Support for IEEE 802.1AS Time and Synchronization Call for Interest

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Supporters

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- Howard Frazier – Broadcom
- Michael Johas Teener – Broadcom
- Adam Healey – LSI Corporation
- Wael Diab – Broadcom
- Mike Bennett – LBL
- Brad Booth – AMCC
- Karl Ruling – ESTA
- John D'Ambrosia – Force10
- Amit Oren – Broadcom
- Larry Green – Ixia
- Kyusang Lee - Actus Networks
- J. Kevin Rhee - KAIST

- ChanKyun Lee - KAIST
- Jongyoon Shin - ETRI
- Seunghwan Kim – ETRI
- Geoffrey Garner – Samsung
- Eric Ryu – Samsung
- Hugh Barrass – Cisco
- Laurent Montini - Cisco

Why Are We Here

- To measure the **interest** in forming an 802.3 Study Group to investigate:
  - Providing support in 802.3 for IEEE 802.1AS by
    - Providing an accurate indication of the transmission and reception initiation times of certain packets

- **Not to**
  - Fully explore the problem
  - Debate strengths and weaknesses of solutions
  - Choose a solution
  - Write a PAR and 5 Criteria
  - Write a standard or specification

Why now ?

- Work in this area has been ongoing since July of 2004 with the 802.3 Residential Ethernet SG

- RESG work was transferred to 802.1 in 2005 as the Audio/Video Bridging group

- 802.1 is working on a suite of Audio/Video Bridging protocols

- 802.1AS Timing and Synchronization is what 802.3 is being asked to support

- Other applications that use IEEE-1588 (carrier, industrial Ethernet) might benefit from this work

Why now?

- *Links to Residential Ethernet CFI and SG work*
- ***http://ieee802.org/3/re_study/public/200407/cfi_0704_1.pdf***
- ***http://ieee802.org/3/re_study/index.html***
- *Links to 802.1 Audio Video Bridging TF*
- ***http://www.ieee802.org/1/pages/avbridges.html***

Goals for Tonight

- ## Presentations:
  - 802.1AS Time Sync Requirements for 802.3
  - 802.1 & 802.3 Recent Cooperative Efforts
  - CFI Poll
- ## Straw Polls
- ## Q&A

802.1AS Time Synch Requirements for 802.3

Michael Johas Teener

802.1 AVB TF Chair

Agenda

- Relationship between 802.1AS and IEEE 1588
- Fundamental requirements for 802.1AS
- Delay calculations
- Accuracy and resolution requirements
- Statement of the problem

Note: This material has been reviewed by others in the 802.1 AVB Task Group, but does not represent a formal position of the Task Group

Time Synch Standards

- The IEEE supports two related time synchronization standards: IEEE-1588 and 802.1AS

- Both need the same facilities from 802.3:
  - Notification of "start of frame" actually being transmitted at a well known point in the physical medium (e.g. the MDI)
  - Notification of "start of frame" being received at the same point
  - Some kind of reporting of the accuracy of the notification

