Leading the Next

Network Based Time-Sensitive Application Handling for Future Home and Office Environment

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Outline

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- Precise timing/synchronization transport
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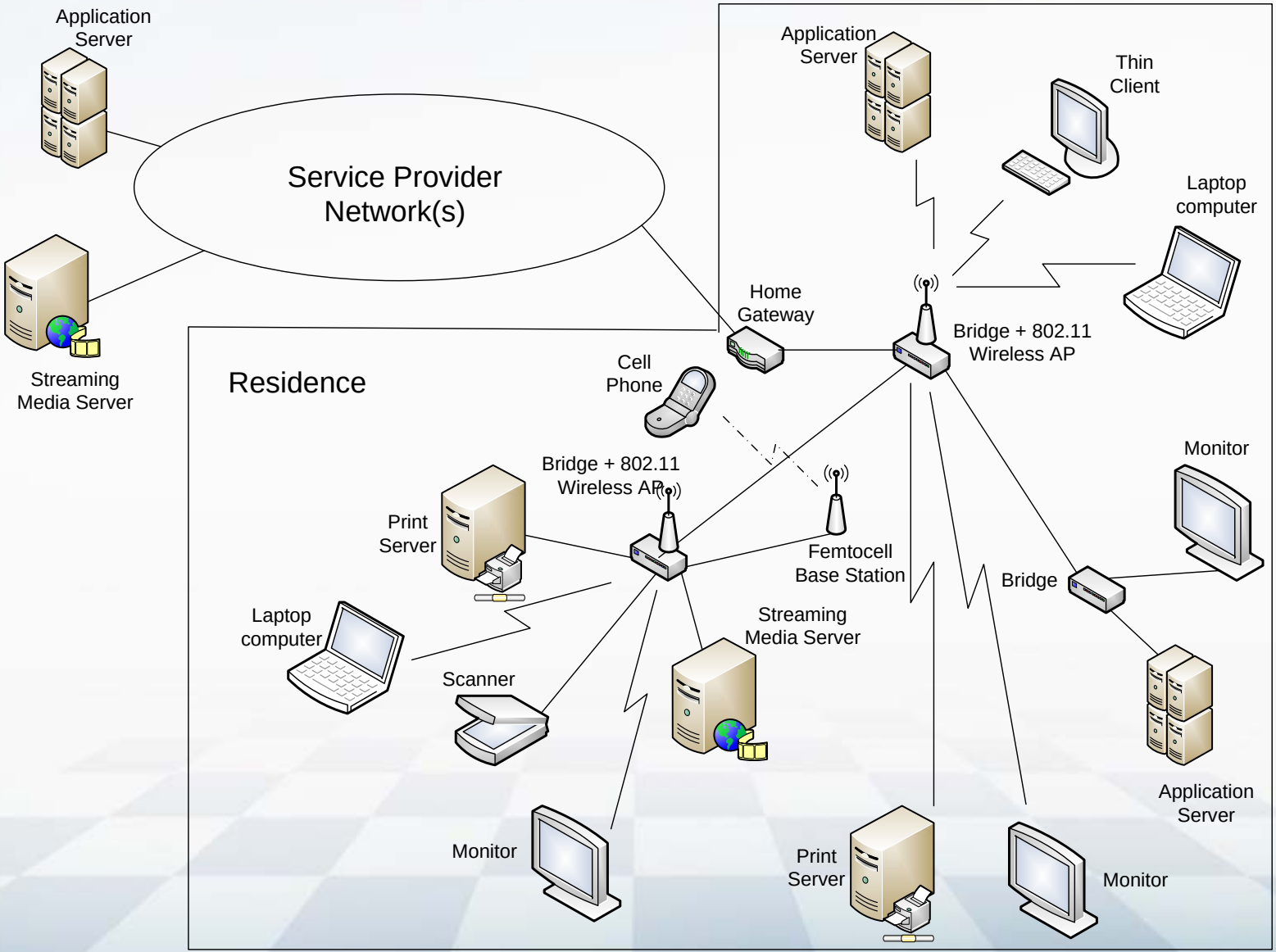
  - Use of IEEE 802.11v
- Brief overview of resource reservation and bridge forwarding and queueing
  - IEEE 802.1Qat, IEEE 802.1Qav
  - IEEE 802.11aa
- Requirements for an Audio/Video Bridging system
  - IEEE 802.1BA

