AV Streaming Quality of Service in 802 Networks (or: *where does all this fit?*)

Michael Johas Teener
mikejt@broadcom.com

AV Streaming QoS Requirements

- Once a stream is established, the quality of that stream should not be degraded during normal operation
  - Regardless of what else is happening on that same network
- Quality is determined by bandwidth and latency
  - For AV streams, two classes of latency are probably acceptable: “remote control” responsiveness of 100ms and “musical instrument” responsiveness of < 10ms
    - “responsiveness” is network round trip plus processing delays
    - 802 work is centered around 32 ms and 2 ms end-to-end delay

Getting AV QoS

- 802.1 bridges provide numerous QoS mechanisms
  - Most use 802.1 traffic classes indicated by 802.1Q priority tag ("priority code point")
  - Using priority tags to indicate priority of forwarding within bridges works well for AV streams …

*but **only** if the use of the tags is managed by some process that guarantees that services (bandwidth, queues) are available along the entire path used by a particular stream:*

Admission Control!

Admission Control, but how?

- Several proposed methods for admission control
  - But can only work in a “closed” environment that prevents interference from non-participating devices
    - UPnP QoS requires all devices (including network infrastructure) participate, at least at the discovery level
    - Various other proprietary systems, such as Cobra, work fine
    - A WiFi - only system will perhaps work in simple cases (e.g., single, non-overlapping AP), but how do APs get QoS on the wire between themselves? How about overlapping APs?
  - Move the “closed environment” problem down to 802
    - Where it belongs, frankly
      - 802.1 bridges are defined for heterogeneous networks
    - Mechanisms already in place, used in the enterprise and metro Ethernets

802 Efforts Underway

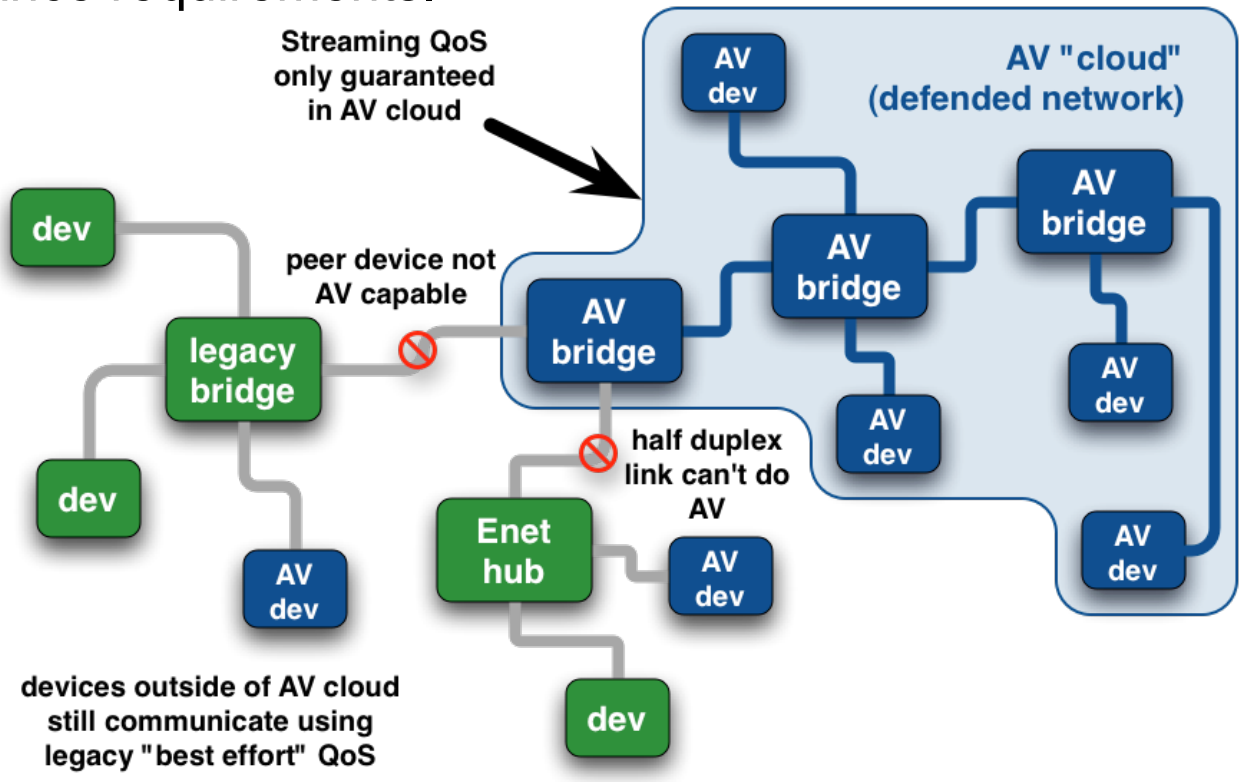
- Originally called “Residential Ethernet”
  - 802.3 study group http://grouper.ieee.org/groups/802/3/re_study/
  - Decided on 802.1 bridge-based approach
- Moved to 802.1 as “Residential Bridges Task Group” in November 2005
  - Should be renamed “AV Bridge Task Group”
  - Chair is Michael Johas Teener of Broadcom
  - Initial effort focused on Ethernet, but side conversations with wireless groups are starting, and will be follow-on projects

Where is admission control?

