NISTIR 7192

2004 Conference on IEEE 1588, Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems

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NIST
National Institute of Standards and Technology
Technology Administration, U.S. Department of Commerce

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U.S. DEPARTMENT OF COMMERCE
Donald L. Evans, Secretary
TECHNOLOGY ADMINISTRATION
Phillip J. Bond, Under Secretary of Commerce for Technology
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
Hratch G. Semerjian, Acting Director

2004 Conference on IEEE 1588, Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems

Co-sponsored by NIST and IEEE Instrumentation and Measurement Society

NIST
Gaithersburg, Maryland
September 27-29, 2004

Conference Sessions: Lecture Room A
Plug-fest Demonstration: Lecture Room B

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AGENDA

Monday, September 27, 2004

- 8:30-9:00 AM: Meeting of Plug-fest participants. This session is open only to Plug-fest participants.
- 9:00 AM – 12:15 PM: Plug-fest integration tests. This session is open only to Plug-fest participants.
- 10:30 AM: Morning coffee break
- 12:15-1:15 PM: Lunch at NIST cafeteria (not included in registration fee)
- 1:15-5:00 PM: Plug-fest integration tests. This session is open only to Plug-fest participants.
- 12:30-1:15 PM: Tutorial participants registration
- 1:15-5:00 PM: IEEE 1588 Tutorial: John C. Eidson, Agilent Technologies
- 3:00 PM: Afternoon refreshment break

Tuesday, September 28, 2004

- 8:00 AM: Bus leaves conference hotel for NIST facility
- 8:30-9:00 AM: Continental breakfast, meet other attendees, pick up conference badges and material. (Allow 30 minutes from arrival at the main gate due to security and parking)
- 9:00-9:15 AM: **Conference Opening**
  Moderator: Kang Lee, NIST
  - Welcome from Dr. Hratch G. Semerjian - Acting Director of NIST
  - Administrative details
- 9:15 AM to 10:30 AM: **Technical Paper Presentations Session I**
  Moderator: Oyvind Holmeide, OnTime Networks AS
  - 9:15-9:40 AM: **A Flexible and Scalable Network Simulation Environment for Clock Synchronization:** Roland Hoeller, Georg Gaderer, Hannes Muhr, Nikolaus Kero, Vienna University of Technology and Oregano Systems
  - 9:40-10:05 AM: **Implementation Design and Performance Issues:** Hans Weibel, Dominic Béchaz, Zurich University of Applied Science
  - 10:05-10:30 AM: **Industrial Automation Requires Synchronization of Line Topology:** Antonius Boller, Siemens
- 10:30 - 10:50 AM: Morning coffee break
- 10:50 AM-12:30 PM: **Technical Paper Presentations Session II**
  Moderator: John C. Eidson, Agilent Technologies
  - 10:50-11:15 AM: **IEEE 1588 Ethernet Switch Transparency:** Sven Nylund, Oyvind Holmeide, OnTime Networks AS
  - 11:15-11:40 AM: **Bridging Networks with PTP:** Karl Weber, Siemens, Jürgen Jasperneite, Phoenix Contact GmbH
  - 11:40 AM-12:05 PM: **Implementation Results of an IEEE 1588 Boundary Clock:** Dirk S. Mohl, Hirschmann Electronics
  - 12:05-12:30 PM: **PHYs and Symmetrical Propagation Delay:** Thomas Müller, Zurich University of Applied Science, Alexander Ockert, Hilscher, Hans Weibel, Zurich University of Applied Science
- 12:30-1:30 PM: Lunch at NIST cafeteria

- 1:30-3:10 PM: **Standards And Business Related Activities**
  Moderator: Kang Lee, NIST

  - 1:30-1:50 PM: **Report of the User Requirements Task Group:** Silvana Rodrigues, Zarlink Semiconductor, Steve Zuponcic, Rockwell Automation
  - 1:50-2:10 PM: **Report of the Technical Extensions Task Group:** John C. Eidson, Agilent Technologies
  - 2:10-2:30 PM: **Report of the Conformance Task Group:** Oyvind Holmeide, OnTime Networks AS
  - 2:30-2:50 PM: **Presentation of Draft PAR:** John C. Eidson, Agilent Technologies
  - 2:50-3:10 PM: **Proposal for IEEE 1588 Trade Association:** John C. Eidson, Agilent Technologies

- 3:10-3:30 PM: **Plug-fest Introduction: Objectives, Participants, and Results**
  Moderator: Anatoly Moldovansky, Rockwell Automation

