TDM E-PON Front-haul Capacity Improvement Through Traffic Classification and Sifting

Post OFC Workshop

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- Motivation
- TDM E-PON Front-haul Architecture
- Proposed Bandwidth Allocation Solution
- Results
- Conclusions

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Motivation

- In 5G, Cloud Radio Access Network (C-RAN) is proposed to disperse the light-weighted radio equipment (a.k.a Remote Radio Heads (RRHs)) and centralize Base Band processing Unit (BBU). The connection between RRHs and BBU is called front-haul link and carried mostly by Common Public Radio Interface (CPRI).

- Dedicated Fiber between each RRH and paired BBU increases cost. Researchers have proposed to utilize multiplexing gain of TDM Ethernet PON (E-PON) to save cost.

- The proliferation of Internet of Thing (IoT) applications and deployment of Multiple Input Multiple Output (MIMO) antennas in RRHs increase front-haul capacity demand and thus make multiplexing gain of TDM E-PON marginal.

Motivation

- **CPRI data compression techniques have been explored to address the problem of marginal multiplexing gain due to high CPRI line rate.**

- **Potential Drawbacks:**
  - Computationally expensive (extra delays)
  - Compression ratio up to 0.5

- **The origin of our idea:**
  - Mobile users do not communicate with RRHs all the time
  - RRHs do need to detect and sample all the time
  - Obtained data could be either useful or useless
  - Detect and discard useless data when transmitting at E-PON

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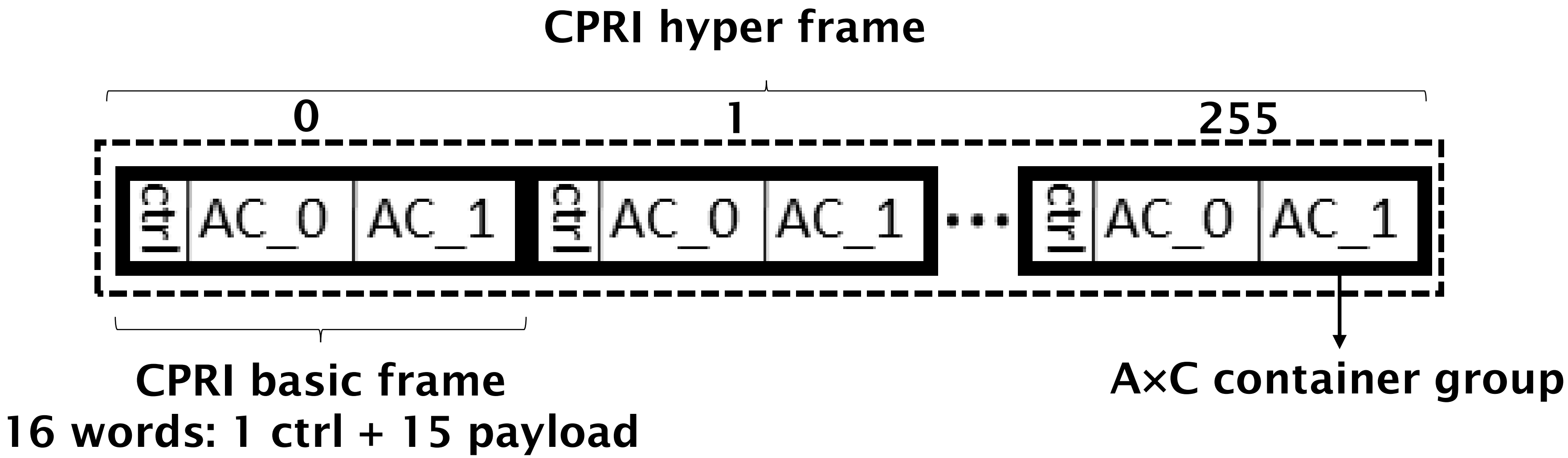
TDM E-PON Front-haul Architecture

- **CPRI basic frame and hyper frame**



Example:
- 20MHz 2×2 MIMO-enabled LTE RRH
- CPRI line rate: 2.46 Gbps
- CRPI word length: 32 bits
- Number of IQ samples per container group: 8

