Throughput requirements

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IEEE 1914
Next Generation Fronthaul Interface
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Throughput requirements			
Date: 2017-04-10			
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Background

Class	Sub Class (FFS)	Priority Level (FFS)	Latency upper bound requirement (FFS)	Throughput requirement (FFS)	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 is required throughout can be accommodated
  - Delay is more critical in the context of CoS definition

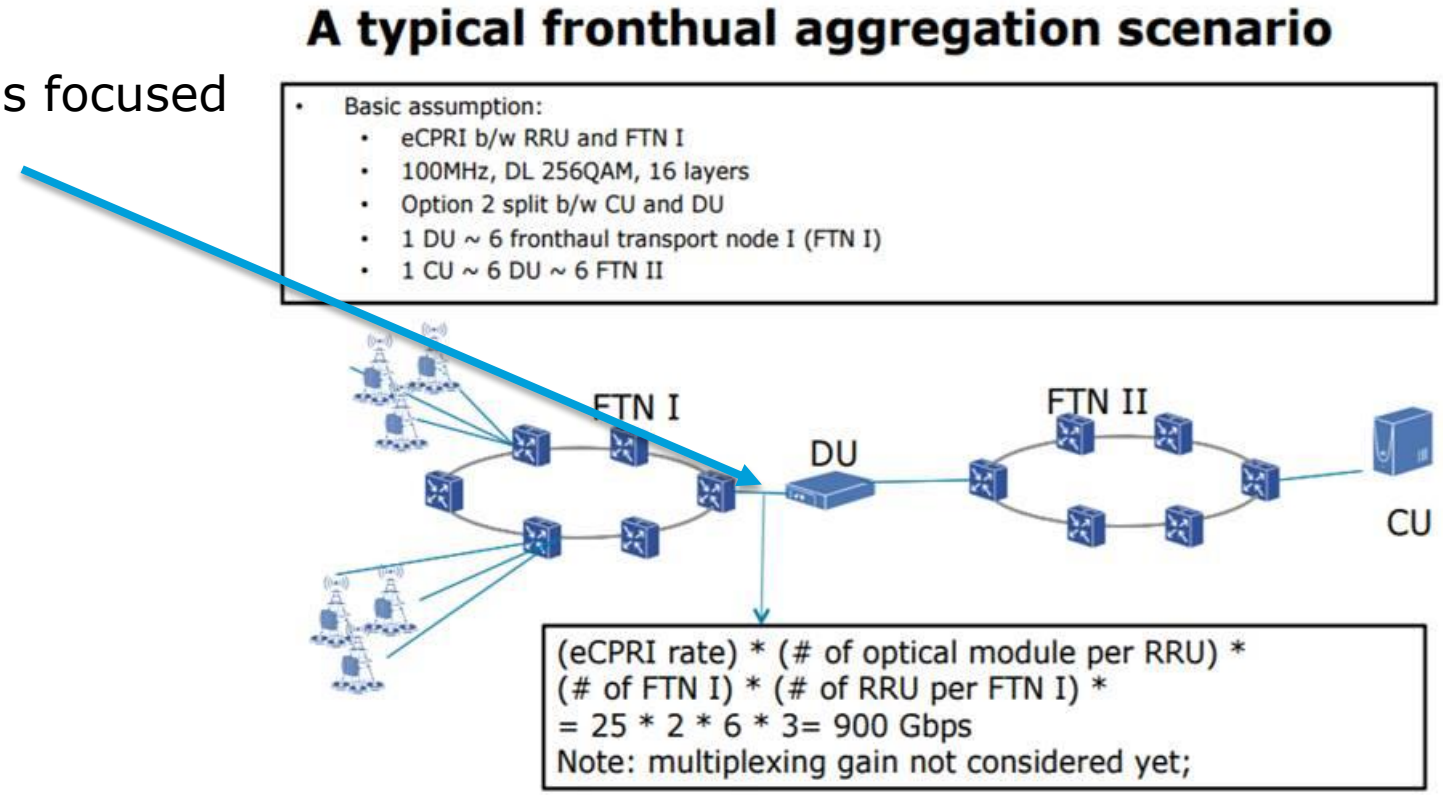
- Still, there is a value in defining realistic deployment scenarios
  - 1914.1 PAR: "5.2 Scope: This standard specifies: (…)
  - 2) Requirements and definitions for the fronthaul networks, including data rates
- Proposal: Fronthaul dimensioning tool
- To facilitate analysis on deployment scenarios

