

SELECTION BETWEEN UNIX IN MINICOMPUTER SETUP AND  
LAN CONFIGURATION FOR A MEDIUM-SIZED COMPANY  
CONSIDERING COMPUTERIZATION

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**ABSTRACT**

With the evolution of VLSI and the microcomputers, the cost of computerization dropped tremendously in recent years. The application of computer systems in medium-sized companies in Hong Kong became a necessity in order to gain the competitive edge over the rivalries. However, the widely accepted configurations of Personal Computers (PC) in Local Area Network (LAN) environment and the UNIX Operating System under minicomputers puzzled many Electronic Data Processing (EDP) managers and Management Information System (MIS) managers when considering computerization of their own companies.

Our project aimed to study the advantages and disadvantages of computerization in a medium-sized company under Unix/Minicomputer and LAN/PC environments in Hong Kong. This report included the study on the requirements of computerization process of these companies and the pros and cons of both the Unix/Minicomputer and the LAN/PC configurations. An attempt was made to provide some recommendations and guidelines for those companies that might want to and decide to employ computers in their business arenas so that they could maximize their return on the investment on the computerization.



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## CHAPTER I

### INTRODUCTION

Being a free port with a favourable taxation system, Hong Kong is well known as the paradise of the "Entrepreneurs" as well as the paradise for "shopping". In such a small city crowded with six millions of hard-working people, most of them are opportunity seekers. As a result, numerous companies were established in this "Pearl of the Orient", especially in the sixties and seventies of this century. Many of them were small to medium-sized companies. As more and more businesses are set up, competition became more vigorous. While the businessmen were putting the full effort in expanding their markets as well as their companies in such a competitive environment, they started to seek assistance from technology in order to deal with the tremendous volume of data they needed to make their daily decisions. This is the point where computers come to have a closer contact with the commercial world in Hong Kong.



## General Overview of Medium-sized Companies in Hong Kong

There were significant number of medium-sized companies in Hong Kong. "Medium sized companies" is referred to as companies with total number of employees ranging from 20 to 100. This covers a great variety of different nature of businesses ranging from Manufacturing to Finance industry.

