PANEL DISCUSSION

William J. Klepczynski, Moderator

DR. KLEPCZYNSKI:

I would like to start off the discussion by asking one question and seeing how things develop. First, I would like to find out if anybody would want to comment on the use of the lead second. Have there been any difficulties with respect to the users? Has it satisfied everybody's needs? Is everybody happy? Are there many complaints?

DR. WINKLER:

Please also comment on the usefulness of the UT-1 code, and any criticism you may have about that.

DR. KLEPCZYNSKI:

I was wondering if Mr. Stanley from the National Bureau of Standards has any user reaction?

MR. STANLEY:

Yes, I indeed have, especially in regard to the DUT-1 code. As most of you are probably aware, we transmit DUT-1 corrections from WWV as a series of double ticks every minute. Some of the seconds markers between the first and 15th seconds are doubled, and by simply counting the number of ticks that are doubled, one can obtain a coarse approximation of the difference between our times field as transmitted and UT-1.

For example, if two of the ticks are doubled, the DUT-1 correction to be applied is two-tenths of a second.

Now, I have received some complaints that the double ticks as transmitted by WWV cannot be distinguished clearly, especially during times of high atmospheric noise. The Canadian station, CHU, uses a similar procedure, but their keying tone is of longer duration and it appears to be much easier to discern their double tick than it is in the format that we are using at WWV. I would be interested in any comments that some of you may have.

DR. WINKLER:

I think one of the problems that we have is that we of the PTTI community are really not directly representative of the many people who use these time signals. And I would like to encourage each one of us who has some interface with that community so that we get some reaction. That community we are talking about is not represented anywhere. Because these are the people on radio receivers and they do not speak up or do not talk back – if you want to say that.

So we really have a problem. I think we will expect in the next year, and continuing, a discussion on the usefulness of the present arrangements, and their possible improvement. I would very much appreciate any ideas or criticisms, because we need these ideas.

MR. LAVANCEAU:

As one of the users of the DUT-1 code, I would like to know what can be done to have the Navy Department transmit the DUT-1 code properly. I notice that many times the DUT-1 code transmitted by Navy stations is not the correct code.

I think that users should be guaranteed the correct UT-1 code. And I wonder what NRL wants to say about this.

MR. STONE:

The reason that it's different on the VLF is that we are using the FSK in order to put a CW signal out, with FSK you have a little bit of a problem, but basically what we were doing was to try to make it closer to our type of transmission.

MR. LAVANCEAU:

No, I'm sorry, maybe I didn't make myself clear. The DUT-1 code transmitted by the Navy station is sometimes not the one that is supposed to be transmitted. Sometimes they forget to change it. I wonder how to make certain that the station will transmit the correct DUT-1 code.

MR. STONE:

That's a hard one to answer. I don't know how you guard against lapse of memory, or whatever it is. But I'm sure that there could be some kind of operational procedure, maybe automatic, that would take care of that. I see no reason why not; it's just a matter of knowing whether or not it's occurring.

DR. WINKLER:

We have a problem which increases with the number of controlled messages and the number of adjustments. I think the point really is, is it necessary to have the DUT-1 code to a tenth of a second? How many people are using it? How many people are getting it from the published value in, for instance, the "Notice to Mariners"? That's really a question which has to be investigated.

DR. KLEPCZYNSKI:

This leads into another problem which I wasn't aware of, but the Manned Spacecraft Center in Houston, Texas, was really upset by the leap second. The Apollo launch can't really be delayed too much after December because if it is, then their time system will be offset by one second. And all their orbits are precomputed, so this is a very difficult operational problem to overcome. They essentially just can't schedule a launch, especially a manned launch, during the period of a leap second.

MR. WARDRIP:

This, I might add, is also true of the Skylab project. They are particularly concerned, not necessarily when they are sending up unmanned satellites, but certainly when they're having manned satellite activity.

DR. REDER:

It's sort of a legitimate question, "Why January 1?" because if you have any program or automatic system you have to work harder on January 1 to recognize the Julian date going from 365 to one, and so on. Why is it that it's done then?

DR. WINKLER:

The reason for that is that otherwise no international agreement could have been reached in the discussions about the change of the old UTC system, and I remind you about your troubles which you had when you were to be prepared to make frequency changes in multiplies of 50 parts in 10^{10}, possibly every year, also steps of one-tenth of a second, sometimes quite frequently.

Don't forget, we have been exceedingly lucky from 1966 through 1972. We had only one step and no frequency change, but the situation could have changed. Following some legitimate complaints from the physicists and from radio engineers who wanted an invariable frequency base connected to the time-signal emission, it became clear that the offset had to be dropped.

