

APPLICABILITY OF Qbu AND Qbv TO FRONTHAUL

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OUTLINE



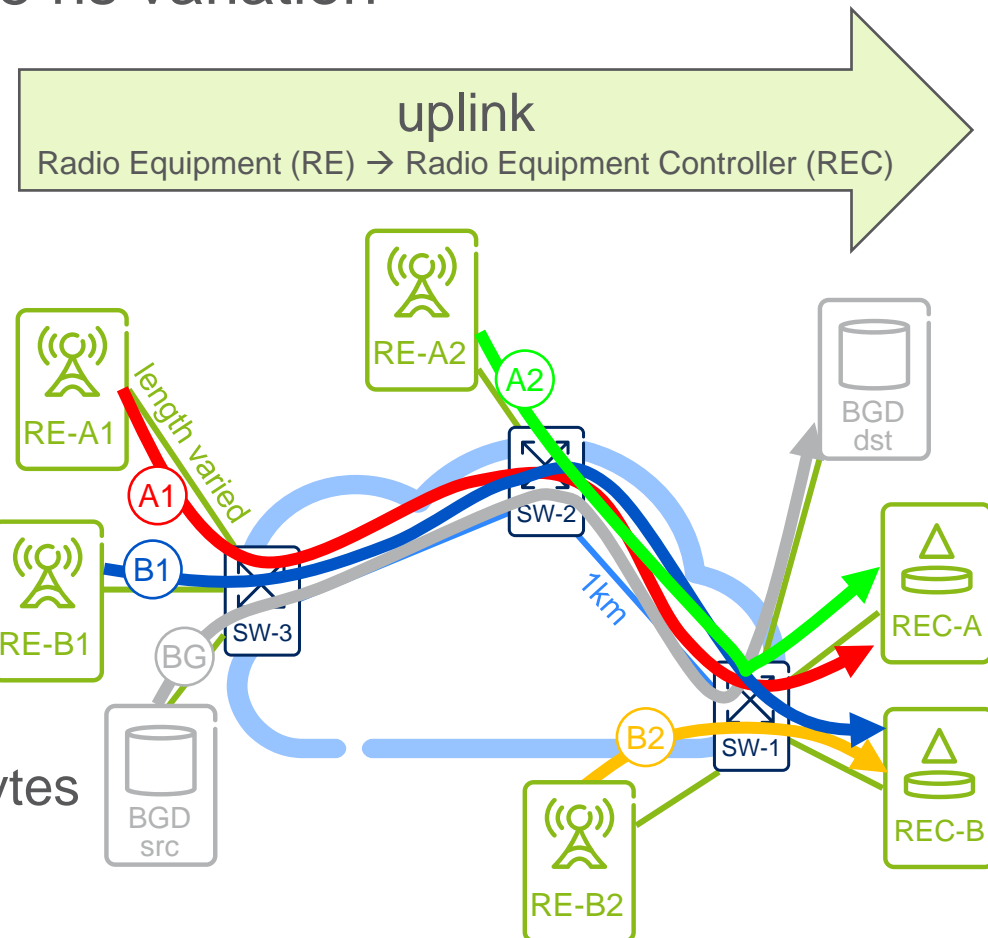
- › Common Public Radio Interface (CPRI) traffic vs background (BG) traffic
 - IEEE 802.1Qbu - Frame Preemption (with IEEE 802.3br IET)
 - IEEE 802.1Qbv - Enhancements for Scheduled Traffic
 - 802.1Qbu and 802.1Qbv with guard band

- › Concurring CPRI flows

EVALUATED USE CASE



- › Tree topology comprised of 10 Gbps links
- › Switching delay: 1500 ns \pm 5 ns variation
- › CPRI traffic
 - Rate: 1.228 Gbps
 - Payload: 300 bytes
 - Period: 1954 ns
- › Background traffic
 - CBR
 - › Payload: 1500 bytes
 - › Period: 9770 ns
 - VBR
 - › Payload: rnd 1000-1500 bytes
 - › Period: 5000 ns \pm 500 ns



CPRI VS BACKGROUND TRAFFIC



- › The effects of background traffic on CPRI are investigated first
- › There is no race condition between CPRI flows in these cases
 - The simulation set-up is designed to avoid CPRI race conditions
 - Frames of CPRI flows always arrive at the switches in the same order and they are always served by the switches in the same order
- › Packet Delay Variation (PDV) is determined as the difference between the largest and the smallest delay that frames of a given flow suffer

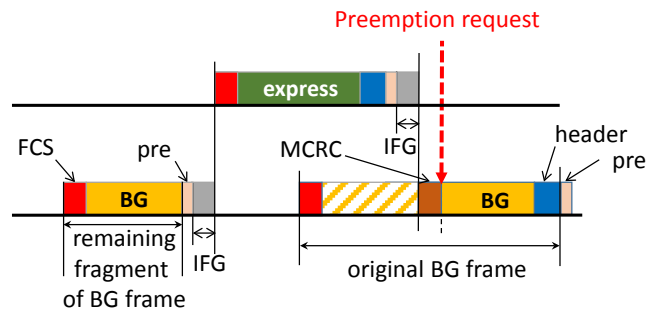
FRAME PREEMPTION EVENT POSSIBILITIES



› 64-byte fragment size is used in all cases (10 Gbps link)

