

OPENING REMARKS

**Dr. Kenneth J. Johnston
Scientific Director
U.S. Naval Observatory
Washington, DC 20392, USA**

Good morning. This talk is usually given by the Captain of the Naval Observatory, so I have to give it in the obligatory way, to introduce everyone to the program that we are going to have at the meeting today. This is the obligatory talk to remind everybody what the objective of the meeting is.

It is a pleasure to present the opening address of the Thirty-third Annual Precise Time and Time Interval ("PTTI") meeting. My first duty is to remind you of the objectives of the PTTI meeting as promulgated in the brochure. The objectives have changed little since the first meeting. These are to bring uses of PTTI together to coordinate their activities, review and present future requirements, and to provide technical information to government engineers, technicians, managers, and scientists. So this is what is in your brochure, this is the objective of the meeting, as we all know it very well.

This meeting will address many important areas of PTTI. These areas have expanded since the first meeting, as has the accuracy of PTTI. The report of the first PTTI Meeting in April, 1969 addresses the areas of precise clocks and timing for the DSN network. The timing standards considered were hydrogen masers, cesium-beam and rubidium vapor cell standards, as well as quartz crystals. The hydrogen masers were considered too difficult for use for practical timekeeping then.

Time was distributed via clock trips with a closure of about one microsecond in a month's time and/or LORAN-C. It was stated that the OMEGA system would become operational by 1972 and would be capable of disseminating clock time with a precision of 1 microsecond. There's an addendum there, too, that said the precision would be about 1 microsecond, but due to ionospheric effects, the accuracy would probably be down by 5 microseconds. The meeting also called for increased cooperation between national and international agencies in the area of PTTI.

The areas of PTTI addressed in this meeting show how PTTI has grown. The areas covered range from precise clocks for space, time dissemination via two-way satellite time transfer and GPS, to time scales and algorithms, as well as commercial presentations by industry. You will also hear the latest advances of many of the world's timing laboratories. Their timing is approaching the nanosecond level. The precision of time synchronization between these laboratories is now at the sub-nanosecond level using two-way satellite time transfer, and in the future, our present carrier-phase techniques. Today with GPS, timing is at the 20-nanosecond level worldwide.

In that first PTTI meeting, it was pointed out that precision timing has been provided – with the notable exception of WWV – as a piggyback operation superimposed as a secondary mission to navigation and communication services. This is also the case today, as GPS was funded because it is a navigation system. Therefore, we must remember in order to fund PTTI, we must look to its applications or requirements. PTTI is needed for navigation, precise positioning, communication, and synthetic aperture radiometry.

There is a myriad of applications for military, commercial, and scientific endeavors. We have identified these requirements in order to improve our PTTI accuracy.

This is something of the obligatory talk that the Captain always gives. We have to look towards requirements of PTTI. PTTI is always funded, in my opinion, as sort of a back-door activity. It is the applications they bring on, and therefore during this meeting, I want us all to concentrate on what future applications we have for PTTI. At the present time, looking at nanosecond accuracy for clocks, with the bringing on of the some of the clocks we will talk about in this meeting – for example, cesium-beam fountains going to optical standards – we will be approaching picosecond accuracy. One of the things we have to think about is what are the uses for those picosecond accuracies. If we don't have uses for them, their development will never be funded.

Well, we have a very interesting and stimulating meeting before us. In addition to discussing the latest developments, please keep in mind some of the overlying issues: standards for full spectrum interoperability, and management of time as a national and international resource. Today what we have to look at is using timing for GPS; we are looking forward to Galileo. I think internationally, we all have to looking towards happily coordinated time. We shouldn't let time get out of the box, so to speak. Right now, we have very excellent international cooperation on timing through the BIPM, and I think this must be supported.

We have to look at the vulnerability for timing as related to GPS dependence, with one system up there that we are all using. And we also have to think of creative planning for future utilization of very precise time.

That's the closing of my remarks. That is the obligatory speech, to remind everybody that not only are we to think about how to get better time, but to actually concentrate on those requirements for time.

With that, let me introduce Len Cutler as the next speaker. Thank you.

LEONARD CUTLER (Agilent Technologies): This year, we lost several people to the time and frequency community, and I would like to say a few words about one of them, Dr. Robin Giffard.

Robin got his Ph.D. from Oxford University, and he was an Associate Professor at Stanford University before he was hired into Hewlett-Packard in 1980. While he was at Hewlett-Packard, and then Agilent Technologies, he was very influential in the design of mercury standards, the very first ones that were delivered to the Naval Observatory; and he was one of the principle architects and designers of the Hewlett-Packard (and now Agilent) 5071A cesium-beam standard. And then he worked in the detailed design of GPS receivers, and later on in developing a technique for ionosphere corrections for single-channel receivers that involved a very unique technique.

Robin was a very gifted physicist. He was very broad and capable; and in addition to that, he was an extremely fine human being. He was one of my very best friends, and I miss him greatly. He passed away on May of this year. While walking his dog, he had a severe heart attack, and collapsed and died.

We miss him greatly, and he will be very hard to replace, if at all. That concludes my remarks about Robin. And I think Mike Garvey is going to say some remarks about Jerry Norton and Jim Cloeren.

MICHAEL GARVEY (Datum TT&M): Some of you may have heard that, on October 30, Jim Cloeren and Jerry Norton were flying an airplane that they had built; they crashed and were both killed. I have known both Jim and Jerry a long time. My first exposure to Jim was at Datum. We bought a design for transit receivers, which had been originally developed at APL. Like a lot of things that are developed, the first time the engineering was a little weak. And Jim taught us how to make that receiver, the transit receiver for a few satellites; it took 20 minutes to get a fix navigationally, and then you get time to 100 microseconds or so. Jim had been involved in the development of that, and essentially taught us how to do it.

Involvement with Jerry, in some sense was at times that of a mentor and someone that we would admire and respect for his technical achievements, and at other times, a bit of a competitor – because we were trying to make quartz oscillators that were as good as Jerry’s. And I have to say that we never succeeded.

As a team, Jerry was more on the hardware side of it, Jim more on the product and program management side, developing low-power oscillators for deep space missions. These were oscillators where mass is measured in grams and power is measured in milliwatts. They developed oscillators for scientific and covert applications, and for customers whose names they never knew, or even organizations they never knew. They were after the ultimate in frequency stability. As I said, no matter how hard we tried, we never made oscillators as good as they did. They developed novel approaches to protecting the oscillators: titanium dewars and sophisticated suspension systems to withstand launch. They addressed the issues of radiation hardness, both from a survival and from a performance perspective.

It is no coincidence that Jim and Jerry died together. They were best of friends, they built the airplane together, probably in a garage (I never saw it; I saw pictures of it). But, to the precision oscillator community, this is a tremendous loss. Thank you.