- The rest of this presentation is done from the point of view of P802.1AS standardization
  - since IEEE-1588 has exactly the same requirements (http://ieee1588.nist.gov/)
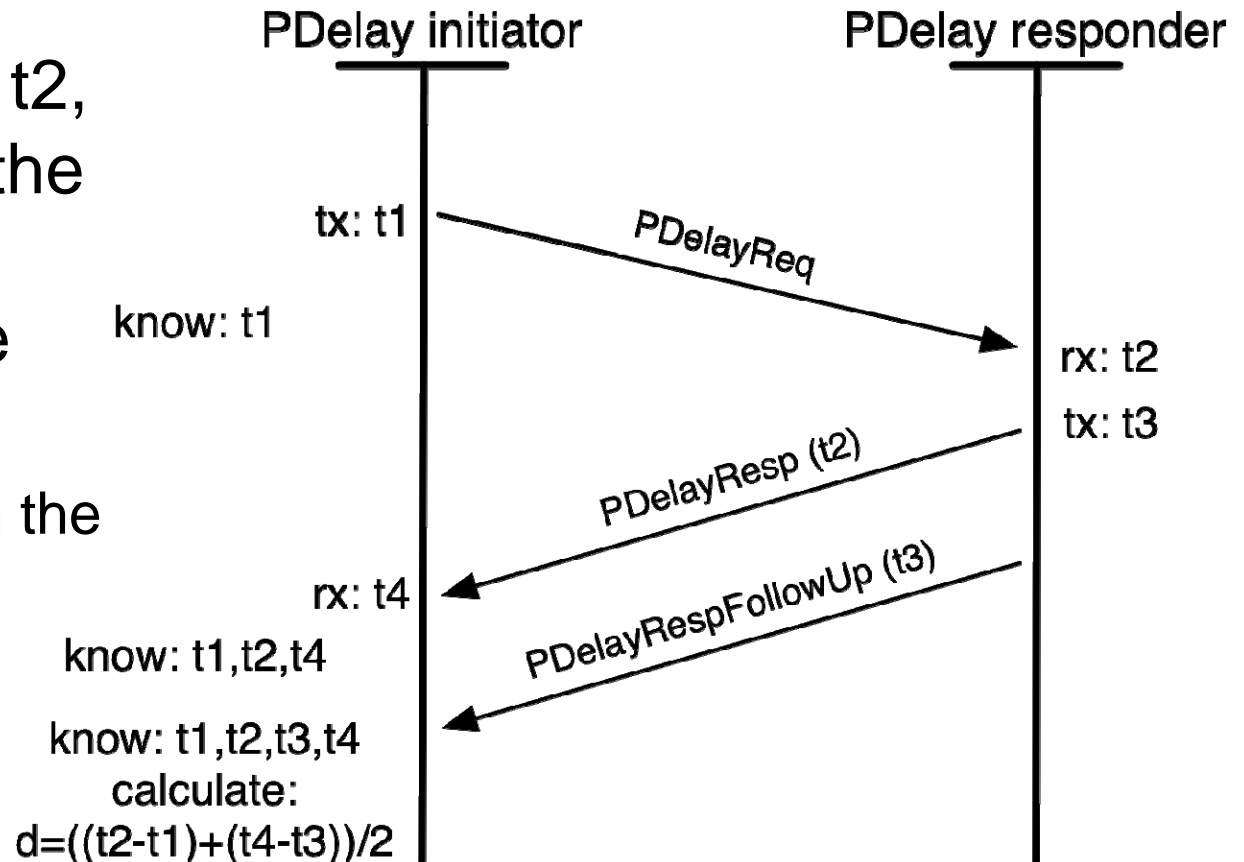
1588 and 802.1AS differences

- IEEE 1588-2008 is the 2nd generation "Precision Time Protocol" based on full duplex point-to-point networks.
  - Many options, can run directly above L2 or above IPv4 or IPv6
  - Loosely defined "boundary clock" operation, no definition of services to higher layers
  - Supports non-802 L2 connections
- P802.1AS is both a subset and a superset of 1588
  - Runs as a profile of 1588 directly above 802.3 as an L2
    - almost no options, much simpler
    - very tightly defined algorithms for predicable performance, services for higher levels are defined
    - compatible extensions to support very fast "grand master" switchover
  - Superset of 1588 to allow various "coordinated shared media" operation, e.g. 802.11 and "generic CSN"

Fundamental requirements

- 802.1AS needs to measure how long it takes for an event to travel from a master clock ("grand master") to a slave clock ("ordinary clock")

- The accuracy and resolution of that time measurement directly affects the accuracy and responsiveness of 802.1AS implementations

