DATA CONCENTRATORS IN FOCUS FOR MINICOMPUTER-USERS

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Occasionally sales representatives of mainframe manufacturers state that asynchronous communication systems are nowadays abolished and they refer convincingly to their intelligent and synchronous TP-systems. Some users accept this information and spread it out with firm belief as their own opinion. No wonder that asynchronous communications have been more or less condemned.

However, the fact is that asynchronous communications with means of data concentrators provide the minicomputer user with significant advantages regarding error correction and transmission performance like the IBM users with an IBM 3270 or IBM 7380 system. This paper is aimed to help you to understand the advantages of using data concentrators specifically with regard to price-/performance ratio.

Before microcomputer-driven data concentrators became available, mincomputer users planning to install more than one low-speed terminal in a remote branch location had to lease a telephone line with two modems for each terminal at high cost (Fig.1a).

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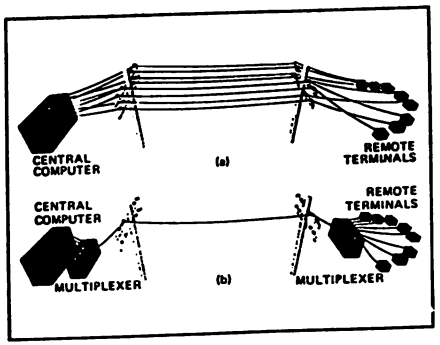

Fig. 1. Two approaches to linking multiple terminals to a central computer: (a) using a separate line for each terminal and (b) using a single multiplexed line.

Most PTT organisations provide for asynchronous modems only two alternatives:

1. a modem for 300 baud (30 characters/sec.)
2. a modem for 1200 baud (120 characters/sec.)

These low speeds do surely not encourage to operate with more than one CRT or printer - since, even with 1200 baud, to fill on CRT screen takes 16 seconds. The unsatisfying transmission speed in conjunction with the lack of error correction has carried asynchronous communications into a dead end.

Another alternative was to use time-division (TDM) or requency division (FDM) multiplexers that enable terminals to share a telephone line (Fig. 1b). However, the lack of sophisticated error-control routines inherent in minicomputer-supported Teletype-compatible CRTs, printers, and other remote peripherals results in unacceptable line-error rates with this approach.

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The error rate problem is especially acute with high-speed time division multiplexers that operate at the maximum rate for a single voice-grade-circuit. The best error rate quoted by any supplier, including the telephone companies, is 10^{-6}. This translates to one error every 90 seconds at 9600 bps; at 4800 bps, one error every three minutes; and at 2400 bps - the minimum line speed required to fill a CRT screen in a tolerable time frame - one error every six minutes.

This error rate is overcome when multiplexed data communication networks use mainframe processors as hosts because the terminals automatically retransmit data containing errors. As a result, mainframe terminal operators see only a slight degradation, if any at all, in terminal response when an error occurs. However, when terminals are linked to a minicomputer, erroneous data blocks cannot be retransmitted. Moreover, implementing a data communications link based on TDMs and minicomputers can be expensive. Modems needed to operate at 9600 bps can cost as much as $ 5000 each, or more than three times the cost of a multiplexer alone. Even at slower speeds, this equipment is costly.

The need for intelligence

To implement a multiplexed multi-terminal network, mini users need "smart" multiplexers that will enable them to hang more than one terminal off a single line at each site while providing the error-control required for efficient operation. In addition, minicomputer users need to use high-speed terminals to minimize operator waiting time during interaction with the computer.

To provide these capabilities at a price mini users can afford, several US companies, such as MICOM SYSTEMS, have introduced microcomputer-driven data concentrators. These devices typically handle four or eight channels.

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A multiplexed network uses two concentrators: one at the terminal end of the phone link, the other at the host computer. Both devices are linked to the telephone line via modems. In operation, the concentrators buffer data prior to transmission, enabling them to transmit variable-length data blocks depending on the loading on each terminal's channel.