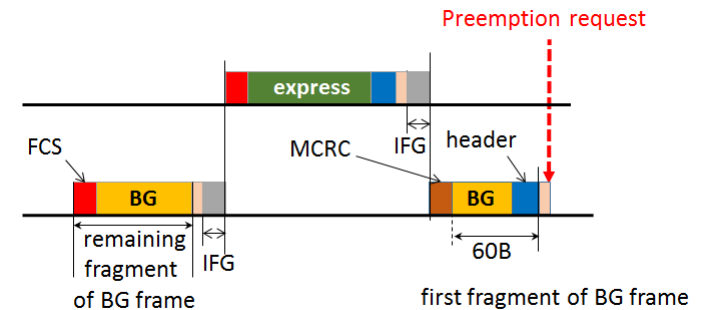
1. Preemption req. in the middle

- Preemption Delay = 13.6ns
- FCS + IFG + remaining bits of current octet



2. Preemption req. at the beginning

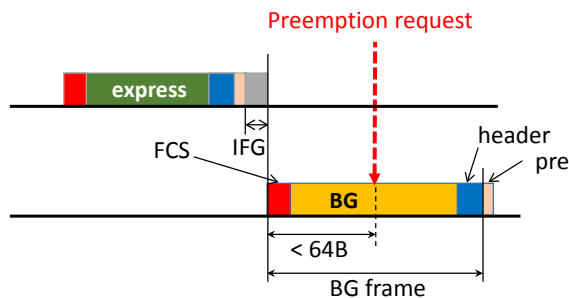
- transmission of BG frame just started
- Preemption Delay = 67.2ns



