Joint ITU-T / IEEE Workshop on Carrier-class Ethernet

Audio / Video Bridging for Home Networks (IEEE 802.1 AV Bridging Task Group)

Michael D. Johas Teener

Chair, IEEE 802.1 AVB Task Group

Technical Director, Broadcom Corporation

Agenda

- 802.1 AV Bridging Task Group
  - What we do
- What is AV Bridging?
  - and Ethernet AV?
- Why is it needed?
- Where will it be used?
- How does it work?

IEEE 802.1 Audio Video Task Group

- Formed late 2005 to provide the specifications that will allow time-synchronized low latency streaming services through 802 networks
- Three current projects:
  - P802.1AS: Time Synchronization
  - P802.1Qat: Stream Reservation
  - P802.1Qav: Forwarding and Queuing for Time-Sensitive Streams

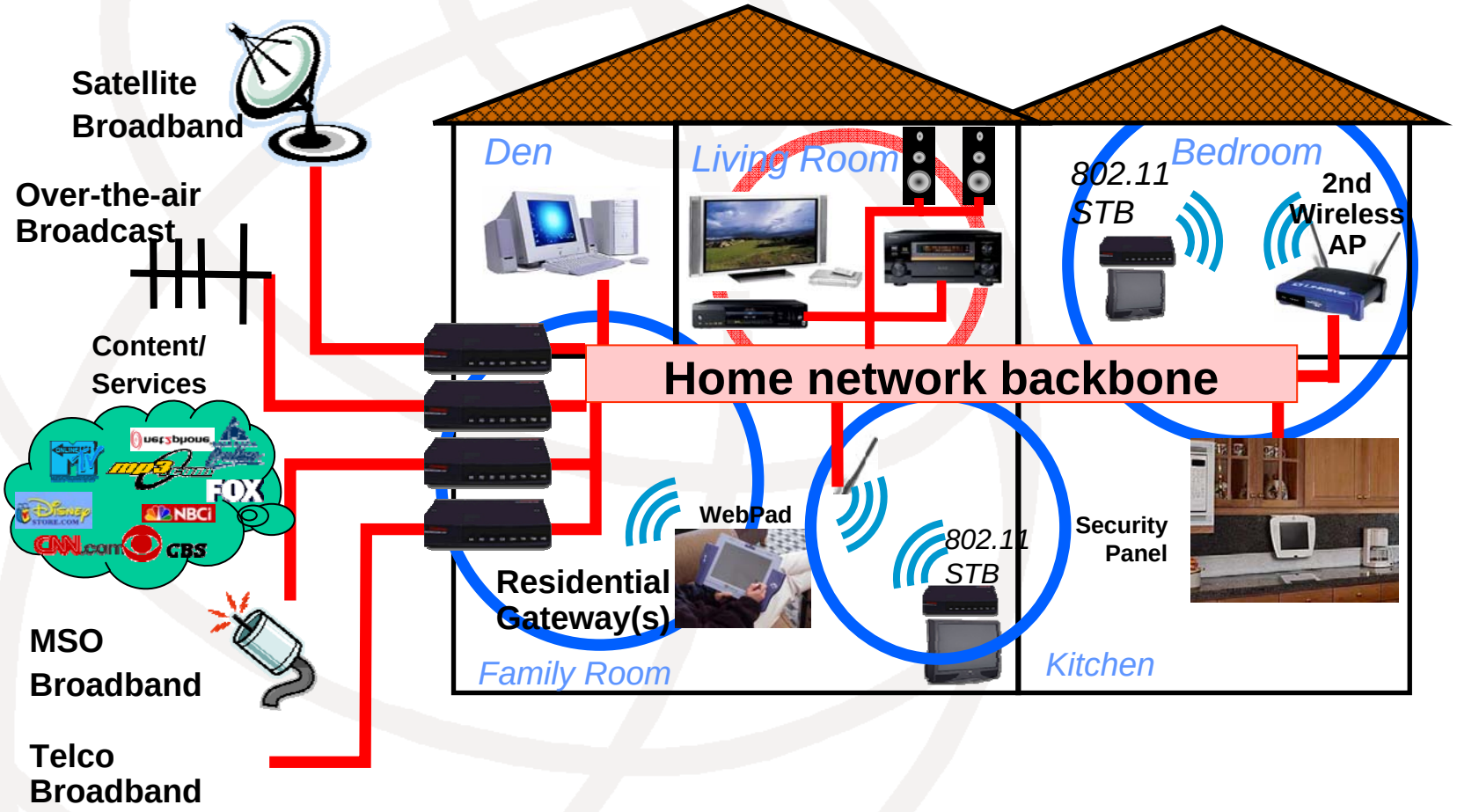
Why is it needed?

- Common IT-oriented networks have inadequate QoS controls
  - all use 802.1 “priority” (actually, “traffic class”)
  - can work in controlled environments (same higher layer QoS)
  - no guarantees, timing synchronization difficult
- Ethernet is the best
  - but it’s easy for the customer to misconfigure or overload
  - no guarantees, timing synchronization difficult

But there are so many other choices!