- **Ethernet frame**
  - Max payload: 1500 bytes
  - Header: 26 bytes
  - Inter-packet gap: 12 bytes

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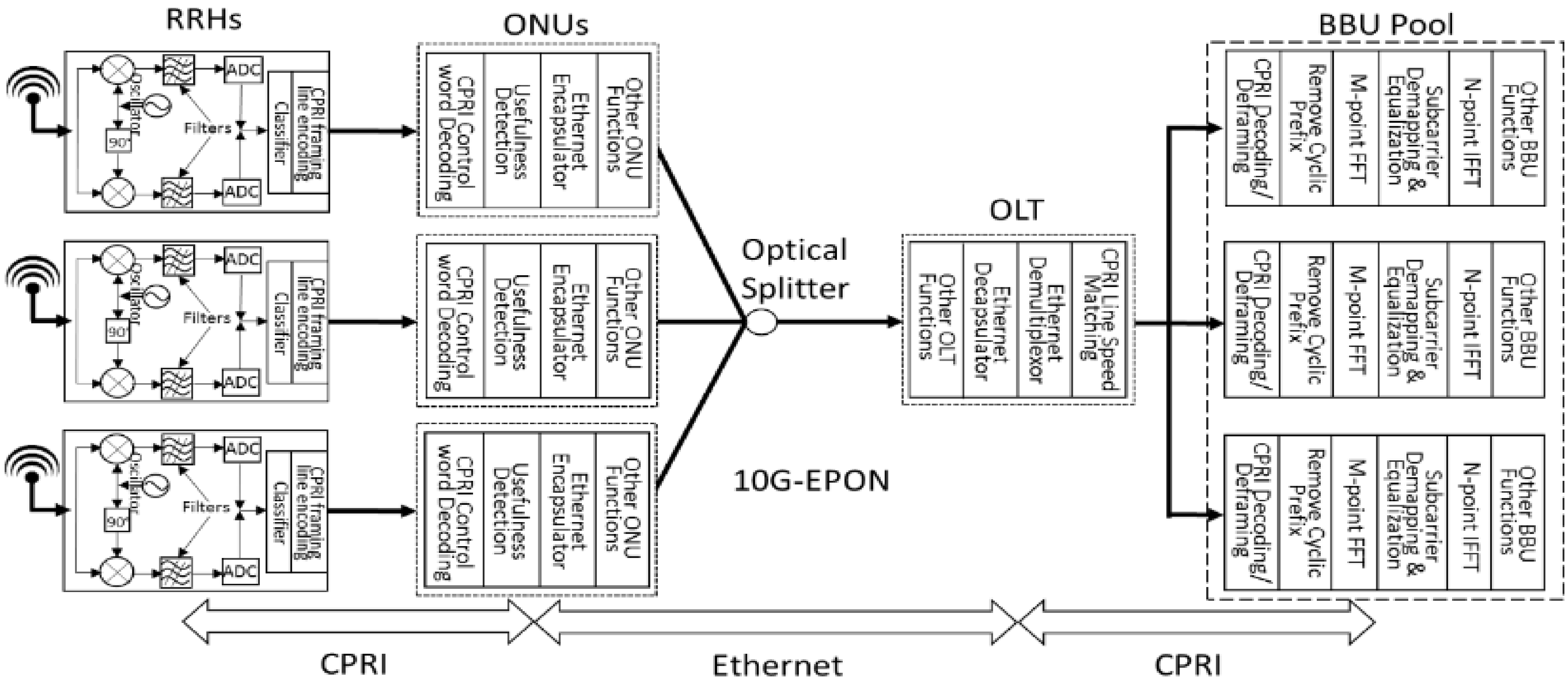
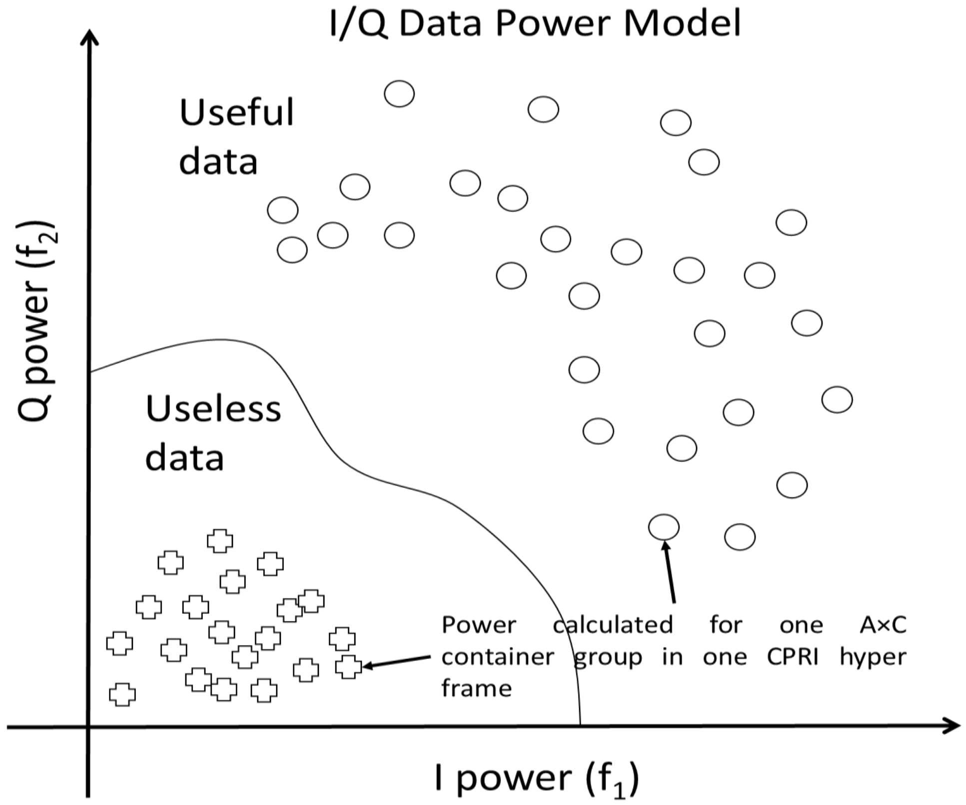
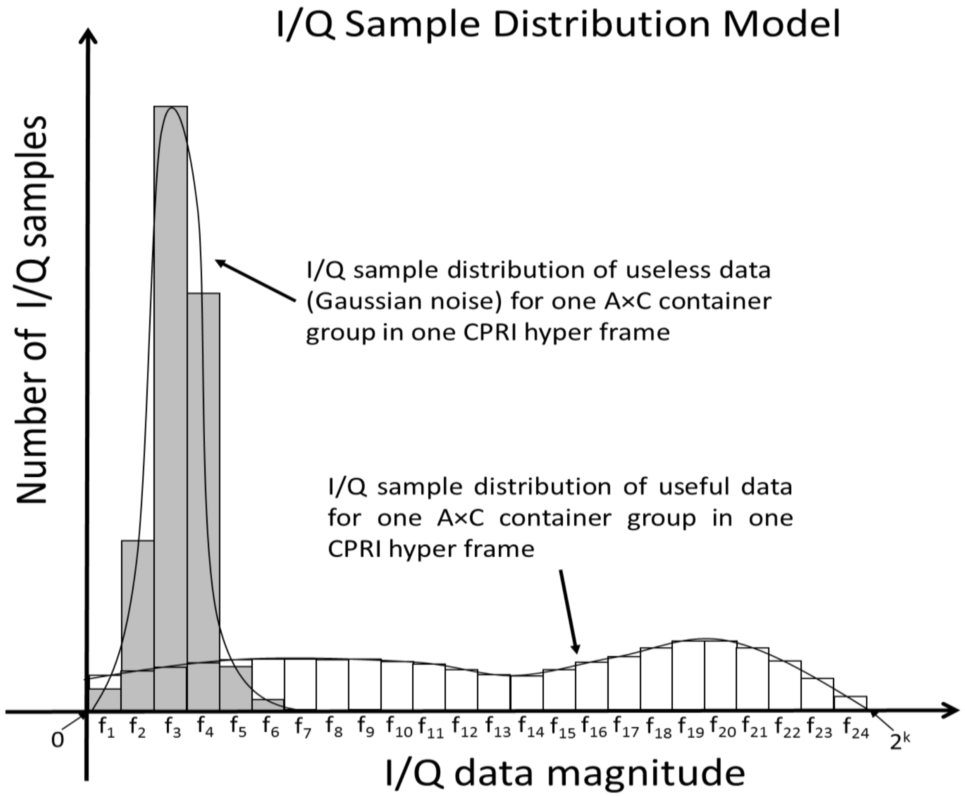
TDM E-PON Front-haul Architecture



