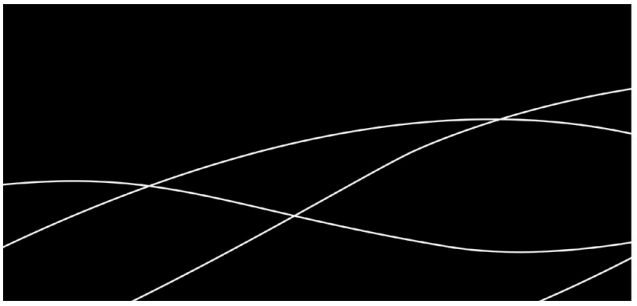
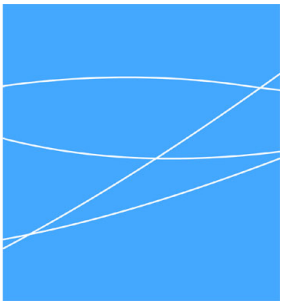




Evolution to Next-Generation Telecommunication Synchronization Networks (Intra-Office Focus)

ITSF November 2004

George Zampetti

Symmetricom

The SSU(TSG) Interface

Symmetricom

Is it time for a facelift?

- The TSG concept has stayed the same for over two decades!
- Set of output sync signals (T1, E1, CC …) has remained unchanged (barring a few enhancements such as output protection, clock performance, management etc.)
- An output signal that supports two-way half duplex operation on existing cables looks very promising

Why Change? (30,000 ft View)

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- Sync Cable Plant Management
  - How accurate are my cable assignment records?
  - Do I really have diverse feeds and output cards?
  - How many terabits of service are really supported by this output card/cable?
  - How can I keep future cabling installation costs low?
  - Do I have the correct phase for my CC references?
- Synchronization QOS
  - How can I keep FCC–Reportable Outages traced to sync very low?
  - How can I pinpoint and resolve a sync trouble that is downstream of the office TSG?

Why Change? IP Is Coming

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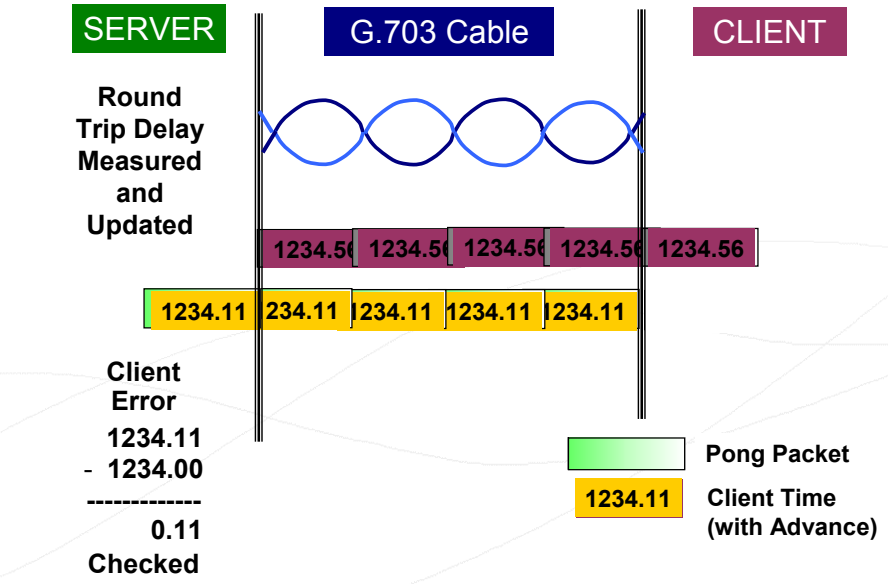
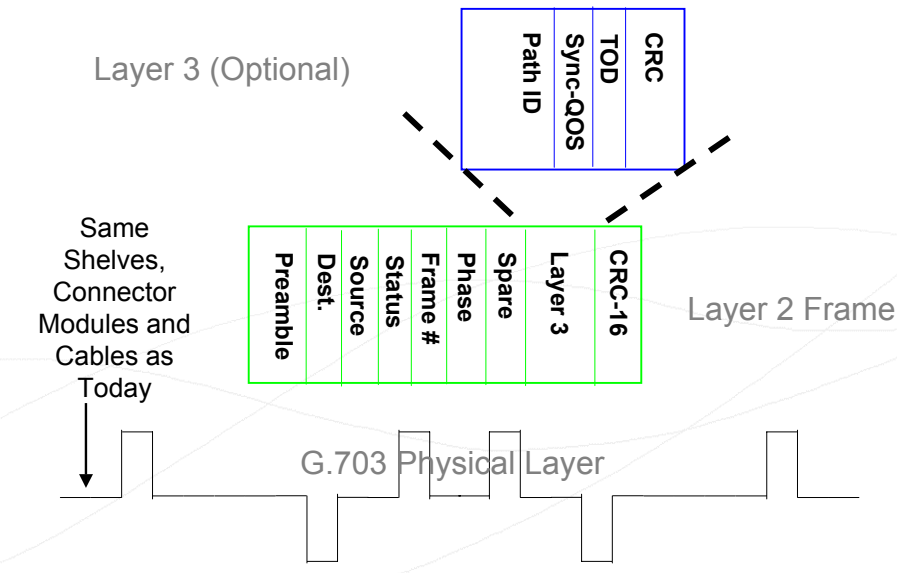
- Is Quality of Service (QoS) important?
  - Measurements such as one-way latency requires time of day.
  - How should I distributed time of day in a central office?
- Are real-time voice-over-IP and video-over-IP on the horizon?
  - Then QoS and associated Service Level Agreements will need to be supported.
  - Circuit-packet boundaries (media gateways) may need both time and frequency synchronization.
- Will QoS enhancements such as DiffServe and MPLS require pro-active packet scheduling?
  - Routers will need both time and frequency synchronization.

