Joint ITU-T / IEEE Workshop on Next Generation Optical Access Systems

DBA & QoS on the PON - Commonalities with Switching & Routing

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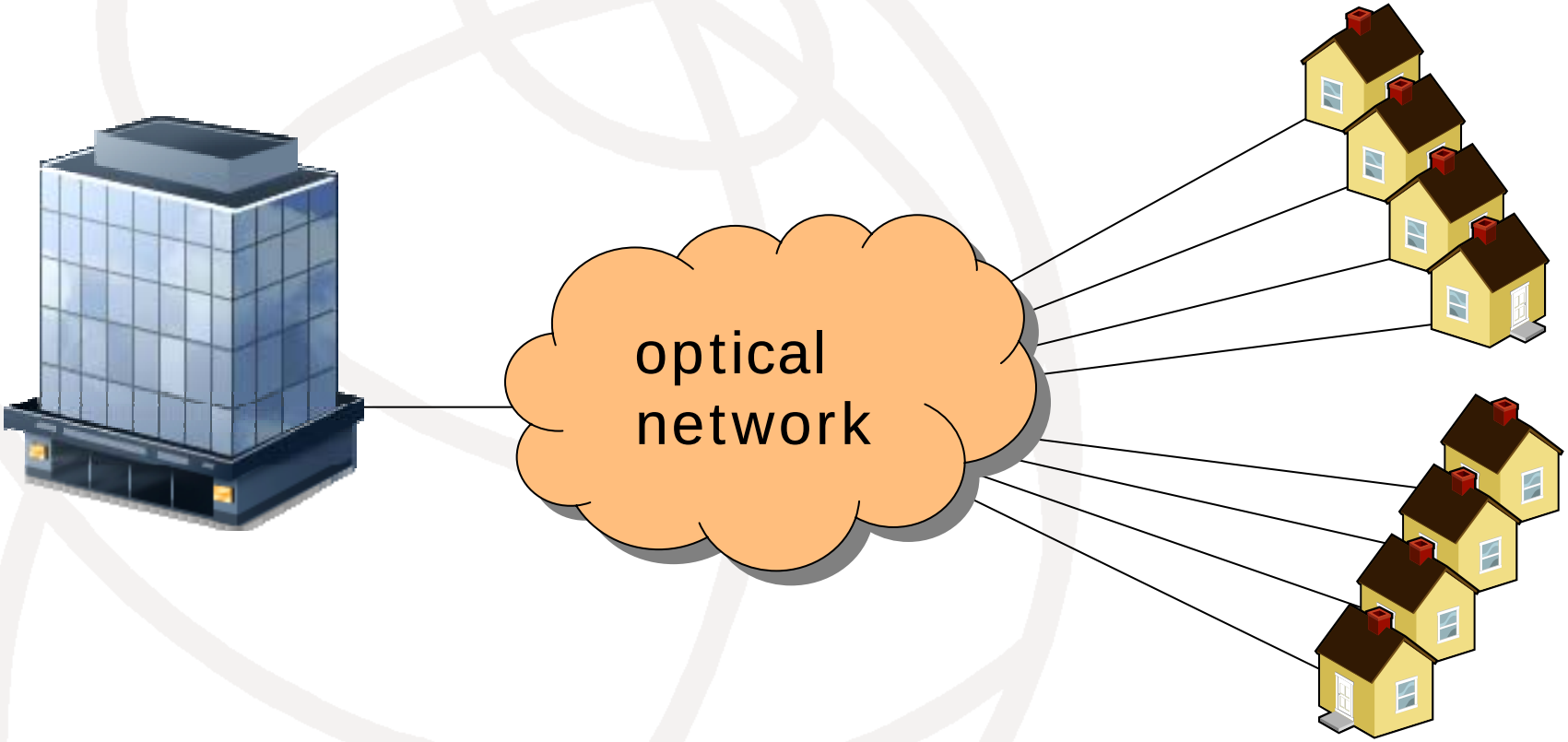
Agenda