- (picture with policy at top, actions below)

802.1 AV network

- What was previously called a “ResE cloud” is now called an “AV cloud”
  - Set of “802.1 AV profile” devices that are directly connected to each other
- 802.1 AV profile devices must perform specified services with specified performance requirements.



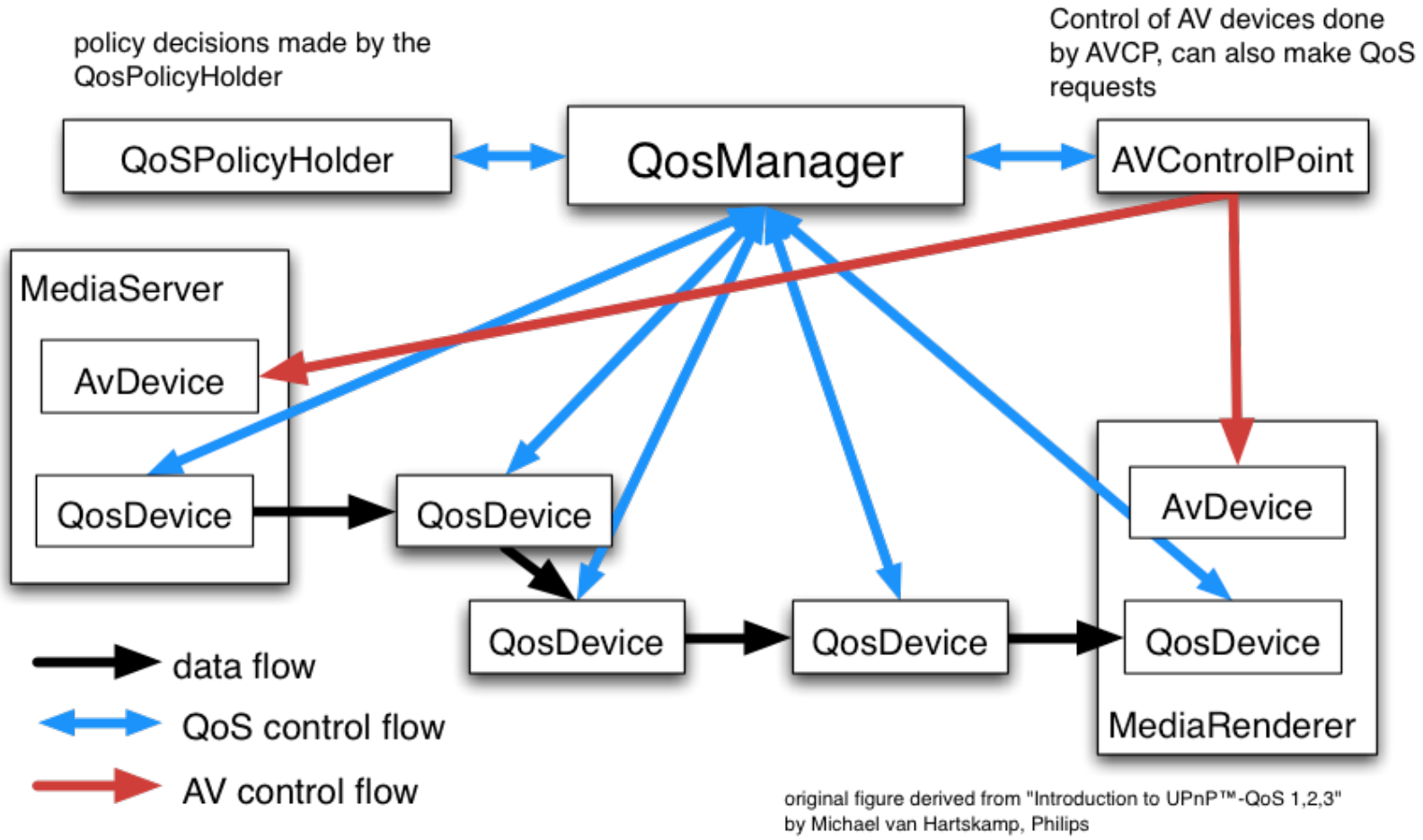
Services required by 802.1 AV profile

- Precise synchronization
  - Network provides well synchronized reference clock with adequate quality for CE applications with the most stringent requirements
  - Timing information also used for network services
- Well-defined and interoperable queuing and forwarding rules for traffic classes (using 802.1 priority tags)
  - Provide bounded end-to-end latency of 2 ms and (perhaps) 32 ms
  - Traffic shaping requirements for transmission of tagged frames
  - Rules for retagging of frames at AV cloud boundaries
- **Admission control system** for usage of priority tags
  - Stream registration and preliminary reservation using MRP application
  - End-to-end confirmation of reservation using separate “reservation confirmation” frame