- There are two basic procedures within 802.1AS that need to know the exact time of an 802.3 event:
  - measuring the delay time of an event through a network link (one cable hop)
  - propagation and correction of a time synchronization signal through the network (time offset)
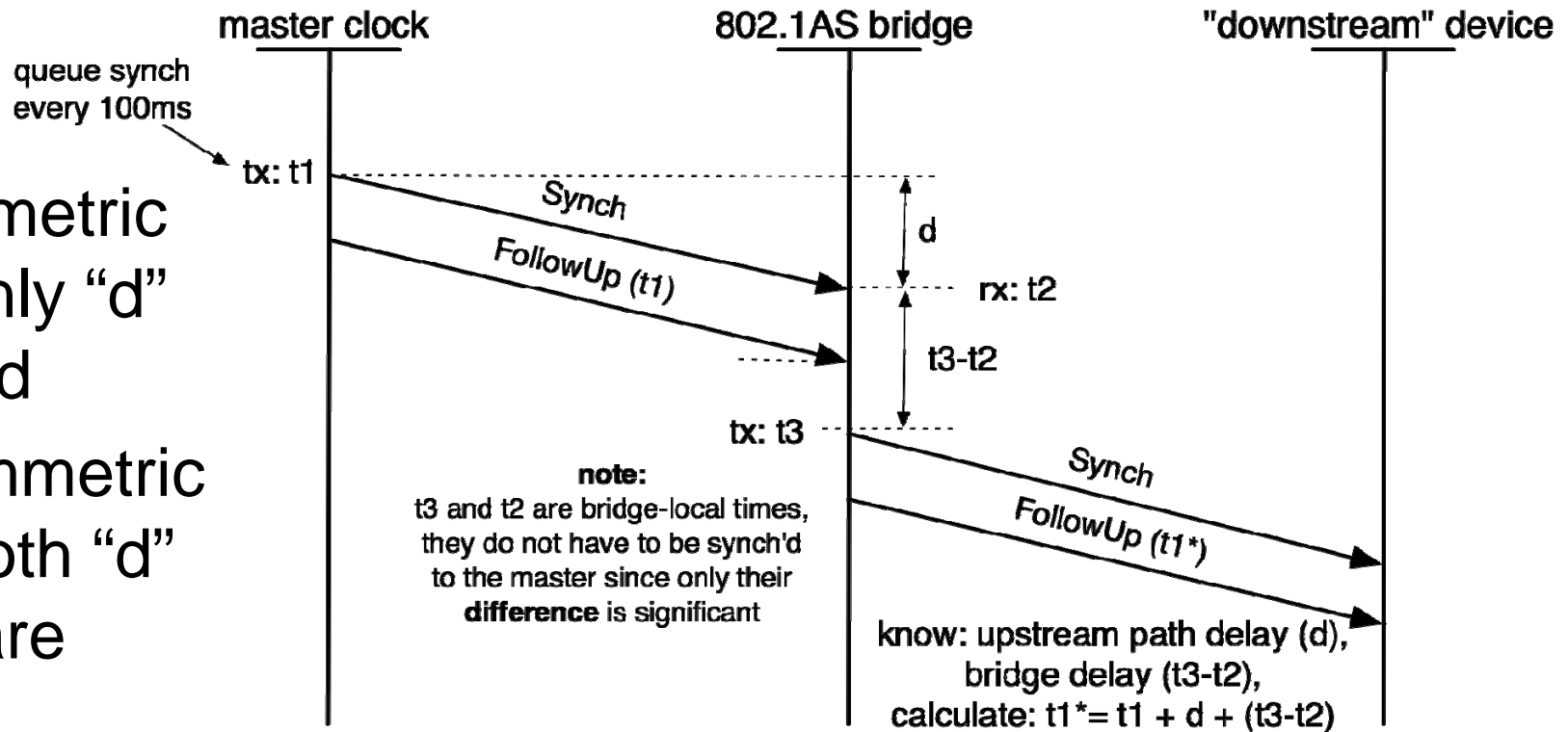
Delay calculations

- Process requires t1, t2, t3 and t4 *and* that the propagation time in both directions is the same
  - or the offset between the two is known

PDelay initiator   PDelay responder

tx: t1   PDelayReq   rx: t2

know: t1   tx: t3

PDelayResp (t2)

rx: t4   PDelayRespFollowUp (t3)

know: t1,t2,t4

know: t1,t2,t3,t4
calculate:
$d=((t2-t1)+(t4-t3))/2$

- For known fixed extra delay "x" for t1->t2 direction:
  - $d=((t2-t1-x)+(t4-t3))/2$

Time offset calculation

master clock

802.1AS bridge

"downstream" device

queue synch
every 100ms

tx: t1

Synch

FollowUp (t1)

d

rx: t2

t3-t2

tx: t3

note:
t3 and t2 are bridge-local times,
they do not have to be synch'd
to the master since only their
difference is significant

Synch

FollowUp (t1*)

know: upstream path delay (d),
bridge delay (t3-t2),
calculate: t1*= t1 + d + (t3-t2)

- For symmetric paths, only "d" is needed
- For asymmetric paths, both "d" and "x" are needed:

  –t1* = t1 + d + x +(t3-t2)

  –(note that "d" is the delay from ingress, while "x" is the offset from egress)

Accuracy and resolution requirements

- Most applications of 802.1AS assume:
  - measurement granularity (resolution) of time is ±20ns
    - actually 0-40ns because truncation is assumed
  - local clocks are accurate with 100ppm
  - delay is symmetric within (*a*) and does not change more than (*b*)
    - (*a* and *b* are numbers that are TBD, but small)

