DISTRIBUTED PROCESSING - A HEWLETT PACKARD SOLUTION

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The purpose of this paper is to present a new concept in the way in which data processing is done within any organization which presently utilizes a central mainframe computer with terminal access distributed between many users.

The term distributed processing has had various meanings through the development history of different computers. One meaning that might be attached to the term is that which also might be called array processing. This involves an array of processors distributing the power of the CPU and performing tasks in parallel to accomplish the computation in a shorter period of time. This is definitely not the meaning that I wish to attach to the term distributed processing.

For the purpose of this discussion, the following phrases characterize 'distributed processing':

- localization of some computational power and program memory

- maintenance of a central node for computation and data base
- minimization of datacommunication traffic
- utilization of the relative strengths of distributed CPUs
- maintenance of privacy by means of local data bases
- utility of shared central mass storage and peripherals
- concept of synergy of "one man - one machine"

This definition warrants an easily understood clarification, as the concepts are more easily grasped with the presentation of a concrete example. The distributed processing referred to is that which is achieved by clustering together a group of what has been termed 'personal computers' around a central node consisting of a mainframe CPU. Unlike the simple terminal interface to a central CPU which has been prevalent, this configuration leads to clear advances in price, utility, performance security, etc. Before proceeding, the terms personal computer and mainframe CPU need clarification.

The mainframe computer was the first result of constructing electronic devices to perform large amounts of computation or calculation. Prior to the late 1930's and the early 1940's, rudimentary machines had been constructed to handle either calculation with numbers or some other sorting or controlling function. In order to handle problems which involved extreme efforts of mental and hand calculation, investigations were begun into constructing an electronic machine which would automate

the calculation process. Perhaps one of the most famous examples were the calculations to produce a book containing tables of artillery projectile paths under varying conditions of shell mass size, charge mass and volatility, wind conditions, atmospheric density and of course barrel elevation and azimuth. As so many variables were involved and such great accuracy was desired, it was necessary to perform many hundreds of thousands of calculations to produce a satisfactory result.

This example serves well in showing the emergence of the mainframe computer for two reasons:

- the machine was constructed largely for a single purpose, to perform large numbers of similar calculations
- it was technilogically impossible to produce a computer capable enough, portable enough, and in great enough numbers to couple them directly with the artillery units to produce real-time computation

The artillery projectile computer project was successful and interest grew rapidly in performing diverse computational tasks. However, fundamental limitations still existed, the primary for this discussion being the great expense of producing the central processing unit and the amount of maintenance to keep it performing correctly.

As the years went by great improvements were made in refining the CPU, however it's expense, bulk and necessary level of maintenance continued to justify it's name -

central processing unit.

The purpose of this immediate topic is to stress that the computational structure of the mainframe developed not due to its inherent suitability for the job, but due to technological limitations in producing inexpensive, portable and reliable computational machines of enough capability to allow each user his own processor. Granted this limitation, the only practical solution required a central processor with multiusers timesharing the CPU through terminal ports. This multiuser aspect allowed sufficient utility to amortize the comparatively expensive CPU, and continues to be reflected today in the continuing drive to allow greater numbers of users to share the same machine, driving down the per-user cost of computational power.

Turning now to defining the meaning of personal computer, it must be stressed that the term can produce varied opinions. The preferred definition here is a microprocessor-based processing unit with additional local program and data memory and some form of mass storage and I/O capability. More abstractly, a machine with sufficient power and utility to be used in a stand-alone mode with the capability of being programmatically altered to perform a very wide range of tasks. The last point is important as it is wished that programmable calculators be excluded, their use being too limited to manipulation of numbers and device control.

The element that has made possible the personal computer is the large scale integration of many semiconductor devices onto monolithic chips. This has led to the realization of an effective processing unit which is inexpensive, very portable and highly reliable. Personal computers cost a fraction of the price of their computing counterparts of ten years ago, and fill the requirements of cost, reliability and portibility necessary for personal use.

Subsequent to the emergence of the first microprocessor and the continued density improvements of RAMs and ROMs in the late 1960s, there emerged the use of these components as a replacement for large amounts of combinational circuitry that had previously been needed to perform certain electronic control functions. These first uses of microprocessors did not justify the name computer, as no means of user programmability was available.