frame flow direction

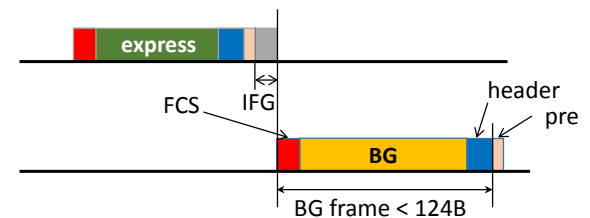
3. Preemption req. too late

- Max Delay = 60.8ns



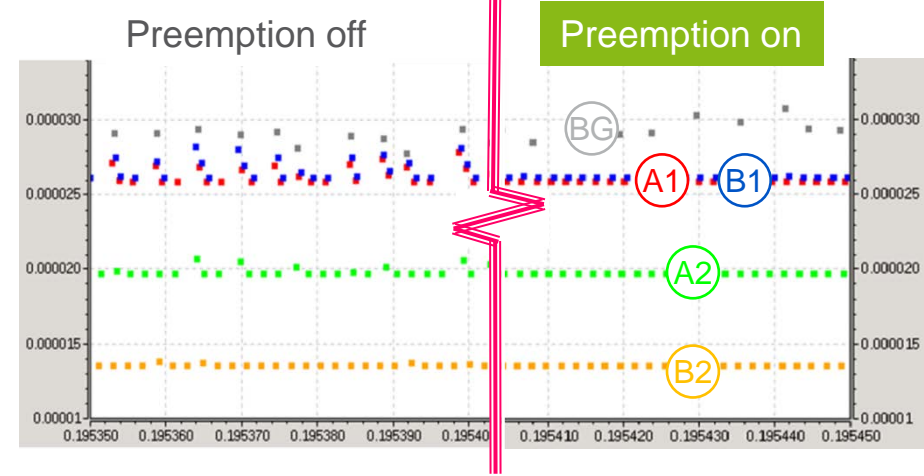
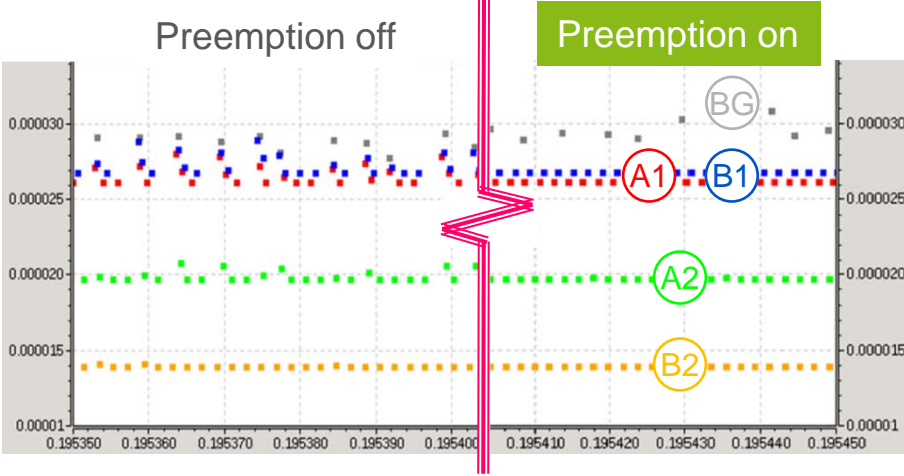
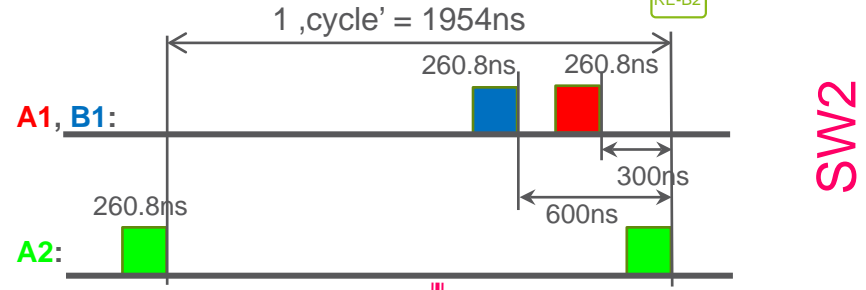
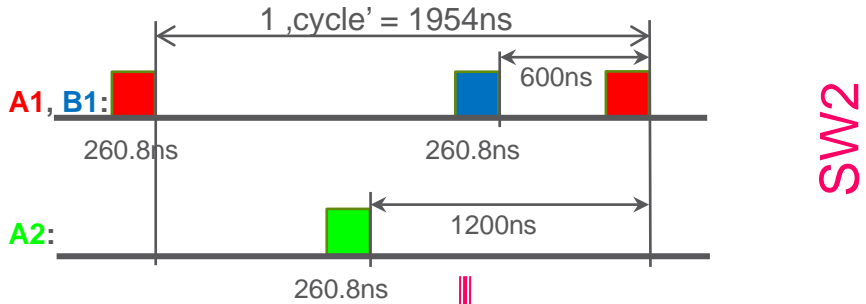
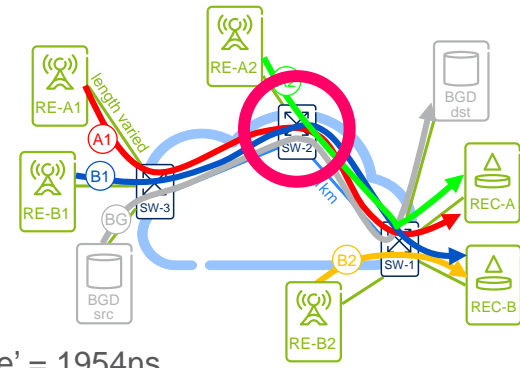
4. Preemption is not possible if frame < 124 bytes

- Max Delay = 114.4ns



FRAME PREEMPTION RESULTS

no variation in switching delay

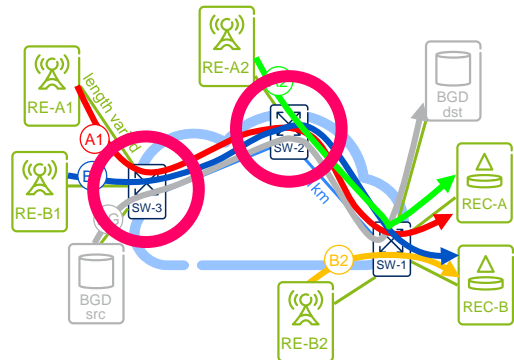


Flow	Min delay [ns]	Max delay [ns]	PDV [ns]
B2	13832.4	13832.4	0
A2	19693.2	19760.4	67.2
A1	26154.0	26227.5	73.5
B1	26754.0	26827.5	73.5

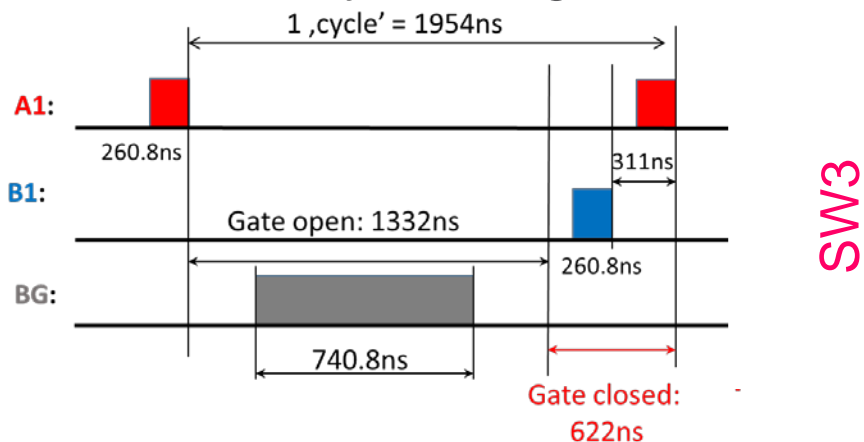
Flow	Min delay [ns]	Max delay [ns]	PDV [ns]
B2	13532.4	13532.4	0
A2	19693.2	19760.4	67.2
A1	25854.0	25953.5	99.5
B1	26154.0	26265.1	111.1

