Interoffice

National Radio Astronomy Observatory

Charlottesville, Virginia

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To: VLBA Members

VLB ARRAY MEMO No. 265

From: A. Shalloway

Subject: Data Communications System

I have just become involved in the design of a data network for the VLBA; thus, I have a limited amount of hard facts and figures to present. However, since the operation of the network is influenced by many VLBA design factors and vice versa, I felt it important to get some ideas out immediately and receive some answers back as soon as possible.

There are many ways of setting up the network. Four methods with variations are discussed below.

I. Use dedicated telephone lines to connect all stations together in a star configuration emanating from the center site with a maximum of four stations on any branch of the star.

Two ways to accomplish this are:

A. A polling multipoint system.

Advantages: Central site can broadcast data to all antennae simultaneously - see fringe system described under satellites below.

Disadvantages: For all practical purposes, it is a half duplex system which cuts the data transfer in half; and if it is a continuous multipoint system (instead of 3 or 4, one for each branch of the star), it will cut the data transfer by another factor of 3 or 4 or a total of 6 or 8.

B. A serial (per branch) system using standard modems and statistical multiplexers (or having a computer do the equivalent of a multiplexer).

Advantages: Higher data transfer rate.

Disadvantages: Possibly a bit more chance of one station's outage affecting other stations further away from the central site.

Disadvantages of both of the above: Cost is high ($185,000 to $200,000 per year) - probably over a ten-year period, higher than any other system. Because of the remote locations of the antennas, when the dedicated lines have outages, there is a good chance that the dial backup lines will also be out. This is based on our experience in the NRAO network branch from Socorro to the VLA site where a small local telephone company provides the service.

II. Use of a value added network. Those available that look best are Telenet, Tymnet, ADP Autonet and Net 1000. I have not had time to investigate these four and therefore have no individual comment on them at this time. If they provided the entire communications, I believe they would be more expensive than dedicated lines; however, they may be useful as an adjunt to another system. This will be investigated.

III. Use of a network similar to II above, but using satellites. One such system is the RCA Cylix. I have further investigation to do on this, but I believe it would be expensive, just as II above would be expensive, and both II and III would have the outage problem of I. Number III would have the outage problem because the satellite stations are not located at our antenna locations and the data would have to travel over the same local telephone lines to reach the satellite stations.

IV. Our own satellite system. There are two ways to accomplish this:

A. Get a turn-key company to supply the antennae, electronics, arrange for the satellite channels and provide service. I will check into this, but my first guess is that it is going to be expensive.

B. Design our own system after discussions with various manufacturers, buy the equipment, arrange for the satellite channels and debug the system.

Description of two possible ways to set up a satellite system:

This system is based on the following assumption, which obviously, is not in agreement with everyone's opinion:

A. Monitor data need never be sent back to the central site in real time except when a monitored parameter is out of specs or when it is desired to check some parameter from the central site. If everything is operating properly but reference to the parameters will be desired at a later date - either by the astronomer for a check against the observation or by the engineers to plot the operation of the equipment with time - the data can be recorded on the correlator data tape or on a magnetic diskette.

B. One way of checking the fringes - often and with all the telescopes - is to have the central site have an antenna at its disposal and send the correlation data from the central site to all the other sites simultaneously. At the antenna sites there can be a small computer that can do the equivalent of a delay line and cross-correlator and then check the data for fringes. The data will be coming in at such a slow rate - maximum or 9600 bits per second - that a hardware correlator is not required.

Based on the above, the only data transfer from the antennae to the central site is the relatively rare case of a failure or when it is desired to check the monitor data. Even if this occurred four or eight times a day, the cost would be relatively low. This data transfer could be accomplished by direct dialup or use of a value added network as described above.

Under this setup, the central site would have a transmitter-receiver satellite system and each antenna would have only a receiver system. The central site could then transmit the control data, which would take a small amount of time, and the remainder of each day could be used continuously checking fringes.

If there can be no agreement on the above system, we then can have a system with a transmitter-receiver system at the central site and each telescope. This allows various arrangements, and to help consider this option, the following is a rough discussion of cost and operating possibilities.

COST: I have no firm figures yet, only very rough ball park figures from one company and some guidelines from another.

Dalsat Satellite Communications: Transmitter-receiver system = $40,000 to $65,000. Receive-only system = $30,000. 9600 baud half-duplex channel = $1,000/mo. A full-duplex channel with one voice channel = $2,000 to $2,500 per month.

Atlanta-Scientific: I will be receiving a ball park quote from this company soon. The only point of interest now is that this company differed with Dalsat in that it said the ratio of cost of a transmitter-receiver system to a receiver-only system is about 3 to 1. I have hopes that a more precise quote will turn out to be cheaper than the above prices, and especially a year or two from now when we buy the equipment.

If only the central site has the transmitter, data can be sent to all sites simultaneously. If all sites have transmitters and there is only one satellite channel (half-duplex), the system would be operated like a polled system from the center site. In the maximum case, you could have 20 half-duplex channels and have 9600 baud communications between all the sites and the center going on in both directions simultaneously. Obviously, this is more than is required, and some compromise system could be used.