IEEE 802.1 & 802.3 Packet Transmission Pre-emption Problem Statements

802.1 Activity Report to 802.3
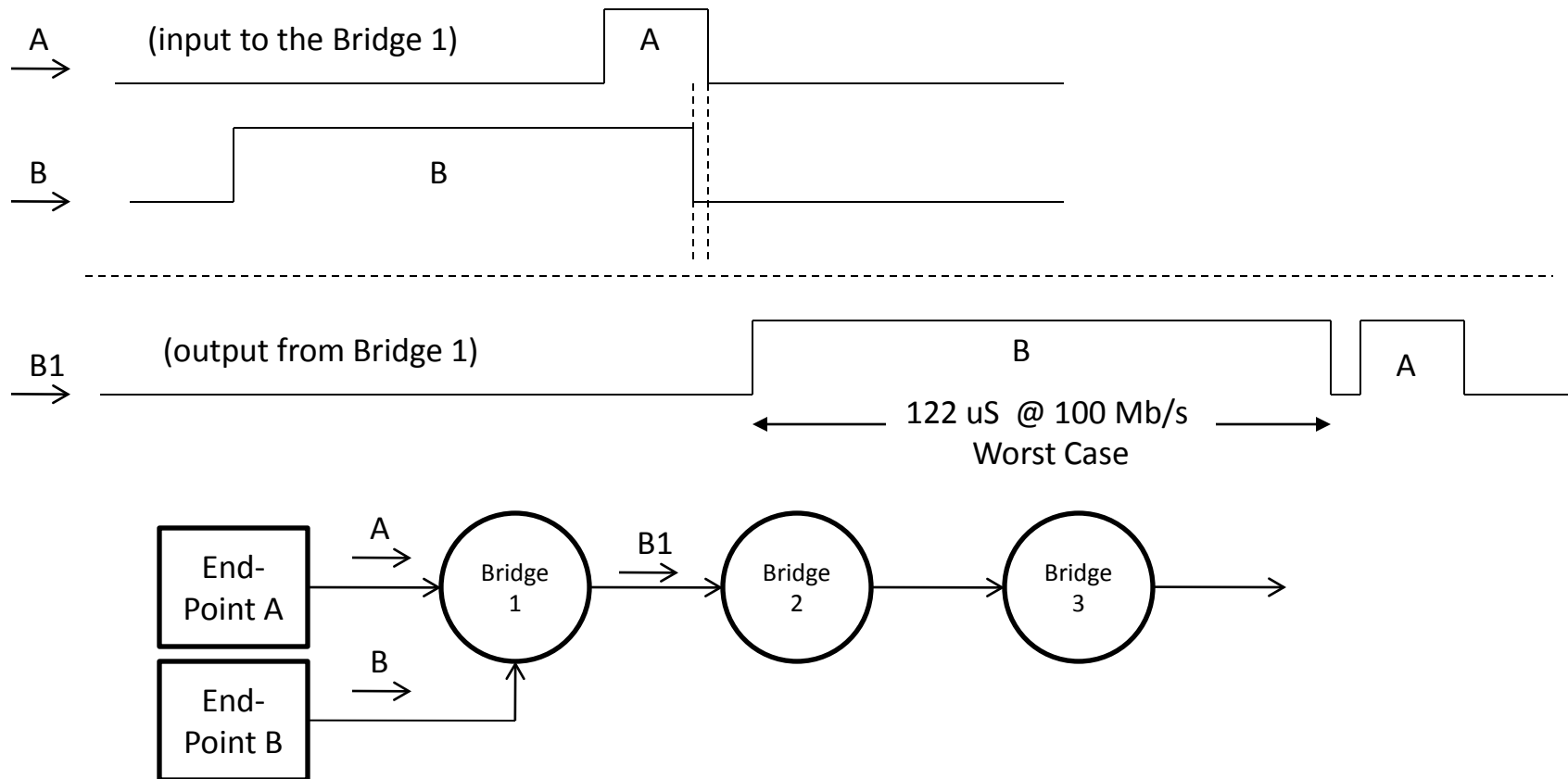
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Pre-emption