By the mid-1970s the personal computer began to emerge, tentatively and lacking in capability, amount of memory, sufficient I/O and most importantly, software. Given these realities, the machines generally found usage solely as means of technological amusement and as a means of playing simple games. By the late 1970s a fundamental change had occurred and personal computers began to be used in serious

applications in science and business.

Today, the personal computer is recognized as a cost-effective means of automating many previously manual operations. Computationally the processor is able to manage many demanding tasks and performs quite well in many applications. Increasing emphasis on increasing the performance of the processor and lowering the cost of the necessary I/O functions and peripherals continues and can be expected to yield new generations of increasingly cost-effective personal computers.

Having discussed these two classes of computers and having brought their development to the present, the next issue that needs to be examined is where do these computers go from here? Will increasingly more advanced technology allow personal computers of ever increasing performance and ever lowering price to become so capable and affordable as to displace forever the mainframe?

My perception of this question is that the answer is no, that the mainframe will continue to serve an important portion of the data processing system requirements of most organizations for the foreseeable future. It is important to note the restriction is made to be most organizations, and the validity of this restriction is easily shown as many small organizations today do rely only on a personal or microcomputer as their data processing

needs are sufficiently limited in scope as to be adequately met by the microcomputers and small peripherals.

However, the characteristics of computer usage in a large organization are usually different. To corroborate the contentio that the day of the mainframes demise is not immediate, a few specific examples of the differences can be made and broken into two categories, immediate and future:

Immediate

* vastly higher performance of mainframe is needed to perform tasks of high numerical accuracy or time consuming tasks
* very involved and large applications require large core or program memory to successfully execute
* cost effectiveness of sharing expensive mass storage and peripherals

These points as to the need for the mainframe might possibly begin to change or weaken as the evolution of technology continues. However, another larger list can be made which will not as easily be displaced by technological change as they are not technology-dependent but rather are a fundamentally desirable feature:

Future

* the mainframe concentrates and universalizes data bases which are accessed by many individuals
* allows control of the processing functions of the organization to be visible and controlled by management

* allows managerial control of the security of data bases
* makes the backup and physical security of important data more predictable and controllable
* removes from the hands of unskilled operators the necessity for determining the validity of the data base and the funtionality of the computer
* ensures all data processing of critical nature uses the same revision application
* inherently allows communication between users as it implies a common network
* allows access to higher levels of networking as mainframe serves as efficient port
* additionally, it is most probable that while technology will bring cheaper peripherals and memory to the personal computer, it will probably always do so to the mainframe
* finally, it appears that perhaps a new generation of supercomputer might appear using Josephson junction technology, but the cooling requirements will obviate the small size and portability of microcomputers

Enough said regarding the essentiality of the mainframe and the inevitability of the microcomputer. Let us now consider a pair of specific computers; the HP 3000 mainframe and the HP 125 personal computer. Explaining the HP 125 and its interaction with the HP 3000 shows where Hewlett Packard believes the computational system for the medium-to-large

organization is headed.

The HP 125 has been designed to be the foremost personal computer available today. As is the case with all Hewlett Packard products, we like to think that the HP 125 offers the customer not a piece of equipment, but also what we believe is more fundamentally important - it is a solution. It brings what we believe are the typical strengths of Hewlett Packard to what is now a somewhat chaotic and young product area. Hewlett Packard has been recognized for some fundamental precepts by which it does business; that the satisfaction of the customer is most important. This is not only the correct attitude, it also has proven to be a good business practice as it has over the years built a clientele of loyal customers. As such, the HP 125 stresses good price/performance, reliability, serviceability, and presents a total solution composed of not just the product but also the system interaction and software to make the hardware investment meaningful.

The HP 125 is structurally based upon the HP 262X terminal family, sharing some common assemblies. The terminal and CPU portion appear outwardly much like a HP 262X terminal, with the mass storage and peripheral devices being connected to an extended I/O panel on the rear.