- 802.11n has superior convenience, but inadequate bandwidth and excessive delays for whole-home coverage
  - … but a vital part of the whole solution
- Proposed CE-based networks are expensive
  - … but MoCA and HPNA use coax, so they are almost everywhere
  - … and power line IS everywhere!
  - … and 1394b/c long distance has best QoS guarantees

Digital Home Media Distribution



Ethernet AV: the Gold Standard

- Backbone for home
  - Highest bandwidth, best QoS, least configuration
- Within the entertainment cluster
  - Highest quality/lowest cost way to interconnect networked CE devices
- Numerous non-“residential” applications
  - Professional audio/video studios, industrial automation, test and measurement, carrier backbone

But it's only part of the solution!

- Ethernet AV is the best backbone for QoS
  - … but Cat5 wiring needed
- Ethernet AV is the most cost-effective high QoS network for endpoints
  - … but not useful for mobile
- So we need to enable the ***heterogeneous*** network
  - Provide QoS services universally!

So …

Unified Layer 2 QoS

- Enhance network bridging
  - Define common QoS services and mapping between different layer 2 technologies
  - IEEE 802.1 is the common technology
- Common endpoint interface for QoS
  - “API” for QoS-related services for ALL layer 2 technologies
  - Toolkit for higher layers

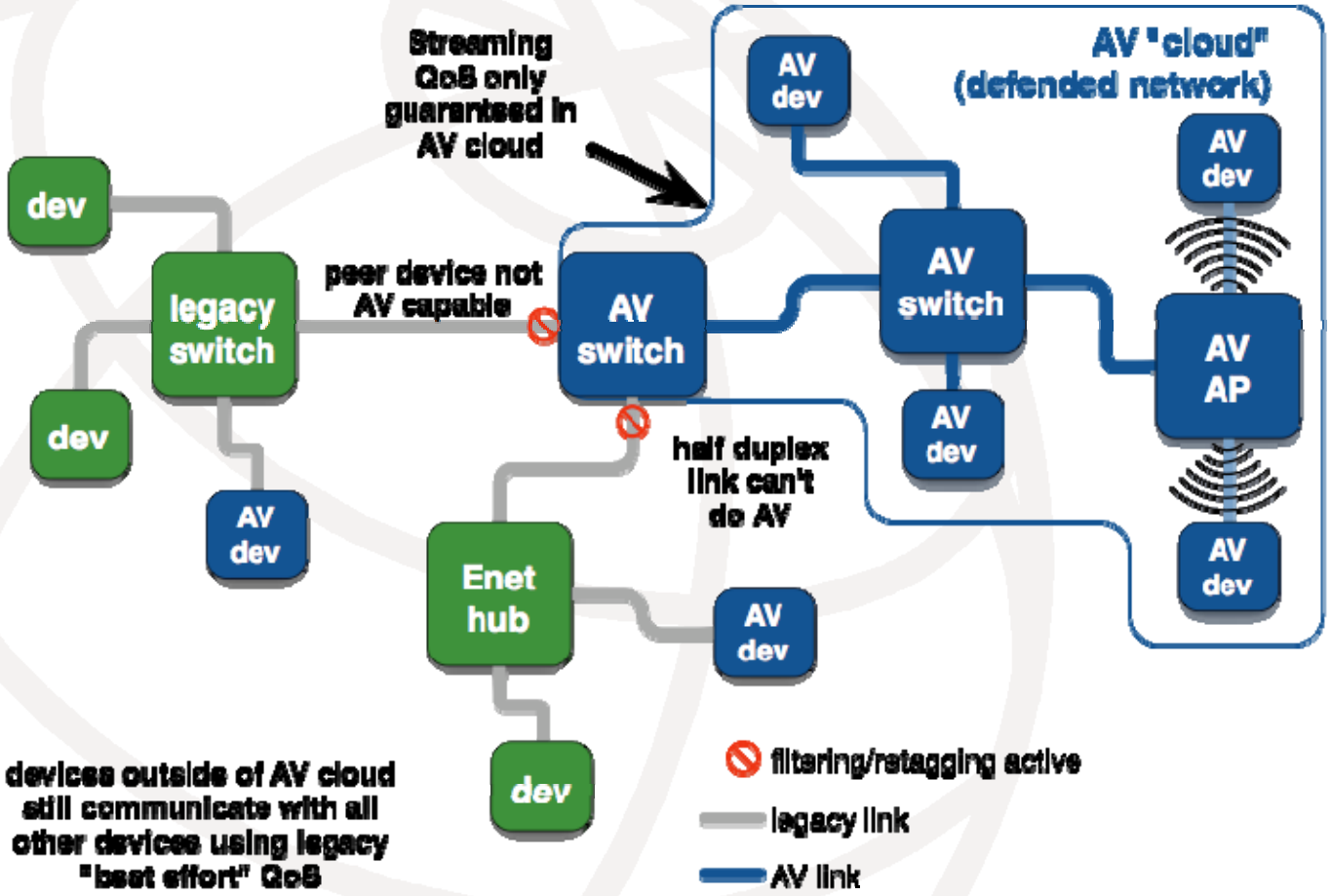
The first step: Ethernet AV™
(Enhanced 802.1 bridges connected by Ethernet links)

- 2 ms guaranteed latency through 7 Ethernet bridges
- Admission controls (reservations) for guaranteed bandwidth
- Precise timing and synchronization services for timestamps and media coordination
  - < 1µs absolute synchronization between devices
  - jitter less than 100ns, filterable down to 100ps (can meet the MTIE mask for professional uncompressed video)

Proposed architecture

- Changes to both IEEE 802.1Q and MAC
  - 802.1Q - bridges/switches - most of work
  - 802.3 - Ethernet MAC/PHY - possible small change to MAC definition
  - 802.11n - WiFi - more work, but basic tools in place
- Three basic additions to 802.1/802.3
  - Traffic shaping and prioritizing,
  - Admission controls, and
  - Precise synchronization