- The Need

- The Problem

- A Generic Solution for the Problem

- The IEEE 802.1/802.3 Functional Model
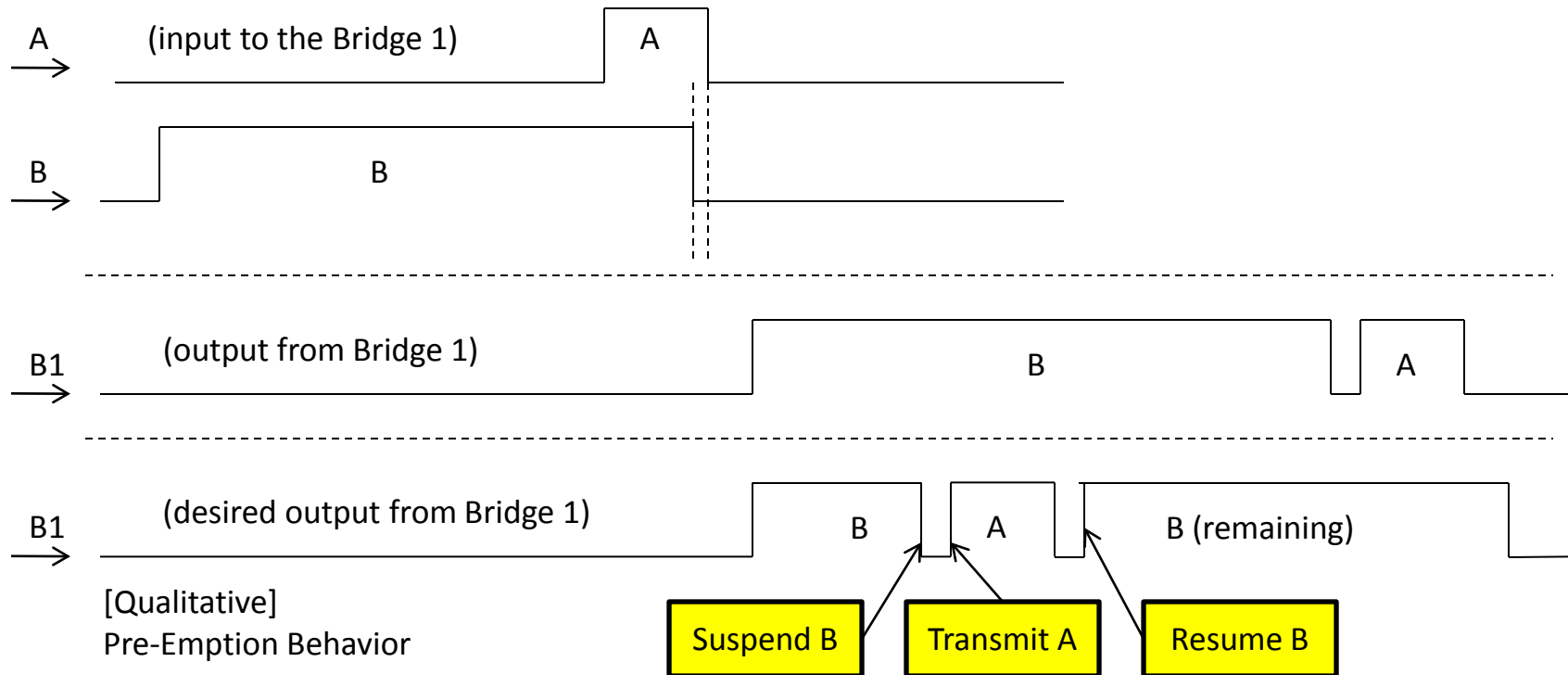
- Summary and Conclusions

Pre-emption Need

- Control Loop use cases in Automotive and Industrial, converged onto rest of Ethernet network infrastructure.

- Automotive -- 100 uS over three bridge hops @ 100 Mb/s and above –
(from March 2011, 802.1:
    in public area: http://www.ieee802.org/1/files/public/docs2011)
  - new-avb-KimNakamura-automotive-network-requirements-0311.pdf
  - new-avb-nakamura-automotive-backbone-requirements-0907-v02.pdf (revised)
- Industrial -- <5 uS per hop, ~32 bridge hops @ 1000 Mb/s and above –
(from January 2011, 802.1). 125 uS over 32 hops desired.
  - new-goetz-avb-ext-industrcom-0113-v01.pdf
  - ba-goetz-industrial-profile-0509.pdf   ← /docs2009
  - Refined objectives from system vendors expected.