- 3:30-3:45 PM: Afternoon refreshment break

- 3:30-5:00 PM: Attendees view and discuss Plug-fest in Lecture Room B

- 5:15 PM: Bus leaves NIST for conference hotel

- 6:30-9:00 PM: **Conference Reception And Dinner**

Bus leave conference hotel restaurant
  - 6:45- 7:15 PM: No-host cash bar
  - 7:15 PM: Conference Dinner
  - 9:00 PM: Bus leave restaurant for conference hotel

Wednesday, September 29, 2004

- 8:00 AM: Bus leaves conference hotel for NIST facility
- 8:30-9:00 AM: Continental breakfast

- 9:00 AM to 10:15 AM: **Technical Paper Presentations Session III**
  Moderator: John D. McKay, Progeny Systems

  - 9:00-9:25 AM: **IEEE 1588 over IEEE 802.11b for Synchronization of Wireless Local Area Network Nodes:** Afshaneh Pakdaman, Todor Cooklev, San Francisco State University; John Eidson, Agilent Technologies
  - 9:25-9:50 AM: **High Accuracy Clock Synchronization Using IEEE 1588:** Pritam Baruah, Pruthvi Chaudhari, Paul Corredoura, John C. Eidson, Andrew Fernandez, Bruce Hamilton, John Stratton, Dieter Vook, Agilent Technologies
  - 9:50-10:15 AM: **Primary Timing Reference Sources for IEEE-1588 Systems:** Paul Myers, Spectracom

- 10:15 - 10:35 AM: Morning coffee break

- 10:35 AM to 12:15 PM: **Technical Paper Presentations Session IV**
  Moderator: Anatoly Moldovansky, Rockwell Automation

  - 10:35-11:00 AM: **DeviceNet Adaptation of IEEE 1588:** Ron Holl, Dave VanGompel: Rockwell Automation
  - 11:00-11:25 AM: **Hardware Assisted IEEE1588 Implementation in a Next Generation Intel Network Processor:** Puneet Sharma, Intel Corporation
  - 11:25-11:50 AM: **Interfacing Mil Standard Equipment to an IEEE 1588 Enabled Ethernet Network:** John D. MacKay, Progeny Systems
  - 11:50 AM-12:15 PM: **Automatic Test Systems using LAN-based Synthetic Instruments and the Role of IEEE 1588:** John Stratton, John Swanstrom, Agilent Technologies

- 12:15-1:15 PM: Lunch at NIST cafeteria

- 1:15 to 2:05 PM: **Technical Paper Presentations Session V**
  Moderator: John C. Eidson, Agilent Technologies

  - 1:15-1:40 PM: **IEEE 1588 in Telecommunication Applications:** Dave Tonks, Semtech
  - 1:40-2:05 PM: **IEEE 1588 Telecom Use Cases and L2 Ethernet Multicast:** Glenn Algie, Nortel Networks

- 2:05-3:50 PM: **Discussion Session**
  Moderator: Kang Lee, NIST & John Eidson, Agilent Technologies

  - 2:05-2:30 PM: **Discussion & Attendee Feedback on IEEE 1588 PAR**
  - 2:30-3:00 PM: **Discussion & Attendee Feedback on IEEE 1588 Trade Association**

- 3:00-3:20 PM: Afternoon refreshment break & networking

  - 3:20-3:50 PM: **Open Discussion on Other Issues**

- 3:50-4:00 PM: **Closing Comments**
  - Kang Lee & John Eidson

- 4:00 PM: Conference adjournment

- 4:30 PM: Bus leaves NIST for conference hotel

EXECUTIVE SUMMARY FROM THE CONFERENCE CO-CHAIRS

The conference was hosted by NIST on September 27-29, 2004 and was cosponsored by the Institute of Electrical and Electronics Engineers (IEEE) Instrumentation and Measurement Society. Acting Director of the National Institute of Standards and Technology (NIST), Dr. Hratch Semerjian, opened the conference with a warm welcome. Dr. Semerjian spoke of the importance of standards on components and system interoperability and his assertion of interoperability's role in the expansion of the PC market to its grand scale today. Dr. Semerjian described how standards are basic to the culture of NIST. Pursuing device and system interoperability based on standards is one of NIST's goals. More than seventy attendees participated in the conference, coming from diverse areas such as instrumentation and measurement, industrial automation, aerospace, power generation, semiconductor manufacturing, and telecommunication.

