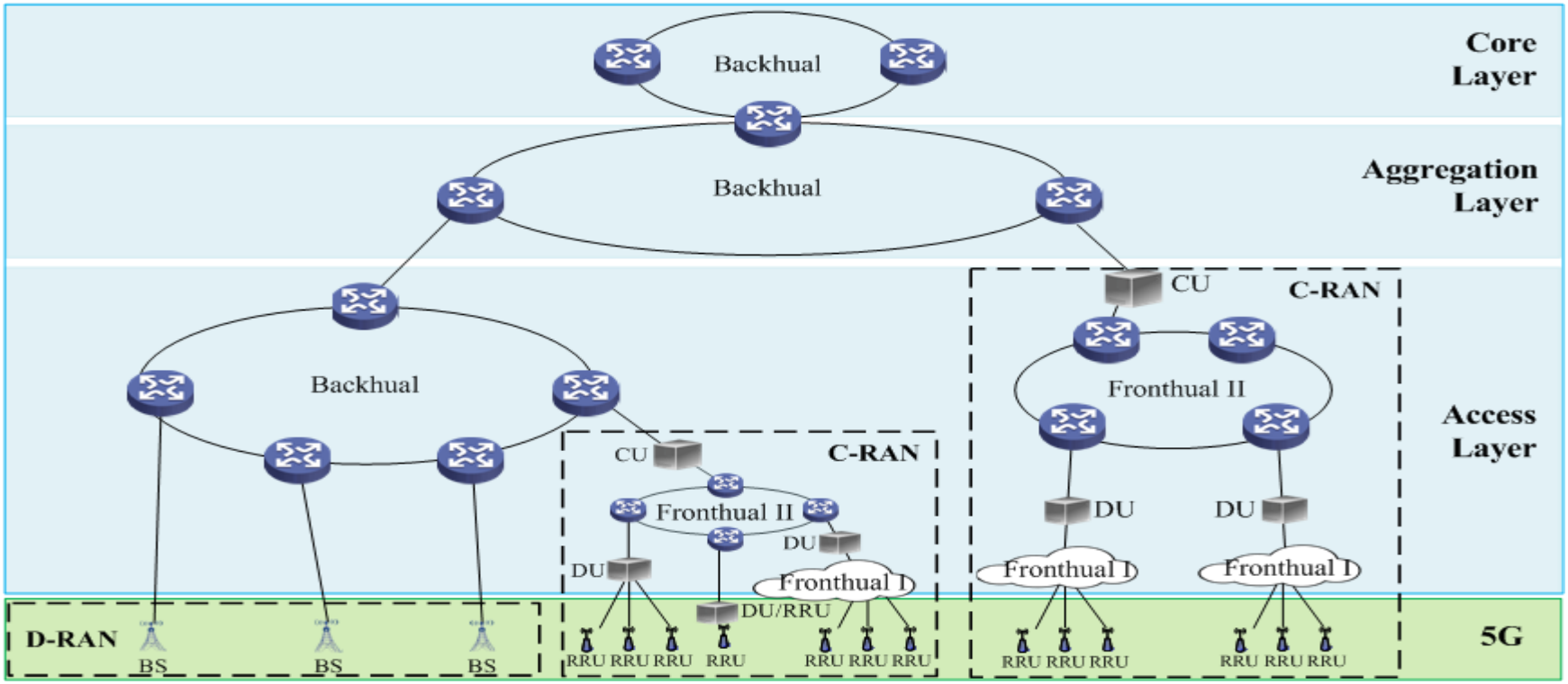
Two-level fronthual architecture



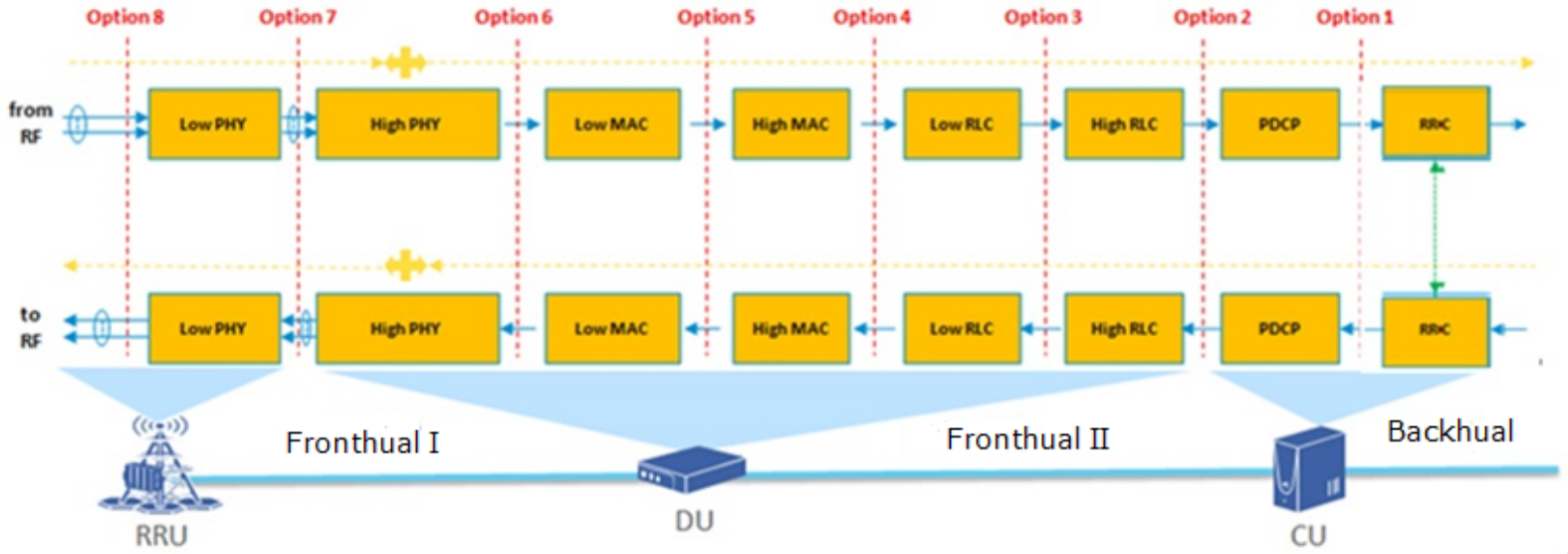
- 5G C-RAN BBU will be divided into the functional entities of CU and DU.
- Accordingly, the fronthual domain will include two levels:
  - Domain I between RRU and DU
  - Domain II between DU and CU
- It is proposed to study and define the requirements for the fronthual domain I and domain II, respectively.