- Problem Statement:
(Ignoring the bridge and other delay for the moment)
  - Max Length Ethernet Frame @ 100 Mb/s =~120 uS – greater than automotive requirements.
  - Max Length Ethernet Frame @ 1000 Mb/s =~12 uS – greater than industrial requirements.
  - "Head of Line" blocked behind Max Length Frame exceeds the requirements above.

The Problem

- The Classic "Head of Line" problem. The worst case is urgent frame A is scheduled behind best-effort maximum length frame B.   But we desire urgent frame to get through (e.g. 3 hops @ 100 Mb/s in 100 uS).
- <u>Except, now we want to do something about this to provide a solution to automotive and industrial network markets</u>.

A Generic Preemption Solution

A → (input to the Bridge 1) ... A

B → B

B1 → (output from Bridge 1) ... B ... A

B1 → (desired output from Bridge 1) ... B ... A ... B (remaining)

[Qualitative]
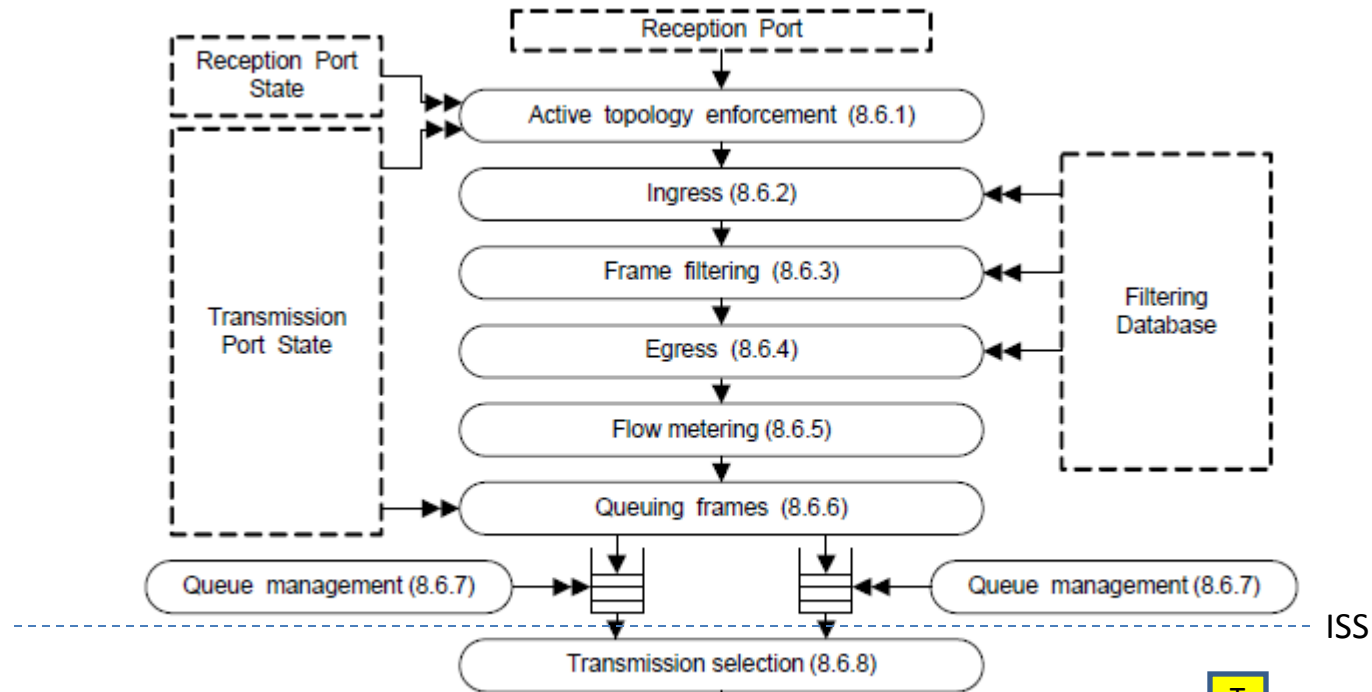Pre-Emption Behavior

Suspend B   **Transmit A**   **Resume B**

- There are few other solution to "head of line blocking" delay behind a max frame length packet.