The three-day event began with a tutorial on the IEEE 1588 standard. The tutorial was unexpectedly well attended by more than sixty percent of the attendees. The main conference started on the second day. The interoperability of components and devices was demonstrated by seven companies and a university in an afternoon session informally dubbed the "Plug-fest." The devices were built to IEEE 1588 specifications, and showed that they could be synchronized to a master clock to sub-microsecond accuracy. The interoperability demo was led by Anatoly Moldovansky of Rockwell Automation, with participation from Agilent Technologies, Hirschmann Electronics, OnTime Networks AS, Rockwell Automation, Semtech Corp, Siemens, and Zurich University of Applied Sciences.

Participants were impressed with the smoothness and outcome of the interoperability demonstrations. Some components and systems were able to achieve clock synchronization to within +/- 40 nanoseconds based on a master clock signal from a global positioning system (GPS) antenna located on the lawn outside the conference facility. This illustrated the effectiveness of the 1588 standard and the ease with which devices can be built to its specifications.

The technical sessions covered subjects such as: primary timing reference sources for IEEE 1588 systems; high accuracy clock synchronization down to a nanosecond for precision measurements; network simulation environment for clock synchronization; device and microchip requirements; and adaptation, implementation, and application of IEEE 1588 in industrial automation, military, and telecommunications. A presentation by a graduate student on the application of IEEE 1588 for the synchronization of wireless local area network nodes based on 802.11b created quite a discussion. The field of wireless communications is of great interest to the attendees, who expressed a wish to see more detailed results in this area at the next conference.

As a result of the 2003 IEEE 1588 Workshop, three task groups were formed to address the issues of user requirements, technical extensions, and conformance of the IEEE 1588 Standard. The results of these three task groups were presented at the conference. These results were reflected in the presentation of a potential draft project authorization request (PAR) to IEEE and the possibility of forming an IEEE 1588 user group or trade association. An open forum was held on the last day of the conference to further discuss the issues of creating a PAR to revise the IEEE Std 1588-2002 Standard and the formation of a user or trade group to promote the standard and facilitate interoperability tests, and of enhancing the standard to expand its coverage from the instrumentation and measurement to other industries such as industrial automation and telecommunications.

Based on the feedbacks of the attendees, there was overwhelming consensus to reopen the IEEE 1588 standard to include:

1. Resolution of known errors,
2. Conformance enhancements,
3. Enhancements for increased resolution and accuracy,
4. Improvements to system management capability,
5. Mapping to DeviceNet,
6. Modifications for variable Ethernet headers (Annex D),
7. Prevention of error accumulation in cascaded topologies,
8. Mapping to Ethernet layer-2 small frame, shorter sync_interval,
9. Extensions to enable implementation of redundant systems, and
10. Improvements to extension mechanism.

If the standard is reopened some attendees suggested that the following additional items be considered as part of the scope:

- Alignment of IEEE 1588 and NTP stratum,
- Clock ID (identification) alignment with telecom T1.101 G.812,
- Security considerations- currently it is possible to take over the GR Role, e.g. with preferred master" or to manipulate sync packets, security IPv6 should be considered for backward compatibility, and there is a need to scope the problem and begin to get around it,
- Internet protocol version 6 (IPv6) Authentication - any IPv6 issues beyond Ethernet header size,
- Authentification for network security, IPv6 is essential or we will development a proprietary protocol version by necessity, or layer-2 mapping,
- Backward compatibility with current standard as its defined today,
- IEEE 1451 TEDS (transducer electronic data sheets)-like information on clock parameters. Better ID of stratum and source,
- Main point is authentication security. Other protocols do this at layer-3. However, authentification signature is large and it grows over time. Further, modification of packets violates authentication signatures or they need to be recalculated. At layer-3 IEEE 1588 should not do its own security. This is redundant and risky.
- Metadata format to allow description of oscillator and time source-ups receiver, vendor extensions for management information (MIB) for the simple network management protocol (SNMP), vendor extensions for metadata,
- Shouter frames and variable sync internal with unicort option will be vital to wireless sensor nets,
- Best master group,
- Some goals may be harder to achieve than others. Consider formulating more than one PAR,
- Inclusion of sync or management messages that permit a grand master to discover the time error of each slave. A message that can be decoded to produce a hardware interrupt to allow a MC (master clock) in a computer without a real-time OS (operating system) to execute an emergency operation in real time.
- Mapping to the control area network (CAN) open, and
- SNMP as a requirement for system management.