Two-level fronthual architecture

- A typical 5G metro network architecture
- Including the backhual and fronthual transport networks, which may be emerged by utilizing the same fiber resources and transport equipments.



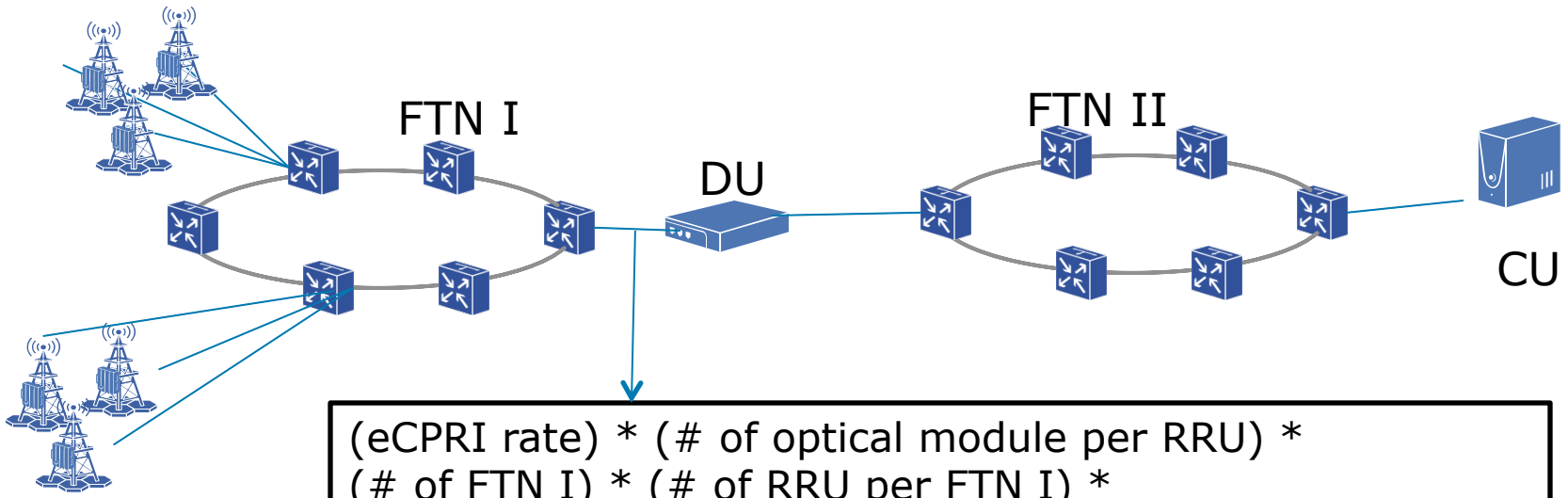
Functional splits and requirements for fronthual I and II