- A generic solution is to suspend the max frame length ("B" in this example) packet, transmit urgent frame, and resume previous.   Note: Other completion options besides resume-previous is retransmit B entirely, or always fragment B (regardless of existence of A) are not desirable).
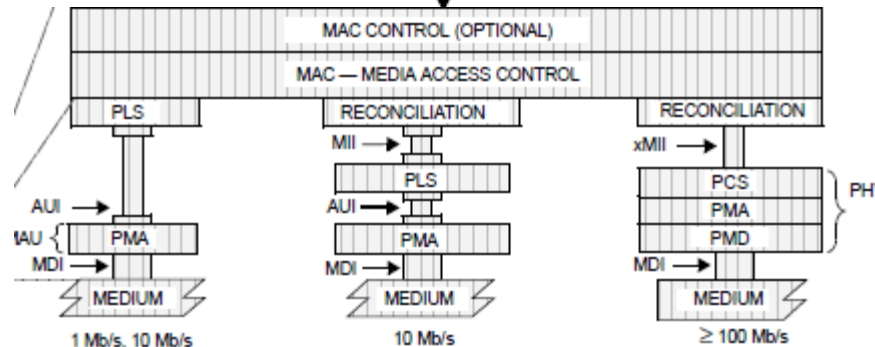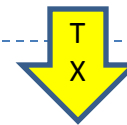
Summary of "Preemption Function"

- Easy to explain – easy to understand.
- Fairly straight forward to implement, pending selection of many [functionally] equivalent proposals.
- Observation – "Everyone knows what 'preemption' means, but everyone has different ideas on how it may be implemented". Let's hold off on this.

- But the MAC Service interface (boundary between 802.1 and 802.3) as defined (particularly .3 side) is not friendly to "Pre-emption" considerations.
  - [Next Slide] Entire 802.1 Frame is sent atomically to 802.3 MAC, as an example. No way to offer preempting frame to 802.3 from 802.1
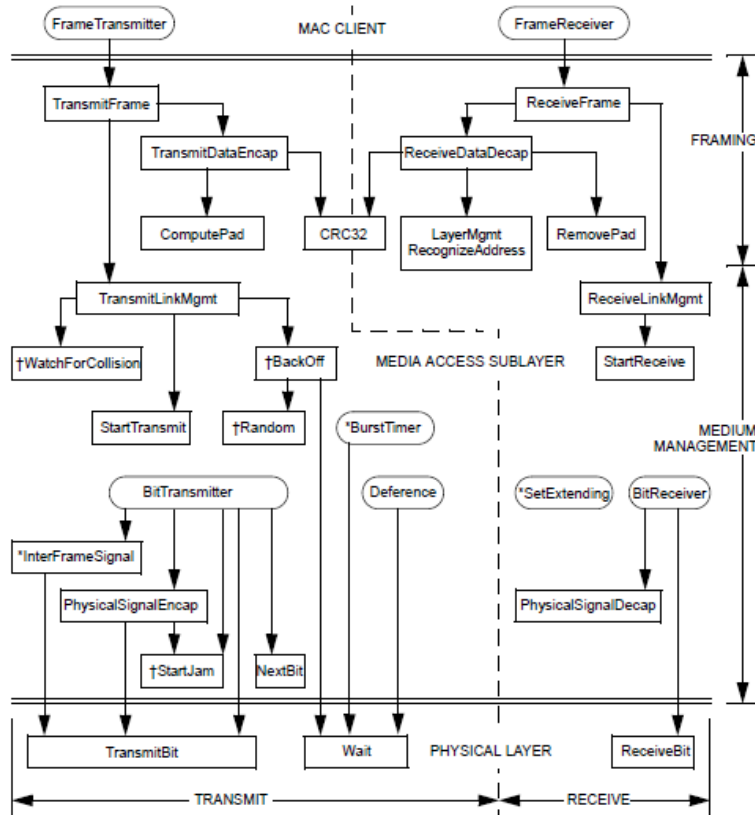
Existing 802.1 and 802.3 Service Interface

Entire Frame is sent atomically to 802.3 MAC
No way to offer preempting frame to 802.3 from 802.1

IEEE 802.3 Clause 4 or Annex 4A

† Not applicable to full duplex operation.
* Applicable only to half duplex operation at 1000 Mb/s.

