'Data Communications Shortens the Distance'

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ABSTRACT

Bose has recently implemented three new data communications services; an HP2333 Cluster Controller, a MICOM Micro-600 Port Selector, and a data communications feature for our ROLM CBX. This paper will describe each of these systems, their capabilities and shortcomings and operational considerations. Details of cabling, configuration, modems, user interface and system documentation will also be presented. Additional details including; how to survive a lightning strike, data communica- tions troubleshooting and tools of the trade will be presented.

Introduction

During the past six years Bose Corporation has outgrown a Series II, a Series III, a Series III plus a Series 33 and now we are upgrading from two Series 44's to a Series 48 and a Series 68. In this period, we have expanded service from six users to seventy users, ten of which are lo- cated at a manufacturing plant that is ten miles away. User require- ments have forced us to include dial in access, dial-out access and Remote Job Entry to a service bureau. Along the way we have reviewed our local terminal cabling several times and have gone through as many schemes for combatting lightning and other electric disturbances. Now that we have experienced all of the possible problems and finally deter- mined once and for all what the user requirements will be for the next three to five years; we feel that we are set to construct the ideal net- work (dream on ...) Actually, what we have done is, for the first time, designed a system that integrates data communications components with our voice communications systems provide a flexible network. I feel obliged to state that at the time of this writing, our new data center is still under construction and we are operating with a mixture of old and new systems. Until we have completed the conversion we will be un- able to draw a final conclusion. We have however demonstrated the func- tion and value of all of the techniques and components that will be presented below.

The Nodes

- Terminals
  - (40) HP2640B
  - (20) HP2624B
  - (12) DIRECT 825
  - (15) HP2645(9)A
  - (3) HP2626W
  - (2) HP2623A
- Personal Computers
  - (3) HP120
  - (10) HP150
- Computers
  - (2) HP3000 Series 48 (Now)
  - (1) HP3000 Series 48 (Soon)
  - (1) HP3000 Series 68 (Soon)
  - (1) Prime 400
- Printers
  - (1) Printronix P300
  - (4) HP2631B
  - (2) HP2631A
  - (1) HP2601A
  - (2) HP2619A
  - (1) HP2617A
- Miscellaneous
  - (2) Command Port on ROLM CBX
  - (1) Command Port on MICOM 600
  - (1) Stats Port on MICOM 600
  - (3) VADIC 300/1200 Baud Modem
  - (2) VADIC Autodial Modem
  - (4) ROLM CBX Data Port

The Links

- CPU to CPU between the HP3000's
- Local terminals to both CPU's
- Remote terminals to one of the CPU's
- Local spooled printers
- Remote spooled printers
- Out and In Modem access
- PC to PC
- PC to both computers

The Network Components and Connections

CPU to CPU -

This is accomplished with the HP DSN/DS software, an INP in each machine and a cable between the two. Even when you add the I/O configuration step, this is a simple connection to establish. DS gives us the ability to transfer files between our two HP3000's and to execute Sessions on one machine when a terminal is connected to the other. We have experienced tremendous throughput degradation over the DS line when more than three users are working. We also find that CPU loading on the two ma- chines can effect performance. A general statement would be that for quick (tapeless) file transfers it is indespensible but for remote sys- tem access we need a better solution. There are a few things to con- sider when configuring your DS Lines. Because each site is different I suggest that you consult with your SE Data Comm Specialist but, here are some suggestions:

. Use meaningful device class names eg. Our line from System 1 to System 2 has the device class names DSLINE and SYSTEM2 DSLINE is meaningful to your SE and CE while your users can access it with the comand :DSLINE SYSTEM2.

. Never tell the users the Logical Device #. They will code it into something critical that will blow up the next time you do an I/O configuration change.

. Make sure that your block length is compatible with all HP Soft- ware. HPSLATE, DEL, V/3000 and other products require larger than "suggested" block size.

. Close DS Lines before a SHUTDOWN; your system could HANG or the code that is downloaded to the INP could be corrupted. We have even seen the remote machine hang when a system is shut without first closing the line.