Introduction

- Our goal is to allow a single network infrastructure to carry both time-sensitive and non-time-sensitive traffic
- Major uses include residence, small office/campus, studio, concert hall/theater, etc.
  - Some aspects of AVB may be used in carrier-grade Ethernet networks e.g. to convey time information over wireless backhaul links
- We have been working through the IEEE 802.1 Audio/Video Bridging (AVB) Task Group (TG)
  - To develop a set of standards for transport of time-sensitive applications over bridged LANs
  - Wired transport – IEEE 802.3 (Ethernet), Coordinated Shared Network (CSN, e.g., MoCA)
  - Wireless transport – IEEE 802.11
- AVB applications include digital video, high fidelity digital audio, gaming, traditional data traffic (non-time-sensitive)
  - In many scenarios, applications reside on media server and are rendered to display, speaker, and/or thin client
  - Media server applications may be deployed on same LAN or remotely via service provider network

Example network



Potential applications and std. activities

- A network to support all difference services
  - Multimedia mobile handset, HDTV, computer, and communication will handle the same services
- Interactive high bandwidth video stream over the network can make the “thin client” applications more feasible
  - Client device is primarily for mobile handset, display, playback, user-input, etc.
  - Client device has minimal power requirements and functionality
- Four AVB standards are under development
  - Precise timing and synchronization (IEEE 802.1AS)
  - Resource reservation (IEEE 802.1Qat)
  - Bridge forwarding and queuing, and traffic shaping (IEEE 802.1Qav)
  - Requirements of an AVB system (IEEE 802.1BA)

AVB Application Requirements

Summary of audio and video application jitter and wander requirements

Requirement	Uncompressed SDTV SDI	Uncompressed HDTV SDI	MPEG-2, with network transport	MPEG-2, no network transport	Digital audio, consumer interface (S/P-DIF)	Digital audio, professional interface (AES3)
Wide-band jitter (UIpp)	0.2 (270, 360 Mbps)	1.0 (1.5 Gbps) 2.0 (3 Gbps)	50 μs peak-to-peak phase variation requirement (no measurement filter specified)	1000 ns peak-to-peak phase variation requirement (no measurement filter specified)	0.25	0.25
Wide-band jitter meas filt (Hz)	10	10			200	8000
High-band jitter (UIpp)	0.2	0.2 (1.5 Gbps) 0.3 (3 Gbps)			0.2	No requirement
High-band jitter meas filt (kHz)	1	100			400 (approx)	No requirement
Frequency offset (ppm)	±2.79365 (NTSC) ±0.225549 (PAL)	±10	±30	±30	±50 (Level 1) ±1000 (Level 2)	±1 (Grade 1) ±10 (Grade 2)
Frequency drift rate (ppm/s)	0.027937 (NTSC) 0.0225549 (PAL)	No requirement	0.000278	0.000278	No requirement	No requirement

Note: See Reference [1] and references given there for more detail on jitter/wander requirements

Wireless Base Station Timing Requirements

Summary of wireless base station (femtocell) timing requirements

Requirement	TDMA	CDMA	GSM	CDMA2000	WCDMA FDD	WCDMA TDD
Maximum Frequency Offset (ppm)	0.5	0.05	0.05	0.05	0.05	0.05
Maximum Phase Offset (μs)	No requirement	± 10 (relative to UTC)	48/13 (GSM COMPACT; relative to other base stations)	± 10 (relative to UTC)	No requirement	2.5 (relative to other base stations)
Desired Maximum Phase Offset (not strict requirement) (μs)	No objective	± 3 (relative to UTC)	No objective	± 3 (relative to UTC)	No objective	No objective
Maximum Observation Interval for Phase Offset (s)	Not Applicable	28800 (8 hr)	Not specified	28800 (8 hr)	Not Applicable	Not Applicable

AVB Application Requirements

- AVB TG has developed a time synchronization requirement of ± 500 ns for a reference configuration consisting of 7 hops (wired or wireless) within a residence/office/studio/etc.
  - i.e., on the user side of the home gateway that separates the service provider network from the LAN on slide 4)
  - This requirement is driven by professional audio applications
- The AVB standards also define two classes of time sensitive traffic with respect to guaranteed latency
  - The precise values for the latency guarantees will be in IEEE 802.1BA
  - Class A: latency not to exceed 2 ms over 7 hops
  - Class B: latency not to exceed 20 ms over 7 hops
    - note: the value of 20 ms is still under discussion in the 802.1 AVB TG