The HP 125 combines three functional abilities within one package:

* it serves as an autonomous microcomputer
* it serves as solely a data terminal
* it creates a synergy of use by combining the function of the microcomputer with the data terminal

As a microcomputer, the HP 125 operates using the CP/M operating system. This operating system has become a defacto industry standard for use with the 8080 or Z-80 microprocessor. To support the operating system, a Z-80 with 64K bytes of system RAM is used. This constitutes the bulk of the CPU, the only other significant electronics being a boot ROM to load the operating system from the disc connected to the IEEE 488 interface connector and the byte-parallel interface to the terminal portion of the system. With this relatively simple CPU, the CP/M operating system standardizes within the memory space the necessary functions like input/output, file system, etc. which allow applications software to be hardware independent. Manufacturers of hardware who desire to utilize the standard operating system merely customize those portions which are necessary to allow the hardware to correctly perform the hardware

dependent I/O functions.

The benefit of supporting the CP/M operating system is that the HP 125 then is able to directly run many hundreds of applications that run under CP/M. Applications include accounting packages, mailing list programs, word processing, languages, etc. with more applications being added to the list daily.

One drawback of the standardized CP/M operating system is that the author of a generalized application package has had to depend upon the least common denominator of hardware I/O capability. This becomes most readily apparent with the terminal interface. Most CP/M systems have been constructed by building a box to contain the CPU. The user then selected a terminal which he connects to CPU box. This of course means that the application written for the CP/M operating system has been forced to assume the least capable set of terminal features as more advanced features are not supported on many terminals.

Acknowledging this shortcoming, the HP 125 will be released with a great deal of specialized software, some of which has been customized for the superior capabilities of the machine by authors of existing software applications and some of which has been written by Hewlett Packard. With these two sources of software in addition to all generalized CP/M software, the HP 125 will bring an unprece-

dented amount of microcomputer software to the purchaser.

As mentioned, the terminal portion of the HP 125 is a fairly advanced data terminal, utilizing softkey structure to access such features as the mode of logging data from video memory to either the integral thermal printer or the serial printer connected to the I/O port. Softkey tree selection of functions now only serves to lessen the amounts of keystrokes necessary to select functions, but also serves to guide the user.

The softkeys within the HP 125 not only have the inherent functions embedded within them to implement the terminal features, but are also user programmable to contain up to 80 bytes which can be used for everything from string substitution to escape sequences which actuate execution of subfunctions contained in applications. Each user programmable softkey can be accessed from either a keypad stroke or an application program for user selection. An application or user programmed pneumonic label can be placed within the bottom two rows to correspond to each of the eight programmable keys.

With these advanced terminal features, the HP 125 offers advanced features for a CP/M stand-alone computer system.

The HP 125 maintains a separate terminal functionality within its operating capabilities. When power is applied to the system it normally defaults to the terminal mode of operation, with the selection of loading the operating system to become a microcomputer being selectable by the depression of a single softkey. As a data terminal, the HP 125 has capabilities similar to those of the HP 2621, with some enhancements common to more advanced members of the HP 262X terminal family. Additionally, it presents some features not previously available.

First a brief description of the terminal capabilities of the HP 125 before a discussion of those terminal features unique to it.

As a terminal, the HP 125 presents the user with 24 lines containing 80 characters of text. Also on the screen are a 25th and 26th row containing the labels for either the embedded softkey tree structure, or when selected, the user programmable softkey pneumonics. The terminal allows selection of half-bright, underline, inverse video, or blinking enhancements on a line-to-line basis.

The keyboard is the full extended keyboard which contains dedicated cursor control, scrolling, softkey, numeric pad, and screen-oriented editing keys.

Input/output is provided by an IEEE 488 port and two serial ports. One serial port is nominally dedicated to a serial printer, the other to datacommunications.

Datacomm runs at 9600 baud and supports various handshakes necessary for use with different CPUs and modems. The datacomm port also supports the 13265A direct-connect modem. The printer port is configurable for variable amounts of nulls, parity, and the sense of the rate-pacing handshake. This allows the HP 125 to directly use a large amount of serial printers without the necessity of any special logic or cables.

As an option, the HP 125 supports a thermal printer which is integrated into the top of the terminal package. Either this printer or a serial printer (if configured) are supported within terminal firmware by a softkey tree which allows the direct printing of the entire contents of video memory, the visible screen or a selected line. Additionally, logging modes can be set so that all data coming to the video memory or only that data overflowing video memory is printed.

