Support for IEEE 802.1AS Time and Synchronization
Call for Interest

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Supporters

- David Law – 3Com
- Steve Carlson – HSD
- 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/index.html](http://ieee802.org/3/re_study/index.html)
- Links to 802.1 Audio Video Bridging TF
- [http://www.ieee802.org/1/pages/avbridges.html](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 2\textsuperscript{nd} 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 predictable 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 \( t_1, t_2, t_3 \) and \( t_4 \) *and* that the propagation time in both directions is the same
  - or the offset between the two is known

- For known fixed extra delay “\( x \)” for \( t_1 \rightarrow t_2 \) direction:
  - \( d = ((t_2 - t_1 - x) + (t_4 - t_3))/2 \)
Time offset calculation

- 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!