ENHANCEMENTS FOR SCHEDULED TRAFFIC

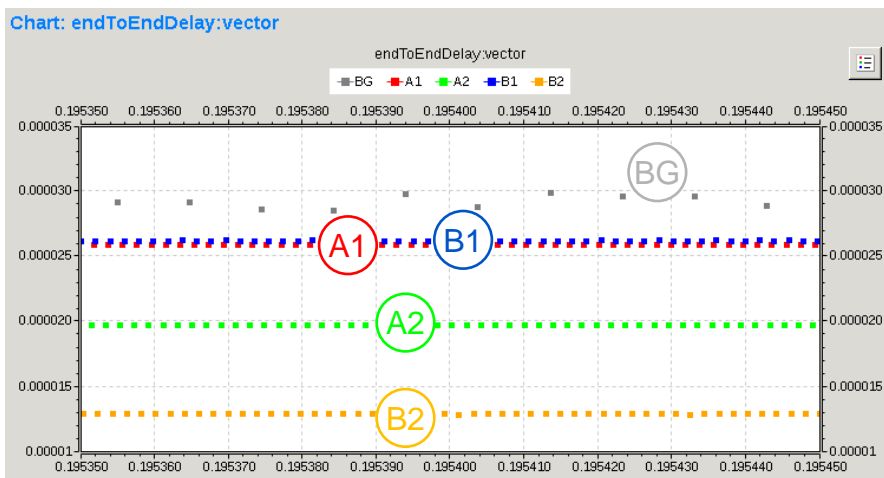
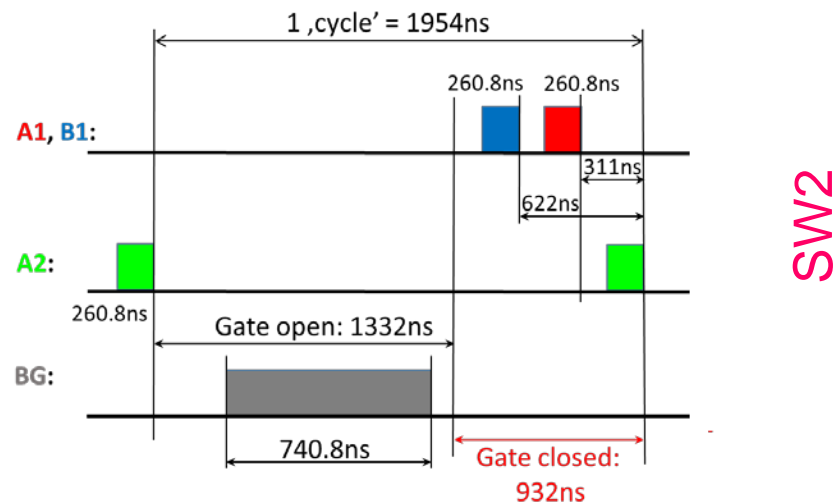
Traffic source synchronization inaccuracy: ± 10 ns



Gate on 900-byte background at SW3:

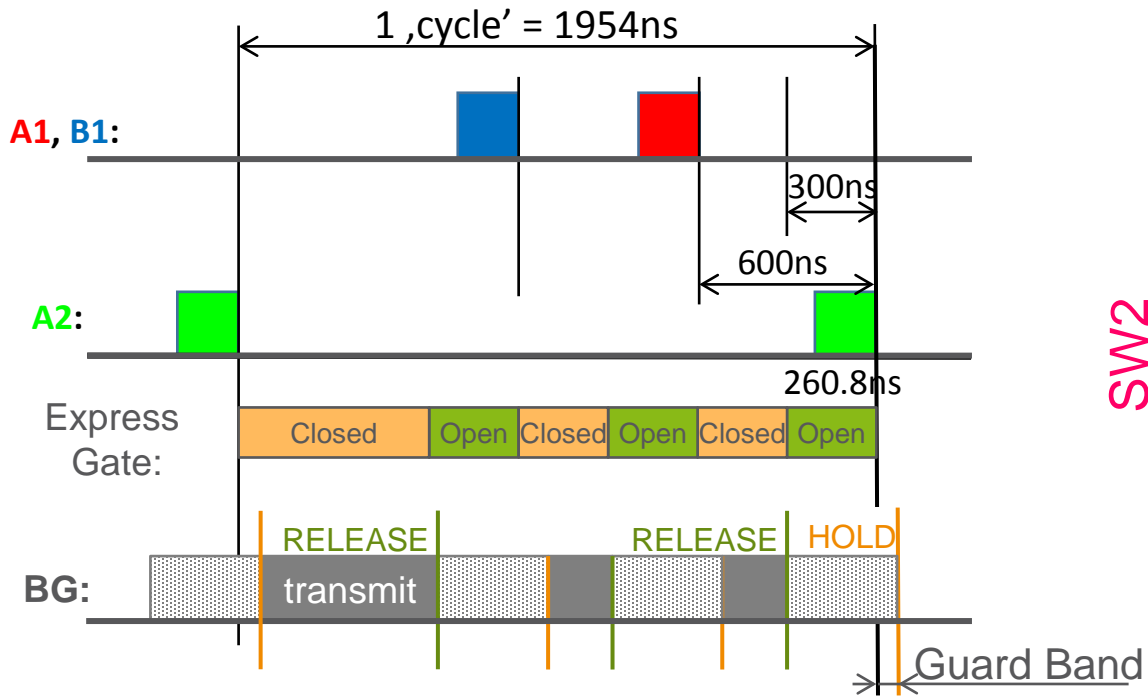


Gate on 900-byte background at SW2:

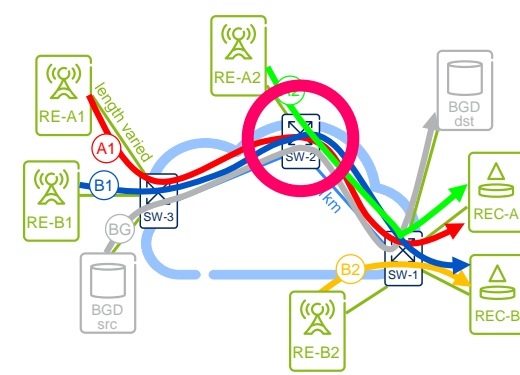


Flow	Min delay [ns]	Max delay [ns]	PDV [ns]
B2	12812	12842	29.9
A2	19680	19719	39.5
A1	25840	25888	47.9
B1	26150	26198	47.9
BG	28484.0	30453.1	1970.3

FRAME PREEMPTION AND ENHANCEMENTS FOR SCHEDULED TRAFFIC WITH GUARD BAND



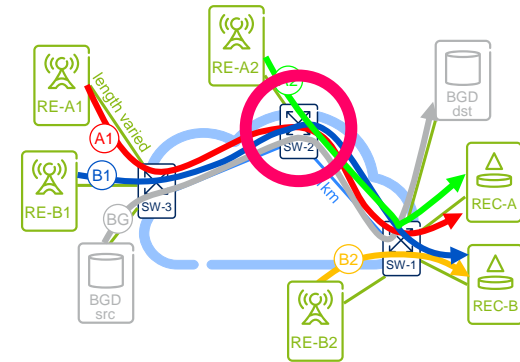
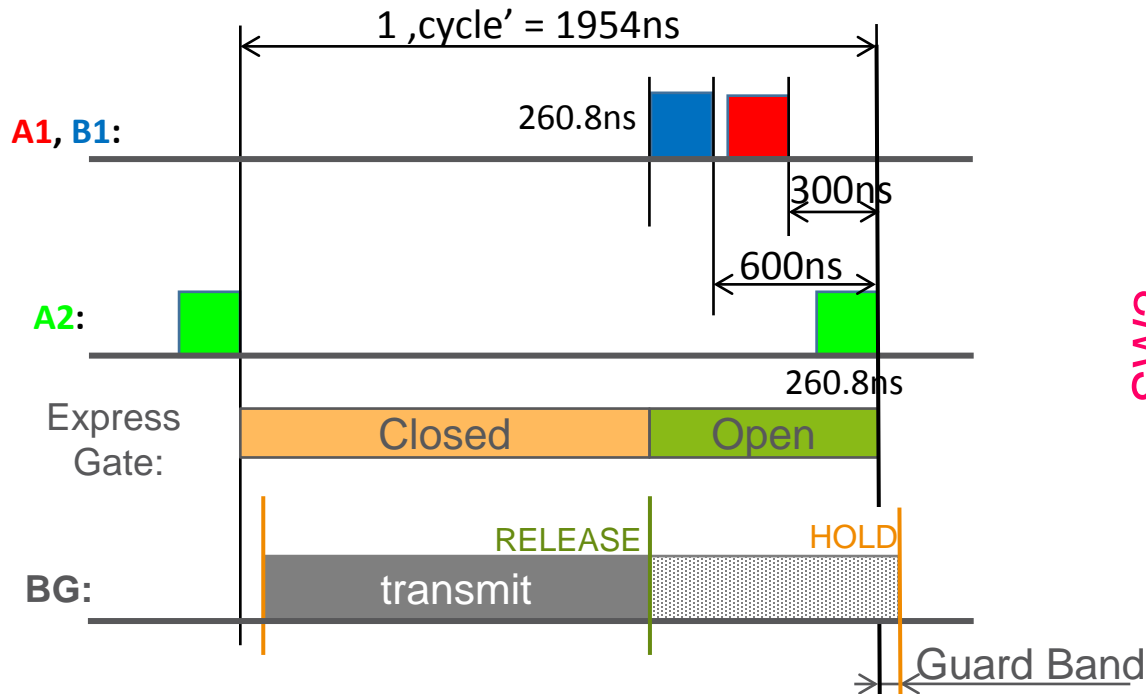
SW2



