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EPoC FDD Downstream RF Bandwidth Proposal

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Outline

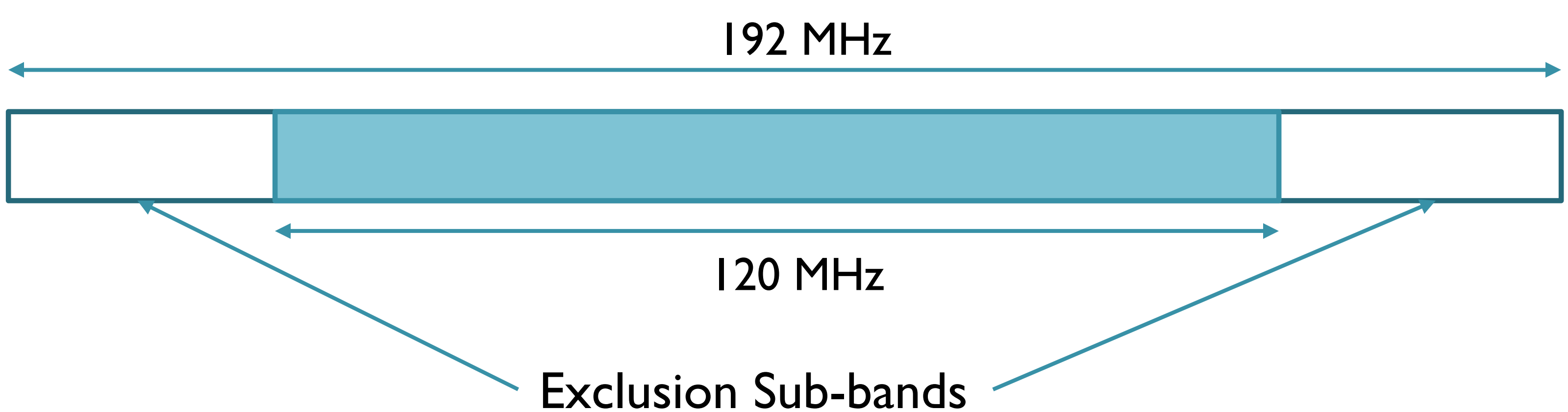
- Proposal for Downstream RF Bandwidth
- Complexity for Proposed RF Bandwidth
- Complexity Scaling with RF Bandwidth
- Evolution in RF Bandwidth

Proposal for Downstream RF Bandwidth

- RF Bandwidth depends on product supported data rate
  - CLTs and CNUs will support some of these data rates

Supported Data Rate	FDD Downstream RF Bandwidth
1.6 Gb/s	192 MHz
3.2 Gb/s	384 MHz
6.4 Gb/s	768 MHz

- Smaller RF Bandwidths can be supported by use of Exclusion sub-bands



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Complexity of the Proposed Bandwidth

- The complexity of 192 MHz system is right for the market today
- The analog-to-digital converters (ADCs) and the digital-to-analog converters (DACs) can be significantly less complex and power hungry compared to a higher-bandwidth system
- 192 MHz OFDM PHY
  - FFT and IFFT, QAM modulator/demodulator, Channel Estimator, and other Modulation/Demodulation functions can all be build it a low-cost CMOS device
- FEC
  - The high-speed forward error correction for 1.6 Gb/s can be built in a low-cost CMOS device

Complexity Scaling with RF Bandwidth

- What is the impact of scaling the RF Bandwidth on device complexity?
- Let $BW_2 = K \times BW_1$, where K is an Integer
  - Example: BW_1 = 192 MHz, K = 4 and BW_2 = 768 MHz

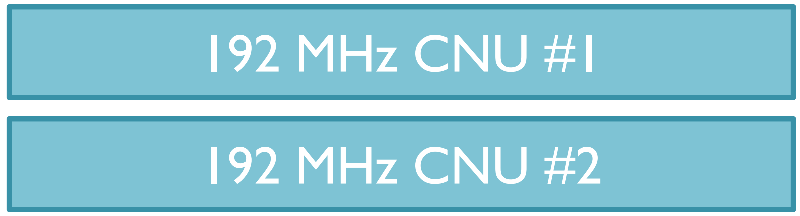
TX/RX Sub-block	Scaling with K	Scaling with K=4
ADC	≈K	≈4
DAC	≈K	≈4
FFT/IFFT	$K \log_2(K \times N)/\log_2(N)$	≈4.6
Modulator	K	4
Demodulator	K	4
Channel Estimator	K	4
FEC Encoder	K	4
FEC Decoder	K	4
RF PA TX Power (Linear Scale)	K	4

