Timing Measurement Enhancement for Synchronization of AV streams

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Name	Company	Address	Phone	email
Kevin Stanton	Intel Corporation	JF2-53, 2111 NE 25th Avenue, Hillsboro OR	+1 (503) 712 - 1888	kevin.b.stanton@ieee.org

Abstract

p802.1AS specifies a precise time synchronization protocol and architecture intended to operate across multiple 802 LANs. The task group is initially targeting support for 802.11 and 802.3, and MAC-level support for the timing-offset measurement is required.

The accompanying proposal (11-06-1614-00-000v) recommends modifications/additions to the Presence feature of the p802.11v draft in support of precise multi-MAC timing synchronization.

Motivation

- **Wireless speakers have strong customer demand**
  - Diffusion Group: 53% want
- **Most homes have both 802.11 *and* 802.3**
- **Multi-speakers/displays requires Time Synchronization**
  - Both for simultaneous "Start" and to counteract long-term drift
  - 11us for tightly coupled stereo
  - 15-45ms for lip sync
- **Time synchronization required for "media push" and multicast**
- **MAC-client-only solutions lack accuracy and guarantees**

> 802 Time synchronization standard needed over heterogeneous LANs
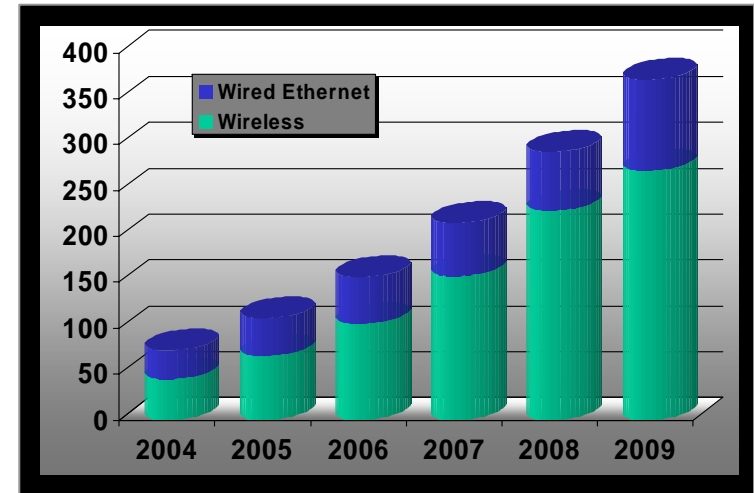
Source: Home Networking Nodes (IDC Aug'05)
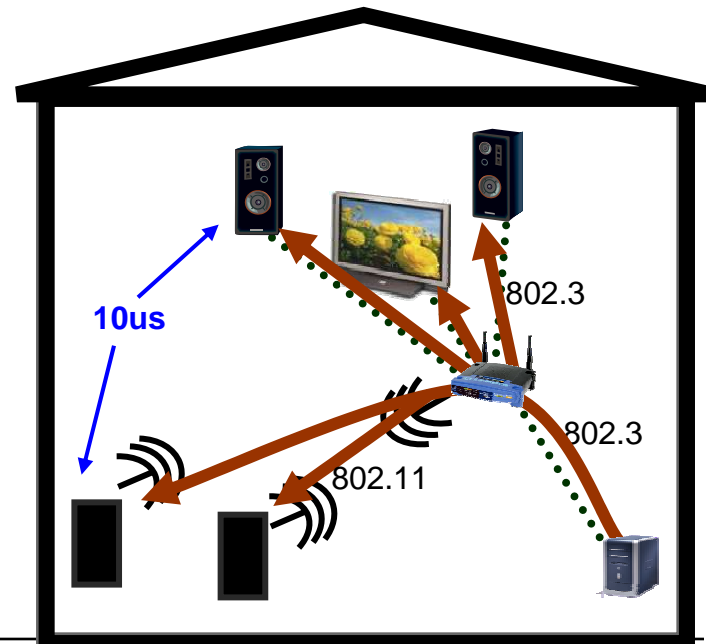
Standards from the
802.1 Audio/Video Bridging Task Group