- Fronthual Domain I is based on lower layer functional splits.
  - High bandwidth, stringent delay and synchronization
- Fronthual Domain II is based on higher layer functional splits.
  - Lower bandwidth, less stringent delay and synchronization
- In the first step, it is proposed to use one most possible split option for requirement definitions of fronthual domain I and domain II.
- Based on the split option, it is proposed to define the requirements for fronthual domain I using lower layer splits, fronthual domain II using higher layer splits.

A typical fronthual aggregation scenario

- Basic assumption:
  - eCPRI b/w RRU and FTN I
  - 100MHz, DL 256QAM, 16 layers
  - Option 2 split b/w CU and DU
  - 1 DU ~ 6 fronthaul transport node I (FTN I)
  - 1 CU ~ 6 DU ~ 6 FTN II



(eCPRI rate) * (# of optical module per RRU) *
(# of FTN I) * (# of RRU per FTN I) *
= 25 * 2 * 6 * 3= 900 Gbps
Note: multiplexing gain not considered yet;

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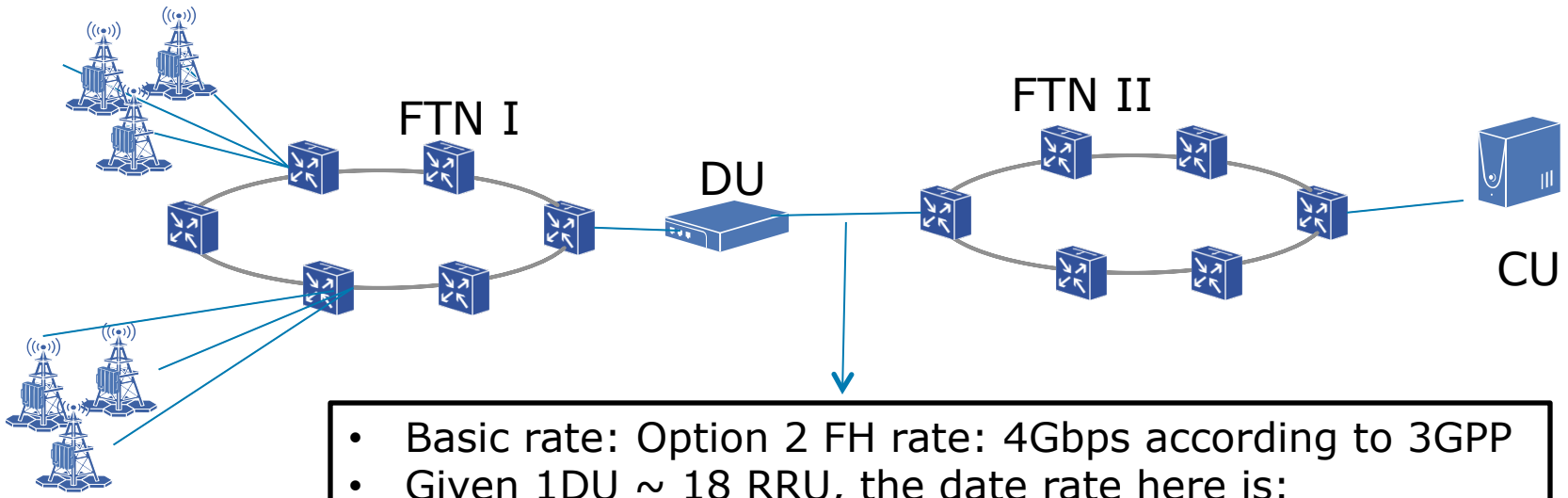