All configuration information is stored in a CMOS RAM which has battery backup, allowing the user-selected configuration to be maintained when the system is powered down.

The terminal supports remote operation and configuration by use of escape sequences. As an example, the keyboard has a 'home cursor' key which positions the cursor at the first character in video memory. An application program can also

home the cursor by transmitting the correct escape sequence to the terminal. By this means, applications running in either the CP/M CPU within the system or an application running on a mainframe can efficiently manipulate the terminal features to provide a friendly applications interface to the user.

The afore described features make the terminal portion of the HP 125 a high performance terminal for use with both the CP/M CPU and when used with a remote mainframe. These features are fairly comparable to those which are supported within the HP 262X family.

Additional to these, the terminal implements several unique features which are fundamental for its use as a CP/M terminal interface and which also generally provide better performance.

Within the terminal, an I/O map is maintained which allows the mapping of any source devices to any destination devices. (For the purpose of this discussion, note the terminal considers the output of the CP/M processor to be an input!) An example may better illustrate this:

In order to diagnose a difficulty in running a CP/M-based application, the HP 125 user can map the output (console out) of the CP/M CPU to be not only the CRT screen, but also datacomm port 1. To this port he has connected a modem which ties over the phone lines to another HP 125 (or terminal) on which a knowledgeable user of the application is viewing. By this means, the output of the application and keystrokes entered by the

user (CP/M operates in a full duplex mode) can be viewed for debugging. Further, were the user to map datacomm port 1 as the input for the CP/M CPU (console in), the remote viewer can also run the program and allow the direct operator to watch in order to learn the correct manner in which to run the application.

As another example of the value of this feature, consider a CP/M application written to perform an accounting function. Within the application, various output is routed to either the screen or to the printer for hardcopy. Often it is desired that this fixed output routing be altered, perhaps to obtain hardcopy of items normally sent to the screen. With the HP 125 I/O map, this is easily accomplished.

Another distinctive feature of the HP 125 is that all the ROM-based routines which give the terminal portion of the product its capabilities are vectored through locations in RAM upon powering the system on. By this means, an application which doesn't prefer to use the terminal capabilities as dictated by the ROM routines can intercept the routine call and substitute in RAM its own specialized routine. An example of this ability is also illustrative:

In the normal mode of operation, the cursor control and editing keys as supported by terminal firmware allow

the user to manipulate the text on the screen directly. However, this 'feature' may not be desirable while in the midst of running an application. The application can consequently be written to intercept the keystroke processing routine and can then trap keystrokes which are extraneous to the application previous to returning control to the terminal ROM code for keystroke execution. Or by this means, the functionality of keys can be altered.

By this method of embedding a high degree of functional capability in ROM but yet allowing customization of routines critical to certain applications, the HP 125 goes well beyond the capabilities of most microcomputers. Very sophisticated terminal features are ROM resident, and specialized features are application programmable.

Understanding the HP 125 from the physical and features standpoint allows us now to address the unique capability that Hewlett Packard brings to the field of making distributed processing an asset for organizations with large and diverse computing needs.

In a previous section, the permanent and essential nature of the mainframe was discussed. As present users of the HP 3000 computer can probably attest, a major usage of the system involves the creation, maintenance and access to data bases which allow the smooth function-

ing of large organizations. This automation of data base with instant and accurate access has been the principle benefit of the computer to the business world.

Granted that the personal computer and the mainframe have been discussed and the individual merits of both are appreciated, an examination of the interaction of the two for doing distributed processing is appropriate.

Personal computers have begun to appear within the ranks of large organizations for use either by individuals or for the needs of a small department. While the personal computer has obviously fulfilled a purpose, the utilization factor could be greatly larger. The HP 125 performs well the tasks being addressed by the personal computer, but brings much greater utilization without a greatly appreciable higher price.

The function that is easily recognized for a personal computer within a large organization is what may be called data display and analysis. This term is meant to describe the typical interaction of a manager with those performance criteria of his organization represented by a collection of data.

For the display and analysis of data, the personal computer of today tends to fail to efficiently perform its function. The data base for most organizations is large, communal in nature, subject to frequent correction or update,

and most necessarily must be current and correct throughout the organization. Using a stand-alone personal computer, much time consuming and detailed analysis has been done only to find the raw data was incorrect due to an error in transcription or a recent update.