- **p802.1AS – Time Synchronization**
  - Based on emerging IEEE 1588 version 2
- **p802.1Qat—Stream Reservation Protocol**
  - Used to reserve bandwidth for streams
  - Admission Control
- **[802.1Qav]—Traffic Shaping**
  - Bandwidth & latency guarantees
- **802.1???—Recommended Practice**
  - Specifies network parameters
  - Defines a "defended network"

Effort now comprehending both wired and wireless LANs

802.11 feedback yesterday asked for 802.1Qav PAR to include 802.11

Location estimation: 802.11 TGv using TOA

Goal: Measure distance between 802.11 entities (in ns)

1. **Requester schedules M1 for Tx**
2. **As it passes through the PHY, t1 captured**
   - Using requester clock
3. **Time t2 captured in PHY on Rx**
   - Using slave clock
4. **Responder MAC automatically sends M1 ACK very quickly (a control frame)**
5. **t3, t4 captured as above**
6. **M2 carries** (t3-t2) **to requester**

If link delay is fixed & symmetric:

Link delay = [(t4-t1) – ($t3$-$t2$)] / 2

Clock offset between master and slave
  = [($t2$-t1) – (t4-$t3$)] / 2

BUT Requester doesn't know t3 and t2…

Timestamps known by Requester

t1

t-ms

t1, t4

t-ms

t1, (t3-t2), t4

Requester   Responder

t1

Presence Request
M1

t2
t3

M1 ACK

t4

Presence Response
M2: (t2-t3)
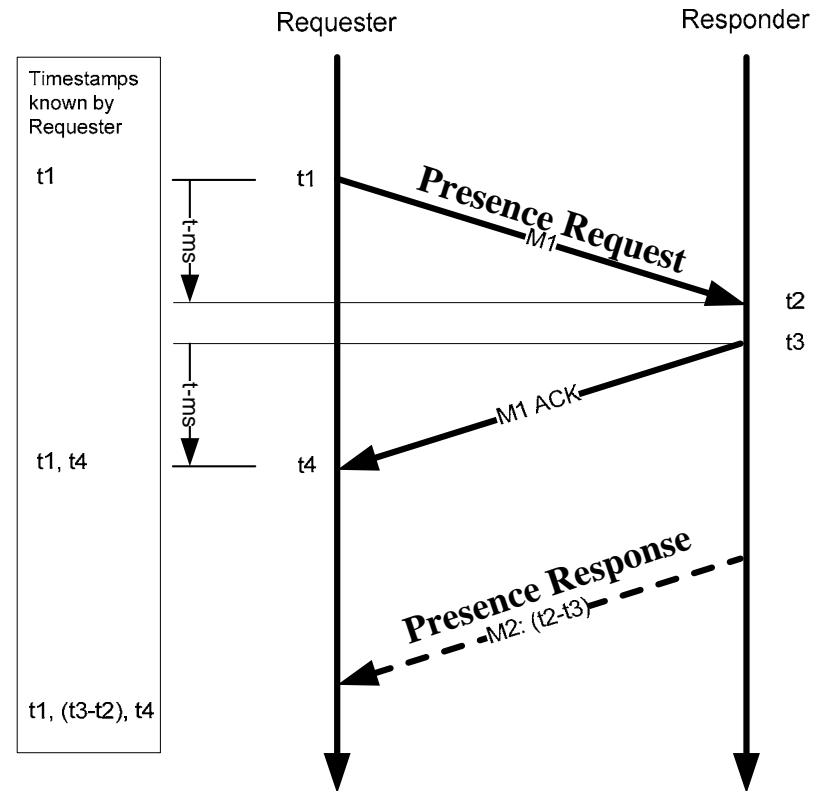
Backup

[Slides from my previous, 5/20/06 presentation 11-06-0984-00-000v]

Time Synchronization:

A high level view

- **Grand Master selected**

- **Clock tree established**

- **Offset to Grand Master determined**
  - Per "Link"
  - Accumulated downstream