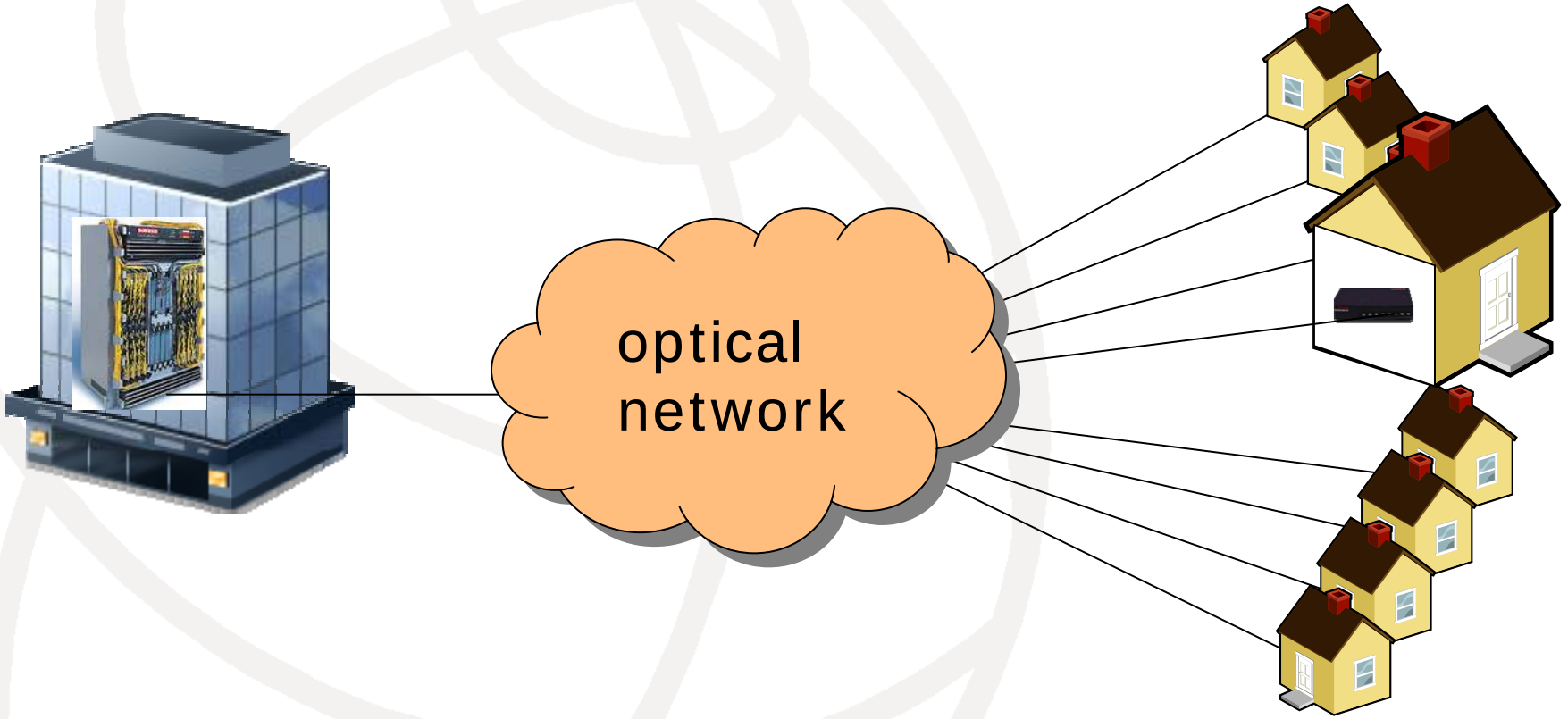
- Passive and P2P optical networks
- Layer 2 – 4 QoS mechanisms
- IEEE 802.1 AV Bridging and Ethernet AV
- Summary