TDM E-PON Front-haul Architecture

Traffic classification





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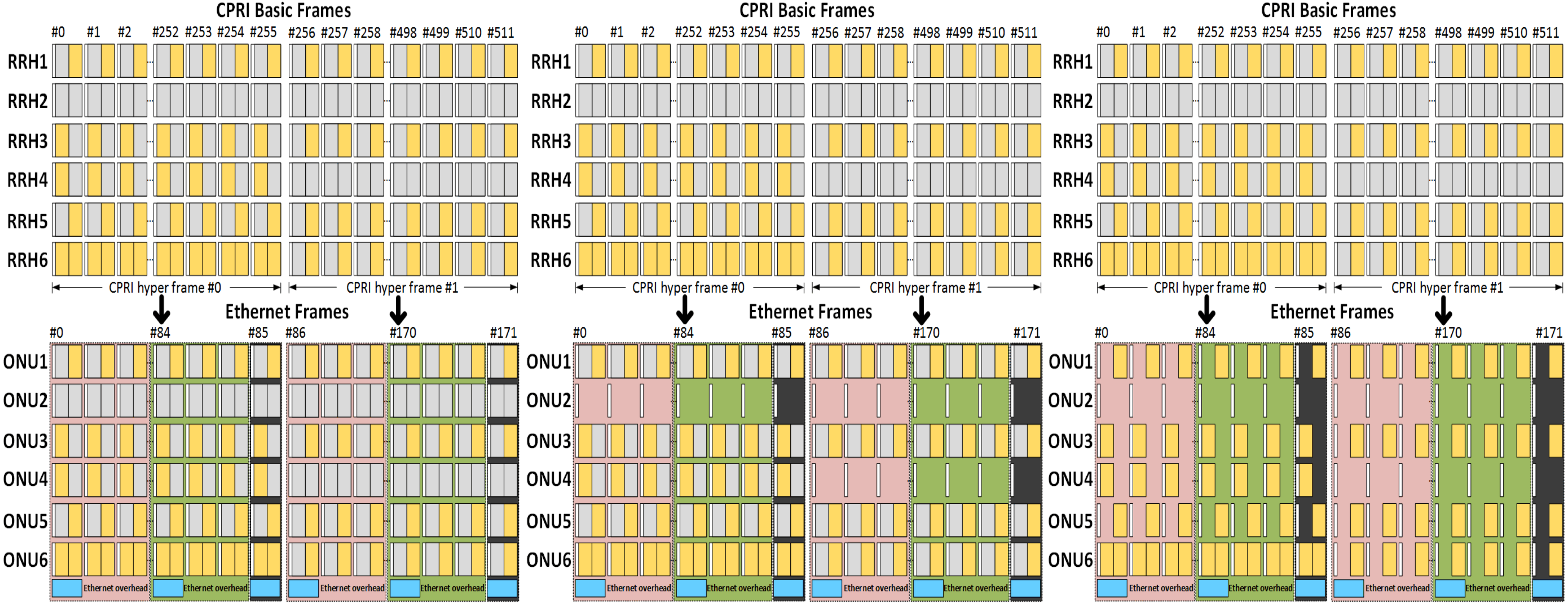
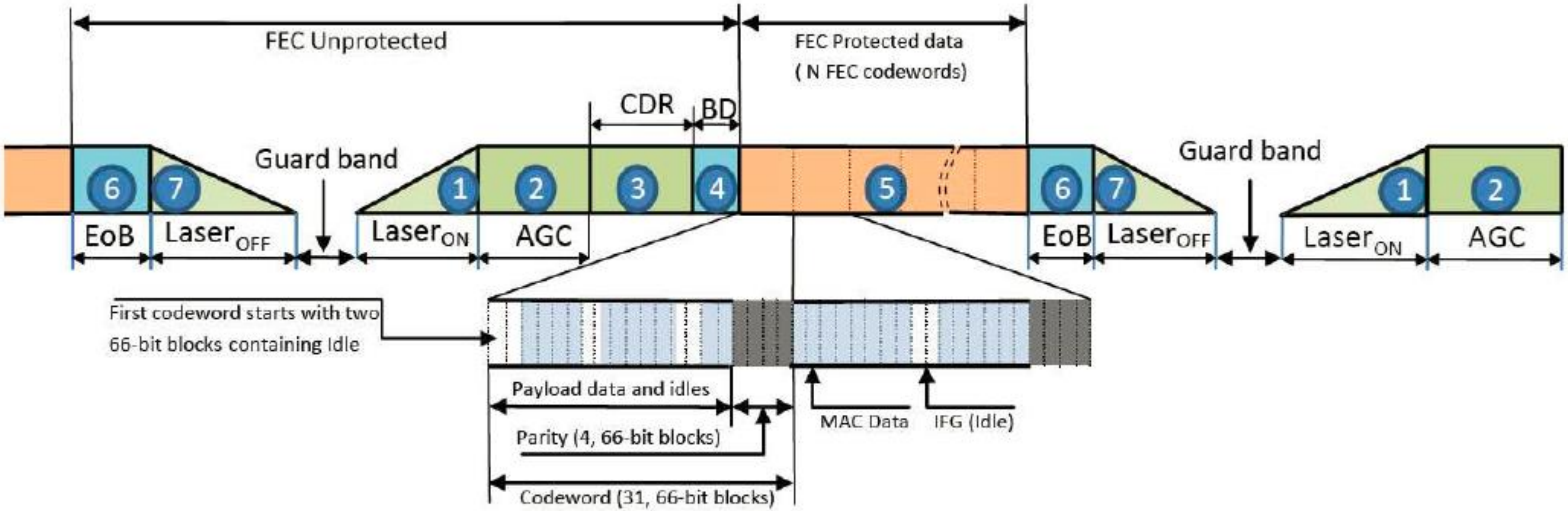
Proposed Bandwidth Allocation Solution



