

# Throughput requirements

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**IEEE 1914**  
**Next Generation Fronthaul Interface**  
**Jinri Huang, huangjinri@chinamobile.com**

**Throughput requirements**

**Date:** 2017-04-10

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# Background

Class	Sub Class (TSN)	Priority Level (TSN)	Latency upper bound requirement (TSN)	Throughput requirement (TSN)	Reserved	Informative
control & management	synchronization	0		Low BW		
	Low latency RAN control-plane	1		Low BW		
data-plane	Subclass1	2		R3_low - R3_high		3GPP model Option 6,7,8
	Subclass_2	3		R4_low - R4_high		3GPP model Option 4,5
	Subclass_3	4		R5_low - R5_high		3GPP model Option 1,2,3
Transport NW control & management		?	?	Low BW		
Reserved						

Way forward after Oct16 f2f [1]:

- Need to fill in the transport class table
- Requirements (following Prof. Choi's contribution, Transport requirements for different splits (ATT) )

Contribution from Feb 2017 telco:

- Proposal to use latency requirement as primary factor for CoS specification, instead of throughput [2]

[1] 201610 IEEE 1914 f2f meeting summary

[2] tf1\_1702\_cai\_tazi\_NGFI\_COS\_specification\_1.pdf

# Thoughts on throughput requirements

- Delay requirement can only be met if required throughput can be accommodated
  - Delay is more critical in the context of CoS definition
- Still, there is a value in defining realistic deployment scenarios
  - 1914.1 PAR: "5.2 Scope: This standard specifies: (...)
  - 2) Requirements and definitions for the fronthaul networks, including data rates
- Proposal: Fronthaul dimensioning tool
- To facilitate analysis on deployment scenarios
- Invitation to share views on parameters and their values in foreseen deployment scenarios to be included in the standard (informative)

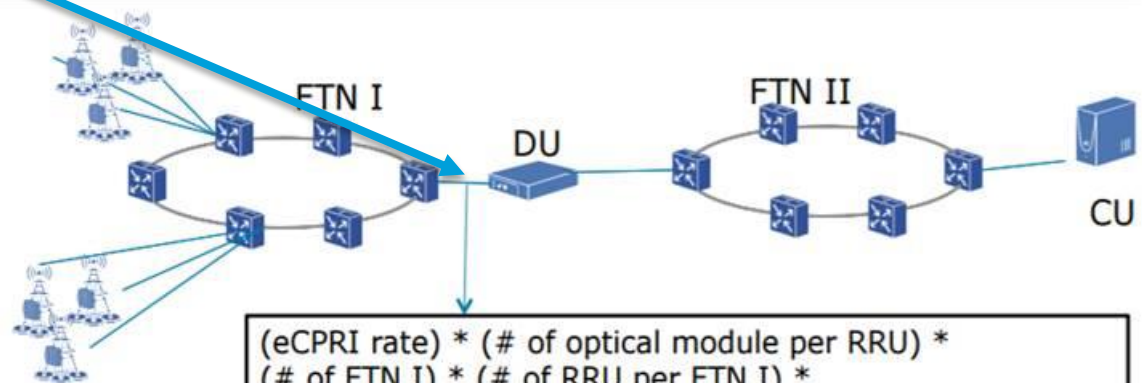
# Considered architecture

From IEEE 1914, tf1\_1701\_huang\_two-level-architecture\_2.pdf

## A typical fronthaul aggregation scenario

Calculations focused here:

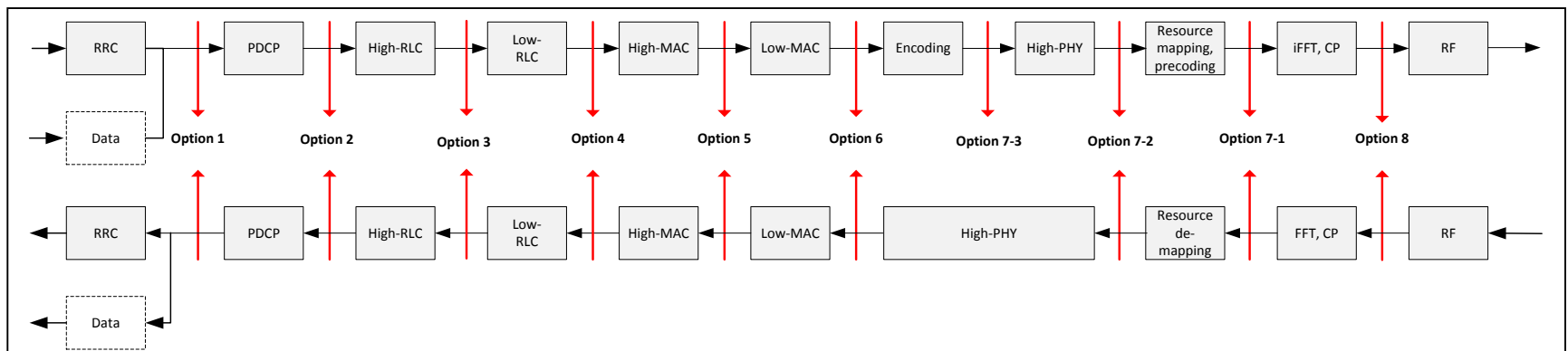
- Basic assumption:
  - eCPRI b/w RRU and FTN I
  - 100MHz, DL 256QAM, 16 layers
  - Option 2 split b/w CU and DU
  - 1 DU ~ 6 fronthaul transport node I (FTN I)
  - 1 CU ~ 6 DU ~ 6 FTN II



$$\begin{aligned} & (\text{eCPRI rate}) * (\# \text{ of optical module per RRU}) * \\ & (\# \text{ of FTN I}) * (\# \text{ of RRU per FTN I}) * \\ & = 25 * 2 * 6 * 3 = 900 \text{ Gbps} \\ & \text{Note: multiplexing gain not considered yet;} \end{aligned}$$

# Considered functional splits

Splits naming convention based on 38.801. Splits 7.1, 7.2 and 7.3 edited by MTI

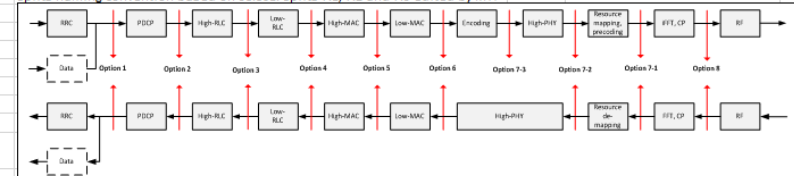


# Presentation of the tool

Fronthaul dimensioning tool for LTE in DL and UL					
Developed by Foxconn and MTI					
Contact: Aleksandra.Checko@mtigroup.com, Andrijana.Aramova@mtigroup.com					
Edit values of input parameters to see resulting fronthaul throughput.					
Configuration					
Input Parameters	Variant 1 Value	Variant 2 Value	Variant 3 Value		
Radio	Bandwidth per user [MHz]	20	100	20	
	# of subcarriers per RB	12	12		
	# of antennas	2	16	2	
	# MIMO layers	2	16	2	
	# of symbols per subframe (DL)	14	14		
	# of CFI symbols (DL)	1	1		
	# of UEs per TTI (DL)	1	1		
	avg # of RE for reference signal per RB per subframe per antenna, excluding ones within symbols booked	6	6		
	# of data carrying symbols per sub-frame (UL)	12	12		
	# of RB per PUCCH (UL)	2	2		
	# of bits in log likelihood ratio (UL)	8	8		
	Bit width (I+Q)	32	32		
	Compression, % of original	100%	59%	100%	
	Modulation (e.g. 64QAM = 6, 256QAM = 8)	6	8	6	
	# Sectors	1	1	1	
	Load factor	100%	100%	100%	
	DL or UL?	DL	DL	DL	
	Split option	3GPP Option 8	3GPP Option 7.1	3GPP Option 2	
	FH entering DU	Transport overhead, % (e.g. CPRI 25% or 3.125%, RoE <10%)	0.0%	0.0%	0.0%
		MUX gain on link entering DU [sum of throughputs/aggregated throughput]	1	1	1
# of RRU per FTN I		1	3	1	
# of FTN I per DU		1	6	1	
# of optical modules per RRU		1	2	1	
<b>Resulting throughput on fronthaul, Gbps</b>		<b>1.96608</b>	<b>905.74848</b>	<b>0.1875</b>	

