RAN Split Grouping for Transport

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Next Generation Fronthaul Interface

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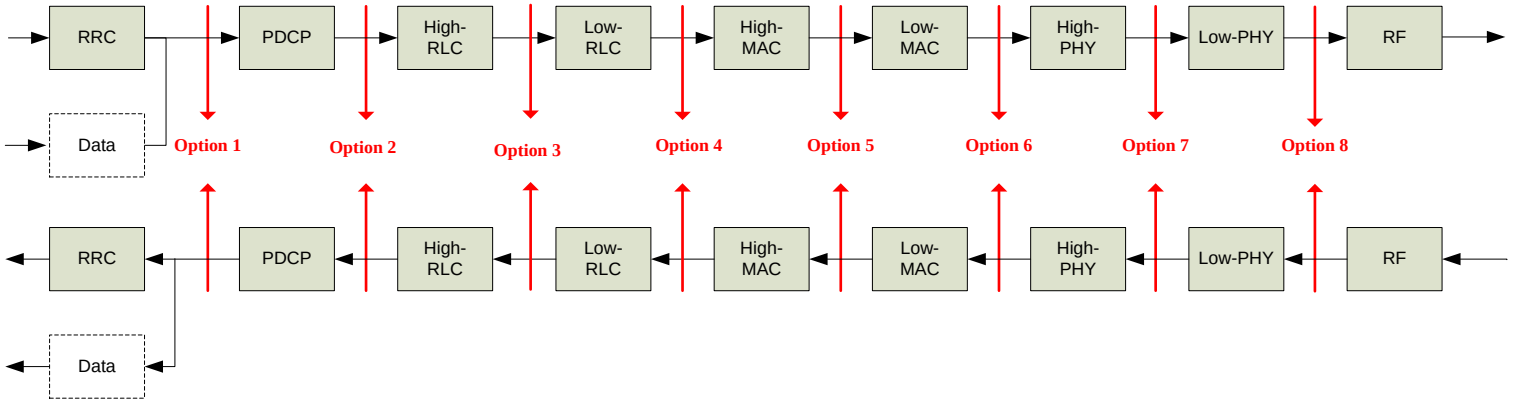
5G RAN/Transport Architecture Challenges

1. **Transport Bandwidth Requirements**
   - Fronthaul BW with PHY – RF split can be very high (100 to 300 Gbps)
   - Backhaul BW requirement is of order of 10s of Gbps
2. **Transport Latency Requirements**
   - FH latency requirement ~ 30 to 50 µs to satisfy HARQ loop timing requirement
   - Backhaul latency requirement 5 to 10 ms for performance considerations
3. **High Throughput Density**
   - Dense deployments using mmWave leading to high traffic density (per unit area)
4. **CPRI Limitations**
   - Max ~ 25 Gbps, Does not scale with BW and # of antenna elements,
   - Closed ecosystem
5. **Interface/Ecosystem**
   - Support majority 5G use cases with minimum # of standardized interfaces
   - Partners for equipment, compute, networking, and end-to-end testbeds/PoC

Split Options <–> Transport link

- **3GPP TR38.801 Reference functional split view**



- **RAN Split**
  - Opportunity to Standardize flexible RAN split options
  - RAN split being discussed in multiple fora and needs time to settle
- **Transport**
  - Choice of split option influences transport requirements
  - NGFI should provide transport functionality to support multiple split options

RAN Split Grouping Proposal

Split Group	Splits	Requirements
High	Op 2: PDCP – RLC Op 3: Hi RLC – Lo RLC	5 – 10 ms
Mid	Op 5: MAC Hi – MAC Lo Op 6: MAC – PHY	100s of µs – 1ms
Low	Op 7: PHY Hi – PHY Lo	10s of µs – 200µs

- Group RAN splits into High, Med, and Low for transport requirement purposes
- Design transport interface for each RAN-split group
- Develop transport architectures/profiles to support flexible deployment options for different use-cases/scenarios

5G Application Scenarios and Splits

Application	Consideration	Split Group
eMBB @ mmWave	• High Throughput Density • Tough Propagation conditions • Lower split BW needs not practical • Co-operative processing gains unclear	**High**
eMBB @ low band LTE – A	• Co-operative processing important for high spectral efficiency • Low to moderate Throughput density	**High** **Low**
Ultra Low Latency / mMTC / V2X	• Very Short TTIs • Fast HARQ • HARQ function in remote	**No Split** **High**

- High Layer and lower layer split groups are imperative for Mobile Broadband applications including 5G FWA and LTE-A evolution
  - High Splits Groups enable mmWave eMBB and low latency use cases
  - Lower Layer Split enables high spectral efficiency < 6GHz
- Focus on higher/lower layer splits to support early 5G applications and LTE-A

Conclusions

- Group RAN splits into low, med and high for transport definition purposes
- Focus on developing transport standard for low/high splits to support early 5G application and LTE-A evolution
- Continue working on and monitoring other industry forum including 3GPP, Small Cell Forum, CPRI etc to form recommendation for 5G RAN architecture splits