Conference Proceedings

The proceedings for the conference will be published as a NISTIR (internal report) before distribution. They will be posted in the IEEE 1588 website at http://ieee1588.nist.gov as soon as it is approved for publication by NIST.

Future Workshop

There was brief discussion on the plan for a future IEEE 1588 conference. Most attendees wanted to have another one. Location will be either at NIST or in Europe, which is to be determined. More detailed plans for the next workshop will be presented in the spring of 2005.

ABSTRACTS

Authors	Company	
Ron Holl, Dave VanGompel	**Rockwell Automation**	**DeviceNet Adaptation of IEEE-1588** DeviceNet is an extremely popular device level industrial network and is ideal for many applications requiring synchronized time, yet there is no current mechanism to accomplish this. This paper describes how DeviceNet will provide this function by adapting it to IEEE-1588 as a standardized PTP network technology. The adaptation includes selection of a message timestamp point, specification of the UUID, definition of both the PTP message format and PTP addressing on the subnet, and integration into the DeviceNet architecture.
Roland Hoeller, Georg Gaderer, Hannes Muhr; Nikolaus Kero	**Vienna University of Technology Oregano Systems**	**A Flexible and Scalable Network Simulation Environment for Clock Synchronization** The problem of synchronization of clocks in distributed systems has received much scientific attention throughout the last decades. A variety of algorithms has been published and issues like fault tolerance or achievable accuracy have been addressed. Nevertheless most applications found themselves sufficiently well synchronized by using means like the Network Time Protocol (NTP) or the Global Positioning System (GPS). Not only the recent interest in using Ethernet for industrial automation or even in sensor networks, but also the advent of the Institute of Electrical and Electronics Engineer's (IEEE) Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems (IEEE 1588) let high accuracy clock synchronization be a new discussed under the light of new applications and technical constraints. This paper presents a flexible and scalable network simulation environment, which allows for detailed and fast investigation of the major parameters of clock synchronization for any given network technology or topology. The simulation environment's architecture will be presented and simulation results together with their possible influences on existing technology or standards will be discussed.
Pritam Baruah, Pruthvi Chaudhari, Paul Corredoura, John C. Eidson, Andrew Fernandez, Bruce Hamilton, John Stratton, Dieter Vook	**Agilent Technologies**	**High Accuracy Clock Synchronization using IEEE 1588** There exist applications in the field of measurement instrumentation, military systems, and telecommunications with synchronization accuracy specifications extending to the nanosecond or sub-nanosecond range. This paper discusses the practical difficulties in achieving this level of synchronization and proposes extensions to IEEE 1588 to make this possible. Experimental results on prototype implementations will be discussed.

Afshaneh Pakdaman, Todor Cooklev; San Francisco State University
John Eidson; Agilent Technologies

IEEE 1588 over IEEE 802.11b for synchronization of wireless local area network nodes

IEEE 1588 is a new standard to synchronize independent clocks running on separate nodes of a distributed measurement and control system to high degree of accuracy. It used a precision-time protocol (PTP). In this paper it is advanced a method to implement clock synchronization over IEEE 802.11b Wireless LAN (WLAN). Practical experiments are presented. One conclusion is that IEEE 1588 can be implemented over 802.11b with an accuracy of 400ns.

Puneet Sharma; Intel Corporation

Hardware Assisted IEEE1588 Implementation in a Next Generation Intel Network Processor

This paper will describe the hardware-assisted IEEE1588 implementation in a future planned Intel® network processor. A brief overview of the IEEE1588 standard is provided, with particular emphasis on Ethernet applications. The general pros and cons of purely hardware vs. software-oriented IEEE1588 implementations are also discussed and applied to Intel's co-hardware and software IEEE1588 implementation. A detailed description of the IEEE 1588 hardware logic and the Intel XScale® core-based software programming model is included. Finally, some examples of targeted industrial applications for IEEE1588 are described.

Note regarding the 20-minute paper presentation at the Conference: The 20-minute presentation will NOT include a brief overview of the IEEE1588 standard as attendees should be familiar with the standard.

Hans Weibel; Zurich University of Applied Science

Implementation design and performance issues

There exist applications where independence of specialized hardware is more important than accuracy. The Zurich University of Applied Sciences has evaluated the performance of software based time stamping methods. The test setup consists of an IEEE 1588 implementation which is capable to deliver three time stamps per transmission/reception of time critical messages simultaneously: The first time stamp is taken by hardware at the MII, the second at the entry point of the network interface driver's interrupt service routine and the third one is delivered by PCAP. A comparison of the time stamps allows the performance of different methods to be evaluated. The PTP protocol engine is able to select one of the three available time stamps as the source to calculate offset and delay. The synchronization behaviors and accuracy of different configurations can be analyzed. An interesting configuration is a hardware based master clock (e.g. a boundary clock located in a switch) combined with purely software based slave clocks.