In effect, the data concentrator, or statistical multiplexer, as it is often called, increases the average traffic on a high-speed line by buffering peak traffic on individual channels.

The concentration made possible by buffering data also increases throughput compared to time-division multiplexers. The reason? TDMs transmit data blocks even when a particular terminal has no data to send. Statistical multiplexers, on the other hand, assign channel capacity dynamically according to the load on a given input channel.

The load-averaging method used by statistical multiplexers makes them better suited than TDMs to the interactive mode of operation that characterizes minicmputer-based systems. In interactive applications, the loadings tend to come in bursts, rather than at the steady pace characteristic of batch or remote job entry. Hence, TDMs are often too powerful for minicomputer applications.

Smart means no error

Moreover, by buffering data, concentrators can also check data blocks received on the high-speed link and request retransmission in case of error. To implement this automatically, similar to that used in IBM's SDLC protocol. A data concentrator, for example, typically attaches a cyclic redundancy check (CRC) character to each transmitted block. The receiving concentrator then recalculates the attached CRC to check the block for errors.

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With data concentration, the undetected error rate is so low (better than 1 block in 10^{12}) that data transmission is error-free for all practical purposes. The error-handling does not involve the host minicomputer at all. In fact, in most applications, the mini treats the data communications hardware as if it were simply a hardwired peripheral located in the same room.

The microcomputer based intelligence of a statistical multiplexer is also used to simplify network configuration. The Micom Micro 800, for example, is self-configuring to a large extent. All configuration parameters, including the data rates for each channel, are switch selected, with only 16 DIP switches required to configure a four-channel unit. In contrast, most TDMs have literally thousands of possible strap-option permutations, any of which may be responsible for time-consuming installation problems.

To further simplify system configuration, switch selection of configuration parameters is required only at the computer site. The host data concentrator automatically down-line loads all configuration data. Only one switch need be set in the remote concentrator to inform the unit that it is a "slave" unit.

Data concentrators do have a drawback, however. During prolonged peak transmission periods, or because lines errors have lead to excessive retransmission, "buffer overflow" may occur as data comes into the buffer faster than it can be sent out onto the line. In such a situation, data is lost, with the most active channel losing all its data first, followed by less active channels in order to buffer utilization.

To minimize data loss caused by buffer overflow, data concentrators incorporate switch-selectable options intended

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to suspend data transmission temporarily. For example, the Micro800 takes advantage of the fact that most minicomputers will suspend transmission either on receipt of a special control character (XOFF), or on the dropping of the Clear-to-Send interface control signal. Transmission will resume when the system receives the XON control character or when Clear-to-Send is raised.

If buffer overflow continues and data is lost, an appropriate message is sent to the affected terminal. The Micro800 also automatically transmits a "LINK DOWN" message, when the communications link between Micro800s is down. In short, the concentrator advises terminal users of fault conditions in the communications system.

In the meantime Micom has installed more than 20.000 Micro800's, many used as terminal 'cluster controllers' in DEC, Data General, and Hewlett-Packard systems. For many of the thousands of customers already using the first generation Micro800 Data Concentrator besides the easy "do-it-yourself installation" the most remarkable feature was the "do-it-yourself troubleshooting".

Do-it-yourself Troubleshooting

Any item of data communications equipment such as the Micro800 data concentrator must be connected to a variety of equipment supplied by other vendors (modems, lines, data terminal equipment), all of which can and will malfunction from time to time. Since the Micro800 is designed for do-it-yourself installation, it also incorporates built-in test features to facilitate do-it-yourself troubleshooting.