Flow	Min delay [ns]	Max delay [ns]	PDV [ns]
B2	13832.4	13832.4	0
A2	19702.4	19719.6	17.2
A1	26164.4	26181.6	17.2
B1	26764.4	26781.6	17.2

- › No variation in switching delay
- › VBR background
- › 50ns guard band: max PDV = 17.2ns
- › 70ns guard band: PDV = 0 (no PDV due to BG traffic)

FRAME PREEMPTION AND ENHANCEMENTS FOR SCHEDULED TRAFFIC WITH GUARD BAND



50 ns guard band

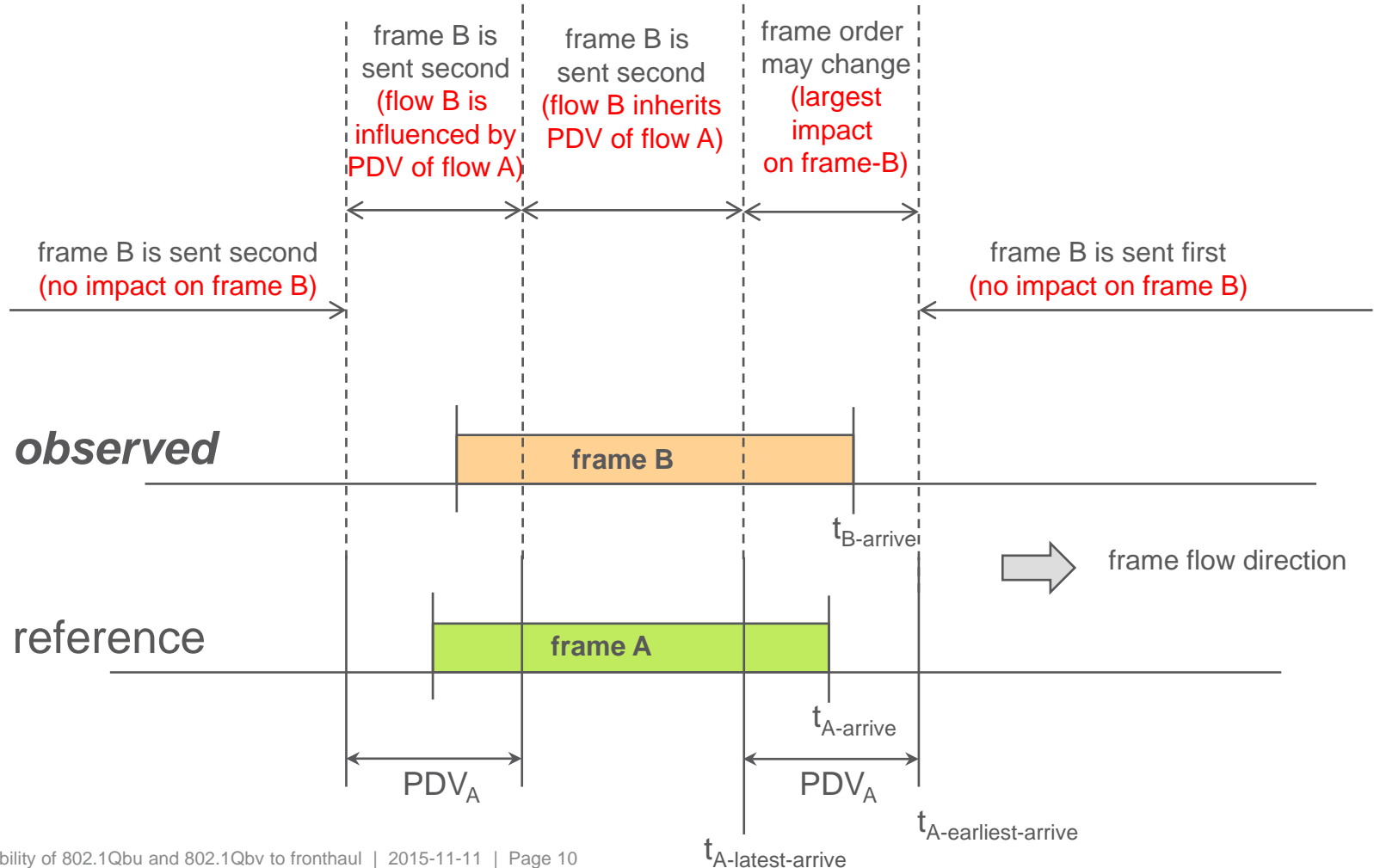
Flow	Min delay [ns]	Max delay [ns]	PDV [ns]
B2	13532.4	13532.4	0
A2	19702.4	19719.6	17.2
A1	25863.2	25880.4	17.2
B1	26154.0	26154.0	0