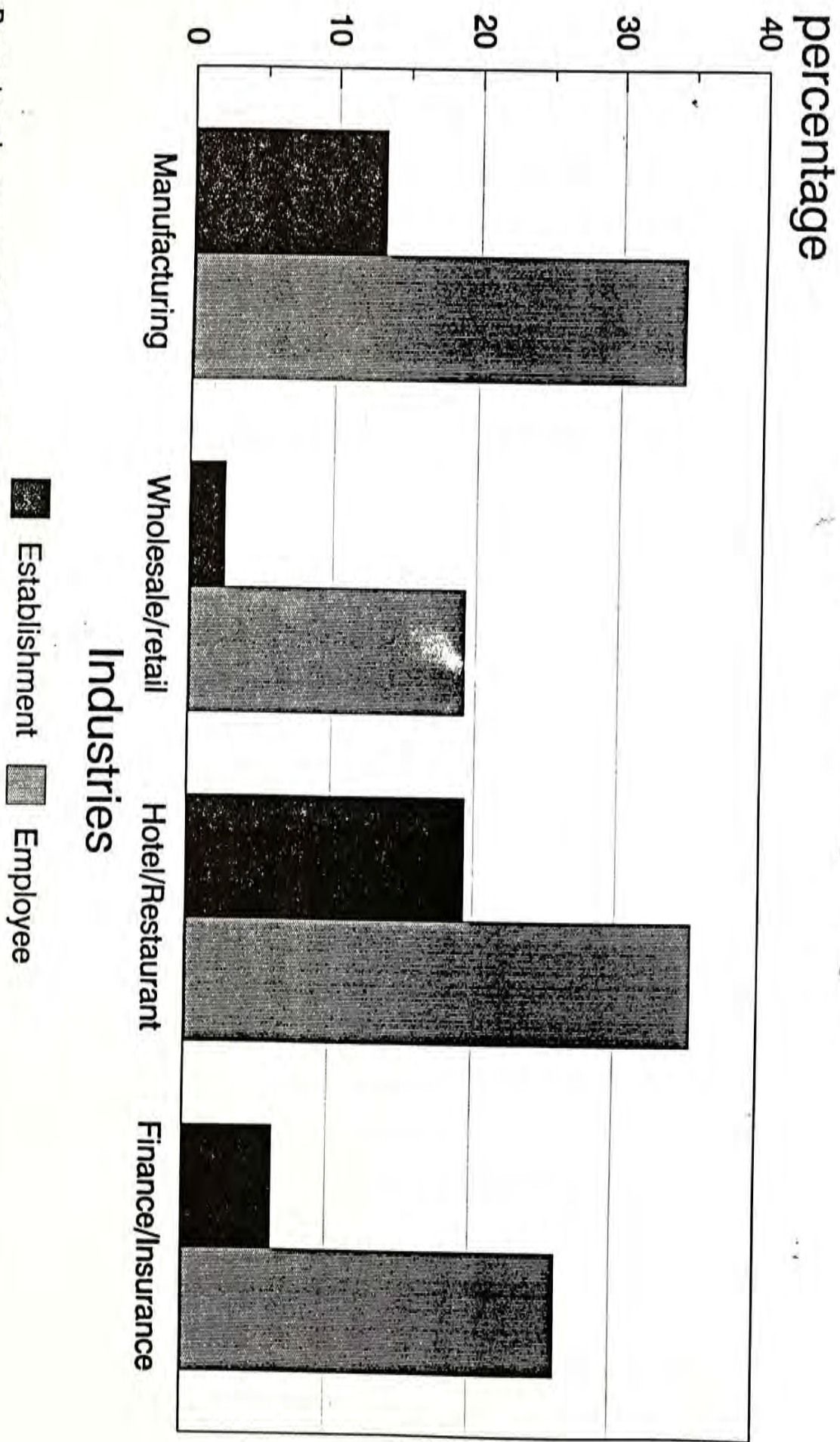
According to the Statistics and Census Department<sup>1</sup>, there were more than 1300 medium sized companies in Hong Kong by the 3rd quarter of 1989 in four major business categories, namely Manufacturing, Wholesaling and Retails, Hotel and Restaurants and Finance & Insurance. Within these organizations some 530,000 people were employed. This was about 10% of the total population of Hong Kong and accounts for more than 17% of the total working population in this colony. A chart showing the distribution of companies among these industries are shown in Figure 1 on next page.

In the late 60's and early 70's in Hong Kong, advances in telecommunication made it practical for information from around the world to be obtained by every business organization at a reasonable and acceptable cost. As a result, every businessman became aware of the importance of these data in their daily business operations. Speed and efficiency were the most prominent yet basic components for

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<sup>1</sup>"Quarterly Statistical Report", Statistics & Census Dept., (3rd Quarter, 1989).

Figure 1 Medium-sized Companies in Four Major Industries in Hong Kong



Percentage is expressed as a proportion of the total population of the industry towards the end of 1989

Establishment Employee

Source : Quarterly Statistical Report : Statistics & Census Dept., 1989.



the success in running a business in Hong Kong. They then looked for tools which could help them gain the competitive edge through speed and efficiency.

Moreover, according to another statistics<sup>2</sup>, there were about 74,000 vacancies available in this kind of companies by mid of 1990 with nearly 50% of such vacancies falling into the manufacturing industry. Figure 2 on next page shows the under-employment conditions for four major industries in Hong Kong. A major factor that attributed to such a high vacancy figure was the brain drain problem that arises because of the changeover of the sovereignty of Hong Kong in 1997. Although the over-heated Hong Kong economy had been cooled down a lot towards the end of 1990 due to the worldwide economic recession and the Gulf War Crisis in the middle east, a lot of medium sized companies were still having problems in recruiting sufficient manpower with reasonably high degree of proficiency in carrying out the jobs required.