The intelligence of the Micro800 is used, for example, to provide the response "LINK DOWN" automatically from the

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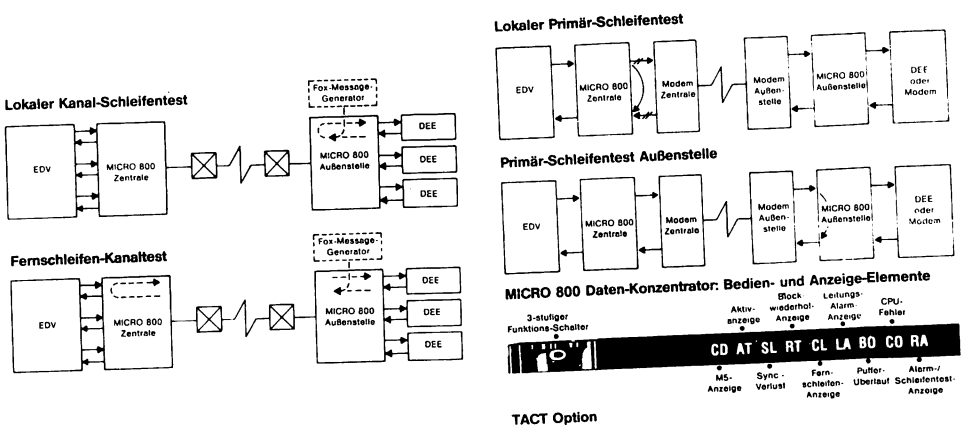
slave Micro800 if an ENQ (Control E) is entered from the terminal and the high-speed communications link between Micro800's is down. Thus, the terminal user is kept advised of fault conditions in the communications system.

Controls and Indicators

The Micro800 includes as standard a comprehensive set of status displays and a thumbwheel switch behind the Micro800 front panel. The 3-position thumbwheel switch provides for activation of two fault-isolation loopback tests and a self-test of the local Micro800 unit.

The Local Composite Loopback test position causes the composite output from the Micro800 to be looped back to itself for testing of the local concentrator.

The Remote Composite Loopback test position causes the composite interface loopback test to be performed remotely to test both the local concentrator and the transmission link to the remote concentrator.



TACT Option

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The Micro800's most powerful built-in test feature is TACT, the Terminal-Activated Channel Test Option. TACT allows any terminal to check out its own operation, or the local Micro800, or the complete Micro800 system end-to-end.

TACT is activated from the terminal by depressing ENQ (Control E), followed by BREAK. This causes the local Micro800 to respond with the message "MICOM IN TACT". The terminal may now select one of four test functions. Depressing "L" (Local Test) causes the channel to enter the Local Channel Loopback mode. Upon entering this mode, the message "LOCAL TEST" is transmitted to the terminal. Thereafter all data entered from the terminal will be looped back to the terminal by the local Micro800. Depressing "R" (Remote Test), following TACT activation, causes the channel in the remote Micro800 to enter the Remote Channel Loopback mode. The message "REMOTE TEST" is transmitted to the terminal. Thereafter all data entered from the terminal will be looped back to the terminal by the remote Micro800.

Activation of the built-in "fox message generator" is achieved in the same manner as the loopback mode selection. Depressing "T" (Terminal Test), following TACT activation, causes the local Micro800 to transmit the message "TERMINAL TEST" followed by a continuous "fox" message to the terminal. Depressing "S" (System Test) following TACT activation causes the local Micro800 to place the remote Micro800 in Remote Channel Loopback mode and transmit the "fox" message continuously to the remote Micro800 where it is looped back and transmitted to the terminal. The message "SYSTEM TEST" is received by the terminal at the start of the test.

TACT is deactivated by depressing BREAK. TACT signals it has been deactivated by transmitting the message "MICOM TACT COMPLETE" to the terminal.

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For Hewlett-Packard-users MICOM provides special support for hp-3000 systems. Thus special XON/XOFF characters are being recognized for buffer and flow control.

Introducing the Micro800/2

Based on the experience with their worldwide installations MICOM has now introduced the model Micro800/2, the first second generation data concentrator. Besides the features already mentioned the Micro800/2 exploits new advances in semiconductor technology to offer eight times the performance of the original Micro800. For example the eight channel-unit can handle eight (8) CRTs with 9600 bps each over one single modem line with 9600 bps. That means a concentration factor of 800 %. In addition, it offers major feature improvements such as data compression, terminal priority, terminal-initiated channel configuration, synchronous and clocked asynchronous channels, and a 'command port' to permit on-line system testing, reconfiguration, message broadcast, and performance monitoring. The Micro800/2 retains the same small size and light weight as the Micro800 to minimize logistics problems and simplify installation and replacement in the field. Like the Micro800, it is designed for "do-it-yourself installation" and ease of operation by non-technical personnel.

