OPENING ADDRESS

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Good Morning.

It is my pleasure to open this, the Thirty-first Annual Precise Time and Time Interval Meeting. This series of PTTI Meetings has continued to serve the timing community and provide an opportunity for users to bring forward their ideas, thus allowing time and time interval providers to make the system developers aware of their latest improvements in the field and the direction research is heading. Our objectives—to disseminate and coordinate PTTI information at the user level, to review present and future PTTI requirements, to inform Government engineers, technicians and managers of precise time and frequency technology, and to provide an opportunity for an active exchange of new ideas associated with PTTI—are more important today than ever before.

The program for this meeting includes topics that show significant developments for the future. Sessions are devoted to issues related to satellite and broadcast time transfer, satellite clock performance, GPS augmentation systems, activities of standards laboratories, military GPS receivers, and updates of recent research in the development of new timing standards. The growing importance of GPS and GPS-based timing is evident. The papers in the sessions of this meeting will, no doubt, demonstrate the latest numbers characterizing the precision and accuracy of the systems that take advantage of GPS for timing. The growing use of GPS, however, is not without its own issues.

One such issue, that the growing proliferation of GPS-based timing, is in fact discouraging the production of precise clocks and frequency standards. It is becoming so cheap and easy to procure GPS receivers to meet timing requirements that manufacturers are reducing or eliminating the future production of timing standards. We need to make sure that tomorrow's clocks will be there when future systems need them.

Another issue with the growth of GPS timing is the increasing dependency on GPS, even though GPS timing will show only incremental improvements over the next 20 years. It now appears to be necessary to consider the need for additional sources of more precise time and frequency. In addition, the development of alternate time transfer methods will definitely be a concern for the future.

The growth of GPS for timing has been so pervasive that new weapons systems are incorporating relatively cheap GPS receivers in their system designs. While these solutions are justifiable from the point of view of the system designers, serious concerns arise about the possible lack of interoperability of 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 often 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 can no longer be acceptable. The increasing use of *interoperable* systems will demand *accurate*, as well as precise, time to yield their full capabilities.

While all of these issues are concerns which must be addressed in the near future, there are two larger concerns with timing that I would like to mention. The first of these was the reluctance to recognize the future needs in timing when the operational requirements for the GPS Block IIF system was being developed. In fact, the requirements, which have been approved recently, are not a challenge at all to current capabilities and will certainly not be the state of the art when the Block IIF system goes into operation in 2013 or later. I would hope that future revised versions will adopt more realistic timing requirements envisioned within the next 20 years.

The second of the two larger concerns is that the PTTI community must begin to challenge system engineers to make use of the anticipated availability of more accurate time and time interval. Rather than asking potential users what their requirements for PTTI are, we (the timing community) need to ask them (the users) what they can do with 10-picosecond timing accuracies or one part in 10 to the 16th frequency. What efficiencies in system design or improvements in capabilities can be realized in the areas of multi-static radar and sonar, wide bandwidth communications, autonomous space position and navigation, or remote sensing with these accuracies? Last year I talked about the need to recognize that precise time is becoming a utility and that we must recognize the need to manage this new utility to meet society's current and future requirements. This is just as true today as it was a year ago. Part of our management responsibility is to make sure that users are aware of current and projected PTTI capabilities.

National and international laboratories must work together to make sure that the world's timing needs are met and that society understands the potential use of what we know we can make available. I hope that this and future meetings will continue to address these concerns. I, again, would like to challenge users of time to think creatively about new possibilities to take advantage of our ability to provide time and time interval with much improved precision and then task us to meet their challenge.

While we spend the next few days here discussing the latest developments in time and time transfer and innovative uses of timing, we also need to keep in mind these broader issues: standards for full spectrum interoperability, management of time as a national and international utility, vulnerability as related to GPS dependence, and creative planning for the future utilization of very precise time standards.

Thank you.