- Basic rate: Option 2 FH rate: 4Gbps according to 3GPP
- Given 1DU ~ 18 RRU, the date rate here is:
  = 4Gbps * 18 = 72 Gbps
- Note: multiplexing gain not considered yet;

A typical fronthual aggregation scenario

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  - eCPRI b/w RRU and FTN I
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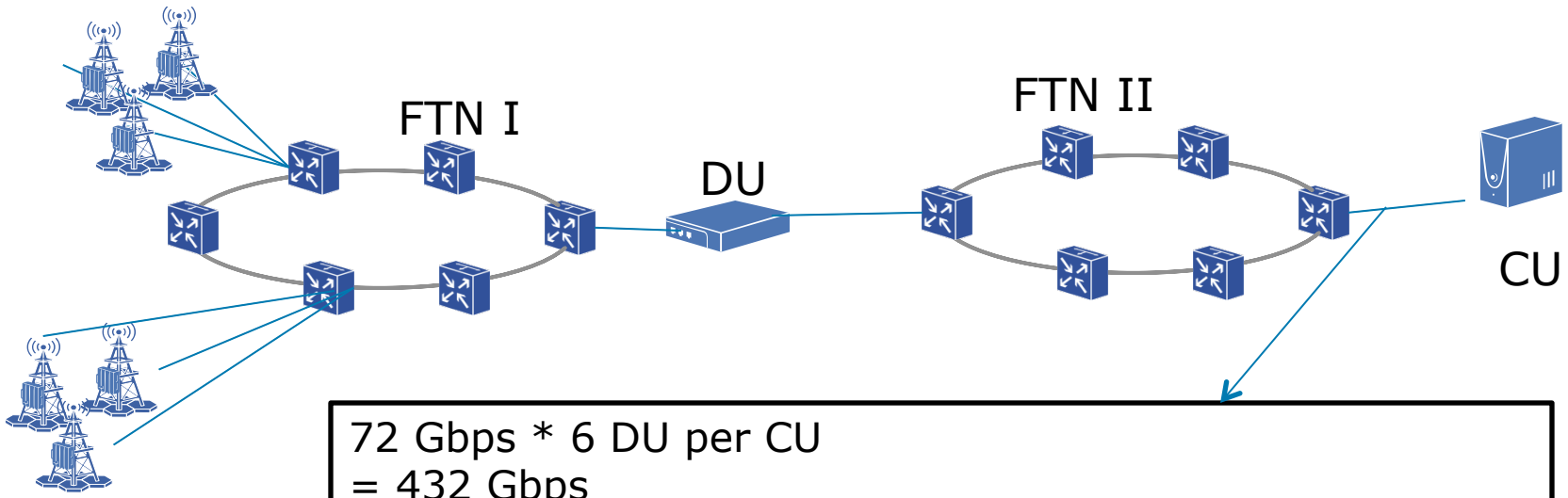