Standards problem for 802.1AS

- 802.1AS for 802.3 specifies the "tn" measurement point as the start of frame at the cable interface
  - there is no place in any 802.3 standard which provides this information
  - the AVB TG needs this to be nicely integrated into an 802 architecture

802.1 & 802.3
Recent Cooperative Efforts

Support for 802.1AS precise
time synchronization protocol
Call For Interest
David Law
3Com Corporation

IEEE Std 802.3ac-1998 VLAN tag

- Amendment project to IEEE Std 802.3 to accommodate the addition of a four octet VLAN tag field

- Project initiated at the request of 802.1 WG in July, 1997 and completed by September, 1998

- Five members of the 802.1 WG and five members of the 802.5 WG were allowed to participate in the 802.3 WG ballot on the draft standard

IEEE Std 802.3ad-2000 Link Aggregation

- Amendment project to IEEE Std 802.3 to allow multiple physical links to be logically bundled together for greater bandwidth and resiliency

- Essentially a joint effort, with significant participation and contribution from members of the 802.1 WG

- Recently moved to IEEE Std 802.1AX-2008

IEEE Std 802.1AE-2006 MAC Security

- Initially "incubated" within 802.3 EFM task force (primarily motivated by EPON)

- Spawned a CFI, which led to the creation of the Link Security Executive Committee Study Group

- Resulted in the generation of 802.1AE and 802.1af (key security – subsumed into 802.1X-REV)

Get IEEE 802®

- Program in which IEEE 802 standards are made freely available six months after initial publication

- Supported in large measure by financial contributions from everyone who attends IEEE 802 plenary sessions

- Initial concept raised by the 802.1 WG, and forcefully advocated by the 802.3 WG

IEEE Std 802.3as-2006 Frame Format Extensions

- Amendment to IEEE Std 802.3 to support "envelope frames" for applications such as provider bridges and MAC Sec

- Initiated in July, 2004 and completed in September, 2006

Congestion management

- Some initial work performed in 802.3 Backplane Ethernet task force

- Eventually moved to 802.1 Data Center Bridging Task Group

- Resulted in generation of 802.1Qau Congestion Notification, 802.1Qaz Enhanced Transmission Selection, and 802.1Qbb Priority-based Flow Control

  – 802.1 will be modifying IEEE Std 802.3 Annex 31A as part of a project numbered 802.3bd to support priority-based flow control

Logical Link Discovery Protocol

- 802.1AB defined LLDP, and included a provision for Ethernet specific Type/Length/Value (TLV) assignments

- The Ethernet specific assignments are in the process of being moved from IEEE Std 802.1AB to IEEE Std 802.3 via the 802.3bc project

Audio/Video Bridging

- Call for interest in July, 2004

- Initiated as the "Residential Ethernet" Study Group within the 802.3 WG

- Moved to 802.1 "Residential Bridges" task group in November, 2005

- Generated 802.1AS Timing and Synchronization, 802.1Qat Stream Reservation Protocol, and 802.1Qav Forwarding and Queuing Enhancements for Time-Sensitive Streams

Conclusions

Conclusions

- Co-operation between 802.1 and 802.3 has been a long-standing practice to ensure that there is a cohesive set of 802 standards

- The work under discussion is a follow-on to the RESG project started in 802.3 in 2004

- When the Residential Ethernet work moved to 802.1 (AVB TF) it was understood that there would likely be a need for a companion project in 802.3

- The time has come

Call for Interest

At the closing plenary, request that 802.3 form a study group to develop a standards project proposal (PAR and 5 Criteria) for Ethernet support for the 802.1AS time synchronization protocol.

Yes: 72   No: 0

Poll #1

How many people are in the room?

94____

51____802.3 Voters

Poll #2

A Study Group to investigate Ethernet time synchronization protocol support for IEEE 802.1AS

I would support and participate in this Study Group:

Total individuals: __38___

Total 802.3 Voters: 23_____

Poll #3

A Study Group to investigate Ethernet time synchronization protocol support for IEEE 802.1AS

My company would support and participate in this study group:

Total companies

Yes: __26___

Poll #4 Meeting Planning

I will attend the Ethernet time synchronization protocol support for IEEE 802.1AS Interim Study Group Meeting in May:

Yes: ___20__ No:_5____

More Q & A

Next Steps

- Request 802.3 to authorize formation of the Study Group at the 802.3 Closing Plenary
  - Request 802.3 to setup the SG email reflector
  - Inform the 802 SEC of the SG
  - Schedule and plan a meeting of the SG at the May 802.3 Interim

Thank You!