. Watch for I/O errors and disconnects in your system logfiles. We found that a disconnect is logged every 30 seconds if the CPU loading gets below 10%. We also detected a fault on an otherwise normal line and traced it to a defective INP by noting a sudden occurrance of Recoverable I/O errors.

Local Terminal Connections

As stated above, we found that the DS line between our two machines was inadequate. We used stock A.B switches for some of the more frequent "System Switchers" but the waste of leaving a much sought after port unused 50% of the time was unacceptable. To solve the problem we have installed a MICOM Micro 600 Port Selector which allows the terminal user to select and queue for ports on all configured machines. More will be said about the MICOM later.

Connecting HP terminals to the HP3000 computers should be a simple task but we have found a myriad of ways to mess it up. The easiest way is to decide to save money and buy the cables from a supply house or even better, make them ourselves. Well lo and behold the HP262X Series that uses a new connector or the cable from a third party that has TX and RD transposed. The wait for parts or cables is an avoidable embarassment. Following is a description of our scheme for connecting "Hardwired" ter- minals to the computers:

. At the terminal end use a Lightning Protected Modem Cable pur- chased from HP. The lightning protect cables have greatly reduced our demand for replacement "ASYNC DC" boards for our 264X ter- minals. The MODEM version is used so that a user could easily install a switch box to an Acoustic Coupler or Modem. Note that we are now able to carry all required signals to a modem if desired. If we used the less expensive "Direct Connect" cable we could not.

. We use standard (BELL Code) "Station" wiring from the user loca- tion to the computer room. We have run two four-wire lines from the offices to "Closets" in the office areas. These are cut down to standard telephone blocks in the closet. This gives us cabling for voice and data to spare at each location. In the office, we connect the terminal to the line with a homemade

RS232C to tele- phone block cable. Eight or four wire modular connectors can also be used and in some locations, wall mounted RS232C connectors are used.

. To get from the "Closet" to the Computer Room "Frame" we run a 50 or 100 pair "Feed" cable cut down to 50 pair blocks on each end. Each of these blocks is equipped with two 25 pin connectors so that all lines can be accessed by a cable or by cross-wiring. The connection from terminal to Computer Room is completed by "cross-wiring" from the "Station" block to the "Feed" block. The use of Station to Feed cross connecting has several advantages.
  - Telephone technicians understand it.
  - Hardware is inexpensive, reliable and available.
  - When a terminal moves, we don't have a useless cable running to the Computer Room.
  - New installations generally require no cable pulling and can be done in minutes.

. The Computer Room "Frame" consists of two fields of standard tele- phone cable blocks. One field is feed cables from the closets bringing the terminal lines in. The other field is computer ports. A cross-wire connection is made here and we are almost to the CPU.

. Having two machines with a total of 64 ports and looking forward to 128 ports in a year or so, we decided that 128 cables across the floor was not a good prospect. Over the years we went from "exact length" to "leave two feet slack" to "buy thirty footers" as our purchasing guide. Our solution was to have some cables made for us. The cable we call HYDRA has six RS232C connectors on one end, a twenty-five pair cable in the middle and a standard TELCO fifty pin connector at the other end. The cable is only four feet long so to get to the Frame we use standard extension cables of the appropriate length which plug into the cable blocks. With one cable for six terminals everything is much cleaner and more reliable.

. What remains is the I/O Configuration. Here are some hints that we find useful.
  - Assign meaningful device class names such as HWTERM for hard- wired, PHTERM for modems, HP2631B & REMOTE1 for a spooled remote printer. These names can help a lot when you forget a logical device number or when a port fails and you must reconfigure.
  - You must use fixed speed if you want to be able to log on at 4800 or 9600 Baud.

. Your system console port (LDEV20) is a strange one. We discovered that an MPE gremlin can alter your I/O Configuration for LDEV 20. Here is the gotcha: You have your console configured for fixed speed at 9600 Baud; You slow to 1200 Baud for Remote Diagnostics; System Crash; Warmstart (Console is at 1200 Baud); Speed up to 4800 Baud; Shut Down; Coolstart; System will not start. If you now change the terminal speed to 1200 Baud the Coolstart will work and if you look at your I/O Configuration you will find that LDEV 20 has been changed to 1200 Baud. This is an MPE Bug; watch for it.