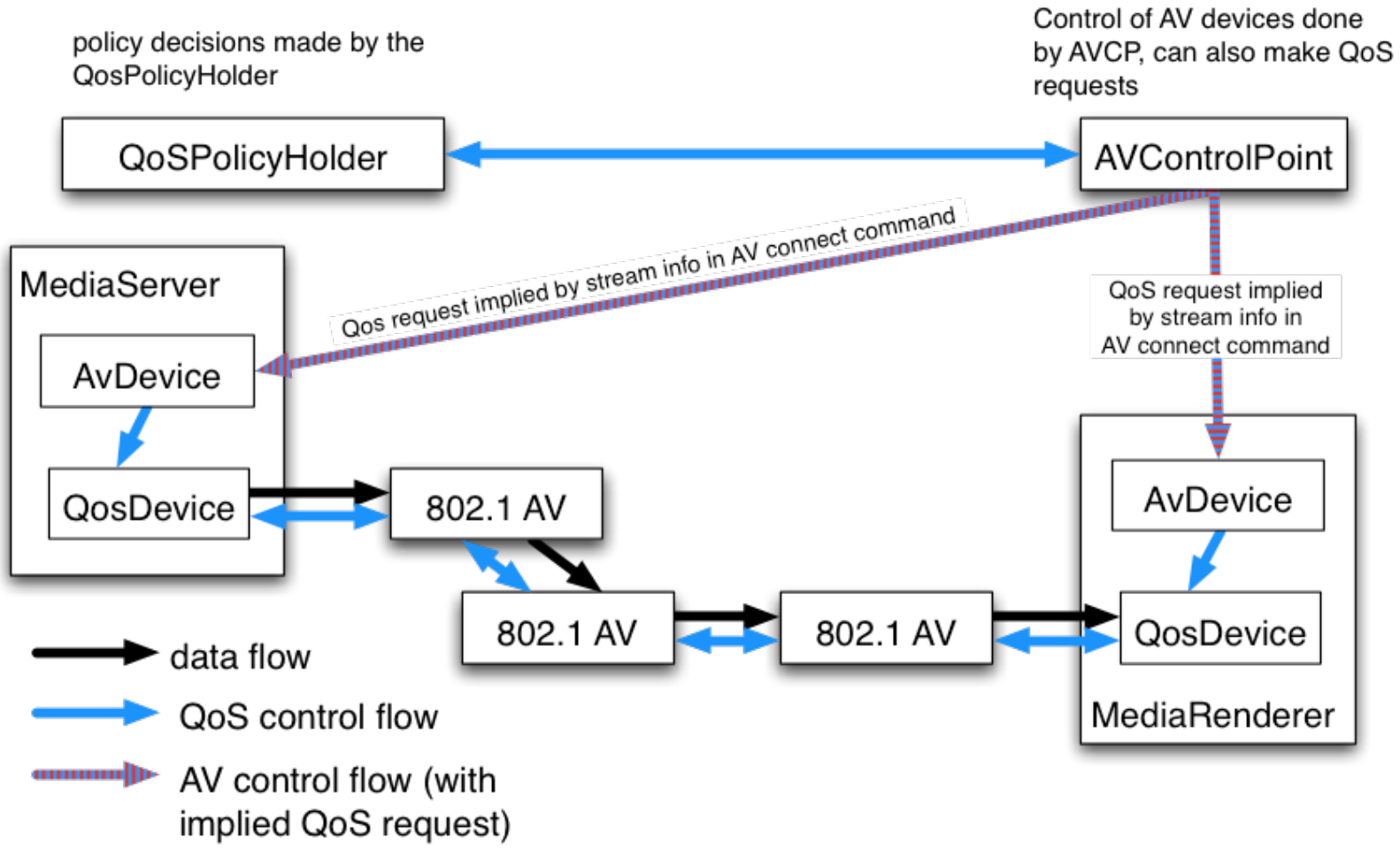
End-point API for 802.1 AV profile

- Admission control
  - Listener requests bandwidth and latency class by sending 802.1 “MRP” registration frame
  - Listener is granted or denied request when corresponding 802.1 “RESV” frame is received
  - Middleware/network stack needs to respond to 802.1 link discovery protocol, and to provide timeouts as needed
- Sending streams
  - Must use 802.1 priority tagging
  - AV streams should shape traffic (not “bunch up” frames)
- Time synchronization if needed
  - Simplified version of IEEE 1588 API
  - Helps with traffic shaping (provides well-known clock)