Such a unique phenomenon occurred in such a small place in the World, Hong Kong people were always known for their responsive and timely reaction to crisis, no matter how big and serious it is. With the popularity of PC clone in the mid 80's in Hong Kong and the low cost of hardware and software available for these systems, Hong Kong businessmen, especially those in the medium-sized company sectors, adopt the idea of improving the efficiency and

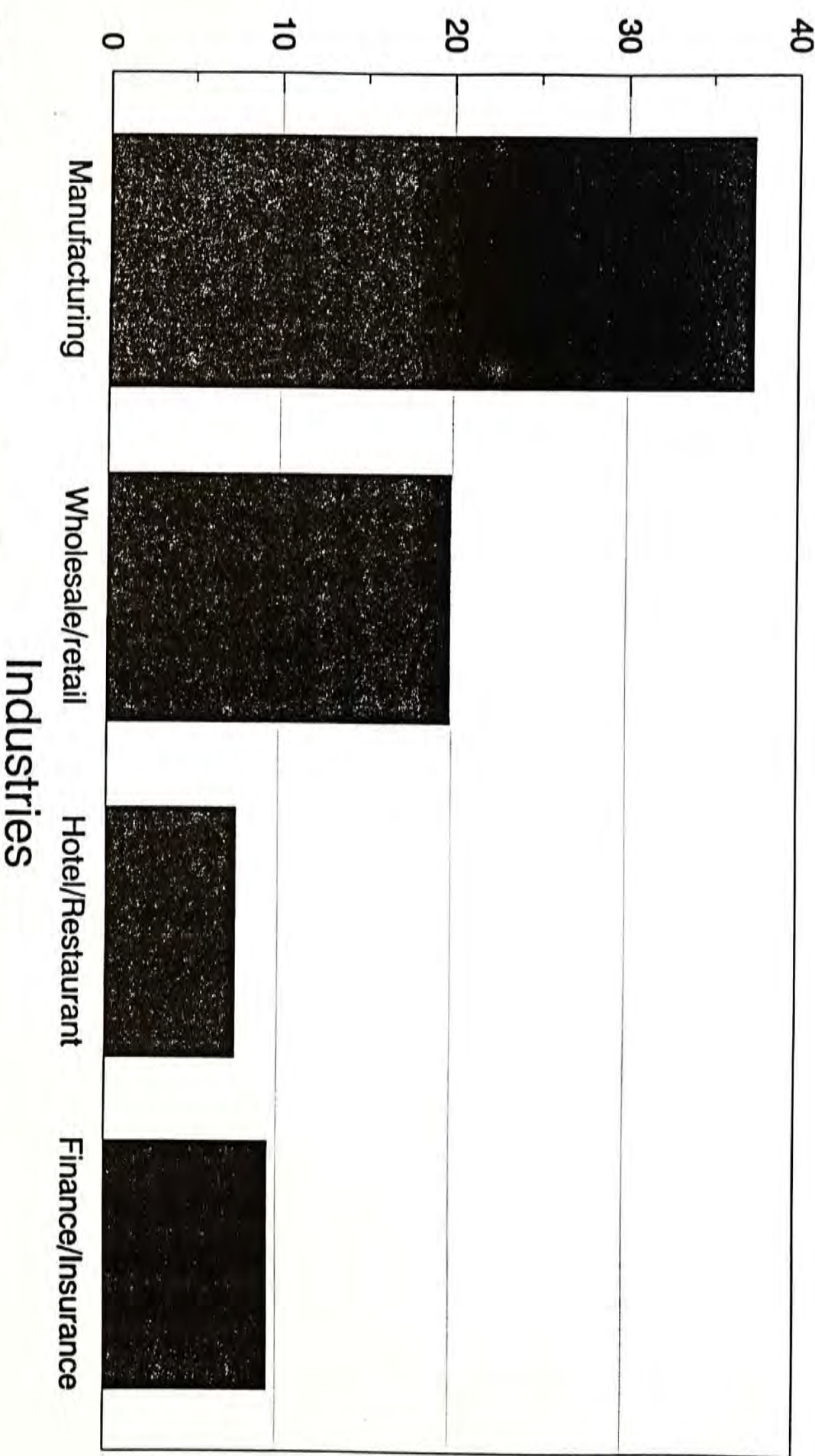
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<sup>2</sup>"Quarterly Statistical Report", Statistics & Census Dept., (3rd Quarter, 1990).



Figure 2 Underemployment Condition in Four Major Industries in Hong Kong

Vaccancies (in '000)



Companies of all sizes are included in the third quarter of the year 1990.