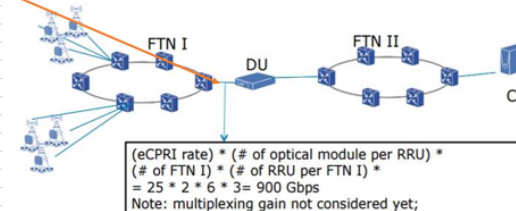
Assumptions	
PUSCH in UL	Split 7.3, UL - only data for PUSCH taken into account, control channels impact is treated as negligible here
PDSCH in DL	Split 7.3, DL - only data for PDSCH taken into account, control channels impact is treated as negligible here
187.5	Throughput requirement in Mbps for split option 1-6 [NGMN Small Cell Backhaul Requirements, June 2012] for 20 MHz, 64QAM, 2 MIMO layers. That includes transport overhead
Option 7-3 (DL)	3GPP considers it only for DL: Only the encoder resides in the CU, and the rest of PHY functions reside in the DU.
Option 7-1 (DL)	iFFT and CP addition functions reside in the DU, the rest of PHY functions reside in the CU.

Splits naming convention based on 38.801. Splits 7.1, 7.2 and 7.3 edited by MTI



## A typical fronthaul 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



$$\begin{aligned}
 & (\text{eCPRI rate}) * (\# \text{ of optical module per RRU}) * \\
 & (\# \text{ of FTN I}) * (\# \text{ of RRU per FTN I}) * \\
 & = 25 * 2 * 6 * 3 = 900 \text{ Gbps} \\
 & \text{Note: multiplexing gain not considered yet;}
 \end{aligned}$$

Source: IEEE 1914, tf1\_1701\_huang\_two-level-architecture\_2.pdf



# Exemplary configurations

		Configuration				
Input Parameters		Variant 1	Variant 2	Variant 3	Variant 4	Variant 5
		Value	Value	Value	Value	Value
Radio	Bandwidth per user [MHz]	100	100	100	100	100
	# of subcarriers per RB	12	12	12	12	12
	# of antennas	16	8	8	8	8
	# MIMO layers	16	8	8	8	8
	# of symbols per subframe (DL)	14	14	14	14	14
	# of CFI symbols (DL)	1	1	1	1	1
	# of UEs per TTI (DL)	1	1	1	1	1
	avg # of RE for reference signal per RB per subframe per antenna, excluding ones within symbols booked	6	6	1		
	# of data carrying symbols per sub-frame (UL)	12	12	12	12	12
	# of RB per PUCCH (UL)	2	2	2	2	2
	# of bits in log likelihood ratio (UL)	8	8	8	8	8
	Bit width (I+Q)	32	32	32	32	32
	Compression, % of original	59%	100%	100%	100%	100%
	Modulation (e.g. 64QAM = 6, 256QAM = 8)	8	8	8	8	8
	# Sectors	1	1	1	1	1
	Load factor	100%	100%	100%	100%	100%
DL or UL?	DL	DL	DL	DL	DL	
Split option	3GPP Option 7.1	3GPP Option 7.1	3GPP Option 7.3	3GPP Option 5	3GPP Option 2	
FH entering DU	Transport overhead, % (e.g. CPRI 25% or 3.125%, RoE <10%)	0.0%	0.0%	0.0%	0.0%	0.0%
	MUX gain on link entering DU [sum of throughputs/aggregated throughput]	1	1	1	1	1
	# of RRU per FTN I	1	1	1	1	1
	# of FTN I per DU	1	1	1	1	1
	# of opticals modules per RRU	1	1	1	1	1
<b>Resulting throughput on fronthaul, Gbps</b>		<b>25.15968</b>	<b>21.504</b>	<b>4.736</b>	<b>5</b>	<b>5</b>