Passive and P2P optical networks



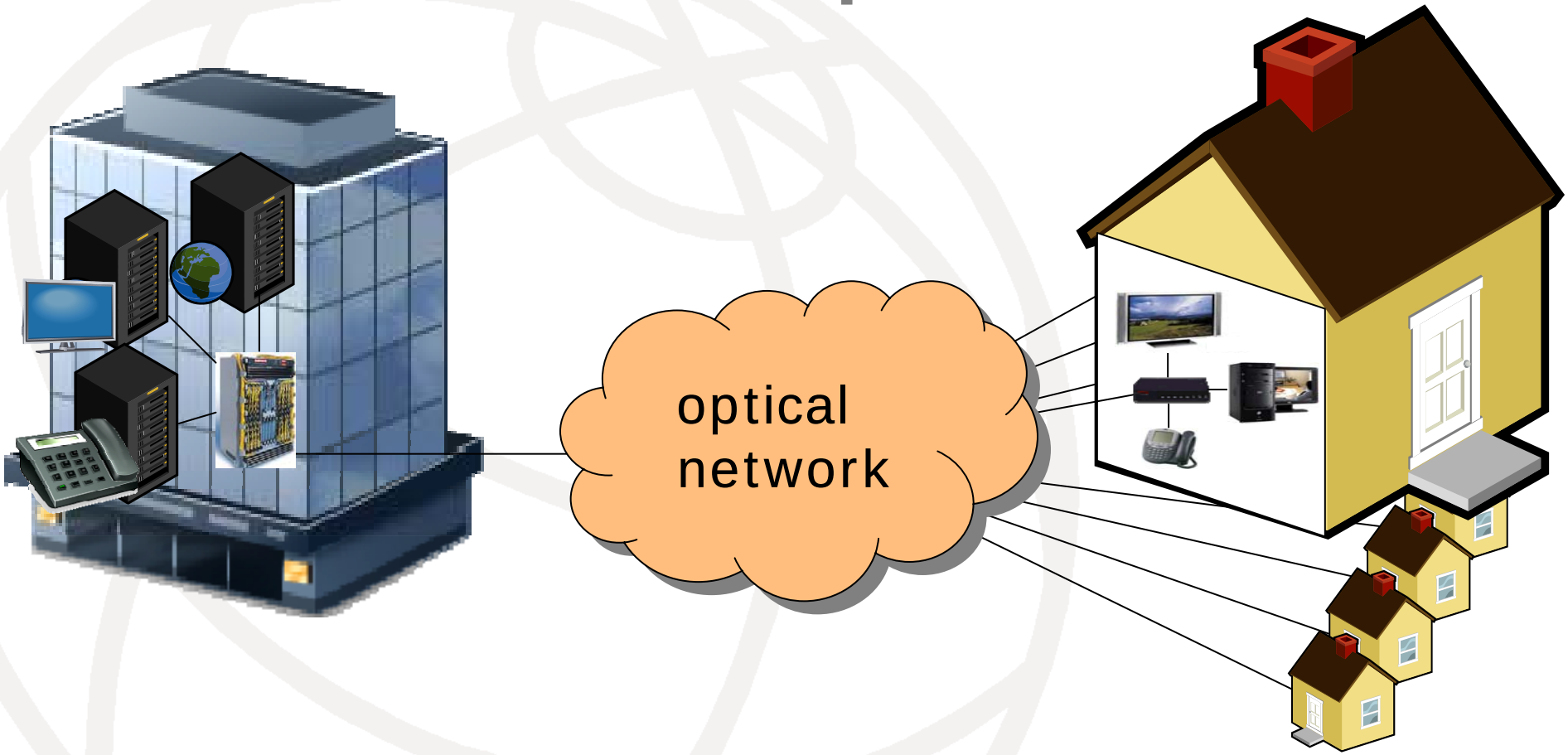
cable-centric view

Passive and P2P optical networks



equipment-centric view

Passive and P2P optical networks



service-centric view

Passive and P2P optical networks

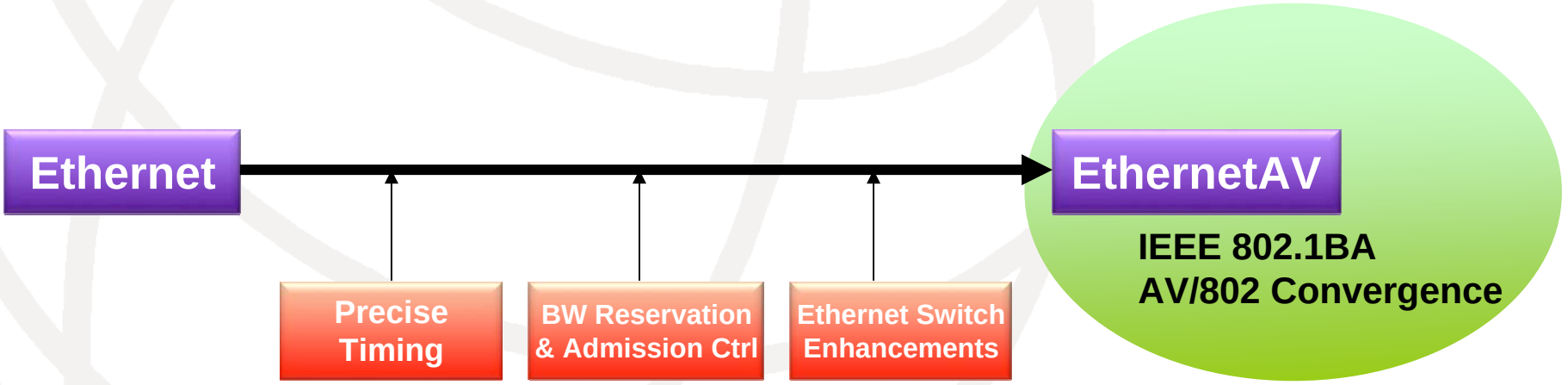
- From a service perspective, a passive optical network should be indistinguishable from a point to point network

Layer 2 – 4 QoS mechanisms

- Layer 4
  RTP – IETF RFC 3550 (ITU H.225.0)
- Layer 3
  DiffServ – IETF RFC 2475
- Layer 2
  AV bridging – IEEE 802.1

What is AV bridging?

- IEEE 802.1AS: Precise Timing in an 802 network
  (< 1uS synchronization, <100 nS clock jitter, ~100 pS achievable)
- IEEE 802.1Qat: End to end QoS bandwidth and latency reservations
- IEEE 802.1Qav: Network bridge (Ethernet switch) enhancements
  guaranteed latency <250 uS per hop,
- IEEE 802.1BA: Audio Video Network Systems (plug-and-play profile)
- Very low cost adder (approaching zero)



IEEE 802.1 Audio Video Bridging Task Group

- The IEEE 802.1 AVB Task Group is responsible for developing standards that enable time-sensitive applications over IEEE 802 networks
  - part of the IEEE 802.1 Working Group that is responsible for bridging (Ethernet “switches”)
- The primary projects include:
  - queuing and forwarding of time-sensitive streams (P802.1Qav)
  - registration and reservation of time-sensitive streams (P802.1Qat),
  - time synchronization (P802.1AS) and
  - overall system architecture (P802.1BA)