Precise Timing and Synchronization

- IEEE 802.1AS (see Reference 2) includes the following elements
  - **Specifications for timing transport over full-duplex 802.3 (Ethernet) links** using a profile of IEEE Std 1588™ – 2008 Precision Time Protocol (PTP) (see Reference 3)*
  - **Specifications for timing transport over 802.11 wireless links using facilities** provided by IEEE Std 802.11v (see Reference 4)
  - Additional specifications to ensure acceptable jitter, wander, and time synchronization performance for AVB applications
- IEEE 1588V2 is a very general protocol specification for transporting timing over LANs and WANs by time stamping the departure and arrival of messages sent between nodes
  - Intended for a wide variety of application areas, e.g., telecommunications, industrial automation, test and measurement, consumer electronics, etc.
  - **Primarily a protocol specification, i.e., does not include specifications to guarantee timing performance**
  - Provides for the specification of *PTP profiles* by application areas (e.g., standards bodies) that will specify the IEEE 1588 options used by that application

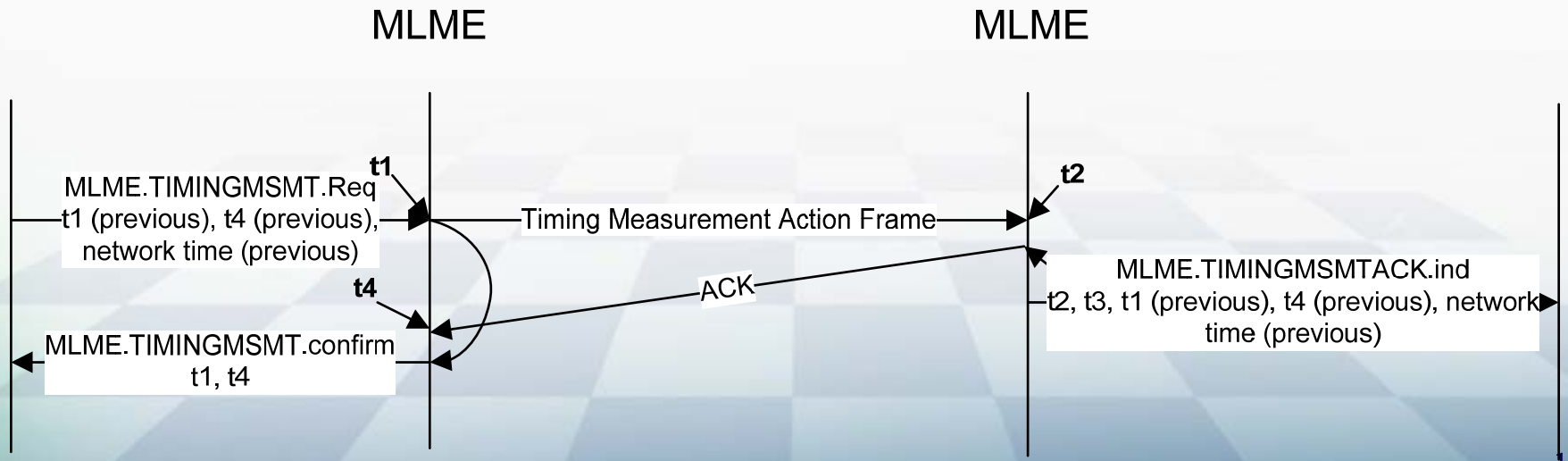
* Informally referred to as IEEE 1588V2
An informative annex of 802.1AS will describe timing transport over a CSN using the same profile

Synchronization Basics in 802.1AS PTP Profile

- Sources of inaccuracy in time synchronization
  - Link asymmetry
    - Can only be corrected for via separate measurement; i.e., the PTP protocol does not transport sufficient information to determine the asymmetry
  - Variable latency in the PHY
  - Timestamp measurement granularity
  - Clock noise/drift
  - In performing averaging/filtering, the accuracy improvement depends on how fast the phase error is varying, relative to the filter bandwidth
    - The filter is more effective at reducing inaccuracy due to fast variation relative to the filter bandwidth

Synchronization over 802.11 links

- Synchronization over 802.11 links in 802.1AS uses the same basic principles described above for 802.3 links
  - The 802.11v TG is developing a timing measurement (TIMINGMSMT) facility that will be part of the Mac Layer Management Entity (MLME)
  - With this facility, a master node can cause a time stamped message exchange with the slave via a service interface request primitive
  - The timestamp values are provided to the slave via an indication primitive
- IEEE 802.11v and its use by 802.1AS are under development
  - 802.1AS will use the timing facility being developed in the 802.11v TG for location determination