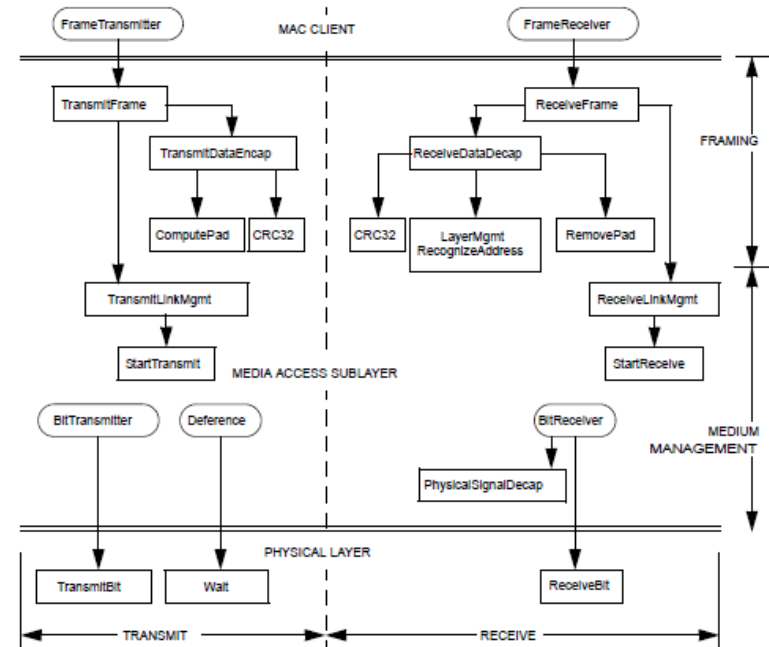Figure 4–1—Relationship among CSMA/CD procedures

Figure 4A–1—Relationship among MAC procedures

Annex 4A (Full-Duplex only) may be the best clause to consider for preemption function.

Leave Claus 4 alone.

Proposed 802.1 & 802.3 Service Interface

- Problem – A packet is sent from 802.1 to 802.3 in zero time. 802.3 transmits the frame.

- Generic Solution –
  1. 802.1/802.3 MAC Service Interface needs to be augmented to convey a second preempting frame.
     - Additional information may be in form of "preempt-indication", or second "transmit-urgent-request" or any other TBD during standardization.
  2. 802.1 Services determine frames that are preemptable, preempting, and not preemptable.
     - Effect of AVB shaper, transmit selection, congestion management (if relevant) TBD during standardization.
     - 802.1 could complete its preemption so that it works with any MACs that supports preemption capability.
  3. 802.3 MAC to consider preemption related enhancements and handle preemption point and preemption framing.
     - Depends on the latency objectives and fragmentation header formats. TBD during standardization.

Thank you!

