

## **PTTI OPENING ADDRESS**

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Ladies and Gentlemen:

It is a pleasure to have the opportunity to address the Thirty-ninth Annual Precise Time and Time Interval Meeting this morning. This series of PTTI meetings has continued to serve the timing community for nearly 40 years, providing the chance for precise time and frequency users to demonstrate their ideas and present their requirements for improving the Defense Department's ability to meet the nation's security needs. Similarly, these conferences have allowed the providers of time and time interval the opportunity to make system developers aware of the latest improvements in the field and those that are likely to be in line for future operations. The objectives of the series of meetings, namely to disseminate and coordinate PTTI information at the user level, to review present and future PTTI requirements, to inform civil and DoD engineers, technicians, and managers of advances in precise time and frequency technology, and to provide an opportunity for an active exchange of new technology associated with PTTI are as important today as ever.

Sessions at this meeting are devoted to the most recent developments at time and frequency standards laboratories as well as topics that promise significant developments in the future. These include advanced clocks, clock modeling and simulation, algorithms and methods, time and frequency transfer techniques, measurement technology, timing systems and applications, military applications, and satellite navigation. Those items cover the PTTI field. And this year we have added a student poster competition.

We are reminded frequently of the growing importance of satellite navigation in everyday life today. Precise timing provides the heart of these systems, and the nearly routine use of GPS around the globe underscores the need to provide precise PTTI information not only to enable today's routine uses, but to ensure that positioning and navigation information becomes available in all environments, including the interiors of buildings and urban canyons. Systems are being planned internationally that will enhance our capabilities in that direction. It is critical that we keep in mind the PTTI requirements to ensure their compatibility for safety of life.

Although we know that the positioning and navigation functions of satellite navigation systems are made possible by precise timing, we know that more users of GPS are using the system to obtain timing information than position information. This fact points out the critical nature of time and frequency in today's infrastructure. GPS-based timing is, in fact, discouraging the development of precise clocks and frequency standards to meet operational needs. It is so cheap and easy to procure GPS receivers to meet timing requirements that manufacturers may be reducing or eliminating the development of future timing standards. We need to make sure that tomorrow's clocks will be there when we need them.

Another concern with the growth of timing from satellite navigation services is the developing dependency on them as the sole means of obtaining timing information. GPS is designed to be a robust system, and steps are being taken to make it even more robust. However, it will be necessary to consider the requirement for other possible sources of precise time and frequency, particularly in hostile

environments. The development of possible alternate time transfer methods will definitely be a concern for the future.

The growth of GPS for timing has been so pervasive because it is so easy to incorporate relatively cheap GPS receivers in system designs. While these solutions are justifiable from the point of view of the project system designers, serious concerns arise regarding the potential loss of our ability to inter-operate these systems as a result of multiple and possibly inconsistent timing standards. This situation illustrates the growing need for system designers to consider the need for timing accuracy as opposed to precision. We hear about stovepipe systems that depend on some kind of timing for their success. However, in the admirable pursuit of reduced system costs, designers plan only for a time/frequency base that is consistent and precise within their own system without regard to the degree of interoperability with other systems. This kind of designing could pose serious problems in the future. The increasing use of inter-operable systems will demand accurate, as well as precise, time to permit this interoperability. The Department of Defense has clearly realized that interoperability is a major issue. It has become evident that standards for time and time interval play an increasingly important role in ensuring that modern defense systems can communicate among themselves and function effectively. We must strive to eliminate the costly practice of developing systems independently without regard for the requirement to operate with existing and future systems.

A national Positioning, Navigation, and Timing architecture is in the process of being implemented. It seeks to address the needs in this area over the next 25 years. PTTI is a critical component of that architecture and this community will be challenged to meet the goals of that plan. Some of the key components are addressed in the topics of this meeting, namely advanced clocks, clock modeling and simulation, algorithms and methods, time and frequency transfer techniques, and measurement technology. Just to enable the systems needed to meet the anticipated transportation needs of the future, we will need to make significant progress in each of these areas. Future communications growth will also require improvements in all those areas. These applications and potential threats to our infrastructure will also require robust and redundant means to deliver accurate time to users. Interoperable networks employing more than one means to transfer PTTI information will likely be the state of the future.

I would like to close with a final concern. That is the PTTI community must continue to challenge system engineers to make use of potential developments in more accurate time and time interval. Rather than asking potential users what their requirements for PTTI are, we need to ask them what they can do with 10-picosecond timing, or one part in  $10^{16}$  frequency. National and international laboratories must work together to make sure that the world's timing needs are met and that society can make use of what we expect to make available in the future. I hope that this and future meetings will continue to address these concerns. But, in addition, I would like to challenge users of time to think creatively about new possibilities that take advantage of our ability to provide time and time interval with improving precision. This utility of precise time will, in the future, provide improvements for us all, and we need to plan now to take advantage of this resource.