Topology & connectivity



Establishing the AV cloud

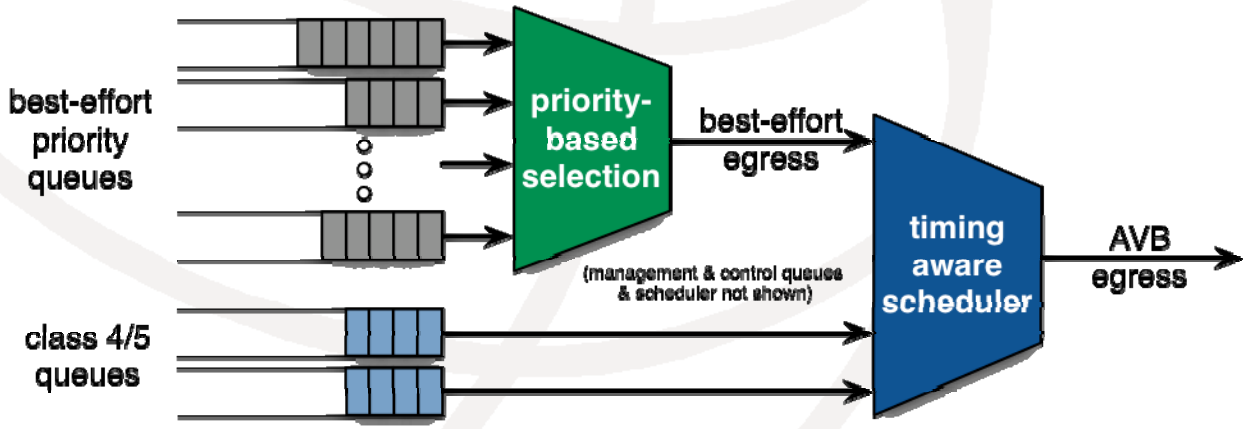
- IEEE Std 802.1AB defines “LLDP”: Logical Link Discovery Protocol
  - Allows link peers to determine each other’s characteristics
- Will be enhanced with P802.1AS service that gives a relatively precise round trip delay to a peer
  - Allows link peers to discover if any unmanaged bridges or other buffering 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 limiting transmission within an "observation interval" which is 125 µs or 1ms depending on traffic class
  - Traffic shaping in bridges using per-class methodology (diffserv-like)
- Mapping between traffic class and priorities

Traffic Class?

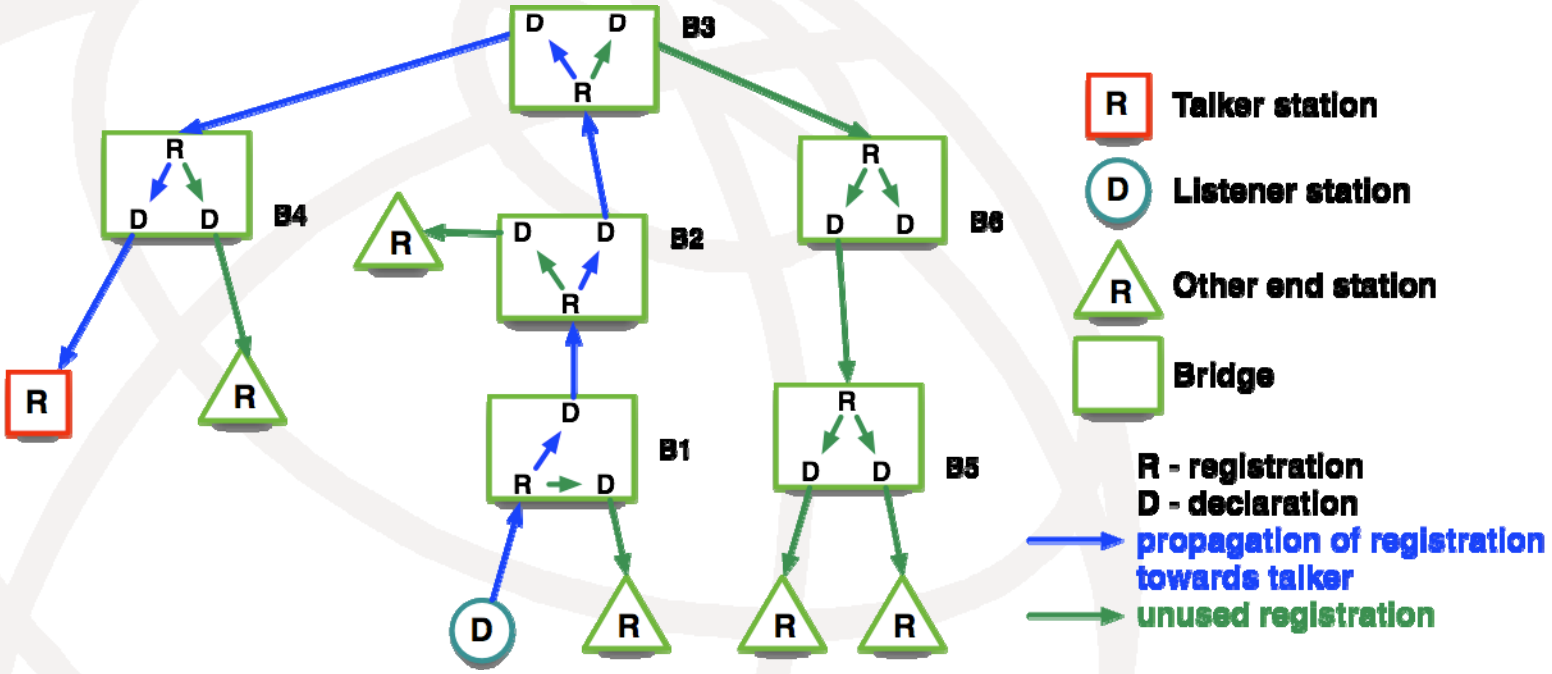
- 802.1p introduced 8 different traffic classes
  - Highest (6 & 7) reserved for network management
    - low utilization, for emergencies
  - Next two for streaming (4 & 5)
  - Lowest four for “best effort”
- AV bridging:
  - Class 5 is for lowest latency streaming (2ms through 7 hops)
  - Class 4 is for moderate latency streaming