Two backup slides

Recent 802.1 bridge models

Relevant 802.1 documents.
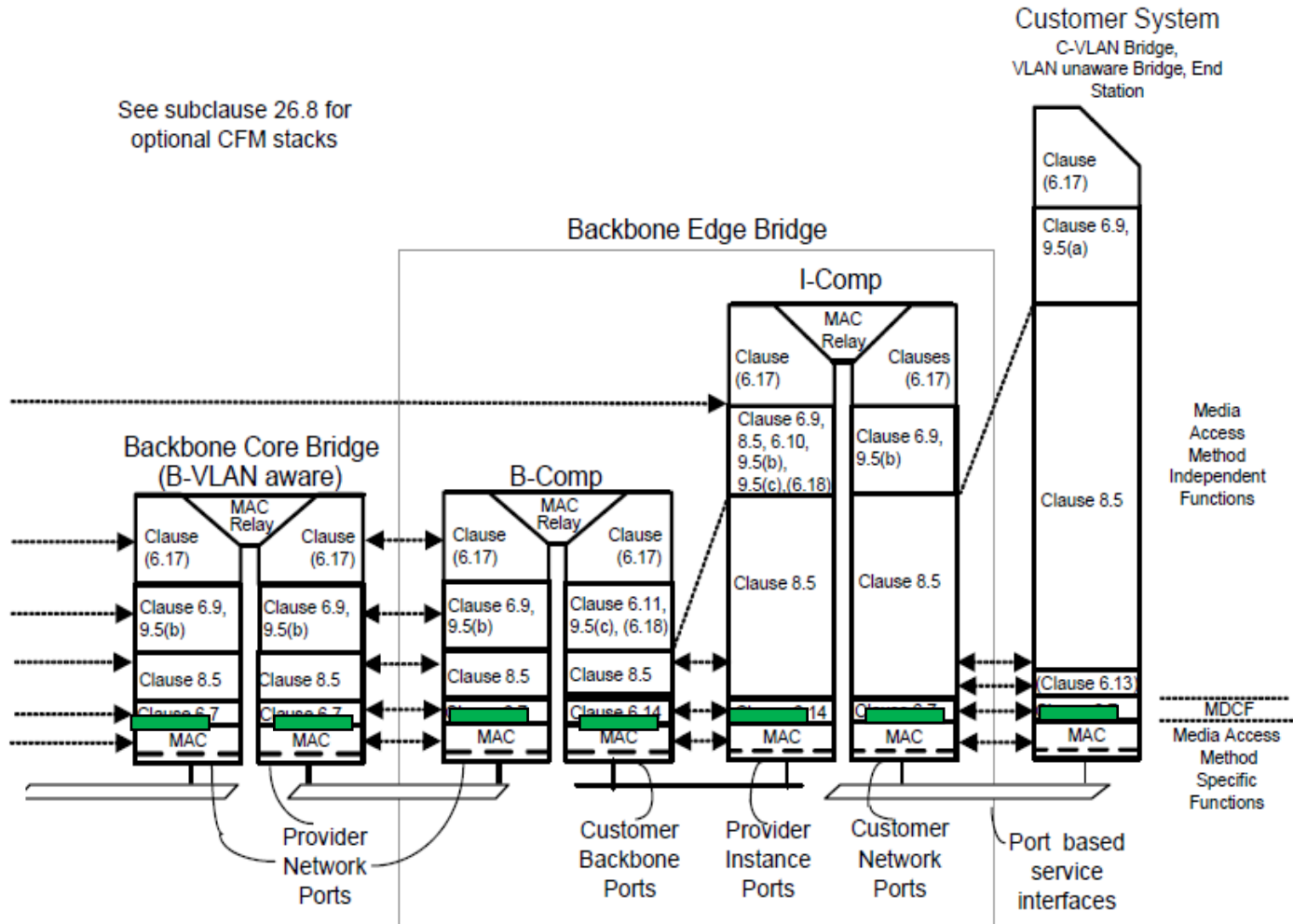
Provider Backbone Baggie Pants Model

Figure 25-4—Port-based service interface

Suggested preemption Q-Rev work

Relevant 802.1 documents

All located in: http://www.ieee802.org/1/files/public/docs2011, except noted.

- Automotive
  - new-avb-KimNakamura-automotive-network-requirements-0311.pdf
  - new-avb-nakamura-automotive-backbone-requirements-0907-v02.pdf
- Industrial
  - ba-goetz-industrial-profile-0509.pdf ← /docs2009
  - new-goetz-avb-ext-industrcom-0113-v01.pdf
  - at-klein-kleineberg-avb-redundancy-continuation-0711.pdf
- Preemption Related
  - new-avb-kim-8021-8023-Preemption-Problem-Statements-0711-v03.pdf
  - new-avb-kim-8021-Preemption-DRAFT-PAR-5C-0711-v04.pdf
  - new-imtiaz-goetz-fragmentation-0511.pdf
  - new-kim+goetz-Ultra-Low-Latency-Switching-v5.pdf
  - avb2-cgunther-sr-class-preemption-0711-v05.pdf
  - new-avb-boiger-ultra-low-latency-shaper-0711.pdf