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SHARP APL COMMUNICATIONS NETWORK

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Local access to SHARP APL is now available in over cities throughout Canada, the United States, Europe and Australia. The communications facility supporting this system consists of Sharp's own dedicated network - supplemented by the public carriers Dataroute in Canada, and Tymnet and Telenet in the US. Since 1973, Sharp has been introducing its own internally developed packet switching system, first of all in Europe and from 1976, worldwide. Today the system controls one of the largest and most advanced networks in the world.

The system has brought a number of significant and unrivalled benefits to the users of SHARP APL:

1) **High** Reliability: communication failures are much less frequent than with conventional multiplexing systems. Furthermore, users are always kept informed of the status of their connection with APL.

2) **Fast Response:** the system is optimized for interactive APL usage.

3) **Virtually Error Free Transmission:** transmission errors are automatically detected and corrected by the system.

4) **Terminal Flexibility:** varying terminal types and speeds may be connected.

5) Low **Connect Charges:** the efficient line utilization of the system enables relatively low APL connect charges. The location of the many local access points also reduces user dial-up costs.

COMMUNICATIONS

Network Topology

The hardware behind the SHARP APL network consists of over 40 Computer Automation Alpha LSI-2/20 minicomputers located throughout the world. In their role as communications processors they are known as **concentrators.** Each concentrator forms a **node** in the network and is connected to one or more other nodes by highspeed synchronous lines. Two high capacity transatlantic cable lines link North-America and Europe. In the event of one failure of one line, the total traffic may be switched to the remaining line.
Users of SHARP APL need only dial in to their nearest node on normal low speed telephone lines to gain access to APL. This link or access to the computer is called a **port** and, at present, the APL system can simultaneously support over 200. The processing heart of the network, located in Toronto, Canada, consists of an Amdahl 470 V6II and an IBM 360/75 operating in a dual CPU master-slave configuration. A number of IBM 3705s provide communications front-end processing and function as nodes in the network as well as providing extra facilities.

Elements of Packet Switching

All messages sent between APL and a terminal, connected to the network are split into one or more fixed length **packets.** Along with the message itself, each packet contains destination information and error checking data. Having left the originating node, the packets travel independently through the network under the control of a protocol, being forwarded on from one node to the next until their destination node is reached. Only then are they reassembled into their correct order to form the original message.

Virtually error free transmission is possible because at each node through which a packet travels, the packet is checked for errors. If an error is detected then retransmission is requested from the previous node; otherwise the packet is forwarded on to the next node in its route. As well as ensuring the integrity of the transmitted data, the Sharp network protocol prevents possible breaches of security due to line failures.

The length of each packet in the SHARP APL network is optimized to give a fast response to the concise messages which arise with the normal pattern of interactive APL use.

Line Utilization

The efficient line utilization of the Sharp packet switching system is based on statistical multiplexing. Advantage is taken of the fact that not all terminals connected to the network operate simultaneously at full speed. This system makes possible relatively low APL connect charges.

In conventional systems such as time division multiplexing, a fixed bandwidth must be allocated for the duration of the terminal connection. Packet switching systems can achieve very high line utilization by freeing communications resources when they are not actually being used by a terminal, for example, when the user is thinking and no characters are being sent. As a typical example, ten 300 baud terminals may be serviced with ease on one 2400 baud line.

At times of overload, the Sharp concentrators can queue packets until a transmission slot is available. To the user this appears as slight inter-packet pauses.

Concentrator Intelligence

A high degree of intelligence is built into the concentrators. Line "hits" or failures may not result in disconnection of the user from APL if lines stabilize within 15 seconds. The concentrators are able at all times to reply to users, keeping them always aware of the status of their connection with APL.

Intelligence in the concentrator also enables the system to automatically recognise and adapt to the type of terminal being used (ASCII or BCD) and also its speed, for example 15 or 30 characters per second. To ensure an even response amongst users, packets arising from highspeed terminals running perhaps at 120 characters per second are given a lower transmission priority and extra buffering.

Concentrators may be installed in customer premises where several terminals are in use at the same location. This can give reduced dial-up costs and alleviate high-error rates on poor local telephone lines. Terminals may be hardwired into the concentrator to eliminate the need for extra modems.

The flexibility of the concentrator software also allows it to be modified for special purpose applications such as interfacing directly to customers' computer systems. As an example of a customized facility, the network is currently used to support a Telex facility involving a special-purpose concentrator that can automatically accept and store Telex messages.

Operational Convenience

The operational ease of the SHARP APL network is a major factor in its reliability. The network supports itself in the sense that the same communication lines are also used to load new or inactive nodes with a fresh copy of the concentrator software. Essentially, the whole of the network can be controlled and managed from any one node. Nodes may be configured and restarted without interrupting the operation of the intervening nodes. An error tracing facility also allows the software in a node to be inspected and modified remotely from another. The **down line load** facility coupled with the intrinsic reliability of the Alpha LSI hardware enables completely unattended operation of the concentrators except for maintenance.

The network also utilizes itself for accumulating **monitoring** information on the performance of the system. Information such as error rates and traffic loads between each pair of connected nodes enables the isolation of potential bottle-necks and communication failures. This information is accumulated centrally and may be analysed directly from APL