Complexity Scaling with RF Bandwidth

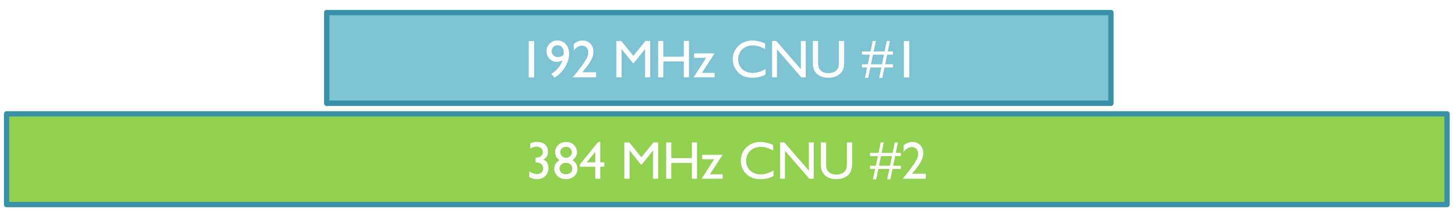
- Table on previous slide assumes PHY blocks are scaled it complexity (size) while maintaining clock frequency
- It is possible to run the clock frequency at a higher rate and in those cases the size may not scale at the same rate as in previous slide
- However, if a higher clock rate is used there is an increase in power consumption
- In some case, the clock rate cannot be increased since the clock is at near highest rate, at the smaller bandwidth
- Complexity increase can impact both size and power consumption

Evolution in RF Bandwidth

- First Generation 192 MHz CNUs



- It is possible to evolve a system from First Generation products of 192 MHz to Second Generation products of 384 MHz (or 768 MHz)
- One approach is to center the two bandwidths at the same center frequency



- PHY Layer allocates resource blocks of sub-carriers to the appropriate CNU
- PHY is RF Bandwidth aware

Evolution in RF Bandwidth – Resource Allocation Examples

- Equal Resource Allocation

- More resources to CNU#2

- All resources to CNU#2

XGMII

- Let us define the "Information Rate" over the XGMII interface as the data rate of Ethernet Frames, measured in Gb/s. This excludes the Idle Frames sent over the XGMII
- The maximum Information Rate depends on the underlying PHY rate. Let's Illustrate with a few examples
- Case #1 – All CNUs 192 MHz and 1.6 Gb/s data rate
  - Information Rate over XGMII interface ≤ 1.6 Gb/s
- Case #2 – All CNUs 120 MHz and 1 Gb/s
  - Information Rate over XGMII interface ≤ 1 Gb/s
- Case #3 – Mixture of 192 MHz (1.6 Gb/s) CNUs and 384 MHz (3.2 Gb/s) CNUs
  - Information Rate over XGMII interface depends on the distribution of Ethernet Frames to Gen1 and Gen2 CNUs

Downstream Scheduler Impact

- If RF bandwidth is lowered from 192 MHz to 120 MHz for all CNUs then scheduler needs to be aware of maximum PHY Rate (1 Gb/s versus 1.6 Gb/s)
  - Limit maximum XGMII Information Rate to 1 Gb/s
- If there is a mixture of Generations with different RF Bandwidths, then the downstream scheduler needs to be aware of the mixture
  - XGMII Information Rate depends on the mixture of CNUs being served
- Either way, scheduler has to be aware of the RF Bandwidths of the CNUs

Motion

- EPoC FDD downstream shall support a baseline RF Bandwidth of 192 MHz
- Moved:
- Seconded:

Conclusions

- Offered a proposal for EPoC FDD Downstream RF Bandwidth
- Demonstrated how an OFDM system with that bandwidth has commensurate timing with the EPOC clock
- Showed how PHY complexity scales with RF Bandwidth
- Illustrated how a mixture of RF Bandwidths can be supported in a network