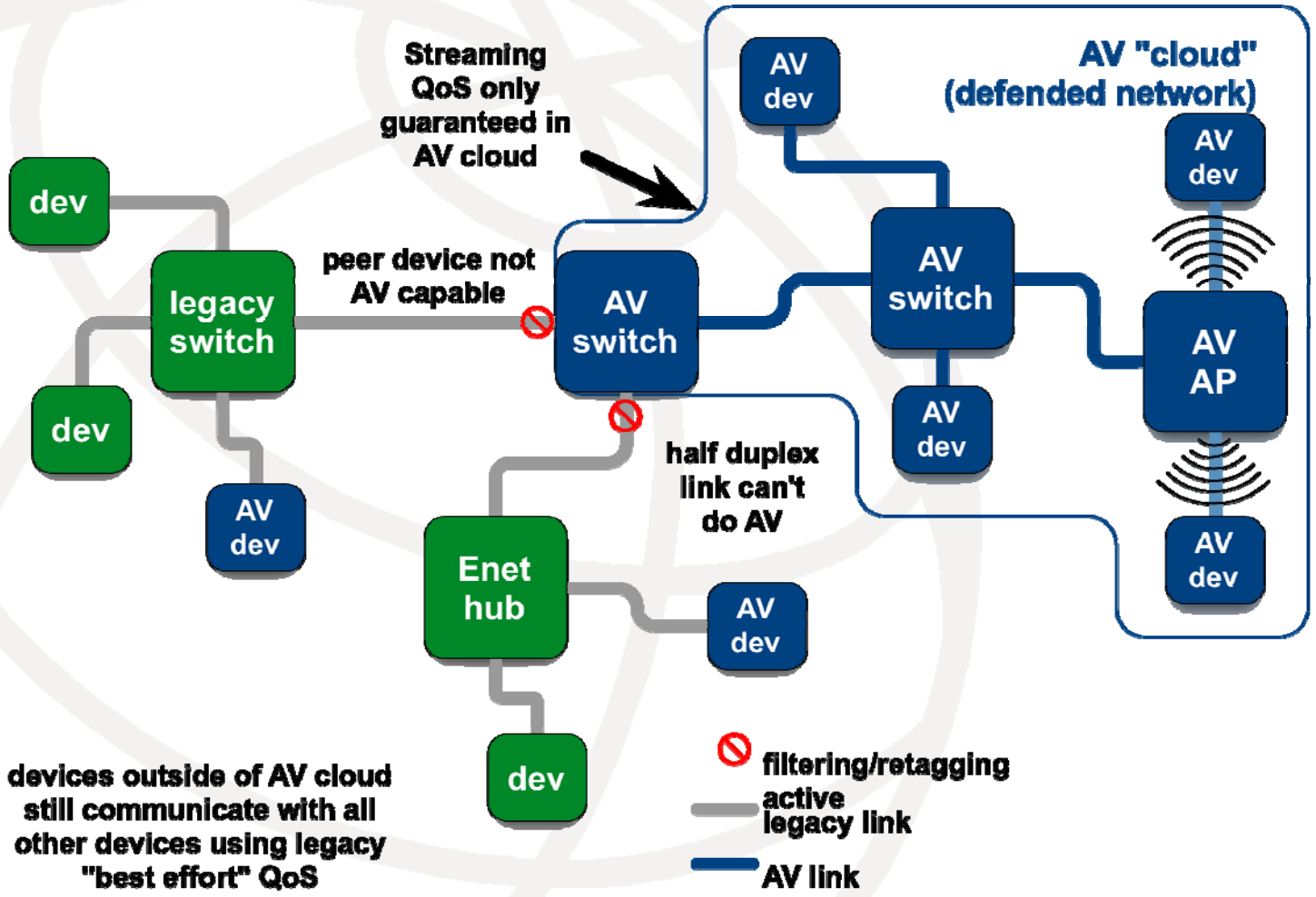
Audio Video Bridging + Ethernet

- 2 ms guaranteed latency through 7 Ethernet bridges
  - and that's using 100 Mbit/sec; much less at 1 Gbit/sec, and much, much less at 10 Gbit/sec
- Admission controls (reservations) for guaranteed bandwidth
- Precise timing and synchronization services for timestamps and media coordination
  - < 1µs instantaneous synchronization between devices

AVB architecture

- Changes to both IEEE 802.1Q (“bridge”) and MAC (media-specific)
  - 802.1Q - bridges/switches - most of work
  - 802.3 - Ethernet MAC/PHY - possible small change to MAC definition
- Three basic additions to 802.1/802.3
  - Traffic shaping and prioritizing,
  - Admission controls, and
  - Precise synchronization

Topology & connectivity



Establishing the AV cloud

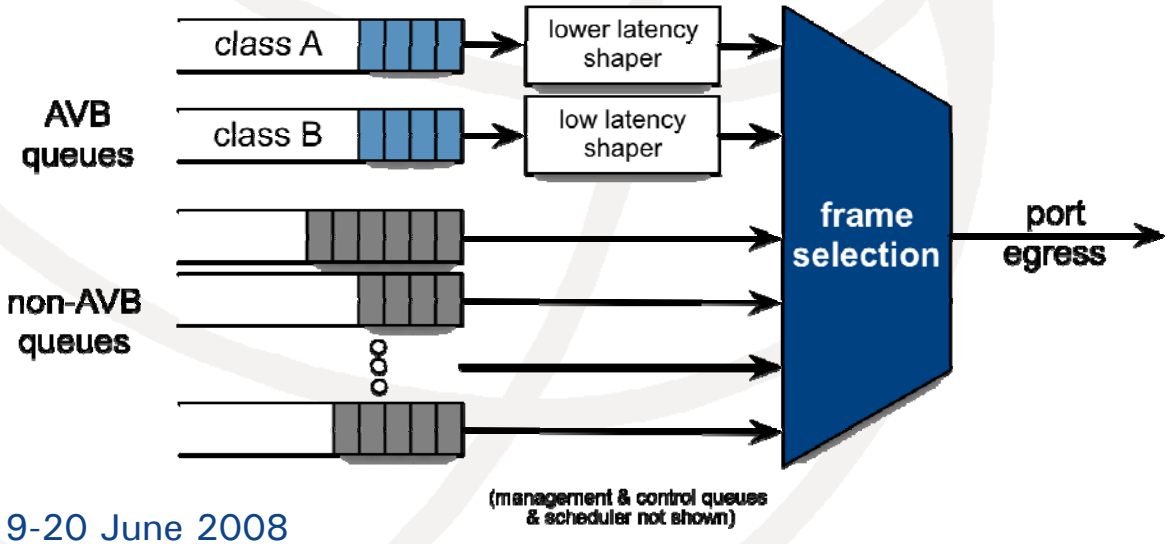
- IEEE Std 802.1AB defines “LLDP”: Logical Link Discovery Protocol
  - allows link peers to determine each other’s characteristics
- Will be enhanced with P802.1AS service that gives a relatively precise round trip delay to a peer
  - allows link peers to discover if any unmanaged bridges or other buffering devices are present on link

Traffic Shaping and Priorities
(p802.1Qav - rev to 802.1Q)

- Endpoints of Ethernet AV network must “shape traffic”
  - Schedule transmissions of streams to prevent bunching, which causes overloading of network resources
  - Shaping by simple credit-based methods with parameters that depend on traffic class (diffserv-like)
  - Traffic shaping in bridges as well as source devices
- Mapping between traffic class and priorities

Traffic Class?