- › No variation in switching delay
- › VBR background
- › 50ns guard band: max PDV = 17.2ns
- › 70ns guard band: PDV = 0 (no PDV due to BG traffic)

CONCURRENT EXPRESS FRAMES



Effect of frame A on frame B depending on the relative arrival of frame B to frame A

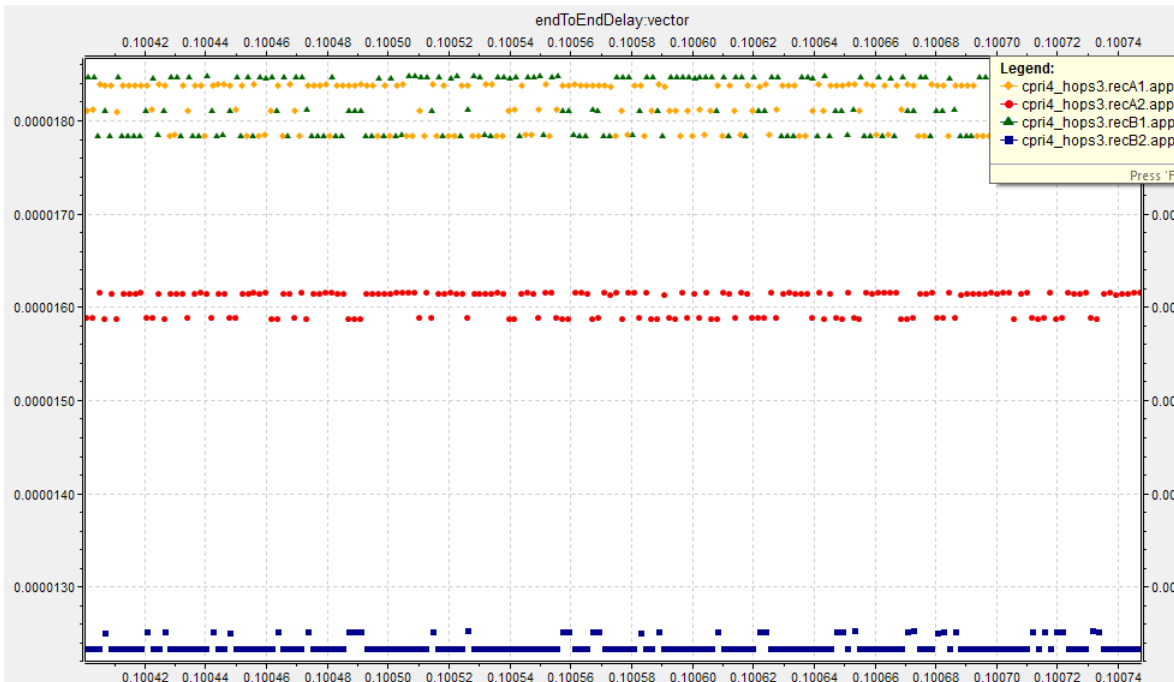
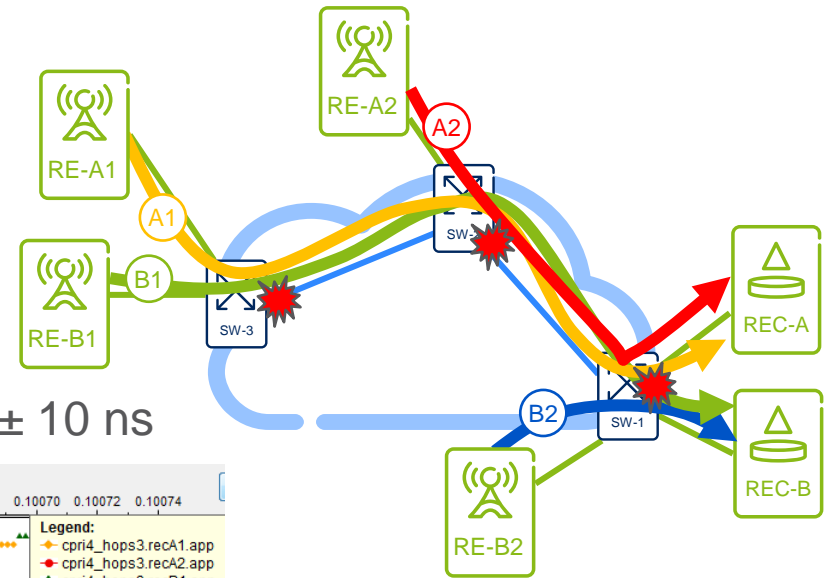