Stream Reservation

- IEEE 802.1Qat (see Reference 5) specifies a Multiple Stream Reservation Protocol (MSRP) that is used to reserve resources in each bridge along the stream's paths
  - The resources are reserved to ensure that the required QoS for the stream can be provided
  - MSRP makes use of Multiple Registration Protocol (MRP) (see Reference 6)
- IEEE 802.1Qat describes *talkers* and *listeners*
  - A time-sensitive stream originates at a talker, and is received by one or more listeners
- In MSRP, a talker announces that a stream can be supplied, and gives the characteristics of the stream
  - Each bridge in the path can determine whether it has the resources to support the stream from information on the streams that are already being transmitted through the bridge
  - The bridge maintains information on whether it currently can carry the stream
  - Listeners can choose to receive registered streams for which the bridges in the path have adequate bandwidth to carry
  - The MSRP protocol uses functions provided by MRP (see Reference 5 for details)

Bridge Forwarding and Queueing

- IEEE 802.1Qav (see Reference 7) specifies a means for a bridge to determine if it has adequate resources (mainly bandwidth) such that the desired latency of a stream being announced can be provided
- To do this, IEEE 802.1Qav describes a credit-based shaper algorithm that operates on outbound queues
- The MSRP protocol defined in IEEE 802.1Qat makes use of IEEE 802.1Qav to determine if a bridge can carry a stream that a talker has announced

QoS Guarantees on Wireless Links

- Work is ongoing in the IEEE 802.11aa Robust Audio Video Transport Streaming Task Group to provide QoS guarantees for time-sensitive Audio/Video streams
  - The work is being coordinated with the work in the AVB TG
  - The 802.1 AVB TG and 802.11 VTS SG have joint meetings at each IEEE 802 plenary
- The precise relation between 802.11aa and the AVB standards is still being developed
  - Expected that the AVB standards will use facilities provided by 802.11aa to provide guaranteed QoS, just as 802.1AS uses the facilities of 802.11v to transport timing and synchronization
  - It is possible that the TSpec provided by 802.1Qat will be mapped to the TSpec expected by 802.11aa

Summary and Conclusion

- Convergence effort to carry more services through network will be important in terms of resource saving and creating new services.
  - The AVB standards being developed in IEEE 802.1 will allow the transport of time-sensitive, audio/video applications in a bridged LAN
  - Enhancement of transport over 802.11 wireless networks should be considered for interactive and convergence services
  - The AVB standards will use facilities being provided by IEEE 802.11v for timing and synchronization and 802.11aa for audio/video stream QoS
- In order for these facilities to be available, they must be provided as part of new wireless technologies
  - In particular, 802.11v time stamping capabilities, messages, and service primitives must be provided in the 802.11 PHY and MAC
  - Standard cooperation between densely deployed wireless base stations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Thank you for your attention!
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References

1. Geoffrey M. Garner, *End-to-End Jitter and Wander Requirements for ResE Applications*, presentation at May, 2005 IEEE 802.3 ResE SG meeting, Austin, TX, USA, May 16, 2005.
2. IEEE P802.1AS/D4.0, *Draft Standard for Local and Metropolitan Area Networks – Timing and Synchronization for Time Sensitive Applications in Bridged Local Area Networks*, August 26, 2008.
3. *IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems*, IEEE Std 1588™ – 2008, 24 July, 2008.
4. IEEE P802.11v™/D3.01, *Draft Standard for Information technology -Telecommunications and information exchange between systems - Local and metropolitan area network - Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications, Amendment 8: Wireless Network Management*, August, 2008.
5. IEEE P802.1Qat/D1.3, *Draft Standard for Local and Metropolitan Area Networks – Virtual Bridged Local Area Networks - Amendment 9: Stream Reservation Protocol (SRP)*, May 19, 2008.
6. IEEE P802.1ak™-2007, *IEEE Standard for Local and metropolitan area networks—Virtual Bridged Local Area Networks, Amendment 7: Multiple Registration Protocol*, 22 June 2007.
7. IEEE P802.1Qav/D3.0, *Draft Standard for Local and Metropolitan Area Networks – Virtual Bridged Local Area Networks - Amendment XX: Forwarding and Queueing Enhancements for Time Sensitive Streams,* July 11, 2008.