COMMENTS ON NAVSAT TIME DISTRIBUTION

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I would like to make some comments and would speak to the last three presentations which have been made. I think the range is very wide--perhaps between something similar to the ultimate concept, which would give practically everything which you could possibly extract with modern technology (621B), to a system which is operational; and that of course is TRANSIT. Here I feel it is necessary to emphasize the points which are important for our conference. Unfortunately, here in this country, the use of this existing operational system has been minimal for time transfer. However, the French are using it. They use the TRANSIT system to synchronize their stations which are in support of the French satellite ranging research effort, and they report a precision obtained to about 10 μsecs. It is done very simply by using the 2-minute time tick which is emitted by the TRANSIT satellite.

As you will probably recall, the satellite emits a continual code stream which contains the orbital information. But every 2 minutes on the even minute, it emits a time tick which can be recognized as the appearance of a 400-cycle switching tone. By measuring the time of arrival of that time tick every 2 minutes, you may get five, six, and sometimes seven of these points in any one pass, you can plot a "best fit" parabola. The point of the closest approach, of course, is the minimum point on the parabola and your time of arrival of the time tick is delayed by the propagation delay from the satellite to you. Again, the problem is how to determine that propagation delay. There are two ways: (1) by using the orbital elements, which are published regularly in the notices to mariners issued by the U.S. Navy Oceanographic Office; it gives information

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better than about 100 μsecs; and (2) by using the satellite signal directly to determine the range. This has been pointed out by Mr. W. Judge from Magnavox. It simply consists of using both the doppler rate at that point of approach and the range. Instead of measuring doppler which would make it more complicated, simply look at the curvature of the parabola which is nothing more than the rate of range change. You can envision that given a circular orbit with known radius, this is a function of the actual distance of the point of closest approach. The farther away the satellite is, the less the curvature of this point will be.

There is a simple mathematical relationship which has been worked out. The point is that here you have a system which offers timing down to (at the present time with our present system) about 10-μsecs precision, and to my knowledge no one in the U.S. is using it. Twice daily the satellite passes over practically every point of the surface of the earth. As I understand from the presentation of Mr. Rueger, there are certain improvements which have been envisioned that will make that time distribution even more precise and will significantly reduce the present data noise of about 10 μsecs. The receiver which we have at the Observatory is of the type which you saw in the photograph shown by Mr. Rueger, and it by no means reflects the latest state-of the art. I am sure many more advanced designs are possible.

In respect to TIMATION, you can see we are on the verge of using an experimental satellite for actual operational transfer of time. One single R&D type satellite can satisfy, as we believe, all PTTI global requirements anywhere with a precision which far exceeds what is required today. The problem is, however, that we cannot presently encourage development of receivers to receive the satellite signal, because it is only an experimental program, and we are not assured that there will be any replacement compatible with existing receivers.