Antonius Boller; Siemens

Industrial automation requires synchronization of line topology

The high data transfer rate attainable through the Ethernet's physical properties opens new dimensions for real-time applications.

A future-oriented concept must have at its core a wide, generally accepted basis, and must be expandable. Seen from this point of view, there is no alternative to switching technology. The advantages of higher data transfer rates, full-duplex communication and collision-free access, however, are bought at the expense of an unsymmetrical communication. Due to the fact that frames are buffered in the switch and the length of time they remain there depends on the network load this may even lead to frame loss in critical situations. This is a most unfortunate peculiarity in the case of real-time applications and the reason why it is not possible to fulfil the requirements of the switched-Ethernet-based motion control applications with the existing IEEE 1588 method. Especially in the industrial automation a basic requirement of the network is the ability for line topology. Hence a cascade of switches has to be synchronized. With today's IEEE 1588-method the required accuracy for a line of switches causes problems.

The presentation shows the need for real time Ethernet in the industrial automation and the problems when using IEEE 1588 for synchronization issues in this area. Furthermore it shows a method which solves these problems.

John D. MacKay **Progeny Systems**

Interfacing Mil Standard Equipment to an IEEE 1588 Enabled Ethernet Network

This paper will discuss the unique requirements for interfacing a number of military standard devices to a 1588 network. The current trend for signal processing on military platforms is to maximize the usage of Commercial Off the Shelf (COTS) products rather than developing full mil-grade equipment. This approach provides a great deal of advantage to the system developer, because it provides access to a variety of low cost high performance devices that have a great deal of field experience and customer support. The drawbacks to this approach occur at the edges of the system, where these COTS devices must interface either with very specialized sensor and transducer equipment, or with 'legacy' standard busses and protocols.

A COTS system with Ethernet as the core network can be subject to this issue, but this can be compounded by the need to provide highly accurate timestamp information via 1588. Typically the legacy devices are clocked by their own internal timing, and drive the system time via COTS interface cards. Timestamps therefore occurred at the 'front end' of the process string, and became embedded in the data stream. While the insertion of timestamp data in a 1588-enabled system would likely be the same, the source of time would need to be either a 1588 network device or a legacy device modified to be 1588-enabled. There are issues with both of these solutions.

These options will be discussed for this use case as well as others. A use case that would require the 1588 protocol to be implemented on a mil-standard asynchronous bus will also be discussed.

Dirk S. Mohl **Hirschmann Electronics**

Implementation Results of an IEEE 1588 Boundary Clock

Boundary clocks are necessary to distribute the precise time over network components like switches and routers. To build such a boundary clock inside an Ethernet switch beside the standard functionality several additional points have to be taken into account.

Ethernet Switches typically use SNMP as management protocol, so relevant parts of the IEEE1588 managed objects have to be accessible through SNMP. Also a switch often gets or provides time over SNTP. The question now is how to combine these two protocols and not to loose IEEE1588 precision. The more IEEE 1588 Switches are used the network the more the issue of cascading Boundary Clocks and its effect on precision and system startup has to be analyzed.

The necessity of cascading boundary clocks often is imposed from the network topology of the application. One aspect of using IEEE1588 is derived from Industrial Automation Technology. There IAONA, the independent platform organization for Industrial Ethernet may give ideas about usage, applications and topologies of the network.

Sven Nylund
Oyvind Holmeide
OnTime Networks AS

IEEE 1588 Ethernet switch transparency- No need for Boundary Clocks!

One of the main IEEE1588 properties is related to the handling of variable network latency between the Grand Master clock and the Slave clocks. I.e. the network load dependable latency through the network elements (e.g. Ethernet switches). This is handled if IEEE1588 Boundary clocks are used on the network path between Grand Master and the Slave clocks. However, this means that each network element in the network must support full Master, Slave and the Best Master Algorithm with increased complexity and cost as the result.

A simpler and cheaper approach is based on using network elements with IEEE1588 transparency and still achieves the same level of timing accuracy on the Slave clocks and being compliant with the IEEE1588 standard. This paper describes the principles of a network element with IEEE1588 transparency.