Two-Way Concept



Two-Way Protocol



Two-Way and IEEE 1588

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- IEEE 1588 is the Precision Timing Protocol (PTP) standard sponsored by the IEEE Technical Committee on Sensor Technology of the Instrumentation and Measurement Society.
- "IEEE 1588 addresses the clock synchronization requirements of measurement and control systems." http://ieee1588.nist.gov/intro.htm
- 1588 is a relatively new timing protocol (standard approved September 2002).
- It is a two-way timing protocol and as will be discussed it is the two-way capability of a timing protocol that provide much of the core benefits.
- "Applicable to local area networks supporting multicast communications (including but not limited to Ethernet)"-John Eidson; Agilent, Feb. 2004 NIST Sync Workshop. Although Ethernet is getting most of the attention 1588 is not restricted to Ethernet and could be supported over other layer 2 distribution (for example the current BITS distribution could be migrated to support 1588).
- "NORTEL NETWORKS proposed that IEEE 1588 be adapted [for Metro Ethernet sync Transport to the Edge]. Positioned as a precision timing service over Metro Ethernet demarcations into Enterprise VPN" –Michael Ouellete,Glen Algie; Nortel, Feb 2004. NIST

IEEE1588 in Two-Way Context

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- In telephony frequency distribution is based on "one-way" distribution from the master (server) to the slave (client).
- Two way timing protocols are fundamentally different in that time is actively transferred in both directions. This provides two key benefits.
  - First, it provides a way to verify that the transport channel latency is sufficiently stable and allows the **elimination of time error** between the two clocks.
  - Second, it provides a continual verification that the **client is properly locked** to the master.
- In general, the lower in the protocol stack the two-way time transfer operated, the better the performance. (Physical layer time tagging is the best)

IEEE1588 in Two-Way Context

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- 1588 is one of many two-way timing protocols. Some other key ones are:
  - **Network Timing Protocol**: is the ubiquitous IP timing protocol operated over layer 3 of the stack. NTP can operate sub-millisecond in a controlled LAN environment but is typically limited to tens of milliseconds is wider distribution applications. It is also a "best effort" type protocol so it can't guarantee a performance level.
  - **Two-Way Satellite Time and Frequency Transfer** (TWSTFT) A full duplex two-way technique using a geostationary communications satellite as a relay station. The TWSTFT technique provides stable and accurate time transfer since it is closely aligned to the physical layer channel. Recently the Bureau International des Poids et Measures (BIPM) has started using two-way via a commercial Ku-band communication satellite as the primary time transfer technique for some European and transatlantic links achieving daily stability under 1ns. http://www.boulder.nist.gov/timefreq/time/twoway.htm