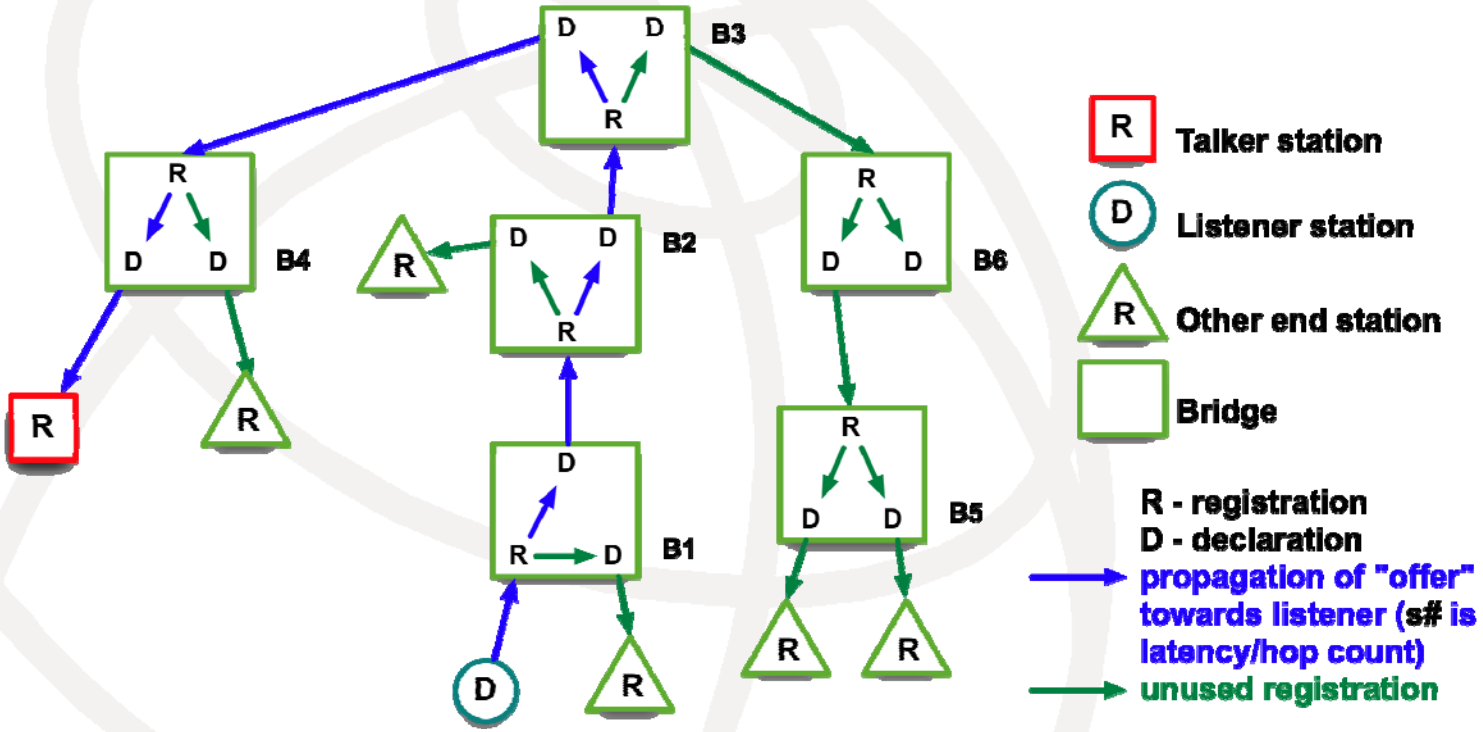
- 802.1p introduced 8 different traffic classes
  - Highest (6 & 7) reserved for network management
  - Next two for streaming video and voice (4 & 5)
  - Lowest four for “best effort”
- AV bridging:
  - Class A is for lowest latency streaming (2ms through 7 hops), Class B is for moderate latency streaming
    - by default, Class A is mapped to priority 5, and B to 4, but can be changed



Admission controls
(p802.1Qat - added to 802.1Q)

- Priorities and shaping work only if the network resources are available along the entire path from the talker to the listener(s)
  - AVB “listeners” register for a stream
  - AVB “talkers” guarantee the path to the listener is available and reserve the resources
- Done via a new 802.1ak “Multiple Registration Protocol” application: SRP (“Stream Reservation Protocol”)
  - Registers streams as a destination MAC address combined with a higher level ID (frequently the IP port address)
  - Reserves resources for streams based on bandwidth requirements and latency class