(a) Without considering usefulness information

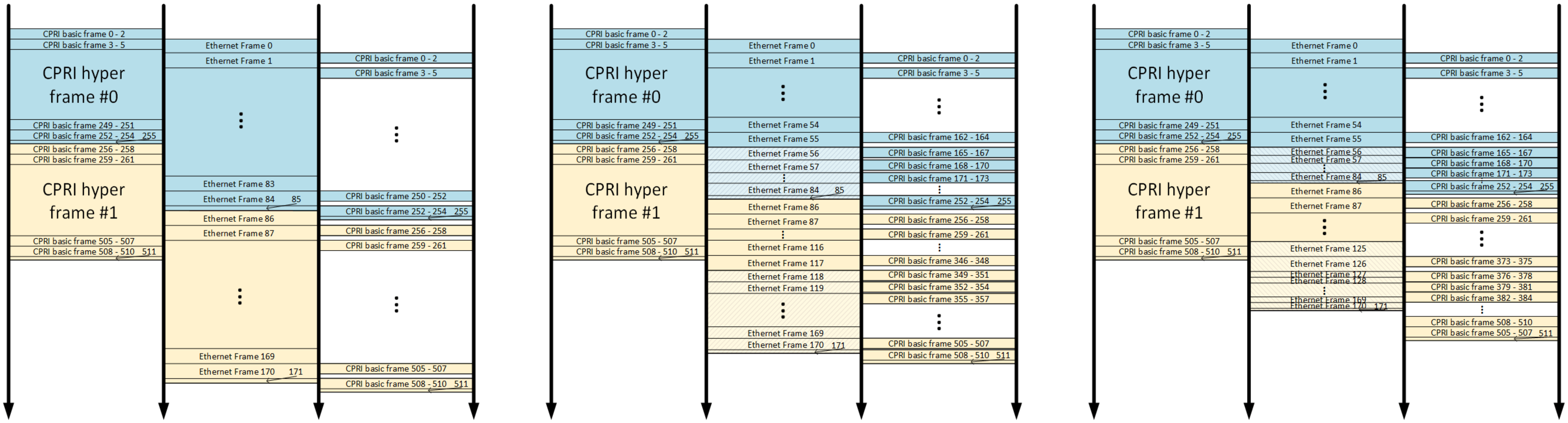
(b) Frame-level uselessness removal

(c) Container-group-level uselessness removal



Roy, Rajesh, et al. "10G-EPON efficiency." *Advanced Networks and Telecommunication Systems (ANTS).* IEEE, 2009.

Proposed Bandwidth Allocation Solution



(a) Without considering usefulness information

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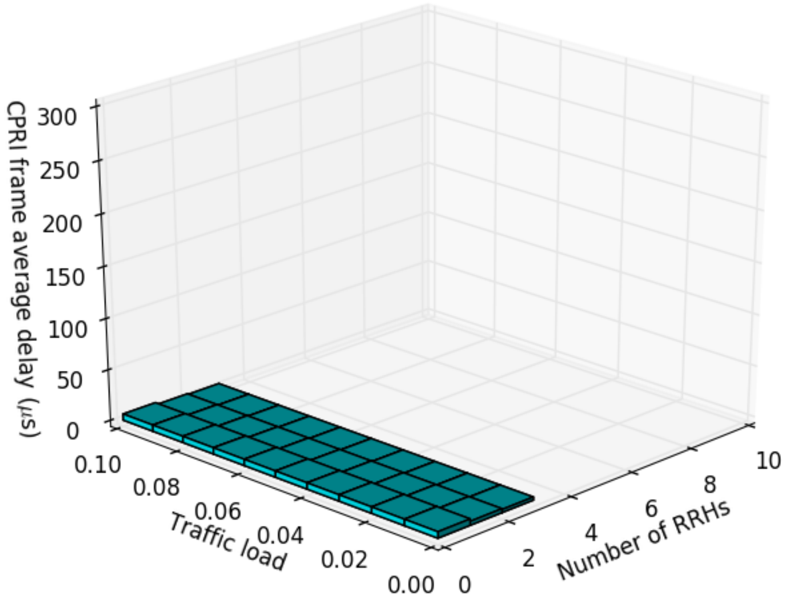
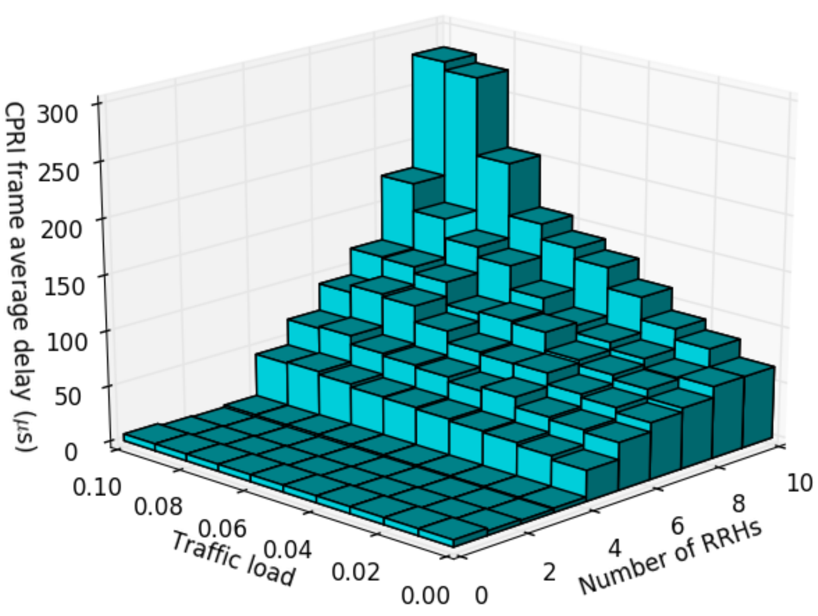
Results