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

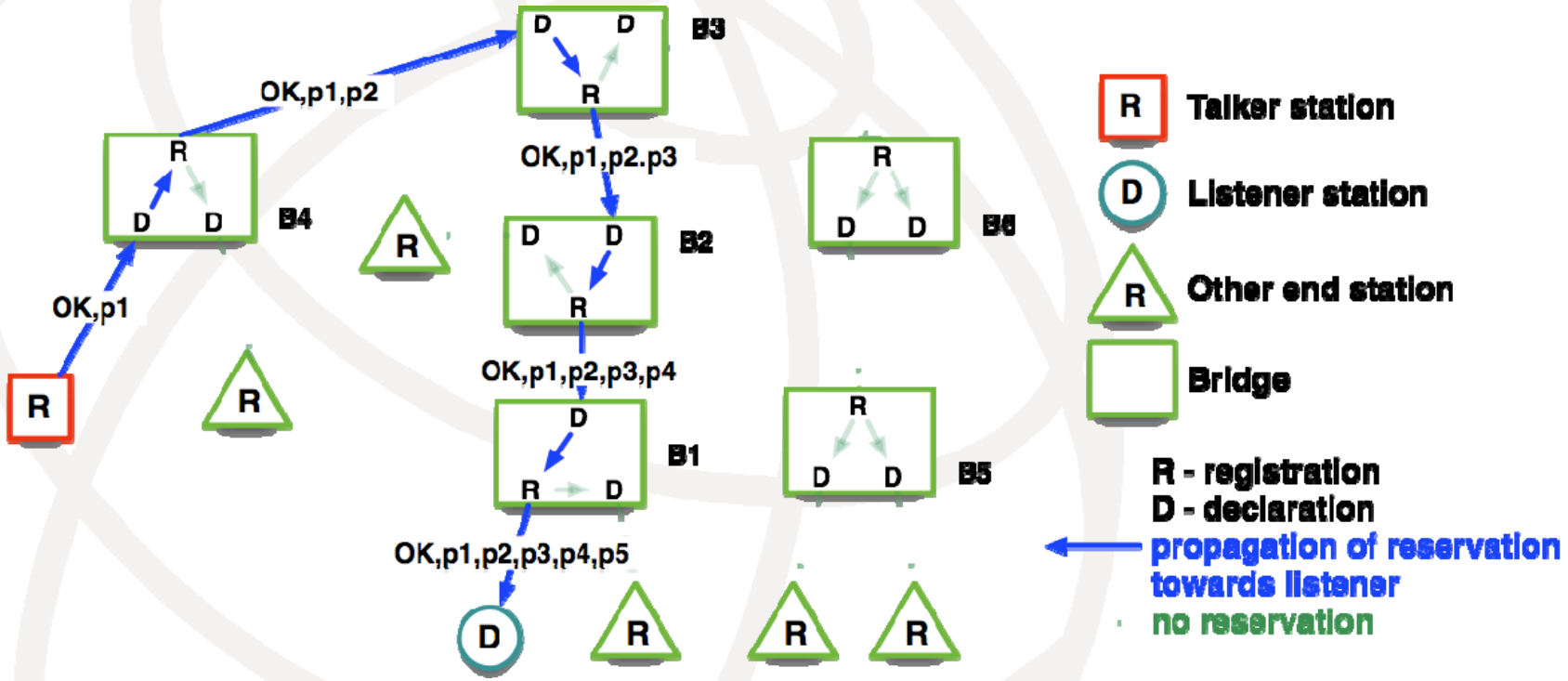
- Priorities and shaping work only if the network resources are available along the entire path from the talker to the listener(s).
  - For AV streams it is the listener's responsibility to guarantee the path is available and to reserve the resources.
- Done via 802.1ak "Multiple Multicast Registration Protocol" and the new SRP ("Stream Registration Protocol")
  - Registers streams as multicast addresses using MMRP
  - Reserves resources for streams as bandwidth/traffic class

Admission Control (1) (registration)