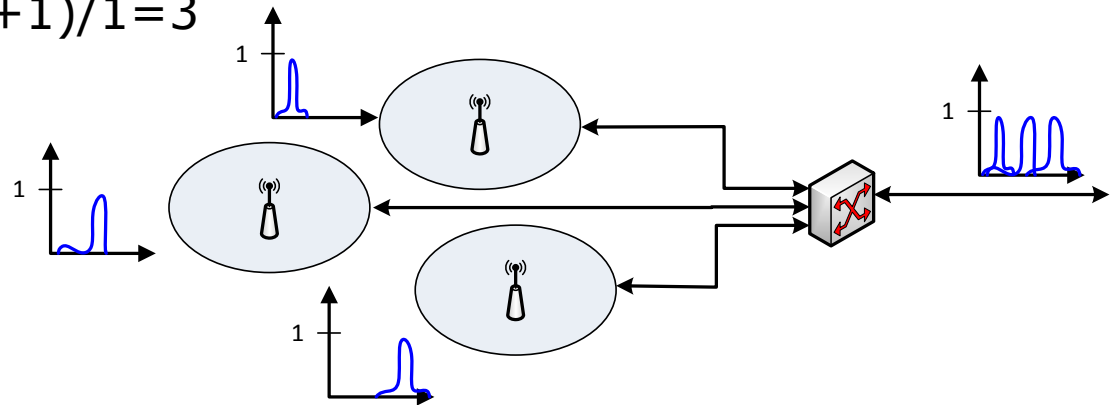
100 MHz  
16 or 8  
antennas

Compression/  
bit width  
256 QAM

# Needs for D0.2/D0.3

- Unified formula for throughput calculations
  - Proposal to use formulas from Fronthaul dimensioning tool
- Unified definition of multiplexing gain
  - Proposal: [sum of throughputs/aggregated throughput] satisfying delay requirements
  - Here  $MG = (1+1+1)/1=3$

$$MG = \frac{\sum^{cells} SingleCellLinkResources}{AggregatedLinkResources}$$



# Bandwidth vs data rate vs throughput

Agreement is needed on terminology:

- 3GPP – bandwidth of data transmission
- SCF – bandwidth interchanged with throughput
- NGFI whitepaper - bandwidth
- IEEE 1914 PAR – data rates of network
- IEEE 1914.1 – bandwidth and throughput



Proposal:

- Data rate – of a link in the network
- Bandwidth of RF channel
- Throughput – actual transfer. But on application level?

# Strawman poll #\_4\_

- Terminology: use throughput in definitions saying it is a transport throughput unless otherwise specified in IEEE 1914.1 standard
- Mover: Aleksandra Checko
- Seconder: Richard Maiden
- Yes: \_19\_ No: \_0\_ Abstain: \_2\_ (technical motion needs  $\geq 2/3$ )

# Strawman poll #\_5\_

- Do we need more discussion on: “Remove throughput requirements from NGFI transport class of service definition. Refer to throughput as informative”?
- Mover: Aleksandra Checko
- Seconder: Stuart Whitehead
- Yes: \_3\_ No: \_8\_ Abstain: \_8\_ (technical motion needs  $\geq 2/3$ )

# Motion #\_5\_ (04/20/2017)

- Remove the throughput requirement column from Table 2 in IEEE 1914.1 D0.2 page 19.
- Mover: Aleksandra Checko
- Seconder: Stuart Whitehead
- Yes: \_11\_ No: \_0\_ Abstain: \_0\_ (technical motion needs  $\geq 2/3$ )

# Motion #\_4\_

- In an appendix, show formulas and parameter definitions from tf1\_1704\_Checko\_FHDimensioning\_1.xlsm as a baseline for throughput calculations. Add informative reference that LTE calculations are as in SCF 159 document and are extended with fronthaul parameters.
- Mover: Aleksandra Checko
- Seconder: Tony Tam
- Yes: \_12\_ No: \_0\_ Abstain: \_0\_ (technical motion needs  $\geq 2/3$ )

# Summary

- Proposal is to provide informative realistic throughput requirements, to be included in the standard
- Contributions to values of parameters to define deployment scenarios are welcome

Thank you