- **Time service provided to MAC client**

Grand Master STA S1

802.11

AP A1

802.3

STA S2

STA S3

AV Bridge 1

.3 Client C3

AP A2

AV Bridge 2

STA S3

STA S4

.3 Client C1

.3 Client C2
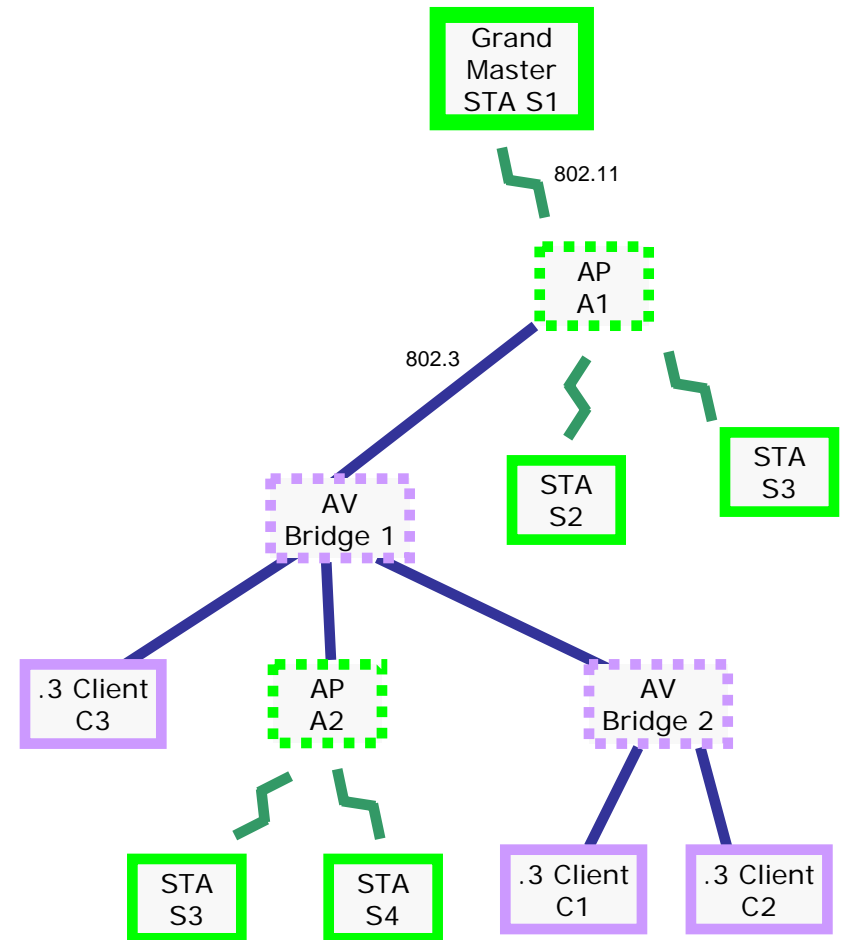
Time sync with IEEE 1588v1
[Similar to a proposed method for 802.1AS]

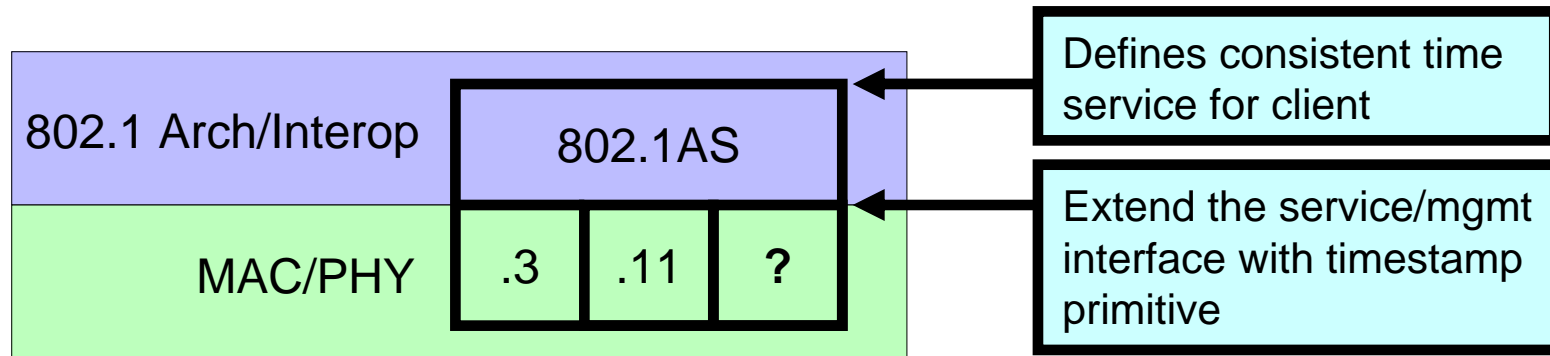**Goal: Synchronize clocks of networked nodes**