Karl Weber
Siemens

Bridging Networks with PTP

Discuss influence of switches in networking today and how it correlates to 1588. General procedures running at switches and infrastructure of such switches. Discuss need for time synchronization in switches Propose Architecture for "PTP Bridges" that enhance accuracy and reduce resource utilization in switches. Criteria for a PTP Bridge protocol that will be accepted by most switch manufacturer

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Thomas Müller
Zurich University, Winterthur

PHYs and Symmetrical Propagation Delay

PTP requires a symmetrical propagation delay or at least a system with known differences between a pair of links. Ethernet Physical Layer transmitter/receiver are not symmetrical. The same can be found in cable specification.

Some parameter may not known and are not specified in the related standards nor by some device specifications. Measurement show a high accuracy but also some significant difference especially in case of auto-negotiation and auto-crossover.

A criteria list for transmitter/receiver is set up to achievable high precision time synchronization. I will do this together with other colleagues.

Dave Tonks
Semtech Advanced Communications Division, Southampton UK

IEEE 1588 in Telecommunication Applications

IEEE 1588 is being considered for various applications within telecommunication networks, including delivering a common time base across a network for billing purposes and for synchronizing service points which have become isolated by use of a packet network. This paper investigates a few of these applications and discusses a number of issues, including expected limitations on network topology, and known or likely performance goals, and, most importantly, probable barriers to adoption. The paper goes on to discuss how these issues could be tackled, and in particular how the current IEEE 1588 standard could be adapted to simplify its adoption in telecommunication applications.

The migration of telecommunication networks away from their traditional circuit-based architecture and towards an all-encompassing packet network has begun. The principal drivers behind this are significant cost-reductions in both capex and opex, and simpler roll-out of new services. When completed, it will be seen to have been a massive overhaul of networking technology, covering all aspects of the network, from switching and transmission to operational, administration and maintenance activities. However, many of the services which have been enjoyed for many years will continue to exist and these are not well served by packet networks. They have critical time dependencies which, if not satisfied, will cause the service to fail to maintain the high levels of customer satisfaction they enjoy today. The problem, then, is in finding ways to satisfy the critical time dependencies in a packet network. IEEE 1588 offers a cost-effective way to deliver timing in packet networks, providing certain limitations can be overcome.

Packet networks differ considerably from traditional circuit-switched networks. The possibility of departing from the 'fixed' route per call, and the use of service level agreements in which it is necessary to know not only just how much traffic of each particular type was delivered, but also how much of it met the delay targets, means that network operations such as traffic-counting have to be moved to the edge of the network. This demands that accurate time be made available right at the edge of the network. IEEE 1588 can provide that time.

Carrying time-dependent services in a packet network is often done using a circuit-emulation technique. But this is best done when a common clock is available at both ends of the connection. Traditional networks inherently provide this clock but packet networks cannot. Adaptive clocking techniques are available but suffer from network behaviors and can only offer a lower performance. Customer complaints could be common. Alternatively, IEEE 1588 can provide the common clock at the ends of the connection and so help maintain quality of delivery. This paper explores these, and other, applications.

John Stratton,
John Swanstrom,

Agilent Technologies

Automatic Test Systems using LAN-based Synthetic Instruments and the Role of IEEE 1588

With the current trend to drive down the total cost of ownership of Automatic Test Systems (ATS), industry standard open architectures have been seen as both a way of driving down the cost of test (for design and manufacturing) and reducing the size of the ATS platforms (eliminate the redundant hardware).

A LAN-based synthetic instrument architecture offers an alternative to the traditional approach that allows systems integrators and manufacturers to minimize the total cost of ownership from digital to the highest performance millimeter wave applications. IEEE 1588 is proposed as the long-term solution for synchronization is the LAN environment.

This paper will analyze the current trends in computer architectures and how it is used in synthetic instrument based ATSs. It will show how future trends in component technologies will drive how synthetic instruments might be designed. And finally, it will show how customers and instrument providers can quickly implement current capability and next generation test technology.

Paul Myers

Spectracom Corporation

Primary Timing Reference Sources for IEEE-1588 Systems

This presentation reviews and compares Primary Time Reference sources for IEEE 1588 systems. Primary Time Reference sources such as GPS, Loran and cellular GSM/CDMA are reviewed. The technical merits, characteristics, performance differences, costs applications and availability are contrasted. The use of these primary time references in the design of a grand master clock and resulting predicted precision of 1PPS outputs is examined. The application of various oscillator types to IEEE-1588 systems is compared in light of primary timing reference selection, and holdover performance.

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