Command Port Feature

All standard Micro800/2 models are equipped with a Command Port which offers a wide variety of monitoring, test, and control facilities. The Command Port may be connected to a dial-up or dedicated terminal provided by the customer or directly to a computer port, and may operate at up to 1200 bps.

Message Broadcast permits a message to be transmitted from the Command Port to selected channels or to all channels, local or remote. This feature may be used, for example, to advise of an impending computer shut-down or the schedule

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for system restoral.

Dynamic Channel Reconfiguration permits the data rate to be changed for a selected channel or permits activation of local echo or generation of specific delays for carriage return, line feed, and form feed, temporarily overriding the channel configuration selected by DIP switches.

Remote Busy permits busy-out of dial up modems attached to individual channels on the remote Micro800/2, facilitating centralized access control in timesharing computer systems.

Centralized Troubleshooting is available from the Command Port, including the full capabilities of TACT as well as control of local and remote composite loopbacks.

Alarm Messages with time and date of occurence are generated automatically each time the Micro800/2 locally or remotely experiences a buffer-full or buffer-overflow condition, encounters unusually high line error rates, or loses synchronization or 'carrier' on the high-speed composite data link. Analysis of the message log helps pinpoint telephone line and modem problems.

Periodic Reports at user-selectable intervals or on demand provide statistics on data traffic, average and peak buffer memory utilization by channel, block retransmissions, and telephone line quality including outages. Analysis of these statistics shows trends in telephone line quality and provides an indication of the ability to add additional channels or increase the speed of existing channels to improve service and plan for future growth.

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SYNC-Option
Forthermore, I like to mention the Sync-Option. In addition to the asynchronous terminals it allows to operate four synchronous CRTs or printers. They may either run in character-oriented protocols (BSC) or bit-oriented protocols (HDLC/SDLC).

I am confident that I have been able to express to you the benefits of using data concentrators since they provide enormous savings in terms of telephone line and modem costs. As carried out in my example of a cluster-configuration with 8 terminals you will need - instead of 8 expensive telephone lines and 16 modems - one telephone line and two modems only. At the same time you can use fast synchronous modems up to 9600 bps instead of asynchronous low speed modems with maximum 1200 baud only. Automatically, you will have gained an error correction which reduces transmission errors practically to zero. Besides this, all these advantages do not load up your minicomputer system. No hard- or software-changes are required.

Nowadays, since savings are more and more becoming a must, the usage of data concentrators is the ideal and most effective tool for cost reduction. Therefore, data concentrators should be considered in any data communications concept.

Asynchronous communications supported by data concentrators are by no means old-fashioned but state-of-art technology with progressive means of cost savings.

Due to the high compression technique telephone lines will be more efficient and transmission will become error-free.

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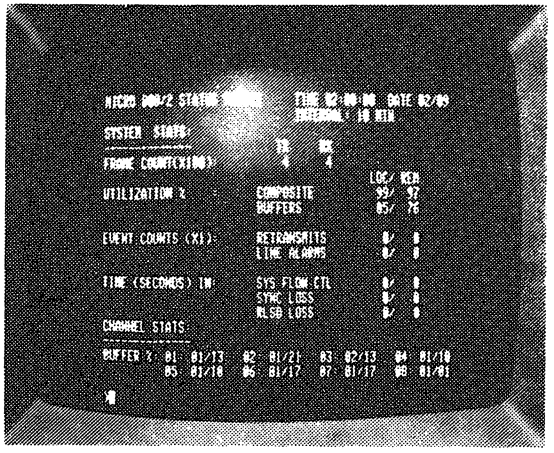

Status Report