DoD PTTI Report

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Abstract

The widespread application of Precise Time and Time Interval (PTTI) in modern electronic systems has been rapidly expanding. This growth reflects the importance of PTTI to many advanced systems. Precise time is closely related to precise distance measurements, the coordination of remote actions over extended periods of time, and the better utilization of the frequency spectrum. DoD Instruction 5000.2 emphasizes the need for a common time reference (The USNO Master Clock) for these systems of vital interest to our security. This report will present the results of the Annual PTTI Summary which describes the utilization of PTTI among the different components of the Department of Defense and highlight areas of primary interest and concerns.

It's a pleasure to once again address you this morning. I'm still tickled over the award presentation earlier this morning. It's well deserved and always nice to get recognition from your peers. And I'm honored to have had the opportunity to present the award in their behalf.

What I would like to do is talk a little bit about major PTTI accomplishments in '94 (Figure 1), where we're headed, and where you can help us in terms of PTTI. Validation of requirements was a significant effort last year, particularly in this day and age of downsizing of resources. Everything is tied back to a requirement; and it's absolutely vital that every one of those requirements be stated and documented in order to go on from there. I'll talk a little bit about improvements to the Master Clock and then to two–way satellite time transfer. With regard to requirements (Figure 2), we took the 1990 survey as a baseline, and essentially re–validated that. In the re–validation process, we determined what the requirements really were for precise time and time interval and who our customers are out there – who uses it and of those who use it who don't recognize that they use it (which is a big problem in precise time). As Mr. McNeff stated, it's free, it's available anytime you want it; you just don't appreciate what's behind that timing signal. Our requirements have been validated by the Oceanographer of the Navy and have been submitted to the Office of the Secretary of Defense. So the requirements are, in fact, entered into the official DoD requirements process, covering not only Navy, but also the Air Force and Army requirements as well.

Improvements to the Master Clock (Figure 3): We are continuously improving the Master Clock. The big improvements for the previous year, a plus year, were replacing a number of the older 5061s with the newer HP 5071 cesium beam clocks. There are 10 hydrogen masers which have been incorporated into the time scale. The biggest comment I could say

on the Master Clock is that the effects of the improvements to the Master Clock can be seen by the contribution of the U.S. Naval Observatory (USNO) to the Bureau International des Poids et Mesures (BIPM), changing to 38 percent from last year's 20 percent. This significant improvement, is largely due to the better stability and, I should say, maybe the better reliability, of these clocks. We retain many of the 5061s, as they're still providing accurate, precise time, and we will continue to keep these clocks in the time scale as long as they continue to perform.

Keeping time is one thing, getting it out to the people who need it is another issue altogether. It doesn't do us any good to have the best time in Washington, D.C., if we can't disseminate it. We have made some significant improvements in the two-way satellite time transfer (Figure 4) this year. The technology transfer from the Naval Research Laboratory (NRL) of their modem to the commercial market was a big accomplishment. These modems are, in fact, operating much better than previously expected. Certainly the production models are really doing the job that they were designed to do.

We've been using the Defense Satellite Communication System (DSCS) for time transfer. It has been working exceptionally well. We have also been doing some experiments with commercial satellites as well. You will hear early in the program discussions of two of the calibration trips, one to Europe, between some of the laboratories in Europe, as well as a trip to the West Coast, using satellite two-way time transfer and an ensemble of clocks from the USNO.

Now, with regard to some of the newer issues in '94 (Figure 5), we are trying to tell our story to the people who need it. We did strengthen the master navigation plan. The reference for the wide-area augmentation system (WAAS) of the FAA will be UTC(USNO), the same reference that is used for the GPS system. So we will have again a single timing reference for both the FAA wide-area augmentation system and the GPS system, itself.

With regard to the GPS monitor station upgrade: By creating an independent clock ensemble at each of the GPS monitoring stations, we will allow the GPS operational community to detect immediately if they have a problem, because they will have the capability of an independent timing signal with which to compare the satellite performance with the monitor station timing signal. This program is underway. You will hear a little bit more about that later on, as well. Development of ultra-high precision timing reference stations at a number of special sites is also continuing worldwide.

Continuing on with accomplishments for '94 (Figure 6): The NATO standard agreement, STANAG 4430, on precise time and frequency interface for NATO was signed. It uses UTC(USNO), tied to the BIPM, as the standard for NATO operations. In support of DISA and the DSCS, as LORAN is shifting from U.S. control to European and Japanese control, USNO is helping to coordinate the timing signals for those systems at the local levels. Our role, particularly in the European area, is to provide some atomic clocks during that transition period, to ensure that timing – again, particularly in Europe – is maintained without interruption until alternate sources are provided. Some cesium clocks have been loaned to the Defense Satellite Communication System so that their timing could be maintained to a standard time. USNO has also transferred clocks to the Autodyn system for the same sort of function – to provide a standard to compare their time to ours.

One of the other items that I wish to stress is the fact that what has been accomplished has been done in the face of DoD downsizing. Our resources are really getting smaller. One of the keys to being able to accomplish those things that I showed for '94 have been the people who have been involved in the programs, and their efforts to get the job done, and to do it on a shoestring, so to speak. Keep in mind, as we will talk a little bit about these things later on in the conference, that we are facing downsizing reduction in the funds that not only buy hardware and improve the software, but also in the number of people who are able to perform these functions. And it's really vital that the folks in this room carry the message of PTTI.