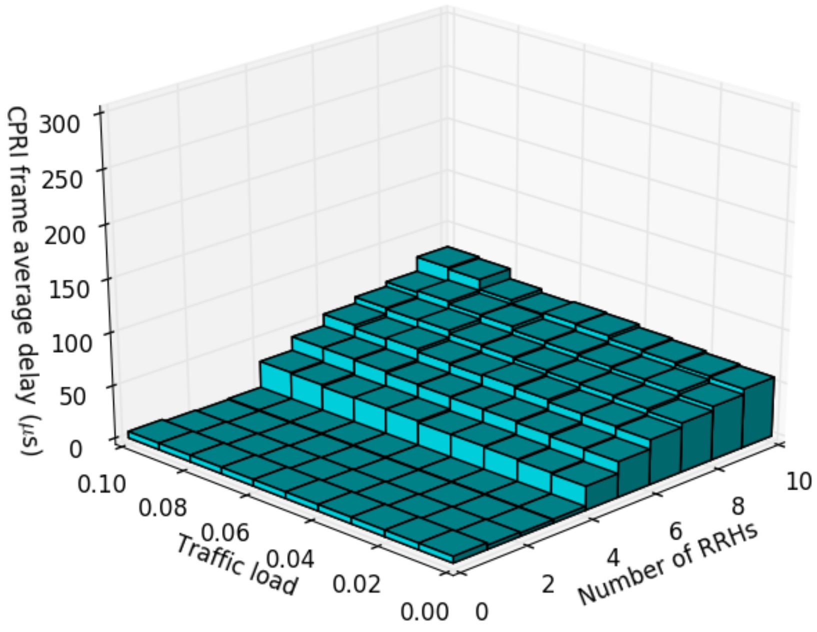
Delay



(a) Without considering usefulness information



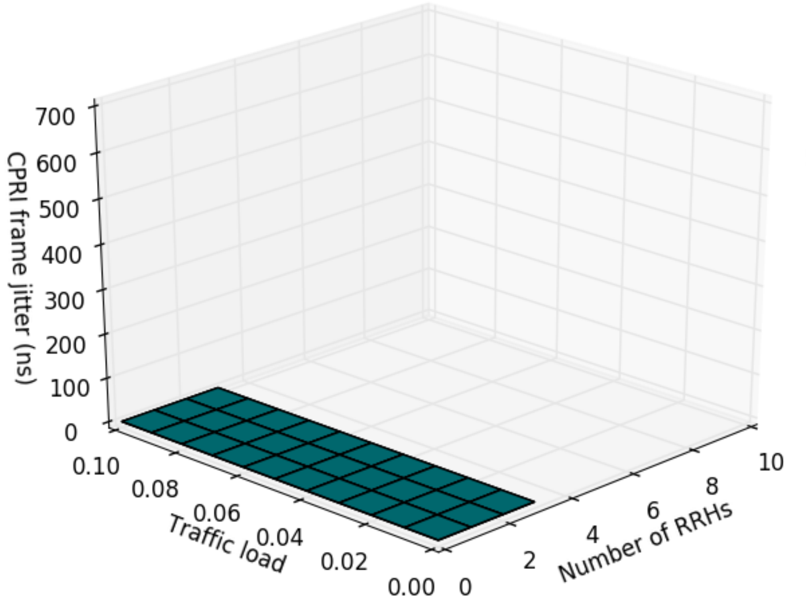
(b) Frame-level uselessness removal



(c) Container-group-level uselessness removal

Results

Jitter



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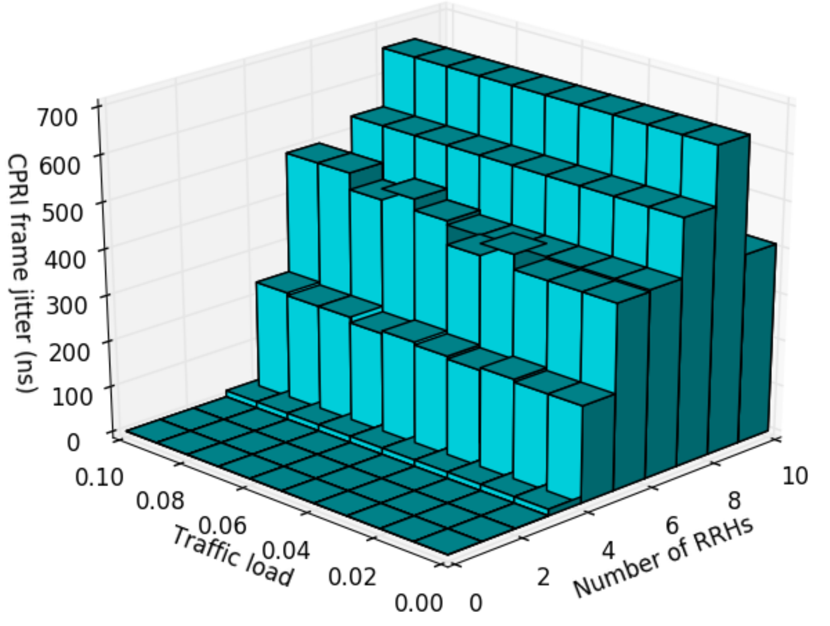
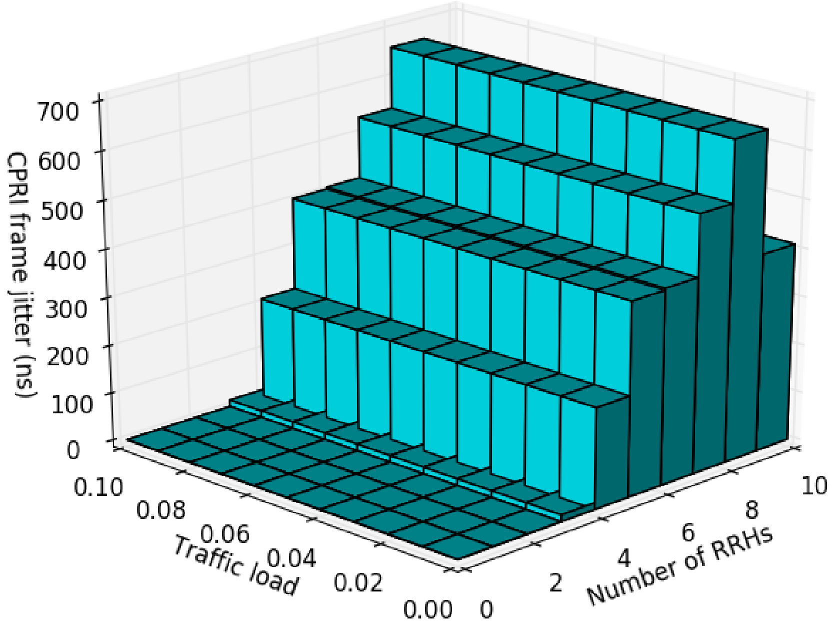


(b) Frame-level uselessness removal



(c) Container-group-level uselessness removal

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Conclusions

- **Without traffic classification and sifting, the number of RRHs attached to the same E-PON is small.**

- **Container-group-level uselessness removal performs better than frame-level uselessness removal in terms of CPRI frame average delay when traffic load and number of RRHs increase.**

- **Both mechanisms achieve similar jitter performance.**

Thank you for your attention !

Questions and feedbacks are welcomed