Practical view to Packet Delay Variation (PDV) management

Ethernet fronthauling – IEEE802.1CM

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Motivation

- PDV can be minimized in system with the mechanisms introduced by IEEE802.1TSN
- System can be also built to tolerate PDV
- Optimal solution is
  - Limit PDV with reasonable effort
  - Build system to tolerate smallish PDV
- This presentation will first show experience from limited PDV packet based fronthaul and show some Ethernet simulation results without TSN features

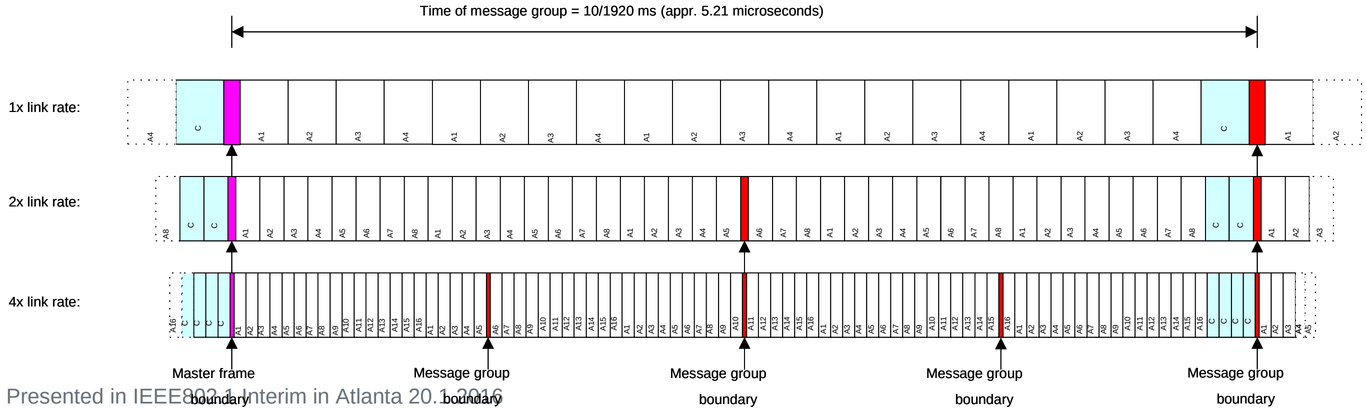
Existing packet based Fronthaul

OBSAI background

- OBSAI is targeted to same use cases as CPRI
  - Optical/electrical point-to-point connections in Fronthaul
  - OBSAI is packet based ATM like technology
    - Fixed size packets (16 bytes payload, 3 bytes header)
    - Address based switching
    - Bandwidth reservation though rule based scheduling
- In commercial use since 2005

Packet delay variation in OBSAI

- Due to OBSAI's frame structure there is some delay variation by default.
- Frame length = 10 ms = n*1920 message groups, where n is link rate multiplier. 1x rate equals 768Mbps
- 1 message group contains 21 message slots (20 data message slots + 1 control message slot at 1x link rate. Control slots are grouped at higher rates so that they meet timewise at all link rates.)
- Maximum delay variation experienced is ~250ns.

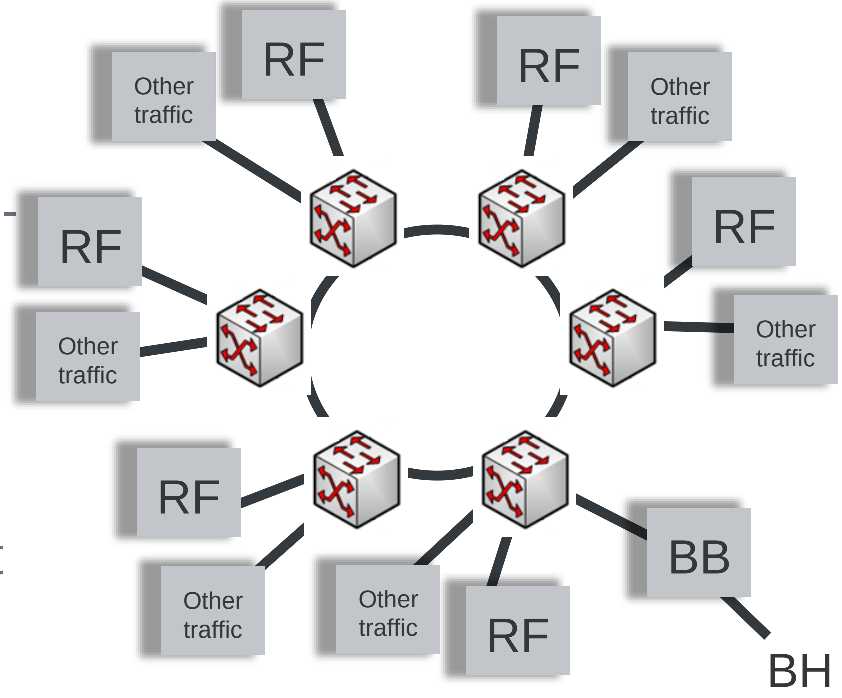


Experience from OBSAI

- Very deterministic behavior is achieved with explicit capacity allocation
  - Transmission rules define which message locations are in use for which AxC
- Basically anything is possible, but in complex networks configuration becomes difficult
- From our perspective Ethernet can also be motivated by simplicity at network level – easier to manage