Layer 1 (Symm) 2-Way Accuracy

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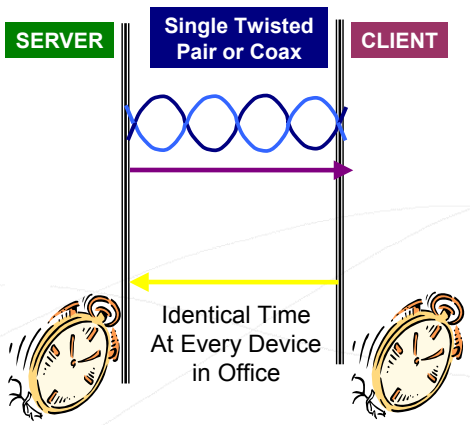
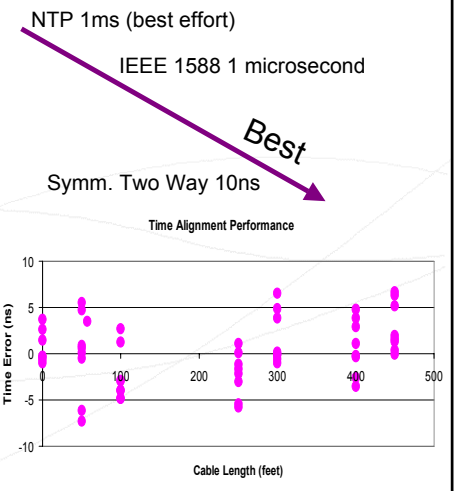
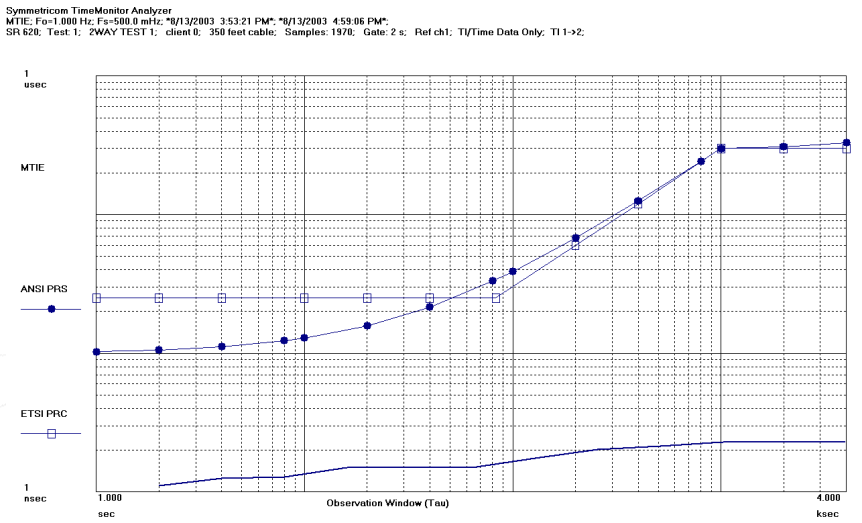
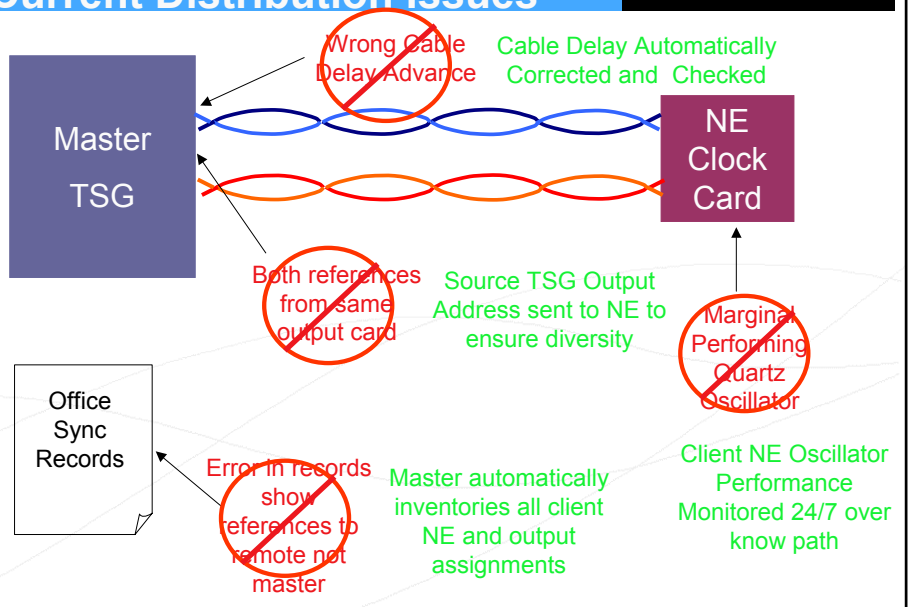




