

#### 5G Synchronization Architecture Karim Traore

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#### **More Than 450 PTP Deployments Worldwide**



- First deployment around 2008
- PTP deployments in 450 production networks worldwide
- 5G network: PTP will become primary synchronization mechanism



#### **Traditional Fronthaul network (4G)**





## **Traditional Fronthaul Network (4G)**

- CPRI defines 3 logical connections between REC(RRH) and the RE(BBU):
  - User plane data,
  - Control & management plane
  - Synchronization and timing
    - Timing and frequency synchronization are critical elements and defined in CPRI
      - Sync is used for time and frame alignment
      - CPRI requires strict synchronization and timing accuracy between REC and RE: the clock received at the RE must be traceable to the main REC clock with an accuracy of 8.138 ns
      - Frequency deviation from the CPRI link to the radio base station must be not larger than 2ppb (2ns/s)
      - Central clock frequency generation in the RE shall be synchronized to bit clock of one of the ports connecting RE and REC
- CPRI scalability challenges
  - High bandwidth requirement on Fronthaul (dedicated fiber or wavelength link for every antenna)
  - 20 MHz LTE with 2 antennas: 2.5 Gbps for one RE-REC (RRH-BBU) connection
  - 8x8 MIMO antenna covering four sectors requires 32 Antenna Carriers(AxCs), which translate into around 32 Gb/s for 20 MHz bandwidth channels. In the case of 100 MHz LTE channels, this same scenario requires five times (i.e., 160 Gb/s)
  - Split LTE stack & leave some functions locally at RRH site and process the signal more before it is transmitted to REC(BBU)
  - New cost effective transport technology: CPRI over Ethernet and CLOUD RAN (CMRI: OPEX&CAPEX reduced by 30% to 53%)



#### LTE Stack functional split options (5G)



support of CoMP & centralized scheduling are possible as MAC is in CU.

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### LTE Stack functional split options (5G)





### LTE Stack functional split options (5G)



## **5G Synchronization Requirements**

		Applications	IEEE 802.1CM category	Time Error requirements	Relative requirement	Absolute requirement	Comments	_
		LTE-TDD (large cells)	N/A	5μ	No	Yes	3GPP, IEEE, ORAN	INTER-
FR1 (sub 6GHz)	FR2 (mmwave)	UTRA-TDD, LTE-TDD (small cells)	Cat C	≤±1.5 μ	No	Yes	3GPP, IEEE, ORAN	SITES REQ.IN REL.15 INTRA-SITE REQ.IN REL.15
410-7125MHz	24250- 52600MHz	Intra-band non- contiguous CA with or with MIMO or TX diversity, and inter- band CA with or without MIMO or TX diversity	Cat B	3 μ (BS type 1-C, 1-H, 1-O & 2-O) 3 μ for FR1&FR2 On-going discussions	Yes	No	Discussions at 3GPP	
		Intra-band contiguous CA with or with MIMO or TX diversity	Cat A	130 ns (BS type 2-O), 260 ns (BS type 1-C,1-H, 1- O) 260 ns for FR1 and 130 ns for FR2 On-going discussions	Yes	No	Discussions at 3GPP	
		MIMO or TX diversity transmissions at each carrier frequency	/ nCat A+	65 ns (BS type 1- C,1-H, 1-O & 2-O)	Yes	No	This category has been withdrawn by CPRI for PTP	



## **3GPP TAE - MIMO and Tx diversity for NR**



#### **3GPP TAE – intra band cont. CA for NR**





#### **3GPP TAE – intra band non cont. CA/inter band CA for NR**





## **Deployment considerations**

- Synchronization applications
- Vendor synchronization solutions to meet applications (e.g., standard network wide based, local proprietary, GNSS, etc.)
- RU support of synchronization at Ethernet or IP layer
  - ITU-T G.8275.1 runs on top of Ethernet, ITU-T G.8275.2 runs on top of UDP/IP
- RU support of Synchronous Ethernet (e.g., class B, C)
- Fronthaul networking nodes support of ITU-T G.8275.1 (BC, TC) or G.8275.2 architecture
- Availability of ideal Fronthaul network, dedicated optical transport or Ethernet/IP transport
- Fronthaul network synchronization size (medium size countries vs large countries)



#### **IEEE P1914 TSN Reference Architecture**



RU-DU: typical below 10 km (2:5km) under 100usec, max. 20 km DU-CU: 2- to 40km

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#### Full timing support with BC (NGFI-I and NGFI-II)





### Full Timing Support with TC (NGFI-I and NGFI-II)





### Full Timing (NGFI-I) and Partial Timing (NGFI-II)





### **Assisted Partial Timing Support (NGFI-I and NGFI-II)**





## **Partial Timing Support**



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#### **Summary**

- End applications: RU, DU and CU
- Requirements: 3GPP and Radio vendor specifications
- RU/DU specifications & Fronthaul and midhaul network specifications
- Synchronization architecture



# Thank you!



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