- Invitation to share views on parameters and their values in foreseen deployment scenarios to be included in the standard (informative)

Considered architecture

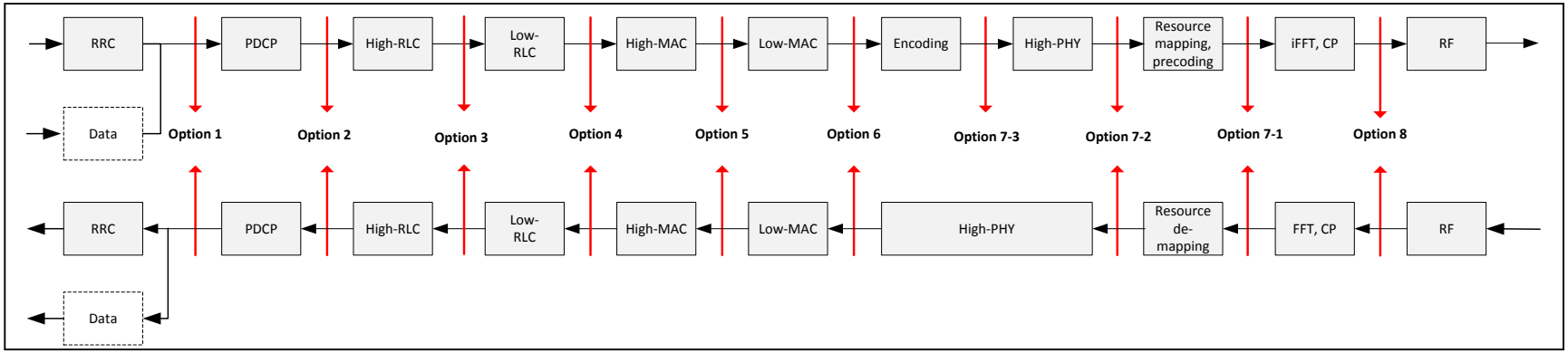
From IEEE 1914, tf1_1701_huang_two-level-architecture_2.pdf

Calculations focused here:



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

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Edit values of input parameters to see resulting fronthaul throughput.

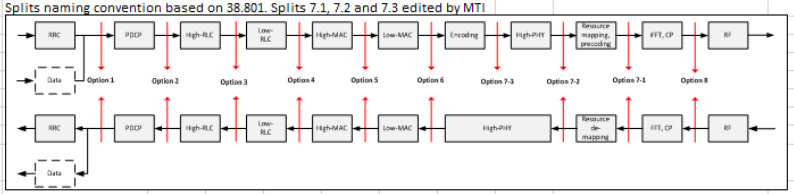
Configuration

	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 likehood ratio (UL)	8	8	
	Bit width (I+Q)	32	32	
	Compression, % of orginal	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 opticals modules per RRU	1	2	1
	Resulting throughput on fronthaul, Gbps	**1.96608**	**905.74848**	**0.1875**

Assumptions

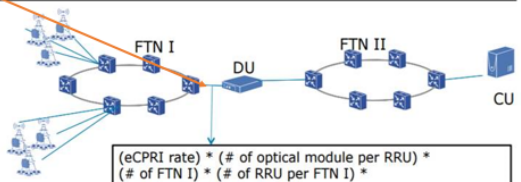
PUSCH in UL	Split 7.3, UL - only data for PUSCH taken into account, control channels impact is treated as negligible here
PDSCH in DL	Split 7.3, DL - only data for PDSCH taken into account, control channels impact is treated as negligible here
187.5	Throughput requirement in Mbps for spilt option 1-6 [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



(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;

Source: IEEE 1914, tf1_1701_huang_two-level-architecture_2.pdf

Exemplary configurations

	Configuration				
	Input Parameters	Variant 1 Value	Variant 2 Value	Variant 3 Value	Variant 4 Value	Variant 5 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 likehood ratio (UL)	8	8	8	8	8
	Bit width (I+Q)	32	32	32	32	32
	Compression, % of orginal	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
	Resulting throughput on fronthaul, Gbps	**25.15968**	**21.504**	**4.736**	**5**	**5**

100 MHz
16 or 8
antennas

Compression/
bit width
256 QAM

Bandwidth vs data rate vs throughput

Agreement is needed on terminology:

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

Proposal:

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

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