DISCUSSION ON GODDARD SATELLITE TIME TRANSFER

DR. WINKLER, The United States Naval Observatory

I think the discussion will take place. I should like to invite a few people here to join me at the table, certainly Dr. Decker, the project team leader of STIFT, and Mr. Starker, if he is willing to come up here. He has given us an excellent discussion of the German projects and could we ask somebody who's familiar with GPS time transfers to volunteer?

Nobody wants to volunteer? Yes, please, would you join us. I would also like to invite Professor Alley to come up and I think that we would have a little group and discuss the various aspects and summarize and ask questions. I would like the audience to be as active as possible.

Let me begin by giving you best regards from our European colleagues Dr. Bernard Serene; I talked with him yesterday morning to get some new information on the status of the LASSO project, and he regrets that he was unable to come, obviously, but on the news we received it appears as Professor Alley has already mentioned, that the LASSO is not dead.

In fact it's a very good chance that it might be a series of two successors, which will either be on a SERIES-2 type satellite, two experiments of course, or where it will be on METEORSAT as a piggyback effort. And then as mentioned by Professor Alley what we will expect, so that we will have to find out what is going to happen.

In looking over the papers which we have heard today and some of the papers which are still to come, and we have again the two classes of experiments of techniques: The one-way time transfers using a navigation system such as GPS, or such as TRANSIT and two-way transmission, using a communication satellite or using the ranging signals which are available on some of the other satellites, in the piggyback fashion.

I was very much intrigued by the slide shown by Mr. Starker today, about unscheduled and completely passive of comparison between Washington and PTB in Germany using completely different GPS receivers and achieving as we have heard a standard deviation of, something like 20 nanoseconds over a period of 10 days which includes all of the variations in the two clocks, in all the circuits and everything. And it includes the uncertainty of the GPS time transfer.

And just from that, but also when these experiences have been reported by David Allan and the NBS group and others. It is obvious that today we have the capability to synchronize any two clocks to about 20 nanoseconds wherever they are. Using the system which, in its original purpose, was far from being operational, but for a time transfer it is more than operational because we have five satellites which can be used and are being used.

Now, may I ask a couple of leading questions? We have heard today about the laser microwave time transfers and these super precision experiments and I would like to ask maybe anyone to answer here, how they see the future, and what role the laser is going to play in lets say 5 or 10 years from now, is it going to be a calibration tool or maybe it will become an operational tool?

PROFESSOR ALLEY:

The laser has the immediate disadvantage of not being able to go through clouds, at least in the powers available to civilian users. But, I think as a calibration technique it could play a very important part in the future.

I would think, for example, if we could calibrate using 1/10 nanoseconds laser pulses, the GOES positioning satellites are few, and the GOES positioning satellites were as they were tied directly to a master clock, for example, at the Naval Observatory then using the conventional readouts, one could improve on the global time transfer from the ten nanosecond level down to the precision of which the GPS is capable which is at the one nanosecond, or perhaps even better.

DR. WINKLER:

That is certainly an interesting comment, because we hear about developments of clocks which are capable of keeping time down to the 10th of a nanosecond and it is a question what utility they would have without a better readout capability. That question has been raised several times, and I think it has not been answered satisfactorily.

I would like to ask Dr. Decker about his estimate, I mean that may be an indiscrete question; but it is a planning meeting and we ought to discuss these things as candidly as possible.

What is your present assessment of this STIFT experiment?

DR. DECKER:

Well, at the present time, this is a study place, so it's not an approved colloquium. And it is rather difficult to start any new program today because all agencies are suffering from budgetary problems.

The system, as presently studied by NASA, would be of benefit to a large outside user group and in order to get something like this going, I think one needs the support or the expression of interest from outside users to NASA to support the start of such a program.

So, at the present time, we do not have any committed start or start of the development of this STIFT system.

DR. WINKLER:

And so it is a concept, essentially, which is still looking for sponsors for support?

DR. DECKER:

That's right.

DR. WINKLER:

And as I heard, Mr. Starker, today, your experiment is apparently going in full force, is that true?

MR. STARKER:

Yes, you are right. It is in full force and it can be, and there is no doubt that it is a decision of great determination.

And to your question about laser or microwave links, I come from a microwave Institute, and I think that microwave links will be the operational tool for time transfer and laser will be used as a calibration tool, perhaps. And for us, not the highest experiencing is our aim in this first experiment with dual links. We find that the experimental technique to use a computer and a noise code as time signals, is a very important thing which can be used with communication satellites or with low-orbiting satellites, as well. And this is our aim and we made some experiments to offer as proof and we got also precisions of smaller than 1 nanosecond.

DR. WINKLER:

Your presentation presented us with such a wealth of interesting information and interesting details, I really think you should look very carefully through your panel paper.

But it appears to me that in Europe the schedules-- that it may be very wise for ESA to establish much closer relationships with this European group and find out how we could possibly participate --- what possibilities still exists? As we have heard, one of the main driving objectives in the German experiment is to gain experience in using clocks in space.

DR. DECKER:

I have a question. Do you have any plans in the future for this particular experiment? You said it was the first one?

I have a suspicion that the technology of clocks are out running our means for comparison at a greater rate now than ever before. I wonder if you care to discuss this point and the fact that at some point in time some action is likely to be needed, what action can be taken?

DR. WINKLER:

Any comments?

MR. TALLEY:

I have one comment with regard to GPS in this area. As far as our observation in orbit is concerned, from the GPS program point of view, it is through KALMAN filter observations at the master control station and if we look at two of the clocks one of which has a temperature coefficient on the rubidium and one has a suspicion of a variation in beam current in the cesium, the KALMAN doesn't show the diurnal effect. Yet we are highly suspicious that the clocks have these variations.

I think that the ability to look at the clocks on the ground has deteriorated to some extent.

We are working to try to separate that.

DR. WINKLER:

I happen to completely agree with him on his comments, that this is true. That, in fact, years from now, we're not going to have any means to utilize much better clocks which we can expect to have. I think that there are definite gaps in our planning and development. We are talking about many experiments but now not one of them will be useful at the one nanosecond level with the possible exception of the GPS system, but this will require some doing.

Further discussion on the clocks?

MR. WHITWORTH, JHU/APL

DR. WINKLER:

Can I repeat? One of the results which you reported at the Frequency Control Symposium that over a period of 2 or 3 weeks the residuals in common view mode between NBS and Washington using precisely the same satellites, the time difference in data, was on the order of 2 nanoseconds.

MR. ALLAN:

That's correct.

MR. STARKER:

I believe that Dave Allan is aware of the type of contamination that is expected and maybe he would care to comment on how civilian users would react to the contamination.

MR. ALLAN:

Basically, I think we cannot talk about these kinds of techniques, but the common view approach would eliminate some of the problems that would be encountered and I think this will allow us to still use the system even under some disturbed circumstances.

So, I think that the system will be continued.

DR. WINKLER:

Instinctively, I have a feeling that the system is of very great use right now.

On the other hand, we have to be prepared. Not one of the systems can be guaranteed to work when we need it and there is nothing more important in time systems than to have a common interface to allow us to get time from one of the other many coordinated systems.

That's the whole purpose of coordination.

Well, I think, Mr. Chairman, that we have finished now and I thank you very much.

MR. KAHAN:

I would like to thank all of these speakers this afternoon.