Ethernet experiments in rather complex use case

- Use case:
  - 6 radio sites in ring sending IQ over Ethernet
  - Other traffic with variable packet size (40-1400 bytes – average being ~550 bytes)
  - Ring connection to centralized baseband processing
- Traffic mix in network
- Max 4 switches between any end point



Results

Figures

- A lot can be done just with basic system level optimizations:
  - Using QoS
  - Randomize transmission times
  - Packet size optimization (keep packet size small)

	Medium other traffic	High Other traffic	Very High Other traffic
Bottleneck Link Utilization	93%	95.6%	99.6%
No Priority – Worst 99%-ile IQ E2E Delay	12.2 us	13.6 us	> 50 us (~ 80 us)
No Priority – Worst 99%-ile IQ Differential Delay	1.65 us	2.13 us	2.85 us
With Priority – Worst 99%-ile IQ E2E Delay	11.9 us	12.1 us	12.5 us
With Priority – Worst 99%-ile IQ Differential Delay	1.25 us	1.7 us	2.0 us
No Priority – No synchronization – Worst 99%-ile IQ E2E Delay	8.9 us	N/A	N/A
No Priority – No synchronization –Worst 99%-ile IQ Differential Delay	1.9us	N/A	N/A

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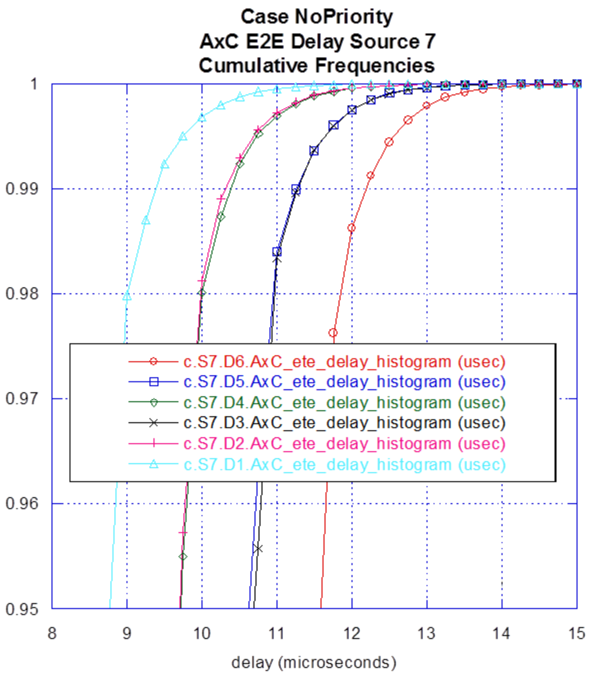
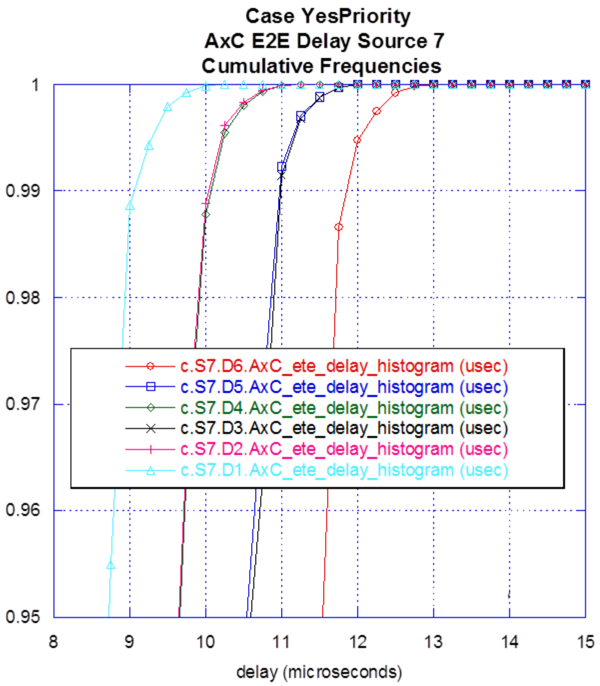
Results
Charts





Conclusions

- Cost of deterministic behavior is complexity in configuration
  - The larger system – the more complex this becomes
- Ethernet fronthaul should also be kept simple
  - Should try to find correct balance between required features from network and allow some delay variation tolerance in the system
  - Low number of hops – less features, high number of hops – more control needed.

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