72 Gbps * 6 DU per CU
= 432 Gbps
Note: multiplexing gain not considered yet;

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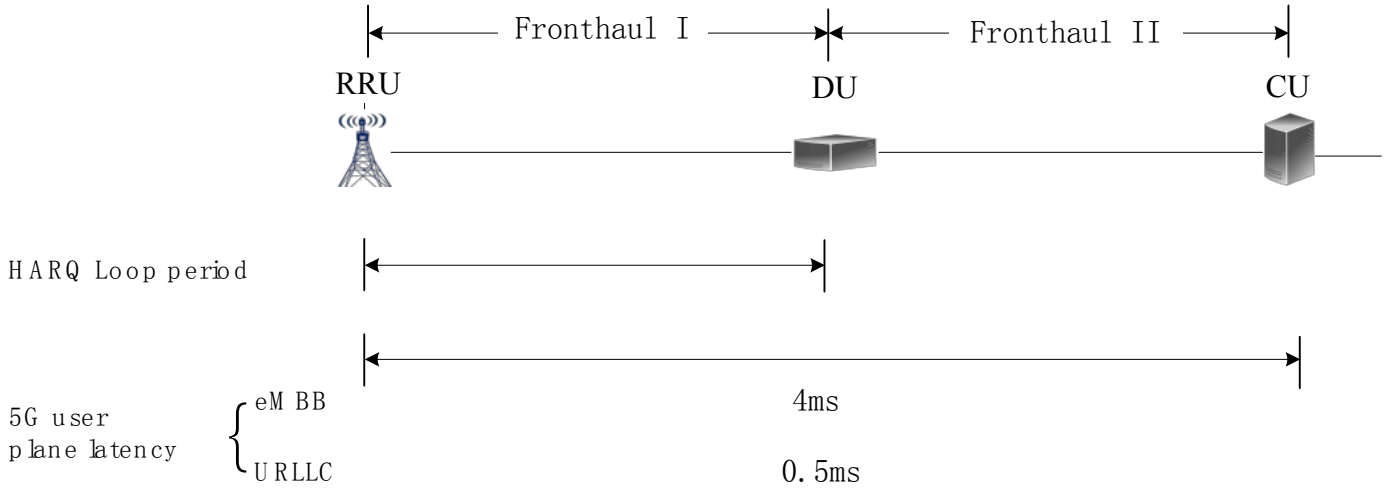
- Discussions on synchronization requirement

Discussions on delay requirement



- The fronthual delay requirement depends on two factors:
  - 5G user plane latency requirement, which is 4ms for eMBB and 0.5ms for URLLC.
  - HARQ Loop period requirement, which has not been defined for 5G.
- 5G user plane latency requirement has influence on both fronthual domain I and domain II.
- HARQ Loop period requirement only has influence on fronthual domain I using lower layer functional splits.

Discussions on delay requirement

- Should we consider eMBB requirement first? Or should we consider both eMBB and URLLC requirements?
- It is proposed to define delay requirement for fronthual domain I based on HARQ Loop period requirement .
- It is proposed to define delay requirement for fronthual domain II mainly based on user plane latency requirement.
- It is proposed to define a delay budget for fronthual transport (exclusive of the delay inside CU/DU/RRU). This will be beneficial to the transport implementation.