Layer 1 Approach Surpasses Stratum 1



Two-way Protocol Resolves Current Distribution Issues



Marginal Clocks Real World

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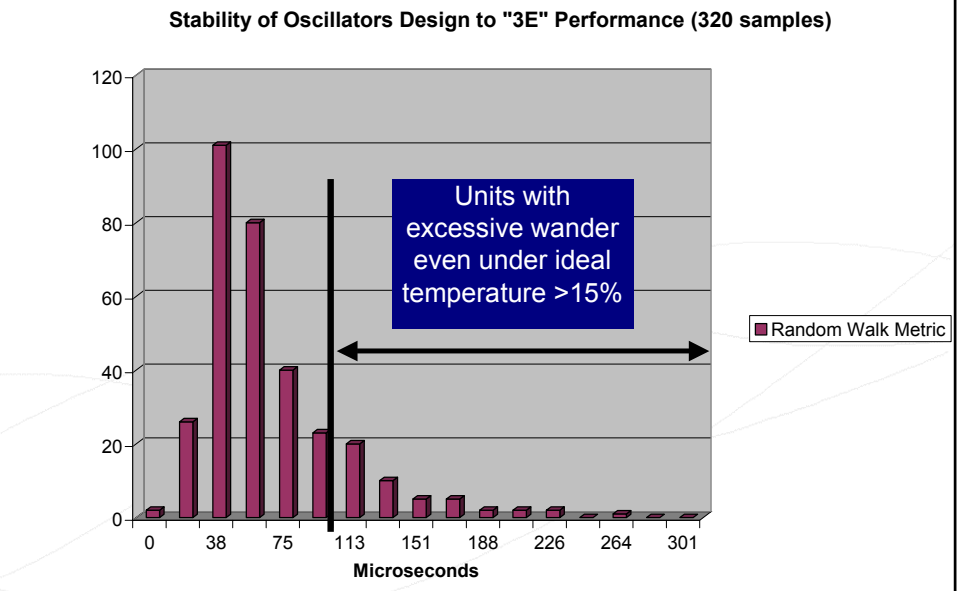