Now you cannot drop the offset without at the same time increasing the tolerance between UT-1 and the time signal. An increase of the tolerance I think was most strenuously objected to by a number of people and a number of nations. For instance, the Russians objected to that increase of tolerance vehemently for years. When it finally became clear that there was still a possibility of reaching some agreement, it was only on the condition that any change take place only at a fixed date. Now that couldn't be done. You cannot have an exact second introduced at a fixed date and still stick to a tolerance of 0.7 second.

So the solution was modified – not one fixed date, but two fixed dates. And finally everybody agreed on two fixed dates. A step second could only be introduced at the end of June or at the end of December.

There is some additional provision in the IAU recommendation – and also I think in the CCIR recommendation – that in extreme cases the step second could be introduced at another month, or at any time. And this may become necessary. Our learning period is very short; we have not seen any really violent change in the rate of rotation of the earth.

But I believe that should answer the question, "Why have these two periods been selected? Couldn't it be at any other time?" The reason is that – in brief – you should make such drastic changes only with complete international agreement. Nothing worse could

be imagined than to have these 40 or so time service stations mentioned before, meet on two different systems, or three different systems which may be half a second apart.

It's for that reason that I think the present system is a great improvement. Of course, by necessity it has to be a compromise. The impression is, "How much do we pay?" Is it intolerable, or can we still effect some improvements?

MEMBER OF THE AUDIENCE:

I am in fact very happy to hear that the leap second is going to cause some problems operationally. We have foreseen some of that. And I wonder if any progress is being made towards a uniform time scale.

The leap second is, as you say, a compromise. And most of the information that needs to be used by those users who depend on it, can be provided by radio signals. In most other cases the publications on the time difference should be adequate. Is there any further development along those lines?

DR. WINKLER:

I know for certain that there will be no change in the basic concept for at least five to ten years. Another change within only two or three years is out of the question.

MR. KEATING:

Does WWV announce shortly before the hour, five or ten minutes before the hour, for example, the maximum usable frequency?

MR. STANLEY:

No, sir, WWV does not announce maximum usable frequency. We do not have that data available to us on a day-to-day basis.

MR. KEATING:

I would like to suggest that that would be very useful.

MEMBER OF THE AUDIENCE:

We find the present system most useful, having originally developed all our equipment around WWVB, the 60-kHz station, because of the various offsets in the other signals. Is there any anticipated dropping of that station now? I have heard rumors that it was to be phased out. Is that so?

MR. STANLEY:

There is nothing definite to report at this time. There is some speculation, of course, that eventually WWVB will be phased out. As for a target data, I have heard that 1980 might be a reasonable date to look forward to now for phase-out of WWVB. But there is nothing certain. And certainly nothing definite at this time.

MR. CURTRIGHT:

I'd like to make a comment on WWV. We in the deep space net, unlike other people, do have catastrophic failures in our timing system. And we do appreciate very much being able to put on the headset or the scope, or whatever, and being able to be in the ballpark, so to speak. It's a very, very usable tool in the case of catastrophic failures.

MR. STANLEY:

I don't mean to paint a gloomy picture. Perhaps I have in talking about the shortcomings of high frequencies for time and frequency dissemination. As satellites come into the picture and become fully operational systems, perhaps WWV may be curtailed. But I think it will be many, many years before the service is stopped altogether.

MR. CURTRIGHT:

I didn't mean to sidetrack the discussion concerning WWV. We use WWV every day for setting the master time on our computers for the ranging operation. However, our master station clocks are compared and phased to WWVB, and it is for this reason I was concerned about the possible termination of that station.

DR. WINKLER:

In the absence of any further comments here, I would like to say something concerning WWV. As I said before, I am in complete agreement: This is an extremely important service, for instance, here on the east coast, in Washington and in Florida; the day-to-day variations in the time of arrival of 15-mHz signals are on the order of 0.1 millisecond. You can get that with a relatively cheap high-frequency receiver. And I think that is very difficult to beat, also in respect to the difficulty of tuning the receiver.

There are, however, a couple of comments. If any station wants to routinely monitor the signals from WWV, or from any standard-frequency time signal which is convenient and close, don't forget that one of the benefits of the new UTC system is that overseas we have quite a number of stations, including the Russian stations, which are very close to the epoch which we use here.

But if you have the signal monitored, I think it should be monitored at the same time during the day. One must insist that the operator not change the bandwidth control on his communication receiver, if he has a variable bandwidth. You should encourage him to demonstrate that to himself, to look for variation in the time of arrival, which can be several milliseconds if a different bandwidth is used.

He should be encouraged to watch the difference in time of arrival as noted when you tune in or when you adjust for the beginning of the tick, as opposed to a zero crossing later on in the tick. The reason for this is that in the first case you depend on the transient response of your receiver, and in the second one you get into the steady-state response.