. Another consideration is the remote dignostics port (LDEV 21). This port should be configured for and connected to one of the HP approved modems. When not in use by HP for diagnostics it can be used for dial access to your machine. See below for more information on modems and security. Here are a couple of things to consider:
  - The diagnostic computer (CMP) has it's own SPEED command and CMP speed is set equal to that of the CONSOLE (LDEV 20) at the last System Start (See above for complication here) therefore, you should change your Console speed and then CMP speed to that of the modem before you enable remote diagnostic access.
  - The CMP presumes that it is connected to an HP terminal. Consequently it uses ENQ/ACK protocol for flow control. If your CONSOLE is not configured for ENQ/ACK, you will ex- perience a long pause every so often while MPE waits for the terminal to respond to a flow control request.
  - We have also found that if Remote Diagnostics is enabled and the modem is disconnected two

phenomenon occur. First; a running system can HANG and Second; a System HALT may occur after responding to the "Date & Time OK?" prompt at system startup.

Remote Terminals

We currently use an eight channel multiplexor and a twelve channel Cluster Controller (HP2333A) to connect 11 terminals and three printers to one of our systems. We started out using only the multiplexor for both terminals and printers. This was an interrim step with DSN/MTS selected as the permanent solution. While we were planning the MTS net- work we learned about the Cluster Controller. The cost of the MTS in- terfaces and special cables combined with the potential user confusion (Enter v.s. Return) were already major concerns. The HP2333A looked like a better solution with few disadvantages except that we would prob- ably receive serial number six and all of its problems. Since the multiplexor would continue to work ok for awhile, we discussed the HP2333A features and functions with the HP factory people, ordered one and hoped for the best. Our experience with the system has been very good and user sattisfaction is high. Running 10 terminals at 4800 Baud simultaneously over a single 9600 Baud leased line we find no percep- tible delays. Both Block and Character mode transmissions work equally well.

In comparing Multiplexor, Multipoint or Cluster options the following considerations arose:

- Cost: The multipoint system was the most expensive due to the terminal interfaces and special cabling. The Multiplexor system was least expensive and the Cluster Controller fell in between.

- User Satisfaction: The Multiplexor offered the least desirable solution due to noticable delays on both transmission and receipt of data. The Multipoint system was responsive but there were several software products that would not run over MTS/Multipoint and the "ENTER v.s. RETURN" conversion presented a potential for confusion. The Cluster Controller gave our remote users a system that was equivalent to that of our local users.

- System Administration: Obviously the I/O Configuration, MTS con- figuration and console commands make the Multipoint and Cluster Controllers more difficult to use than multiplexors.

Data Integrity: Multipoint offers the highest degree of data in- tegrity. Effectively data is error checked and retransmitted if necessary between the CPU and the Terminal. The Cluster Controller provides the same except that only the CPU to Cluster Controller link is checked. Data errors occuring on the line between the Terminal and the Controller will go undetected. The Multiplexor link will only control errors that occur between the two Modems leaving both end links unprotected.

Local Spooled Printers

There are three types of "Spoolable" printers on our systems; HP-IB con- nected, Serial (ADCC) connected and Parallel Differential (26069A I/F Board) connected. We use our HP2608A in a standard configuration for local (less than 12 meters) printing. We have an HP2631B spooled through an ADCC in a standard configuration (See Communicator #30 for some important configuration details). One of our HP2619A clones (actu- ally they are converted Chain Trains that had Data Products interfaces) is shared by both systems. To do so we purchased an automatic switch box that will toggle back and forth between the machines looking for a printer request. It will alternately service System 1 and System 2. Using DSN/DS and remote file access is much less efficient and is more cumbersome. We have also been succesful sharing ADCC connected printers using a "modem sharing" device. We attempted to use an RS232C Serial printer spooler like one would use with a Personal Computer but found that none would support the rather unique flow and status controls that HP incorporated into the HP2631B Remote Spooled Printer Option. As with most other aspects of the HP3000 we've developed a few hints:

- The HP2631B can, at best, print 180CPS. If configured at 2400 Baud you will experience some CPU and I/O overhead due to repeated attempts to add to the printer's buffer. Try using 1200 Baud if you can to minimize the wasted I/O and CPU and suffer little in printer throughput.