Distributed BITS Concept

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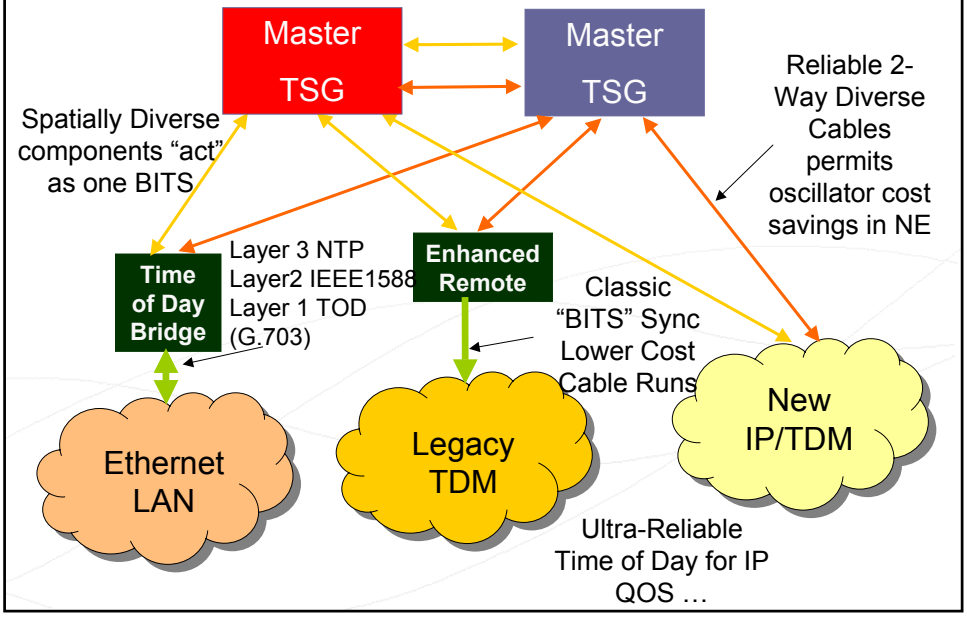
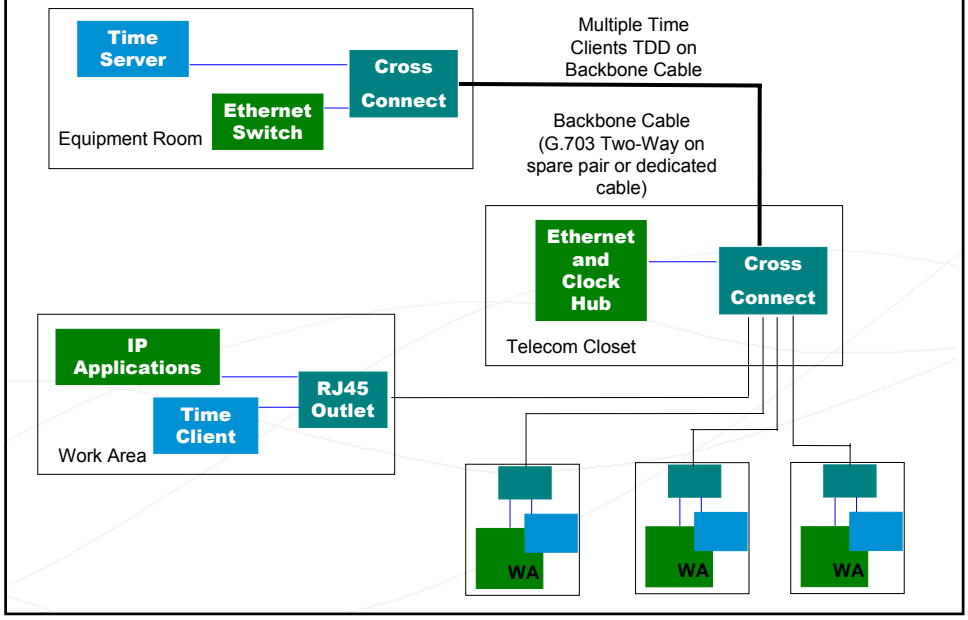
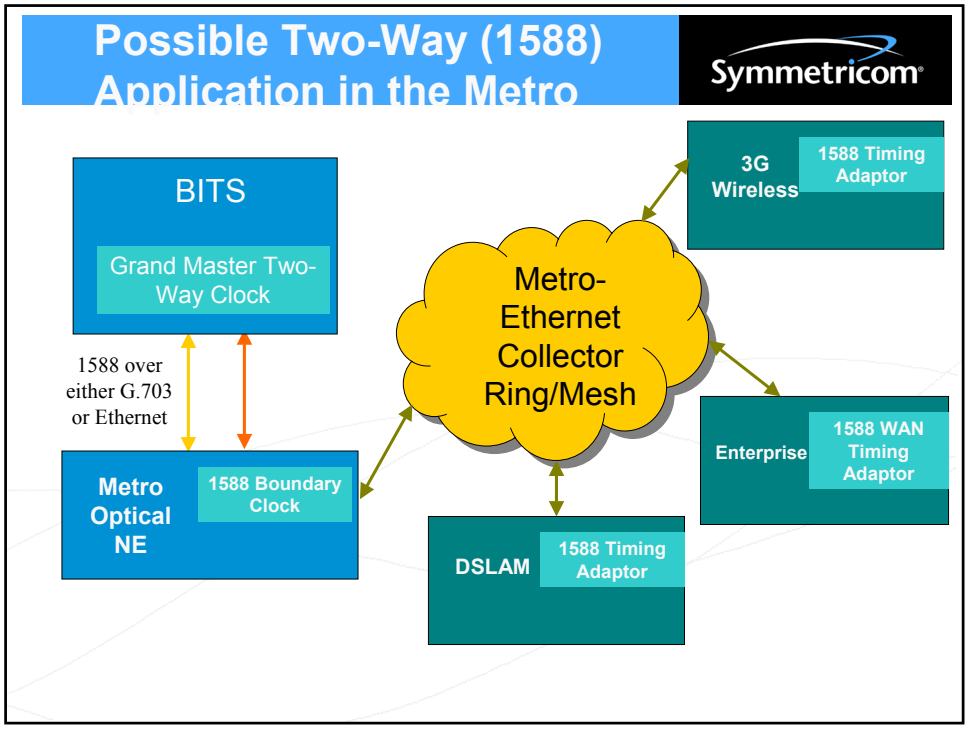


Extending Layer 1 Two-Way for IP



Possible Two-Way (1588) Application in the Metro



Concluding Remarks

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- Decades old Intra-building Sync Standards near end of life.
- New Two-Way Distribution Reliable, Practical and IP Ready
- Approaches with Direct Layer 1 access provide significant performance advantages
- Two-Way protocols provide integrated support of both legacy frequency and emerging timing requirement.