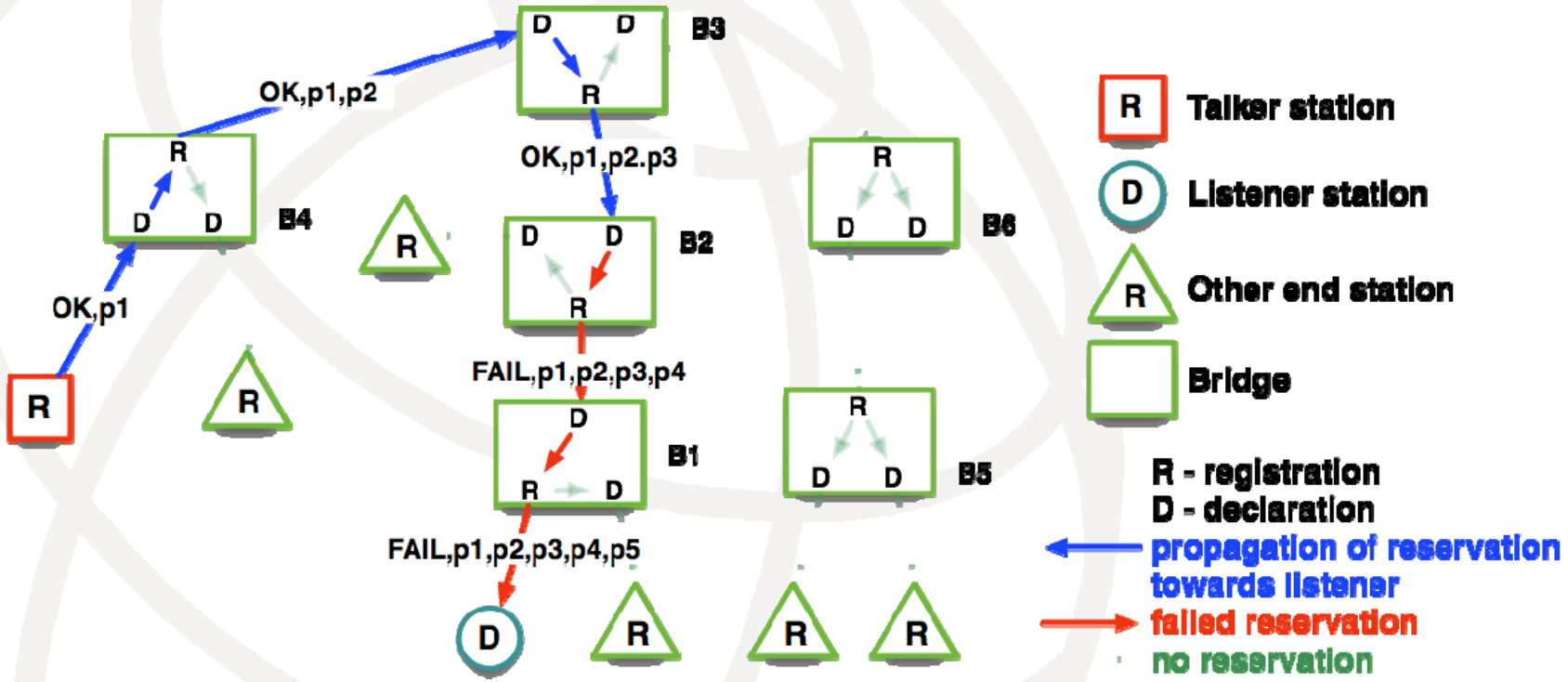


- With MMRP registration, the talker and intermediate bridges know where are potential listeners and how to get to them

Admission Control (2)
(successful reservation)



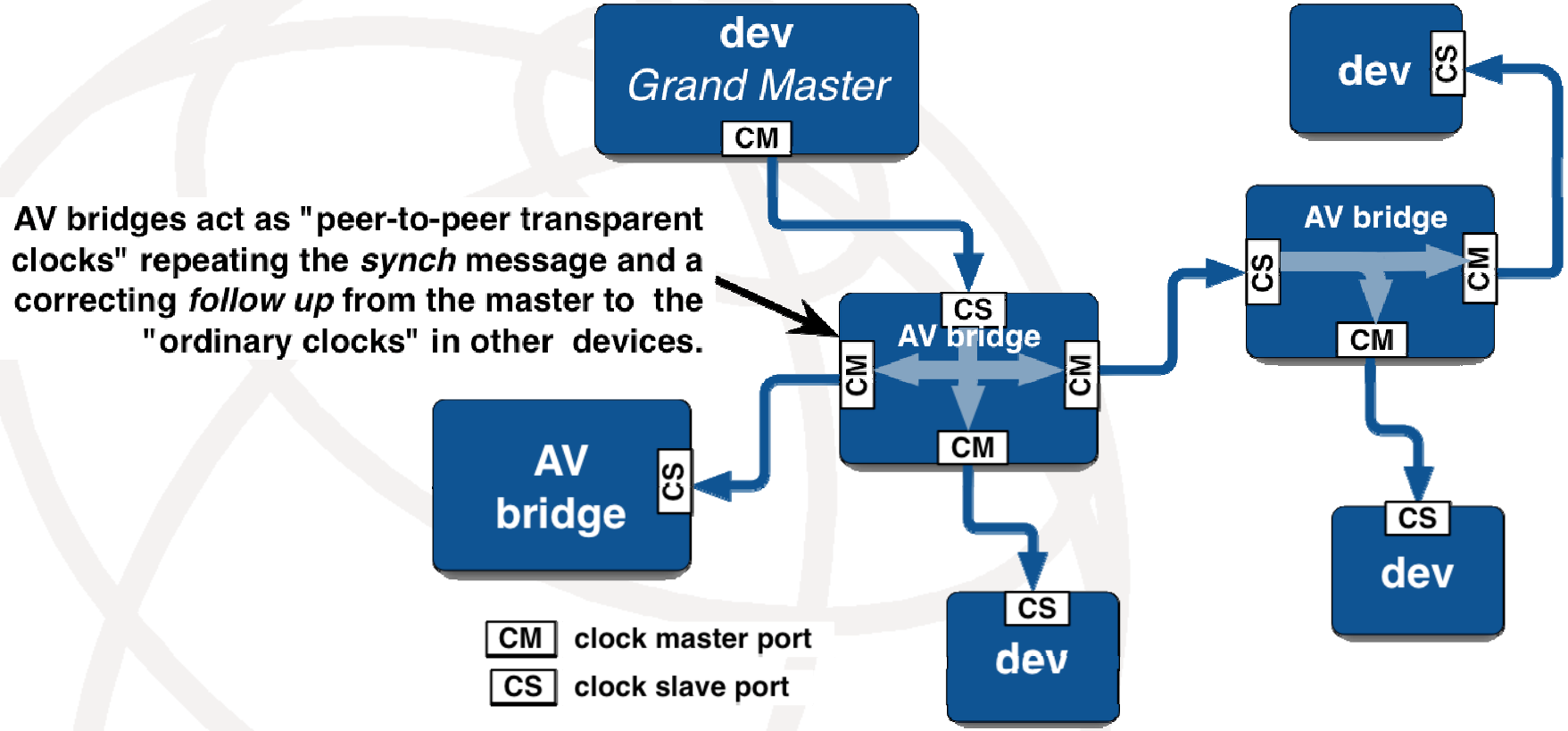
Admission Control (3)
(failed reservation)