1. **Master schedules SYNC (M1) for Tx**
2. **As it passes from MAC to PHY, t1 captured**
   - Using master clock
3. **Time t2 captured as passes from PHY to MAC**
   - Using slave clock
4. **FOLLOWUP (M2) carries t1 to slave**
5. **Slave schedules M3 for Tx**
6. **t3, t4 captured as above**
7. **M4 carries t4 to slave**
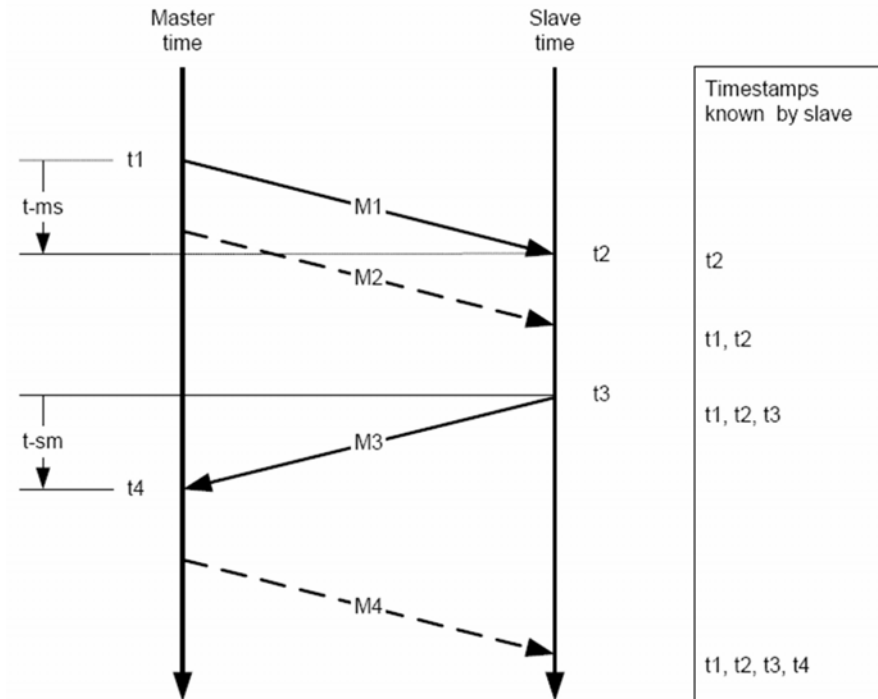
If link delay is fixed & symmetric:

Clock offset between master and slave
   $$= [\ (t2\text{-}t1) - (t4\text{-}t3)\ ]\ /\ 2$$

Our approach in 802.1

802.1 Arch/Interop	802.1AS		
MAC/PHY	.3	.11	?

Defines consistent time service for client

Extend the service/mgmt interface with timestamp primitive

- **Interoperability, client time service**
- **Protocol:**
  - Include "Generic Messages Protocol" recommendation
  - Media may use the "Generic Messages"or define their own
- **Measurement:**
  - Define extension to MAC Service Interface to get timestamp information
  - Define measurement accuracy options, as appropriate for application