Additionally, most information within organizations comes from a multitude of sources. Using a typical division within Hewlett Packard as an example, data bases are maintained that updated or accessed by accounting, personnel, purchasing, scheduling, manufacturing, quality assurance, research & development, administration, etc. This is the data that is the subject of display and analysis.

With todays typical personal computer, the transfer of data between the micro and the mainframe is at best tedious if not impossible or prone to error. The HP 125 strives to make this process the most expedient, error-free and simple process possible. With a wealth of data base management capability available on the HP 3000 computer, the HP 125 leverages great power into the hands of the person who analyzes or updates the data base.

As an example, the HP 125 supports a screen-oriented calculator which allows management personnel to easily create, display and manipulate data. It allows the manager to quickly explore "what if" questions regarding the vital numerical data which represents his success or failure.

Additionally the HP 125 supports a graphical display package which allows significant data to be displayed by means of bar charts, pie charts, etc. With the HP 125, the data for display, analysis and charting can interactively flow over the terminal data comm port to and from the personal computer and the mainframe. All data is from the common base of the mainframe and represents the organizations most recent and accurate figures. All results of analysis can immediately be re-entered into the common data base. Standardized reports from functional areas can access the database from other areas in which they don't necessarily have involvement as to the generation of data, but from which their respective areas can be directly affected.

All functional areas can present reports that are standardized across the organization as to format. Data flows efficiently between organizations, as data entered by one area becomes immediately accessible for all users. The security of the data base is cared for by the information services group, guaranteeing against the hazards of losing critical data. The access of individuals to data is controlled by management; the HP 125 can be programmed to allow only visual display of the data without user copying to printer or disc while the initial access can be protected by the HP 3000 using passwords.

The strength of the HP 125 is its interactive ability

to dynamically perform as a port to the mainframe, a stand-alone personal computer, or a synthesis of the two functions. Stressing the dual nature of mainframe access for data interchange with local analysis, the HP 125 features utility programs which greatly simplify the user interface and lessen the need for sophistication in performing complex or powerful analysis of mainframe data.

As an example, take the purchasing department in a large organization. One of the areas with the greatest potential for cost minimization is the timely and careful control of inventory. Suppose that this organization does basic manufacturing of a wide line of products with many subcomponents and consequently has fifty buyers interacting with a thousand vendors regarding tens of thousands of purchased parts.

Due to the common and large data base needed to track the tens of thousands of parts, the HP 3000 presents a good choice for a central mainframe, probably also functioning for other purposes within the organization. By utilizing the HP 125 as a personal tool for each of the fifty buyers, an extremely powerful controlling application can be quickly written for use by each of the buyers.

Organizing the overall data base using the HP 3000 and IMAGE, the HP 125 can be used serve as the user interface into the larger database for each user. Data is taken from the mainframe into each of the fifty buyers personal computers.

The data resides locally and is manipulated by each buyer for programmed action items such as overdue shipments, low inventory items, high inventory items, changes in scheduling affecting inventory needs, etc. Purchasing management can control and standardize the means of analysis of each buyers proficiency through a common local program. Each buyer using his own data base can generate reports with a common format with all buyers reports. Using the HP 125 graphical package to generate bar or pie charts, the performance indicators can be directly analyzed and evaluated.

In this example, the HP 125 served as the individuals port to the HP 3000 data base, it performed local analysis of data, reduced datacomm overhead and expense, and allowed local generation of reports and graphical analysis.

To summarize, it is believed that the manner in which computers are used by organizations to enter, display and analyze data is evolving towards a new distributed network of processing units. The change on the scene is due to the technological ability to produce processing units that are inexpensive, reliable and capable. The ability to place a personal computer in the hands of an individual has shown to be not only cost effective, but by being personal has involved individuals not previously utilizing computing

power directly. While personal computers have these benefits, they have not fully utilized the greater advantage of being part of the entire organizational data processing network within most organizations.

The HP 125 used with the HP 3000 shows the first step in the evolution of data processing. This evolution will bring computer usage into the hands of increasingly greater amounts of individuals within organizations. Data processing will become more convenient and cost effective.