Precise synchronization (p802.1AS)

- All AV devices participate in a “native IEEE 802 layer 2 profile” of IEEE 1588v2
- This precise synchronization has three purposes:
  - to enable traffic shaping,
  - 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 Ethernet 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
  - Expect technical closure in 2007, final draft standards in 2008
- Will follow Ethernet/WiFi-type product curve
  - 100M/1G/10G NIC/Switch all have markets for Ethernet AV

Key Take Away

- 802.1 AVB technology will be the standard interconnect for uncompromised quality of service
  - soon!
- There will be growth in both technology (speeds and feeds) and infrastructure (switches, ICs, intellectual property)
  - Early markets will likely be professional/industrial, with residential very soon after that

Thank you!

G.8261 (G.pactiming) and 802.1 AV bridging

Michael Johas Teener
mikejt@broadcom.com

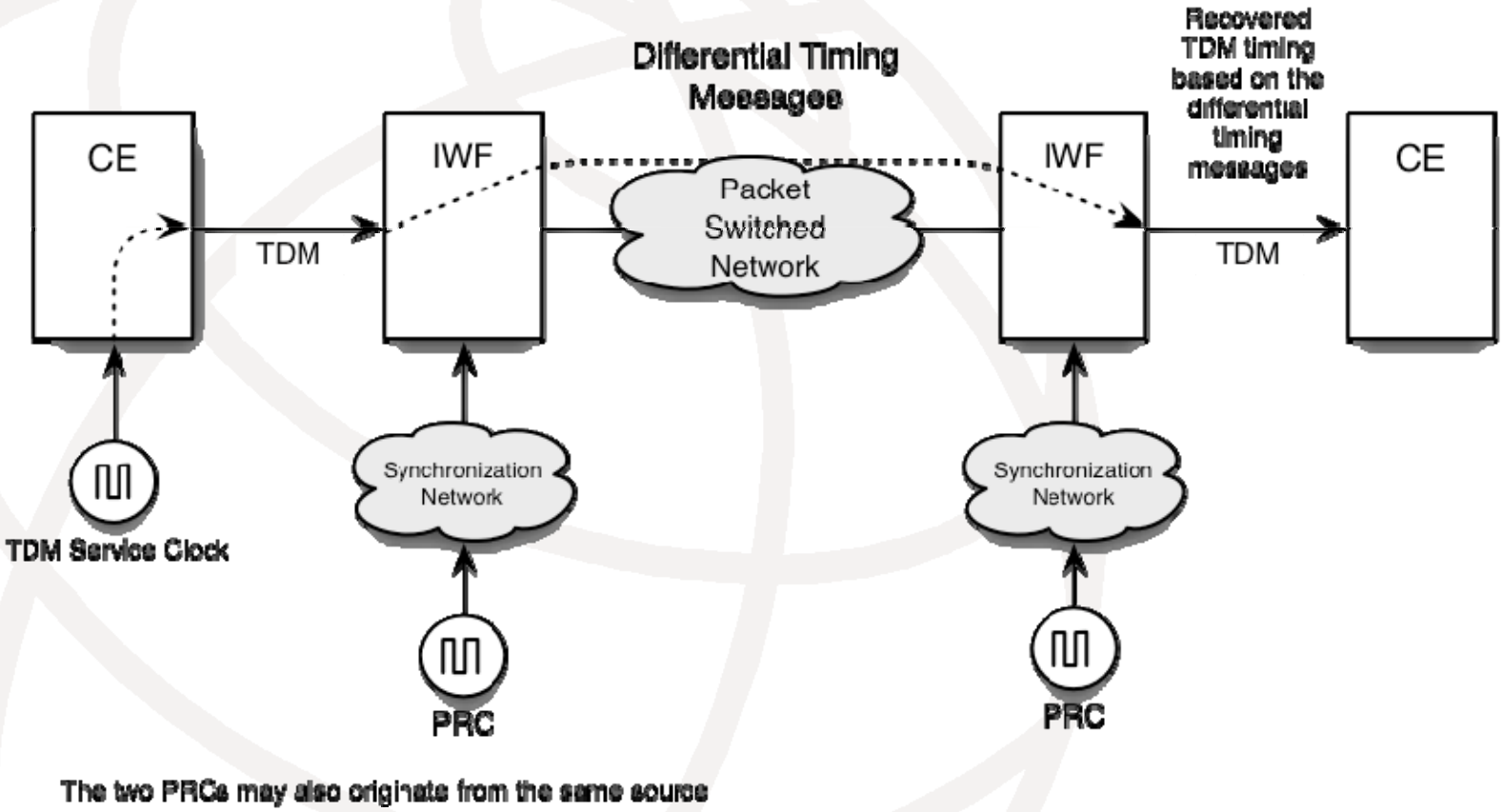
G.8261 Timing recovery

- Bridging between SDH/SONET (and similar) networks requires carrying *both* the data with adequate QoS *and* timing information
  - E.g., an Ethernet network must carry the timing information of one edge SDH/SONET to another.
  - It must also emulate the connection-oriented model for data transport (not lose data from established connections in spite of interfering traffic)

G.8261 Differential Method

- Common reference clock available throughout packet network
- Service clock (at packet network ingress) is encoded using a timestamp with respect to the reference clock and included with data
- Service clock at packet network egress is recovered using reference clock and timestamp information in stream