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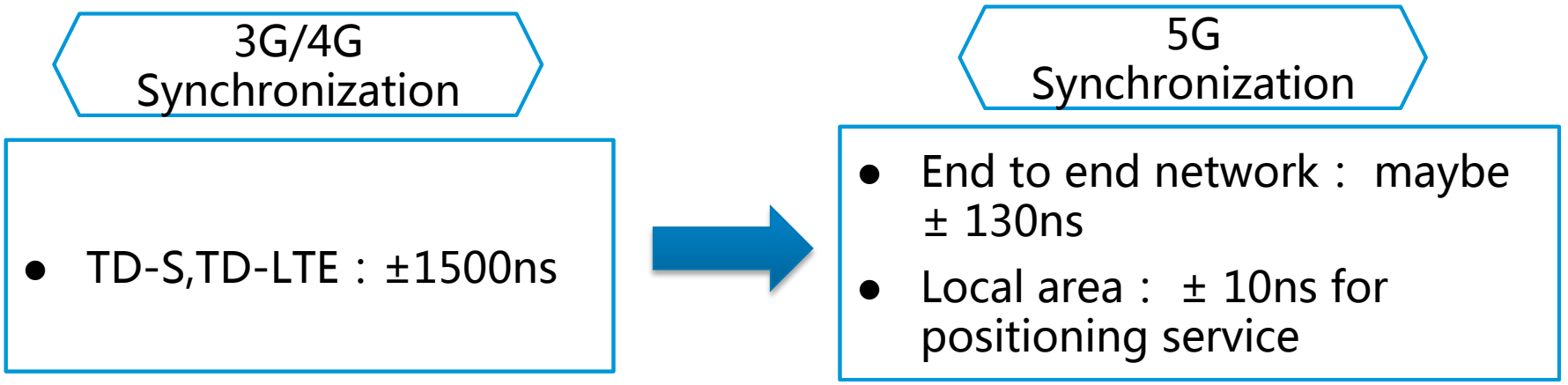
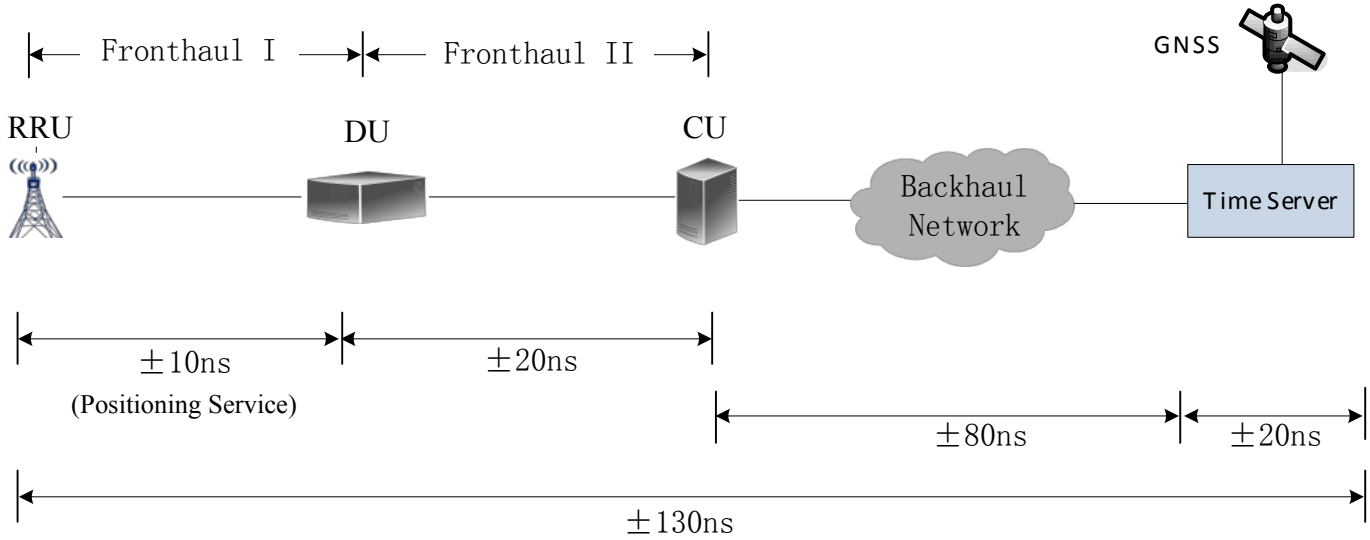
5G synchronization requirement



5G synchronization requirement comes from:

- Carrier aggregation (CA): the inter-band CA would probably be used for the inter-site scenario, which requires 260ns TAE between RRUs.
- Joint Transmission (JT): which requires 260ns TAE between RRUs.
- 5G frame structure: which is under study. In 5G, the frame structure will probably be changed with shorter cyclic prefix (CP) length, which will require more stringent air-interface synchronization compared with 1.5us for TD-LTE.
- Positioning service by the mobile communication: 5G shall support higher accuracy location capability that is less than [3 m], which needs 10ns synchronization accuracy.

Fronthual synchronization requirement



- The fronthual synchronization should satisfy the end-to-end network budget, while it is better to satisfy the positioning service requirement in the CRAN architecture.
- According to the time error allocation on the whole time distribution chain, it is proposed that:
  - The fronthual domain I: ± 10ns (to support positioning service)
  - The fronthual domain II: ± 20ns (related to the synchronization hops)

Thank you!