Source : Quarterly Statistical Report : Statistics & Census Dept., 1990.

productivity of the operation of the companies through intensive and systematic computerization.

### Matters of Concern

As a result of the PC boom in the mid 80's, computer networking which linked up computers together so that they could talk to each other emerged. Different networking vendors were selling different networking systems. Since most of the standalone microcomputers were housed in a relatively small confined area, the networking system required rather short-distance linkages, i.e. in local area. Hence Local Area Network (LAN) became a very popular computer products in the late 80's.<sup>3</sup>

However, the evolution of VLSI dramatically decreased the cost of minicomputers. The increase in sales potential of minicomputers due to its low price created a very competitive environment for the minicomputer manufacturers and vendors. Only an open and portable Operating System was required to run these minicomputers and thus increased the sales of these machines. UNIX Operating system was then created and became a de-facto standard in the industry towards the end of the decade.

Our study was thus to concentrate on the applications of LAN on microcomputer and UNIX on minicomputers for the

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<sup>3</sup>"PCs Bloom on Plant Floor", Computerworld, (May, 1989).



medium-sized companies in Hong Kong. A selection between these configurations was becoming a very difficult decision that nearly every EDP/MIS manager of these firms had to make, sooner or later.

### Chapters Summary

Having defined the topic of study for the project, methodologies adopted in carrying out the research of the project, together with their advantages and disadvantages, was described in Chapter II. Study on the history of both LAN and UNIX Systems was carried out and Chapter III gave a fairly detailed description on the evolution of the systems which might give the readers some degree of understanding on the background of the systems. Through interviewing EDP/MIS managers, system suppliers and integrators and independent system consultants in Hong Kong, a general overview and market trend on the computerization of medium-sized companies was presented in Chapter IV. Then moving to Chapter V, a more in-depth analysis on the features of each of the Systems was presented. Factual data were gathered from various sources i.e. books, journals and system suppliers and the pros and cons of both LAN and UNIX Systems were listed in the chapter. Studies on the recent development on the systems follow and a summary of their recent developments and applications in Hong Kong were to be found in Chapter VI.



Moreover, a list of requirements for the computerization process, together with the market trend of computerization for those companies were also compiled and included in this chapter. A comparison of applying LAN configuration and Unix configuration in computerizing a medium-sized company was discussed in Chapter VII. This chapter also gave readers some ideas on the general configurations of both LAN microcomputer and Unix/minicomputer application systems. A summary on all our findings on these systems could be found in the next chapter, Chapter VIII. Following the findings, we attempted to make some recommendations for the selection of the computer system configuration in medium-sized company in Hong Kong. Our conclusion presented in Chapter IX was neither a LAN/microcomputer nor a Unix/minicomputer set-up, but rather a solution we call it "Happy Marriage".

## CHAPTER II

### RESEARCH METHODOLOGY

In relation to the research topic, the following methodologies were considered.

#### Literature Review

For the research on the topic, large amount of historical data as well as the market information were required. Literature review was considered as the primary means in getting such information and in providing the basic reference framework for further research. The articles, books, magazines and journals referenced were listed in the bibliography section.

#### Questionnaire

This method was initially considered to be used for a more in-depth review on the general computerization

requirements of the medium-sized companies which the research topic targeted.

However, because of the involvement of a lot of technical terms, the use of questionnaires was found to be very limited and low response rate was expected. Therefore, this method was abandoned for the research.

### Observation and Site Visit

Site visit to the target companies and observation for their computerization approach and requirements was the next method considered for further study.

A number of site visits had been arranged. However, because of the limited findings obtained, the method was not considered to be the major methodology adopted in this research. In fact, the method of Selective Interview was used to replace site visit and was found to be more appropriate.

### Selective Interview

Instead of arranging superficial site visits, a number of in-depth interviews with the following parties were arranged :

1. EDP/MIS Managers of medium-sized companies
2. Major computer system suppliers



3. Software System Houses
4. Independent consultants

The interviews and discussions with the above people was found to be very useful, providing numerous valuable information to the study.

### **Methodologies Adopted**

After detailed evaluation, Literature Review and Selective Interview were found to be the most appropriate methods and thus they were adopted as the major research methodologies throughout the study.