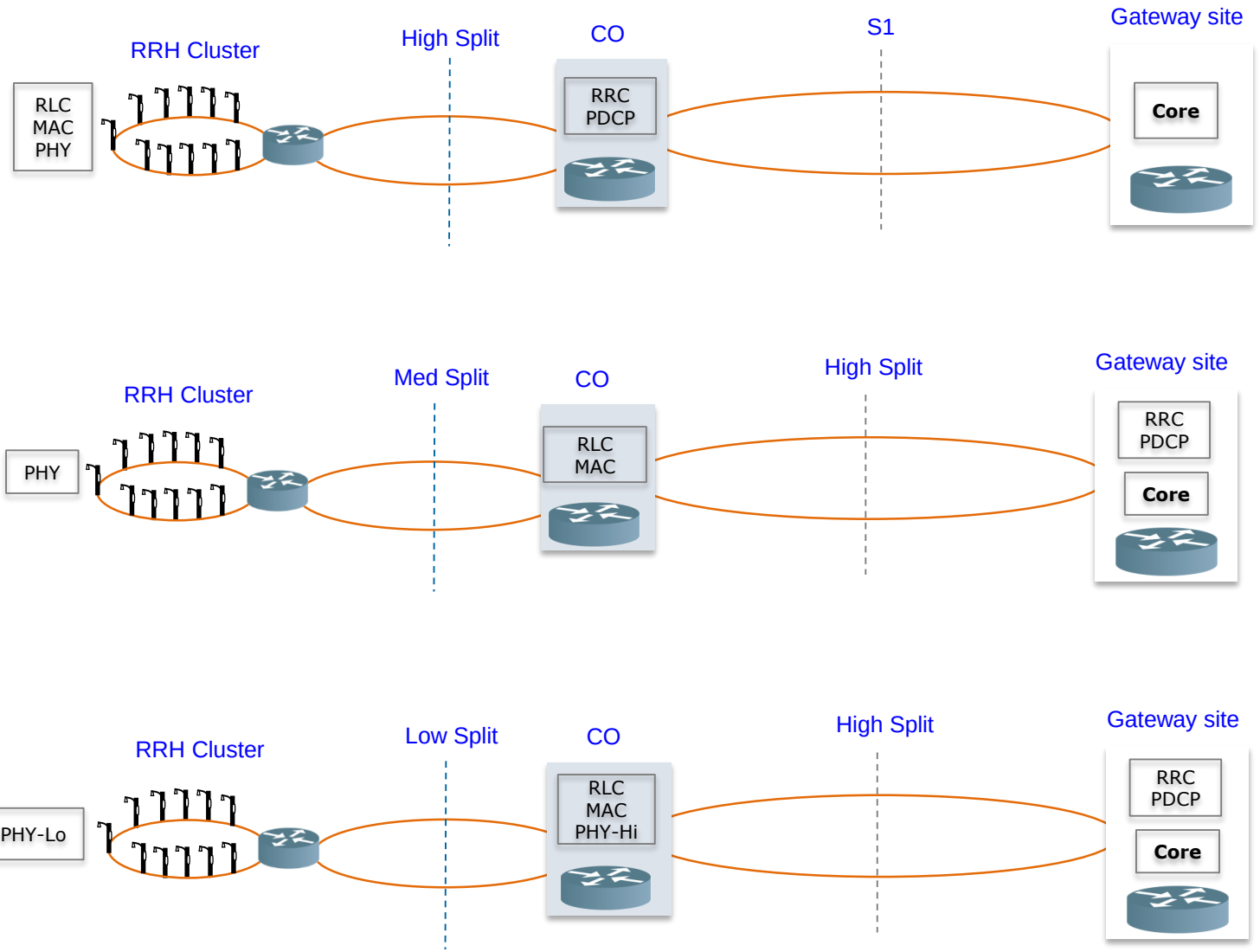
Backup

5G RAN Split Options: Feature Comparison

	3GPP #	Split Option (CU - DU)	LTE-Advanced Features#				Inter-working	FH Transport Req. 5G FWA Example**	
			DL CoMP	UL CoMP	CA (Carr. Agg.)	Cent. Sched.	Multi-RAT LTE-5G	FH Latency (RTT)	FH BW Gbps (Approx.)
High	Op 2	PDCP – RLC	N	N	N	N	Y (DC 3C)	5 – 10 ms*	12
High	Op 3	Hi RLC – Lo RLC	N	N	N	N	Y	5 – 10 ms*	13
Mid	Op 4	RLC – MAC	N	N	N	N	TBS	1 – 3 ms	14
Mid	Op 5	MAC Hi – MAC Lo	Y	N	Y	Y	TBS	1 – 3 ms	15
Mid	Op 6	MAC – PHY	Y	Y (Part)	Y	Y	N	100 – 500 µs	25
Low	Op 7-2	PHY Lay – PHY Pre	Y	Y (Part)	Y	Y	N	50 µs	55
Low	Op 7-1	PHY Pre – PHY IFFT	Y	Y (Full)	Y	Y	N	50 µs	105
Low	Op 8	PHY – RF	Y	Y (Full)	Y	Y	N	50 µs	185

LTE-Advanced features used here as reference for comparison, 5G NR features might be different
* This value is dependent on target e2e performance and not tied to real-time protocol needs
** FWA = Fixed Wireless Access, requirements for other applications may differ

5G Flexible Deployment Options



Technology Use Cases and Splits

Use Case	Considerations	Split Group	Application
Massive MIMO	• 8/32/64 Tx/Rx for sub-6 GHz, • 256/512 for mmWave • High FH BW requirement for low split • Centralization gains unclear	**High/Med for mmWave (D-RAN)** **Low split possible for < 6 GHz**	**eMBB** **LTE-A**
Co-operative Processing	• Tight Synch Requirements • Very low latency and Jitter • High FH BW requirement for low split • Only partial gains with Med Split	**Low (C-RAN)** **Med (C-RAN)**	**eMBB @ low band ,** **LTE-A**
Co-ordinated Scheduling	• Tight Synch Requirements • High FH BW requirement for low split	**Low (C-RAN)** **Med (C-RAN)**	**eMBB** **LTE-A**
Multi-RAT Interworking	• High split enables efficient LTE/NR interworking	**High**	**eMBB** **LTE-A**
Fast HARQ	• Same slot HARQ transmission • HARQ function in remote for low latency	**High** **Med (Intra MAC)**	**eMBB** **Ultra Low Latency**