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O. Ciaffoni, M.L. Ferrer and L. Trasatti:
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INTERLABORATORY LINKS

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O. Ciaffoni, M.L. Ferrer and L. Trasatti
INFN - Laboratori Nazionali di Frascati, 00044 Frascati (Italy)

ABSTRACT

Possible technical solutions to the problem of high speed data links between laboratories are presented. Long distance networks (WAN), ranging from tens to hundreds of kilometers, offer a variety of possibilities, from standard 64 Kbit/sec connections to optical fiber links and radio or satellite Megabit channels. Short range (up to 2-3 Km) communications are offered by many existing standards (e. g. Ethernet) up to 10 Mbit/sec. The medium distance range (around 10 Km) can be covered by high performance fiber optic links together with LAN (Local Area Network) bridge techniques. A possible area of application is between the Gran Sasso Tunnel Laboratory, the outside installations and other Italian and foreign Laboratories.

1. - INTRODUCTION

The importance of high speed data links between laboratories is steadily increasing, due to the higher and higher amount of data produced by modern experiments and to the growing demand for remote control and monitoring of complex apparatus, located in critical environments. In this respect, the Gran Sasso Tunnel Laboratory offers an ideal experimental ground, for two different reasons:

- a) The need to control the experiments from the outside of the gallery (6-7 Km distance). Some experiments are even considering the possibility to locate the counting room outside the tunnel.
- b) The wish to monitor the experiments from remote laboratories, even in the United States.

2. - WIDE AREA NETWORKS

Standard analog data links are limited to 19.2 Kbit/sec. SIP (Societa' Italiana per l'Esercizio Telefonico) is experimenting different techniques of digital data links. Experimental 64 Kbit/sec PCM (Pulse Code Modulation) connections are operative, and a project for a 2 Mbit/sec optical fiber link along the Autosole has been presented.

Radio links offer higher data rates and are essentially cheaper to install, but they require the communicating stations to be optically visible between each other. A good area of application of this technique could be in the connection between relatively close INFN Sections and Laboratories.

Satellite links offer channels with speeds up to 2 Mbit/sec in 34 Kbit/sec steps. Two satellites are available at this moment in Europe for commercial users: TELECOM 1 and ECS. An Italian satellite, ITALSAT, will be available in 1988. However, several problems are becoming apparent: the price, although less than ground connections, is still high, and the delay associated with the long flight path tends to create response problems for high level network protocols which use heavily handshake techniques. An interesting problem connected with the satellite service is that the geostationary orbit, necessary to reduce antenna costs and network management, is already practically full. Almost 80 satellites are flying on this orbit, and their number cannot increase too much in the future. However, DEC is studying the software performance of satellite links, and their use will continue to be important for intercontinental connections.

3. - LOCAL AREA NETWORKS (LAN)

Local Area Networks, in contrast, offer high bit rates, good software support, and a good grade of standardization. Unfortunately, serious limitations in their capabilities are their very short range (in the case of Ethernet, 2.8 Km with fiber optic repeaters) and the difficulty to interconnect different LAN's, either similar or different. Several instruments to overcome this limitation are being proposed: Gateways, Routers, Bridges and Repeaters.

The most powerful, which is also the most cumbersome, is the Gateway. A Gateway, working from level 4 of the OSI (Open Systems Interconnect) standard upwards, converts protocols from a network architecture to another. Its capabilities are high because, since it understands the structure of the data it handles, it can communicate between different networks, for instance implementing a file transfer between two different machines. For the same reason, their throughput is low, because the software overhead they require is high.

Routers work at a lower level (up to OSI level 3). They are not concerned with data structures, and therefore can only interconnect networks of the same architecture. However, they understand message handling and, for instance, can choose the best way to transmit a message through a complicated network. Moreover, they are aware of the packet structure of the interconnected networks, and can translate from one to another. An example is the DEC Ethernet / DDCMP router.

Bridges are even more simple and, therefore, more efficient. They work at Levels 1-2 of the OSI, and transmit packets between different sections of the same network, choosing which messages belong to any section. A typical bridge example is a way to interconnect two Ethernet sections beyond the 2.8 Km limit. Two bridges are installed, one as a node of every section. Every bridge monitors the traffic on its section, and only transmits to the other bridge the packets which have addresses belonging to the other section. This method is very simple and very powerful. Since a bridge only handles packets, and not messages, it does not influence the higher level message and data structures, to which it is transparent. For instance, a bridge between two Ethernet sections is completely unaware of the upper protocol layers, which could be DECNET or TCP/IP or any other standard. On the other hand it can heavily reduce traffic on a CSMA/CD network (e.g. Ethernet), since not all packets must travel to all stations. Every section sees only the packets of the other section (or sections) which are addressed to itself, and is not burdened with the internal traffic of the others. Because of its inherent simplicity, a bridge is capable of maintaining the high bit rates of the original network.

Bridges between Ethernets have been implemented using satellite links (TRANSLAN/Vitalink) and are becoming available for ground connections using fiber optic links from various vendors, including DEC. Unfortunately, the DEC product, because of the fiber technology used, is limited to a distance of 2.8 Km between the two Ethernet sections it connects. This distance is too short to be useful for the Gran Sasso Laboratory, where 6 Km must be covered to carry data outside the tunnel, and where one (or more) Ethernet networks inside the tunnel would have to be connected with one (or more) Ethernet sections in the outside installation.

We have investigated the possibility to implement longer distance bridges using more sophisticated fiber optic technologies. It is possible, using monomode fibers, to obtain channels working at 140 Mbit/sec on a distance of 10 Km without using repeaters. Even multimode fibers, whose technology is more conventional, can carry up to 34 Mbit/sec on similar distances. The price ratio between the two different technologies is about a factor of two. A new transatlantic telecommunication cable using monomode fiber technology is going to be laid down between the United States, England and France.

Several firms, including Italian ones, manufacture and install fiber optic links having these characteristics.

Data handling at the ends of the link is performed using time slot multiplexing techniques, where several channels with different data rates are assigned on a circular basis a predefined time slot. Different kinds of data can thus travel on the same fiber, including television channels and digital data.

We are proposing a collaboration with DEC, which has expressed an interest in the fusion of the bridge technology with these fiber optic channels.

4. - CONCLUSIONS

A wide range of possibilities is becoming available in the high speed telecommunication field, both for long distance connections and in particular for the extension of short dedicated networks to longer distances. A new installation like the Gran Sasso Tunnel Laboratory seems like an ideal testing ground for the application of these new possibilities.