## CHAPTER III

### HISTORY OF SYSTEMS

#### Evolution of Local Area Network (LAN)

In the early 80s' when Personal Computers (PC) from IBM emerged, they became so popular that thousands upon thousands of computers of that kind were sold to various commercial organisations. Most of the computers were standalone machines with word processing packages running on them.

As technology advanced and the widespread use of VLSI, the power of these systems increased and their costs dropped at a rate that nearly every company, no matter big or small, could afford to have one. As microcomputers were being intensively used, problems in passing data across the systems and sharing expensive peripherals arose. Passing data using floppy diskettes or tapes was not efficient nor reliable, people started to seek for alternate ways to move the data around by a more reliable and faster mean.

As most of the computer systems were located in a local area, i.e. within the same company in the same



building, simple thin wire cables were used to connect up the systems and network software and interfaces were made available by different network suppliers. With these network, the computers could talk to each other and share data.

As the number of standalone PCs installed increased, people had to find out ways in connecting the PCs to the existing host computers. A lot of companies had installed mini-computers and mainframes before the introduction of PCs. They then started to buy PCs in the 80's and the flexibility and the cost/performance benefit from these microcomputers were highly appreciated. Having bought the PCs, it is required that their existing mini-computer or mainframe could communicate with the PCs. This thus give rise to different LAN systems which could connect the PCs to the large computers. The concept of Distributed Processing hence emerged.

Moreover, with the price war in the computer industry, more and more companies could afford to install more than one large computers in order to increase the processing power of the Electronic Data Processing (EDP)/Management Information System (MIS). As all these computers were usually located in a confined local area, short distance network linkage was required to connect them up for interprocessor communication, file sharing, peripheral sharing and task scheduling<sup>4</sup>.

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<sup>4</sup>"PCs: The Five-Year View Watching LAN Computing comes into its Own", Computerworld, (June, 1990)pp:SR/11-SR/12.



In order to cope with this rapid growing LAN market in the mid 80's, a lot of different LAN systems appeared in the market. Industrial Standards from various institutional bodies for LAN were proposed, discussed and set down. Nowadays, the LAN systems that are being used are quite sophisticated supporting a lot of features. LAN system then becomes an essential part of the computer installation for most of the companies in Hong Kong.

### Evolution of Unix Systems

In 1968, Ken Thompson and neighbouring staff, working in the Computer Research Group at Bell Labs, had made substantial contributions to the MULTICS project which was a visionary computer environment that had taken the wrong evolutionary fork. While providing very sophisticated features, it required substantial computing resources. Production versions were too large and slow. The original design had to be scaled back during implementation. Nonetheless, several working versions of MULTICS were completed providing extremely pleasant computing environments.

Later, with Space Travel, Ken now had a reason for implementing the theoretical file system that he had designed and simulated earlier during the MULTICS project. Naturally, the machine needed more than a file system to make it useful. Ken and his friends wrote the first



command interpreter (or shell) and some simple utilities to manipulate files.

The word "MULTICS" actually stood for MULTiplexed Information and Computing System. In 1970, Brian Kernighan jokingly referred to their two-user system as "UNICS," for the "UNiplexed Information and Computing System" since MULTICS seemed to be a vastly oversized operating system by comparison. Soon after "UNICS" became "UNIX" and the name has stuck ever since.

UNIX was ported to the PDP-11/20 in 1970. This was not a inconsiderable task since the entire system was written in assembler! This, plus an editor, was apparently enough to be called a text-processing system.

Experience with MULTICS (which had been written in PL/I) taught Ken and Dennis that writing a system in a high-level language was worthwhile. Hence, they kept trying to do this. In 1973, C was enhanced to support structures and global variables. At this point, Ken and Dennis successfully rewrote the UNIX kernel in C. The shell was also rewritten (from assembler) into C. This improved the robustness of the system and made programming and debugging much easier.

At this point, there were approximately 25 UNIX systems. A UNIX Systems Group was created at the Labs for internal support. Several universities contacted Bell Labs and received copies of the Fourth Edition. Agreements were signed not to disclose the source code, but no licenses were in use at this point. Ken made the tapes himself and



did not charge anything. The first tapes went to Columbia University in New York.