- The HP2631B can print 225 characters on standard paper in compressed mode. Unfortunately the SPOOLER reset the option to 10 CPI as it closes each SPOOFLE. Your local SE can give you a patch to defeat this if you desire.

Remote Spooled Printers

The HP2631B makes a good remote spooled printer. It responds to Status requests with Offline, Disconnected and Paper Out indications but can not sense a paper jam. We have ours connected to one channel on an eight channel multiplexor that has an integral 9600 Baud modem which in turn connects via a leased line to a remote plant. Since we were carry- ing two HP2631B printers and six terminals on the same multiplexor we chose a MUX that had a printer priority control feature incorporated. This feature prevents the printers from consuming an excessive percentage of the bandwidth during heavy print loading. I might note that the DSN/MTS system does not have such a feature and significant degrada- tion can occur when the printer is busy.

It is possible to use an HP2608A as a remote, spooled printer even though it is an HP-IB device. HP sells three models of a device called an HP-IB extender. One option allows remote connection via coaxial cable, another uses fiber optics and third uses telephone circuits either switched or non-switched. A local user has an HP2680A Laser printer operating on the coaxial cable version. We have ordered the same for our HP2608A. The only drawback to this system is that the local station can not sense a power failure at the remote end and will subsequently send print to never never land.

Modems

Bose uses a ROLM CBX for internal telephones and access to the Bell Net- work. All of our dial access modems are connected to the internal ex- tension network rather than to Bell lines. This gives us many advantages:

. Security: To access the system you must request to be connected to the appropriate modem. This allows us to change extensions at will and eliminates the Random Try for a data line by a hacker. Changing Bell phone numbers is much more complicated and less secure.

. Flexibility: We can add modems without the Telephone Company delays.

. Features: You can outdial from an answer only modem by calling out on one phone to the destination then transfering the call to the local modem.

. Cost: By using the same lines as the voice systems do we can take advantage of the "Least Cost Routing" feature of the telephone switch. We also avoid all interconnect and dedicated line costs.

. Reliability: With a dedicated data line you count on it working all the time. By using our Private Switch we can get in or out on any of the available trunks.

Following are a few things to keep in mind when configuring modems:

. If you use a PBX that has a "Call Waiting" tone you should have this defeated or your Modems will lose data each time the tone is received.

. Use 1200 Baud and Speed Sensing even for 300 Baud modems to allow backup for 1200 Baud modems without a shutdown.

. If you use hardwired (Subtype 0) rather than switched (eg. Subtype 1) for modems you must strap DTR high for the modem to make a connection. The result of this is that if the caller does not log off (:BYE) his session will be left active on the Port and the next caller to that modem will be able to pick up where he left off. For security this is not desirable but for special cases such as data entry users or printers it may be useful.

The ROLM CBX Data Feature

ROLM offers a Data Communications Option for its Computerized Branch Exchange (CBX). This system allows a user to connect Terminals, Ports, Modems and Printers to the CBX in much the same manner as telephones are. Each device is connected to a Data Terminal Interface (DTI) which is located at the device. Standard telephone cabling is used to carry the data to a Data Line Interface (DLI) which is installed in the tele- phone switch. The CBX then provides a means of assigning ports to groups such as SYS1 and SYS2. The computer is then "called" by the ter- minal through a setup dialog where the user enters a port group name. Available port selection or queuing for one will then be managed by the CBX. Contrary to the advertising this does not use "Current Telephone Wires". Each DTI must have its own 3 pair cable.

We investigated the use of this feature at Bose as a part of an overall networking and computer hardware plan. The following features of the ROLM package were incorporated into our plan:

Use an outboard device to manage access to the computers. This offers an alternative to using DSN/DS for Remote System Access.

. The Port Access Controller should provide queueing for ports. This allows us to configure the computers with only as many ports as we will allow simultaneous sessions on each.