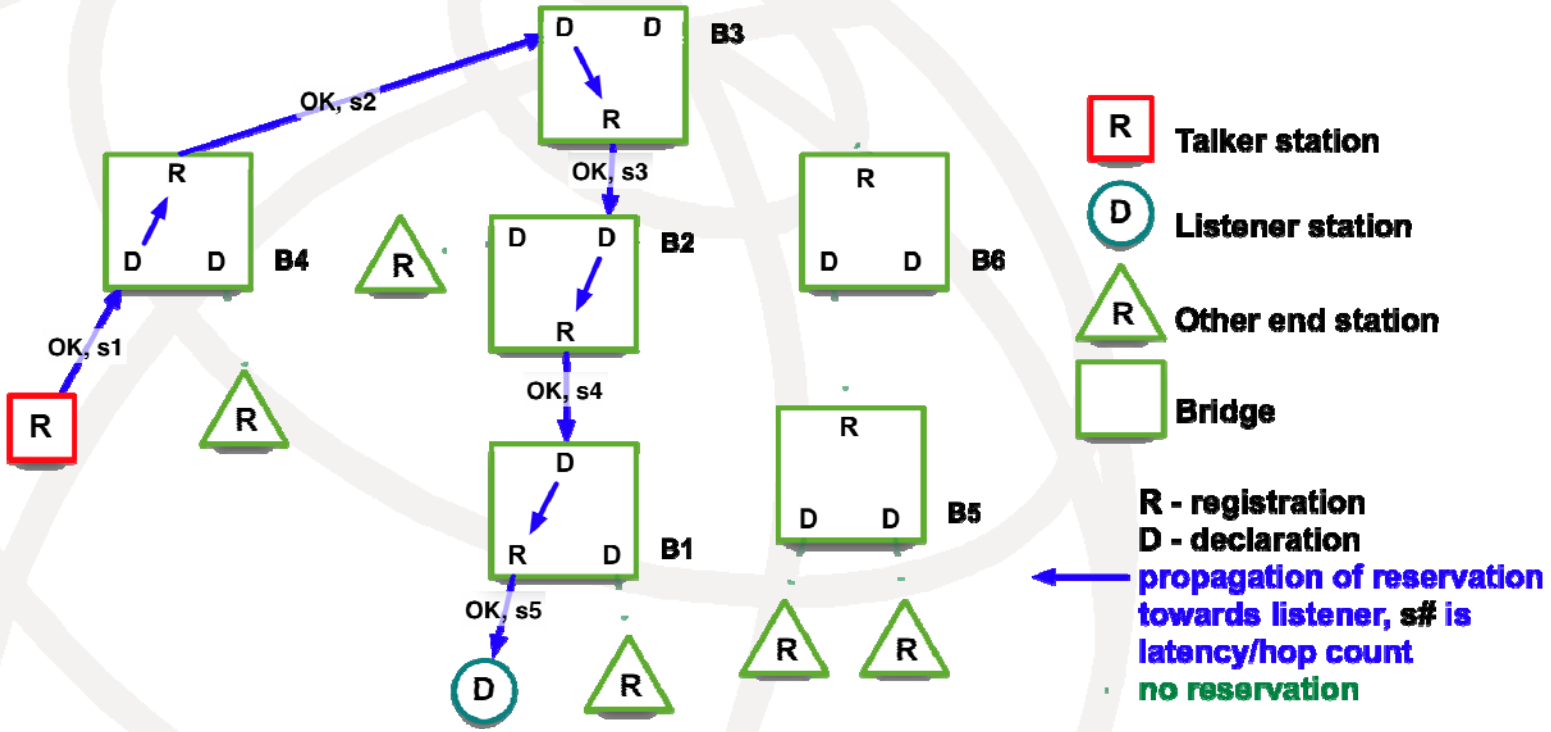
Admission Control (1)
(registration)



- With MMRP registration, the talker and intermediate bridges know the location of potential listeners and how to get to them

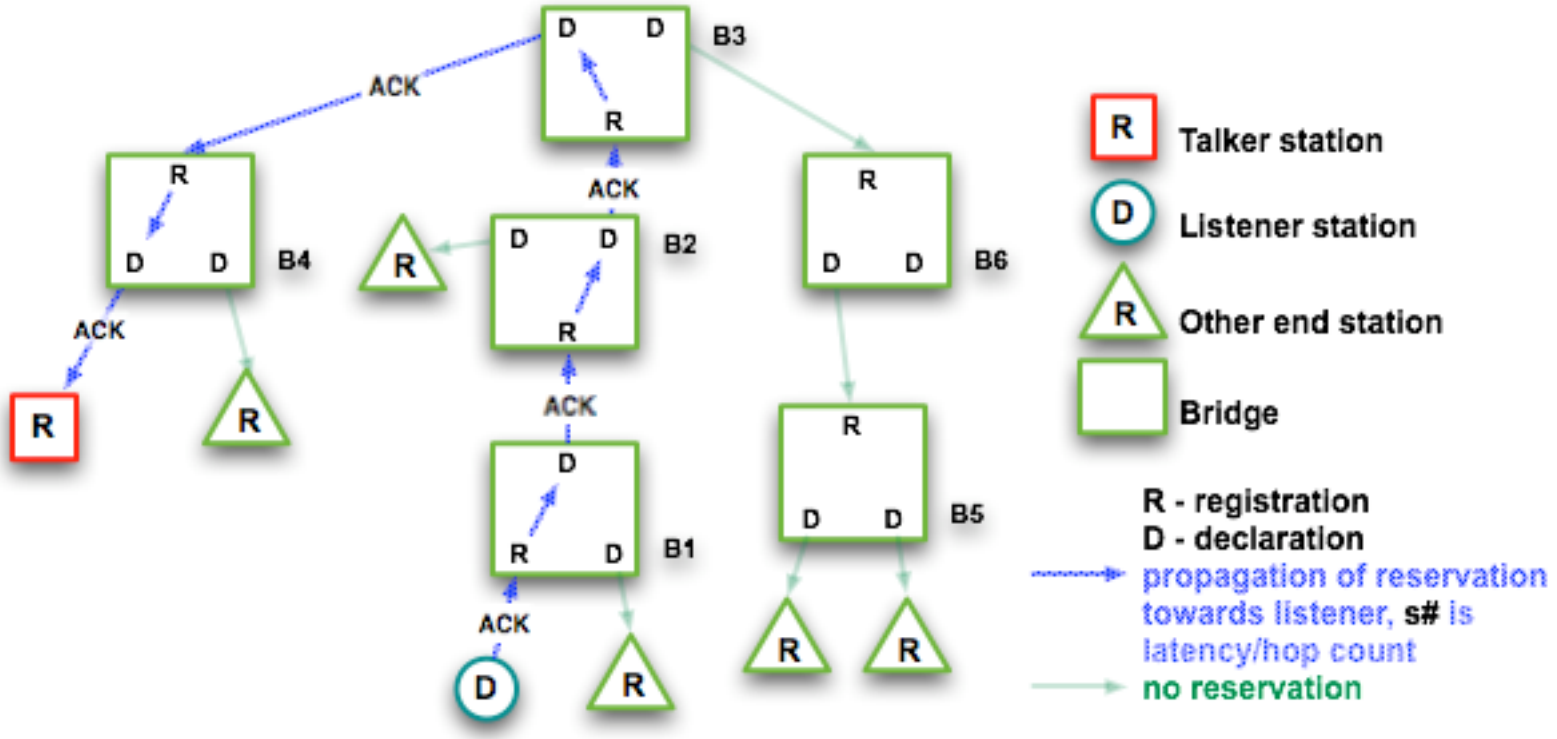
Admission Control (2)