In 1975, the Sixth Edition UNIX system was released. This was the first UNIX that became widely used outside the Labs. AT&T, through Western Electric Co., began offering licenses to commercial and government users.

Mike Lesk released his Portable C Library. The library was a set of Input/Output routines that could be implemented on any machine supporting C compiler. This was an essential step in making C capable of producing portable code. Dennis later rewrote this and called it the Standard I/O Library (now commonly called "stdio"). In 1977, Interactive Systems Corporation became the first company to resell UNIX systems to end users. UNIX was finally a supported product.

UNIX was soon ported to many other types of PDP-11s. It was also ported to the IBM series 1 minicomputer, although some thought this analogous to the bringing together of matter and antimatter.

In 1977, the University of California, Berkeley, Computer Science Department began to distribute their Pascal interpreter. This distribution was called IBSD (1st Berkeley Software Distribution).

In 1979, the Seventh Edition of UNIX system was released which featured a full K&R C compiler. A more sophisticated shell (known as "sh" or the "Bourne shell", after one of its authors, Stephen Bourne) was provided. The system supported larger files. And the results of the



porting effort were felt through a more robust kernel and new device drivers for many peripherals.

As UNIX began to mature, its popularity in the commercial market grew enormously. One of the catalysts of this was /usr/group started off almost as a splinter group from USENIX. USENIX was concerned with the UNIX research and had little interest in promoting its market potential. Financial analysts, bankers, accountants, and other non-technical people were very turned off by the USENIX attitudes which seemed to them somewhat elitist.

In the early '80s, specialized companies, called porting houses, were born to port UNIX to new computers. They could produce a relatively unchanged UNIX, with little development cost. With hardware costs dropping significantly during this period, it became much easier to design and market a successful computer.

With the help of these and other porting houses, UNIX was moved to an amazing number of different machine architectures. At the end of 1983, there were approximately 100,000 UNIX sites running on a wide variety of hardware.

In 1981, /usr/group began the first serious work on UNIX standards. A standard was completed in 1984 and promptly ignored. To this day (and probably till the end of time), UNIX standards continue to be developed by AT&T, the Institute of Electrical and Electronics Engineers (IEEE), the International Standards Organization (ISO), the National Bureau of Standards (NBS) for the U.S. government,

and X/OPEN (a consortium of UNIX vendors).