After a thorough review of the ROLM Data Feature we decided that it (or something similar to it) should become the hub of our local data com- munications network. Although this system provided all of the critical features that we desired, we were disappointed to find several major inconveniences:

Each Port and Terminal is connected to the Switch though a small box called a DTI located at the device. To make a connection to the switch the user presses a switch on the DTI. At the terminal end this was acceptable since the box could sit under a telephone. On the other hand we worked for hours trying to figure out how to house up to 150 of these little boxes in our computer room. The availability of a Rack Mounted Card Cage version would have been ac- ceptable; the shelving to store the DTI's was not.

When setting up a connection at your terminal the CBX communicates at a data speed no greater than 100 CPS. This is painful to say the least.

When assigning ports to users the switch issues them in "Round-Robin" order. The result of this is that statistically all ports will ap- pear to be used equally. This presents a problem if you desire to know how many ports you need to handle the traffic. We would have preferred a "Hunt" method. This would statistically force the first ports in the group to be used the most and successive ports to be used less and less thereby giving a clear picture of traffic.

An incredible omission in the ROLM switch is that it does no logging of connects and disconnects. This leaves the System Manager without any data to analyze system loading or effectivity.

Our study of the ROLM Data Communications feature whetted our appetite for an intelligent Port Access Controller leading us to investigate Develcon, Gandalf and MICOM as alternatives. The basis for our selec- tion of a MICOM/ROLM system is material for another paper but it suf- fices to state that we have incorporated this combination of two systems into our network. The MICOM handles all local terminals and incoming modems while the ROLM will be used to handle outgoing modem lines and some special cases. We feel that as the ROLM system matures it will become a more significant component in our system.

The MICOM Micro 600 Port Selector

For simplicity the M600 placement has been omitted from all of the above details. Actually most of the devices that are connected to the two computers do so through the M600. If you refer back to the section above that describes our computer room wiring Frame you will note that it was described as having two fields of wiring blocks. Actually there are three (I apologize for the lie but believe me it was for your good and my sanity); one is for the incoming terminal lines; the second is for the computer ports and the third is for the MICOM M600. The port and line connections from the M600 connect to the third (physically cen- tral) field by using, again, standard telephone 25 pair cable extensions with connectors (now you know where the idea came from). Terminals that go to the M600 are cross-wired to the center field and those that will be direct-connected are cross-wired directly to the computer port field.

The function of the M600 is essentially the same as that of the ROLM. The terminal user connects to the M600 by typing a Carriage Return (or space bar at 4800 Baud). The M600 prompts for a port class and after accepting it from the user's keyboard it searches for a port of the ap- propriate speed. If none are available, the user is shown the current queue length and is given the option of being added to the queue or dis- connecting to make another class. The M600 comes with the interfaces mounted four to a circuit card rather than in little boxes; it sets up connections at full terminal speed and connects and disconnects are logged through an RS232 port. Unfortunately the M600 also uses a Round-Robin port selection algorithm. Without making any further comparisons between the MICOM and ROLM system, following are some ideas and tech- niques that we have found useful:

. Configure the computer ports as full duplex modems using the switched line option (Sub type 1). This will solve two problems for you. It will cause the session on the computer to be aborted if the M600 fails, if the M600 operator forces a disconnect or if the terminal user disconnects. It will also cause the port and terminal to be disconnected from the M600 if the computer fails.

. The M600 can be configured so that idle ports or terminals will be automatically disconnected after a preset time interval from 1 to 255 minutes. This will return unused ports for reassignment but may cause problems

for terminal users unless the time period is made consistent with user needs. We use one hour on our develop- ment computer and still have some surprises such as a disconnect while awaiting a tape mount or during an FCOPY of 250,000 records across a DSN/DS Line or while printing a long report to a remote printer.

. HPWORD requires that workstations and printers be connected to specific logical device numbers. This can be achieved through the M600 by assign- ing these ports unique class names or by using the M600 console to force a connection between the device and its as- sociated port. The former is prefer- red for the work stations be- cause it allows them to access other resources but the latter is necessary for the printer because they cannot initiate the connection.

. Our M600 Command (Console) Port is connected as a port on the M600 allow- ing any terminal (who knows the class name) to access it. We use 1200 Baud for the Command Port so that modem access is available.