(successful reservation)



- phase one of a reservation is an “reservation” that tests the path and leaves behind a “breadcrumb” trail to the talker

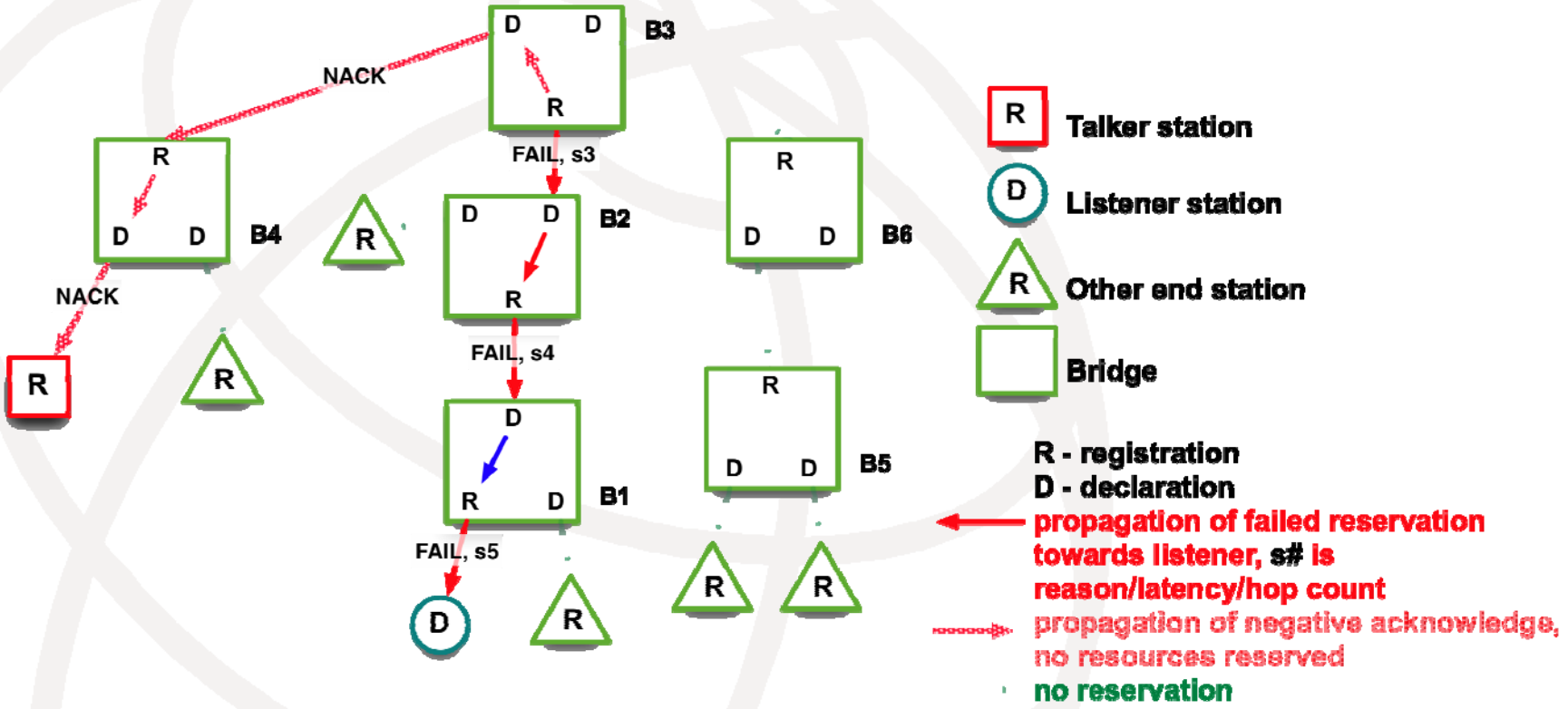
Admission Control (3)
(reservation acknowledge)



- phase two of a successful reservation actually locks down the needed resources

Admission Control (4)

(failed reservation)