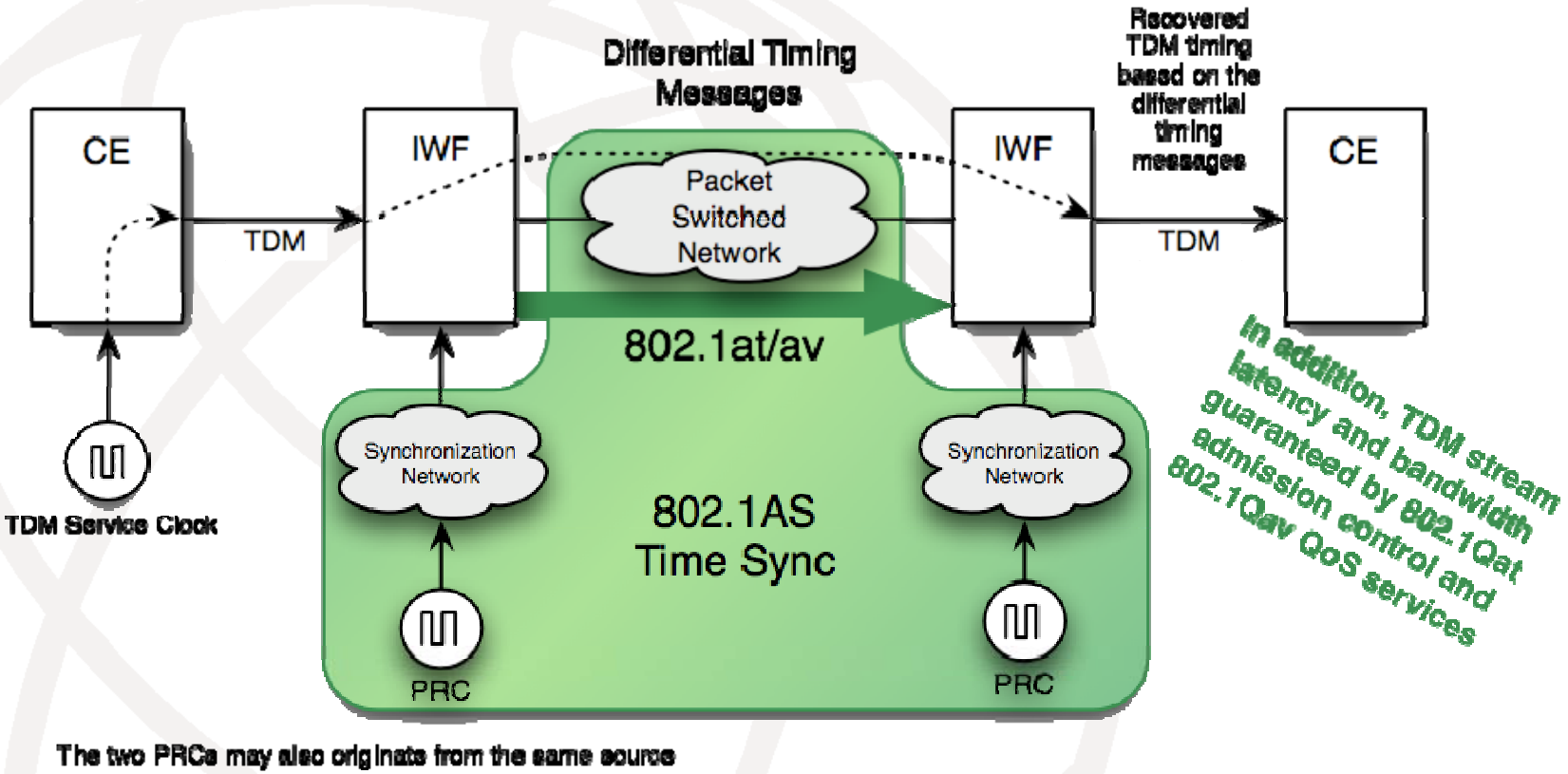
Using the Differential Method



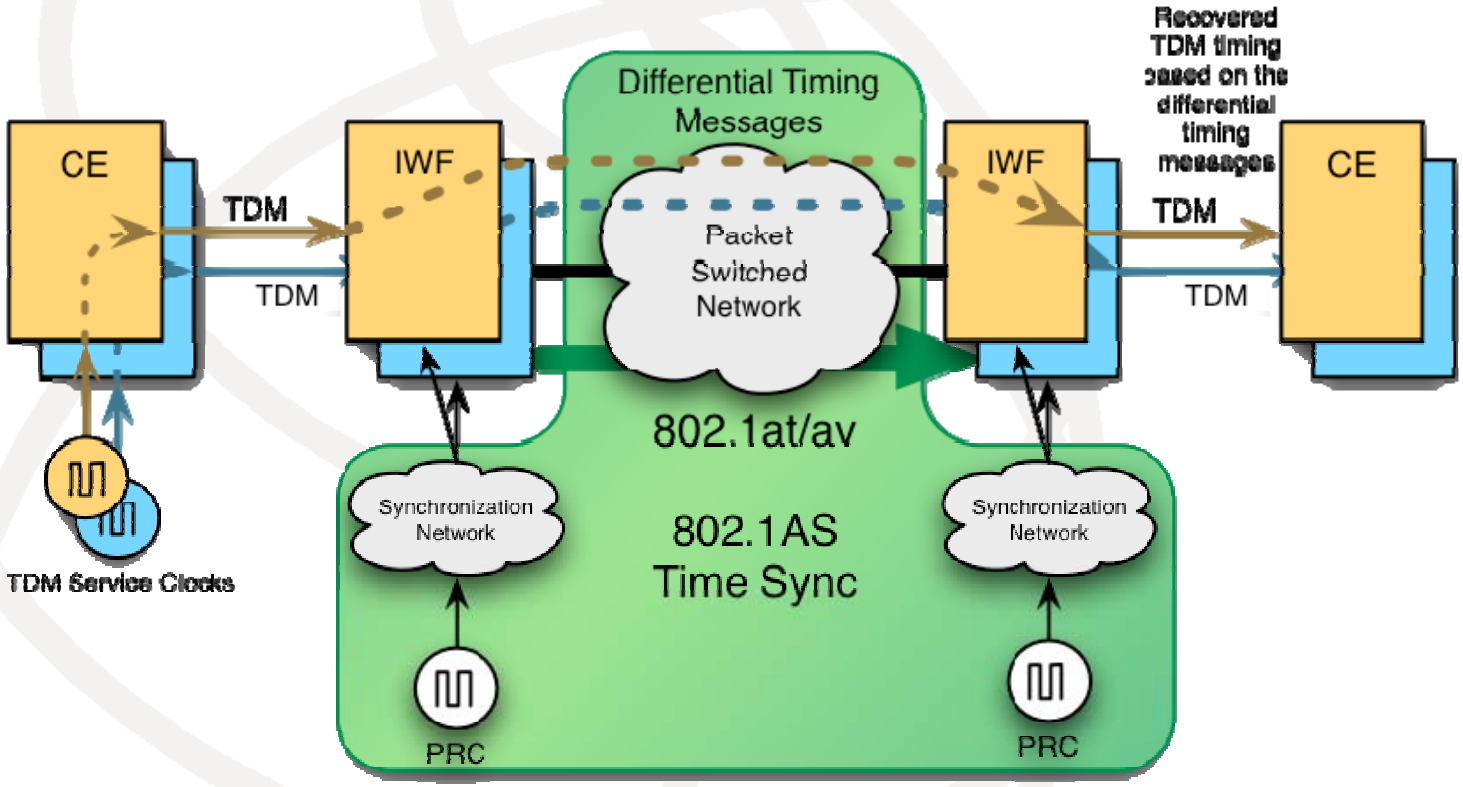
802.1 Audio/Video Bridging

- Provides precise synchronization services
  - 802.1AS - IEEE 1588v2 as applied to 802.1 bridged networks.
  - Probably better MTIE than needed for SDH/SONET
    - (Geoff Garner is currently comparing with TDEV for SDH-1 and -2)
- Provides connection-oriented services
  - 802.1Qat - Stream Reservation Protocol to manage streams
  - 802.1Qav - Guaranteed latency and bandwidth for established streams
- No need to manage PHYs, no need for external PHY-level synchronization
  - Any 802.3 PHY will work, nothing special needed, full configuration flexibility
  - Support for other full-duplex point-to-point PHYs trivial
  - Support for shared media MACs allowed (802.11/16/17) via sublayer definition

Using 802.1 AVB



Using 802.1 AVB for multiple independent clocked streams



Advantages of 802.1 AVB

- Will be heavily used in consumer electronics and professional AV networks
  - Driven to be as simple and low cost as possible
- Easily scaled to much larger networks
  - Architects of the 802.1 understand and require scaling
- Supports multiple simultaneous TDM streams with different clocks

New work needed

- Telecom core networks must be managed at a high level
  - Limiting automatic switchover of clock sources and routing of packets
  - “protected environment” for management vs. “plug and play” usage models
- Standardized packet format for TDM emulation
  - Mapping/demapping for timing recovery (timestamp usage)
- 802.1 AVB protocols have all the lower layer tools
  - Higher level management interfaces and overrides need to be defined

Thank you!