Some of the functions and objectives of the PTTI manager are shown in Figures 7 and 8, respectively. This is a slide from last year, but I wanted to bring it back this year because it still applies. We need to ensure the uniformity of PTTI. We're doing that and working continuously to tell the story that all the communication and navigation systems need to be tied into one standard for time. I can't imagine a more chaotic situation than to have two timing standards and have them off by even a few nanoseconds. It would just create a nightmare. And again, most of you in here appreciate that. But we really need to get that message to the program managers and project managers, both in the commercial market as well as in the DoD, and ensure that they pay attention to the timing signals within their systems.

The requirements process which we went through last year did a good scrub on the requirements. But I'll guarantee you that thereare many that have emerged since then that we are not aware of and have not begun to even look at in terms of their impact. The most stringent requirement that came out of that, potentially a future requirement at the 100 picosecond ("ps") level. If we're going to push to that level, certainly the Observatory needs to have a tenfold better capability, in-house, so that we can transfer time to that 100 ps level to those customers. We aren't there yet. We need to get there.

And that leads into the necessity for research. Such things as the mercury ion device – we have three of those that we are using and will add them into the time scale in the near future. It is still an R&D effort. We are still not certain exactly whether the mercury ion device is the device of the future or will allow us to approach that 100 ps level. But again, industry is looking in that direction, and I think we will push that technology edge here in the near future.

Adequate infrastructure support is really a problem in the downsizing world. As I alluded a little earlier, our dollars that were there two or three or four years ago are not there now. We continue to decrease and lose funding. We aren't seeing the impacts yet; the 5071s are brand new clocks, and there is very little maintenance required for them. But in the out years, I have concerns on the funding levels. Will we be able to maintain the infrastructure and the number of pieces necessary to keep the Master Clock ensemble accurate as well as reliable?

Concerning the utilization of PTTI resources: We work very closely with the GPS in two ways, operations and development. We need to continue similar cooperative efforts for PTTI resources in other areas such as fleet support and planning conferences. There is also a particular problem in the training area. The training in precise time and the ability to maintain equipment on site at the various stations is a concern. In all of our training courses, particularly in the DoD, the emphasis is to minimize the training pipeline and get people through as quickly as you can. Timing is certainly one of those things that is frequently overlooked. It's an

issue with which we continually do battle. We will continue to try to strengthen the training opportunities in PTTI.

That's a quick and dirty overview of the highlights for '94. The challenges for '95 are even more severe in terms of our resources. I'm happy to report that right now we're able to protect our people, who are our most valuable resource. Conversely, our people will then be challenged to continue to do more with less. We've heard it for years; it is a reality today. It certainly is a reality at the Observatory.

QUESTIONS AND ANSWERS

MR. KEATING: This is not so much a question as a comment. I just want to reiterate Capt. Blumberg's comment about training, because I have actually listened to some conversations over a telephone to remote locations such as Hawaii and the Far East. And when you tell a person to move his clock ahead by two microseconds, 50 percent of the time the person on the other end causes actions which moves the clock in the exact opposite direction. And while that could be considered funny, when you're trying to maintain timing synchronization, that's a disaster. So I just want to emphasize that if you're a manager, don't downplay the need for training of your people.

RAYMOND CLAFFIN (CLAFFIN ASSOCIATES): Do you see in the new Congress any chance that this type of scientific military endeavor is going to receive any additional funding? Because, your needs really aren't as big as that of some of the other programs.

CAPT. BLUMBERG: That's one of our biggest problems, we are not as big as other programs and don't get the visibility that a lot of other programs do get. But I am a little optimistic that we will see the DoD budget grow in the future. How long it will take and at what point it does really benefit us is a real question mark. I mean, we have some serious problems across the board within DoD in terms of funding capabilities of getting our ships to sea, getting them properly manned, getting the personnel trained. And unfortunately, as I mentioned earlier, the timing is lost a lot of times in the hustle and bustle in trying to get things done. And so, again, it's our role in here as program managers, certainly my role, to promote timing with my resource sponsor and get him to promote within the Navy and the DoD to try to get the additional funding we need to get on with it.

So in answer to your question, I don't know specifically whether I can be optimistic or not. But I at least feel that we have an opportunity now to fight for a small share anyway.

Major Accomplishments in 1994

★ Validation of PTTI Requirements

★ Improved DoD Master Clock

★ Improvements to Two Way Satellite Time Transfer

Validation of PTTI Requirements

- ★ Original Survey made 1990
- ★ Contacted past respondents
- ★ PTTI Requirements Validated by OP096

Two Way Satellite Time Transfer

- ★ Technology Transfer of NRL developed Modem to Allen Osborne Assoc., Inc.
- ★ Utilized DSCS at X-band
- ★ Calibration Trip in Europe to 7 Laboratories
- ★ Calibration Trip to West Coast

New Initiatives in 1994

- ★ Strengthen PTTI Input to Master Navigation Plan (MNP)
- ★ Reference for WAAS of FAA
- ★ GPS Monitor Station Upgrade
- ★ Development of UHPTRS

Other Accomplishments

★ STANAG 4430

→ Precise Time & Frequency Interface for NATO

★ Support to DISA/DSCS

→ Clock Loans

★ Transfer of clocks to Autodin

Functions of PTTI Manager

- ★ Insure uniformity of PTTI operations
- ★ Derive & Maintain Standards of PTTI
- ★ Prepare Annual Summary of PTTI Requirements
- ★ Coordinate/Monitor DoD PTTI Research Programs

Objectives for PTTI Managers

- ★ Encourage adequate infrastructure support
- ★ Assist with negotiation of MoA and ISA to utilize PTTI resources effectively
- ★ Support DoD PTTI Planning Conferences
- ★ Promote DoD-wide PTTI Training opportunities