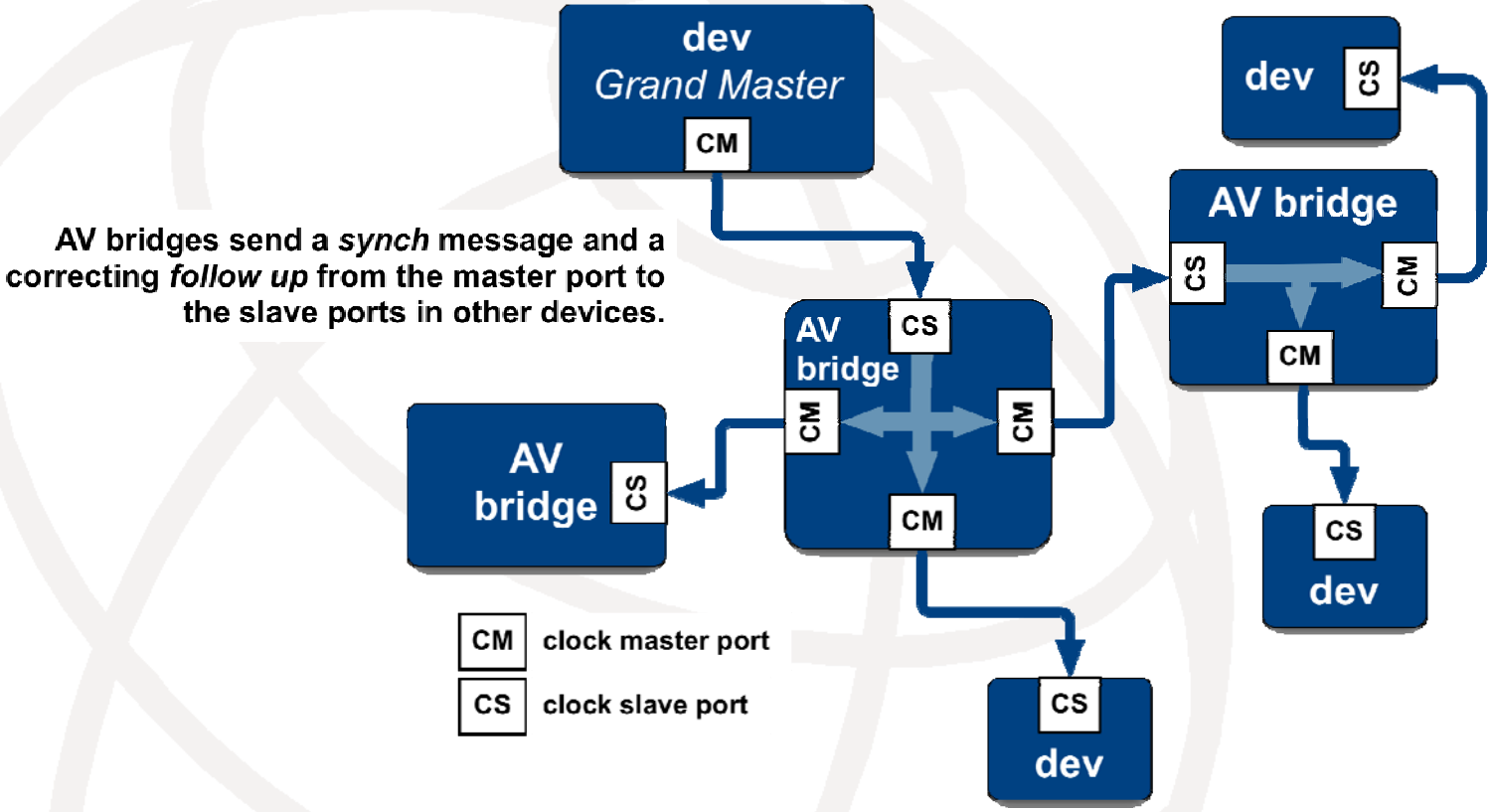


- if resources are not available, the “reservation” is propagated as “failed”
  - no reservation is made, this is done to allow a listener to know that a reservation is not possible now
- a “negative acknowledge” is propagated back towards the talker from the bridge that is first unable to make the reservation, so that the talker knows that at least one listener cannot get the reservation

Precise synchronization
(p802.1AS)

- All AV devices participate in a “native IEEE 802 layer 2 profile” of IEEE 1588v2 “Precision Time Protocol”
  - subset of standard 1588v2 for Ethernet
  - superset of 1588v2 to support 802.11 WiFi and MoCA
- This precise synchronization has two primary purposes:
  - allow multiple streams to be synchronized and
  - provide a common time base for sampling data streams at a source device and presenting those streams at the destination device with the same relative timing

AVB (1588) Grand Master clock



- There is a single device within an AV cloud that provides a master timing signal
  - All other devices (“ordinary clocks”) synchronize their clocks with this master.

Master clock selection

- Selection of the master is largely arbitrary, but can be overridden if the network is used in an environment that already has a “house clock”.
  - Professional A/V studios
  - Homes with provider time-synchronization service
  - Carrier networks
- Selection algorithm and clock attributes are the same as IEEE 1588
  - Typically, fully automatic and transparent to the end user

When?

- IEEE standardization process well under way
  - Early drafts already available
  - Technical closure already for 802.1AS, 802.1Qat/av almost ready, final draft standards in 2009
- AVB services automatically take advantage of improvements in PHY and MAC speeds and capabilities

Summary

- PON is just another layer 2 network
- Bandwidth management and QoS mechanisms for layer 2 networks are being standardized in IEEE 802.1