CPRI FLOWS MAY RACE AT EACH HOP



- › Racing shuffles order
- › This causes PDV

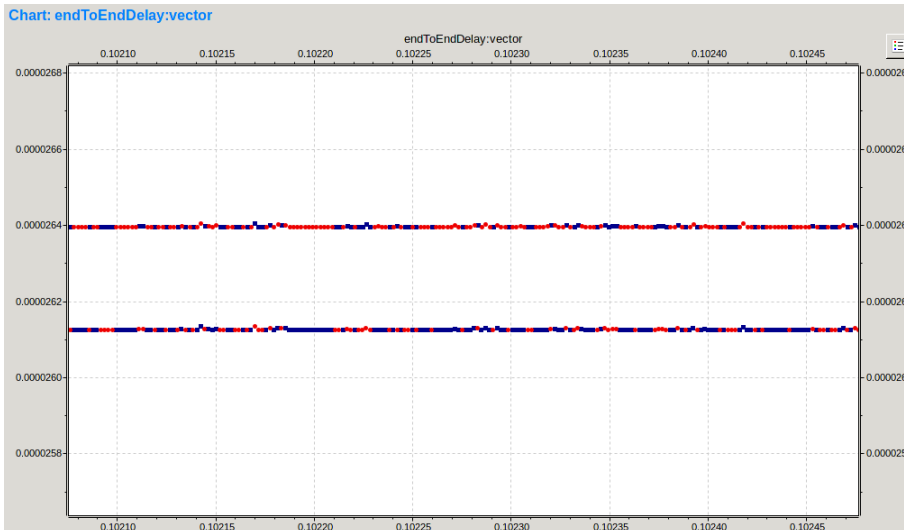
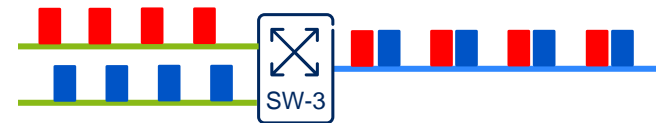
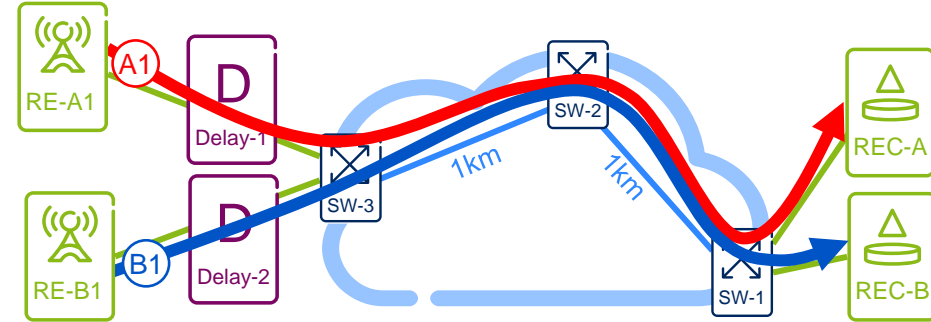
Traffic source synchronization inaccuracy: ± 10 ns



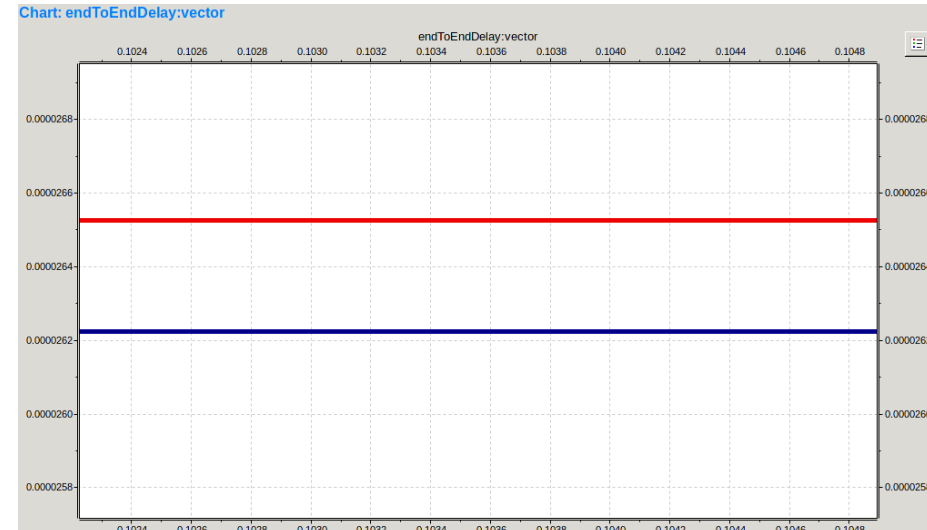
DELAYING AT INGRESS TO THE NETWORK



Traffic source synchronization
inaccuracy: ± 10 ns



Indeterminate order: PDV = 280ns



Deterministic order: PDV = 0ns

SUMMARY



- › 802.1Qbu – Frame Preemption (with 802.3br)
 - It is essential for being able to cope with large background frames
 - Its worst-case PDV can be calculated
- › 802.1Qbv – Enhancements for Scheduled Traffic
 - It can be used to cope with background traffic
- › 802.1Qbu and 802.1Qbv with guard band
 - Zero PDV can be achieved

- › Concurrent CPRI flows
 - Indeterminate order can cause significant PDV
 - This effect can be avoided by assuring deterministic order, e.g., by intentional delaying

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