. The M600 Statistics Port (logged con- nects & disconnects) is also connected as a Port so that it can be monitored from any terminal. The Statistics Port is connected in parallel (See Reference #16) to a printer for hard copy. We plan to log this to some storage device once that system is defined. The Stats Port is also con- figured at 1200 Baud for modem access.

. It is possible to connect Computer Ports as M600 Lines. This al- lows the computer (with some user software) to connect itself to other devices either connected as Lines or Ports. This can be useful with Auto-dial modems to allow the CPU to connect to a remote printer.

. It is possible to connect terminals or printers as M600 Ports. This will al- low users to select the device and "at- tach" it to his terminal. A printer or terminal in the computer room can be used as a message drop in this manner.

. Connecting from terminal to terminal is called Matrix Switching on the M600. This feature unfortunately does not use class names rather you request a specific Line number (and hope that it hasn't been reassigned) to connect to another terminal. This is quite valuable in a network with many Personal Computers as it allows PC to PC connection without modems or extra cables.

We have found the M600 to be a flexible data communications switch in both manual and interactive modes. It has helped to simplify the onerous chore of cabling and connecting terminals to our computers as user needs change while trying to keep the documentation up to date. The M600 hardware and software are continuing to ad- vance bringing in- creased value to our system.

Conclusion

The distance between the Computer Operations Group and the computer sys- tem users may be measured physically in hundreds of feet or in miles but the emotional distance is measured in degree of satisfaction. The data communica- tions system that connects the two will determine if not only limit how close they may get and stay. The needs of the system user are specified in terms of how fast the terminal is, terminal relocation de- lays, new installations, up time, system availibility and response time. The system designer must add cost, com- plexity, backup, data integrity and main- tainability. The right equipment for most networks is readily available, it may be hard to find or even recognize but it is probably out there. We at Bose spend a significant amount of time looking at how others solve their problems, we learn from their experience then we determine the applicability of their solutions to our situation. In some cases, such as the HP2333A Cluster Controller, we must rely heavily on a vendor's reputation and per- sonal evaluations when selecting a solu- tion. In either case it is important to keep the deci- sion process open to change long enough to assimilate data from as many sources as pos- sible; Use as many proven components as possible in critical situa- tions; Provide fal- lback systems for all components or systems and above all try to make your users think of the cables, modems, multiplexors etc. as part of a system not an obstacle that is between them and get- ting their job done.

I wish you success in your Data Communica- tion Networking and hope that you have found some useful information in this descrip- tion of our (cur- rent) network.

References

Texts and Handbooks

1. Data Communications, A user's Hand- book, Racal Vadic

2. Standards and Protocols for Com- munications Networks, Conrad, Car- negie Press, 1982

3. McGraw-Hill's Compiliation of Data Communications Standards, Folts et. al. McGraw-Hill, 1978

4. Computer Networks and Their Protocols, Davies, et. al., Wiley & Sons, 1979

5. Distributed processing and Data Communications, McGlynn, Wiley & Sons, 1978

6. Data Communications Facilities, networks and Systems Design, Doll, Wiley & Sons, 1978

7. Telecommunications and the Computer, Martin, Prentice Hall, 1976

Hewlett Packard Manuals and Guide Books

8. HP2645A Display Station Reference Manual, Hewlett Packard, 1978

9. HP3000 Computer Systems Handbook, Hewlett Packard, 1981, Part #30000-90105

10. Guidebook to Data Communications Hewlett Packard, 1977, Part #5955-1715

11. Introducing the 2631B Remote Spooled Printer, Ishida, Communicator #25, 1980, Part #5951-6113-25

12. HP3000 Asynchronous Serial I/O Printer Support, Couch, Communicator #30, 1982, Part #5951-6113-30

13. Hewlett Packard Electronic Instruments and Systems Catalog, Hewlett Packard, 1983, (Reference for HP-IB Extender)

Technical Papers and Articles From HPIUG Publications

14. Everything You Wanted to Know About Interfacing to the HP3000 - The Inside Story, Scroggs, Proceedings of the 1983 International Con- ference (Montreal), 1983