UPnP QoS Architecture

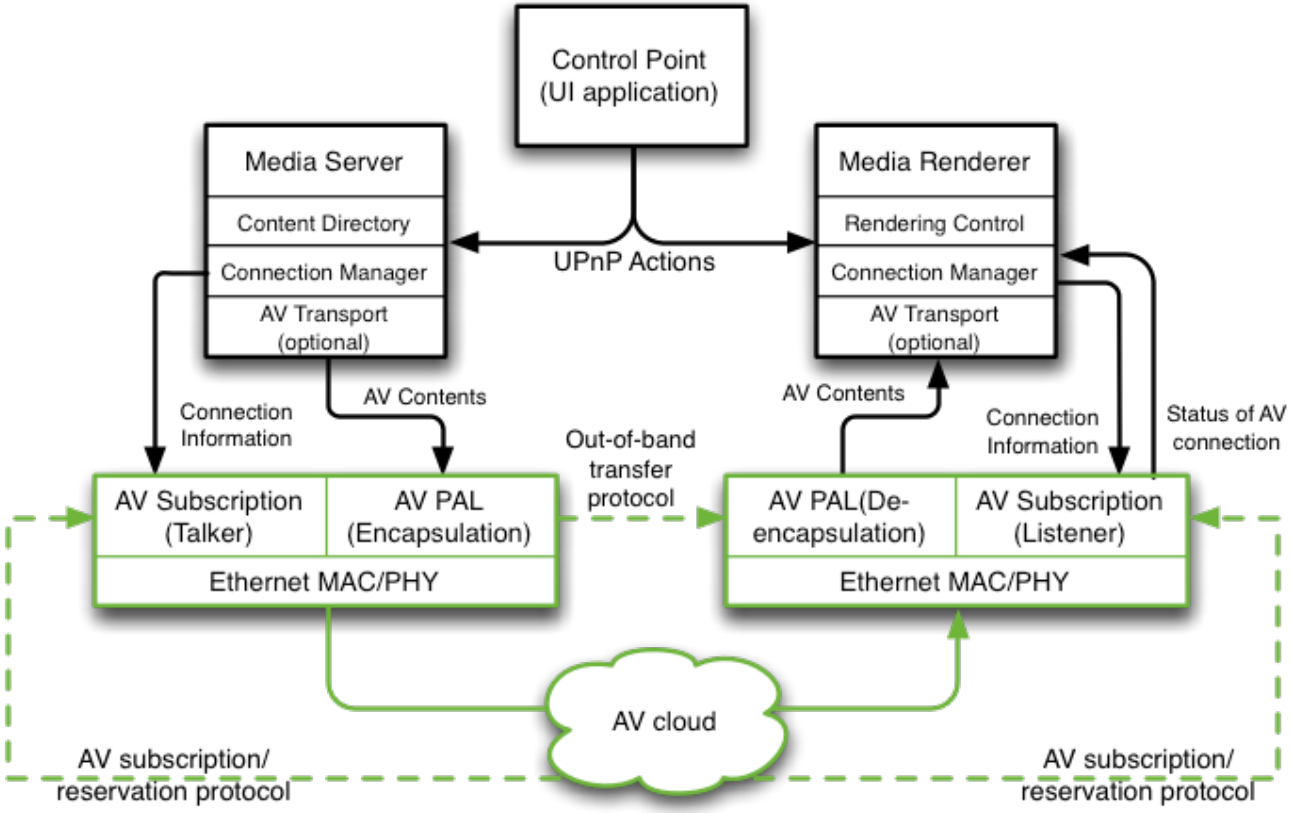


Possible simplified UPnP-QoS (1)



Possible simplified UPnP QoS (2)

- Establish reservation at AV connect



Likely mapping to Ethernet

- 802.1 (and layer 2 1588) will provide all services needed for AV QoS, except …
- 802.3 needs to provide timing information for when a particular frame is transmitted or received (within a small timing variation of perhaps 40 ns)
  - Simple to implement, a bit difficult to specify exactly how this is to be done
  - Minor change to “MAC services” in 802.1 and 802.3

Possible mapping to 802.11/WiFi

- Use of 1588 over 802.11 needs study
  - Timing services may already be available as a byproduct of 802.11 protocols
- Different queuing rules to match time-varying bandwidth available
  - Same priority tagging!
  - Very low latency traffic class(s) (e.g., 2 ms) may not make sense
  - Single “modest latency” traffic class (e.g., 32 ms) may be best
  - Expectation of success must be lower (momentary changes in RF environment)
- Same admission control protocol must be used

Possible mapping to DLNA

- Tbd -- support for both http and rtp streaming, or rtp only?
- DRM considerations/interaction with 802.1 security
- …