15. Lightning Transients and the RS-232 Interface, Habron, Journal HP General Systems Users Group, Vol. III No. 3, 1980

16. Poor Man's Multidrop, Beckett, Journal of the HP General Systems, Users Group, Vol. 2 No. 1, 1978

17. Asynchronous Communications Protocols, Villa, Journal of the HP General Systems Users Group, Vol. 1 No. 6, 1978

18. Lightning and Your Communications Lines, Hartage, Journal of the HP General Systems Users Group, Vol. 1, No. 6, 1978

19. Life at the End of a Phone Line, Crow, Proceedings of the HP General Systems Users Group 1981 International Meeting (Orlando), 1981

20. Pseudo Devices, Primmer, Proceedings of the HP General Systems Users Group 1981 International Meeting (Orlando), 1981

21. Local Area Networking Simplified with a Data PABX, Skaug, Proceed- ings of HPIUG 1982 International Conference (Copenhagen), 1982

22. Performance Characteristics of HP/DSN (DS-3000), Brawn, Proceedings of the 1983 HP3000 International Conference (Montreal), 1983

23. Synchronous Communications on the HP3000, Demos, Proceedings of the 1983 HP3000 International Conference (Montreal), 1983.

Sources of Equipment and Supplies

24. Business Computer Concepts, 108 Kirkwood Drive, Mars, PA 16046, (412) 962-5993 HP2619 Printer Switch, HP-IB Bus Switch, Custom Data Comm Equipment

25. INMAC, 130 S. Wolfe Road, Synnyvale, CA 94086, (408) 737-777 Cables, Switch Boxes and Supplies

26. Gandalf Data Inc., 12301 Old Columbia Pike, Silver Springs, MD 20904, (301) 622-5400 (Eastern Sales Region) Modems, Multiplexors, Port Selectors and Line Drivers

27. Develcon Electronics Inc., 4037 Swamp Road, Doylestown, PA 18901, (215) 384-1900 Port Selector

28. MICOM, 20151 Nordhoff Street, Chatsworth CA 91311, (213) 998-8844 Modems, Multiplexors, Line Drivers and Port Selectors

29. ROLM (New England), 125 Hartwell Avenue, Lexington, MA 02173, (617) 861-0730 CBX and its Data Communications Feature

30. Black Box Corportaion, Box 12800, Pittsburgh, PA 15241, (412) 746-2910 Cables, Switch Boxes, TELCO Wiring Supplies, Specialty Items to solve dozens of Data Comm Problems

31. Solana Electronics, 249 South Highway 101, Solana Beach, CA 92075, (619) 481-6384 Inexpensive eight channel multiplexor/ line driver unit for use wthin a facility (No FCC Interface Clearance)

32. Hewlett Packard Co., 1280 Embarcadero Road, Palo Alto, CA 94303 HP3000 Products, HP-IB Extender, Data Comm Test Equipment

33. Spectron, 344 New Albany Road, P.O. Box 620, Moorstown, N.J. 08057, (609) 234-5700 Cabinets, Patching Equipment and Cables

34. Racal Vadic, 222 Caspian Drive, Sunnyvale, CA 94086, (408) 744-0810 Modems, Multiplexors, Autodialers

Jim Dowling has been a member of the HP3000 user community since 1976. He co-founded and acted as the first chairman of the New England Regional Users Group and has served on the HPIUG Contributed Software Library Committee since 1978, the past two years as chairman. Jim has been with Bose Corporation since 1969 working in Engineering, Project Management, Administrative Systems and since 1978 in Data Processing as Operations Manager. Mathematics, Physics and Electronics Engineering form his fields of Academic training. Computer Science and Information Systems Technology have been a "professional hobby" since he discovered the "magic" of MRP while coordinating the costing and procurement of materials for Bose' largest government contract (a nuclear reactor con- trol system, believe it or not). His two most exciting discoveries in D/P have been Recursive Programming and Data Dictionaries, the former because it taught a lesson on the dangers of applying a tool improperly just because it was an elegant technique and the latter because it prom- ises to be the key to developing Information Technology tools just as the micro-processor has been the key to realizing computing tools.