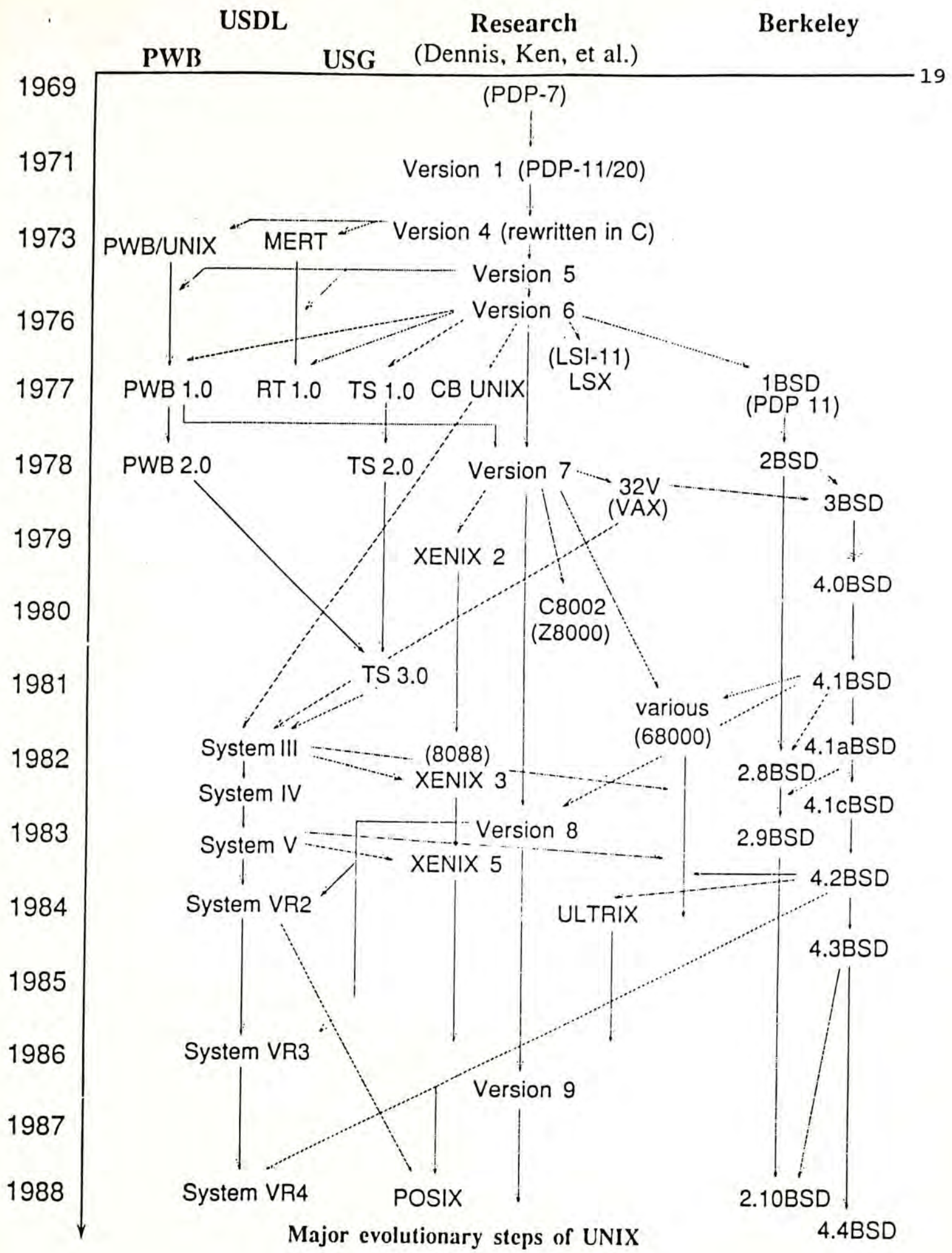
In 1983, IBM joined the fray by offering UNIX on its PC (ported by Interactive), based on the 16-bit Intel 8088. This was not technologically interesting - UNIX had been created on 16-bit computers, after all. What was important about it was that the IBM announcement was the stamp of approval for UNIX. It is hard to describe now exactly how important this was, but there were many people who would not buy a product unless IBM marketed it.<sup>5</sup>

A brief history of the Unix evolution is shown in Figure 3 on next page.

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<sup>5</sup>"Unix - The Complete Reference", McGraw-Hill, (1988)pp:12-65.





Major evolutionary steps of UNIX

Source : Life with Unix, D. Libes.

## CHAPTER IV

## COMPUTERIZATION IN MEDIUM-SIZED COMPANIES IN HONG KONG

Requirements and Consideration on Computerization

The basic criterion for computerization to any company was to buy the most cost effective system, hardware and software, in order to benefit from their operation. With the advance of technology and the drastical dropped in price for PCs and PC- LANs, these companies were exposed to a wide varieties of computer systems of which they could afford.

However, before they rushed in to sign the sales order, it was better to give some thoughts on the following points which were the summaries of the opinions of some EDP/MIS managers and system integrators<sup>6</sup> whom we interviewed.

Firstly, the time the company was willing to spare for installation and maintenance of the system should be carefully planned and scheduled. Usually, a company would

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<sup>6</sup>Interviewee List : refer to Bibliography - Interview section for details.



not have much time to do this and hence ease of use and transparency of the system were important to the users. The ones that had these features generally cost more. As a result, each company should determine the trade-off point between the cost and loss of productivity.

Secondly, 'who' and 'how' the user training would be provided and conducted were important. The companies could train and maintain system by themselves or the system supplier could provide such services. Dependence on internal support was cheaper but the current high turnover rate puts such option under a considerable risk. People started to look for support from a full services vendor who usually would cost more. Anyway, it was the area which concealed some hidden costs that could be of an unexpectedly large amount.

Thirdly, the company should assess the pros and cons of both PC-LAN and minicomputer system running multi-user/multi-tasking applications. It would always cost more if one found out that the newly installed system could not cope with your operational requirements, either in terms of speed or capacity. The whole project would either have to be abandoned and the investment already spent to be wasted or have to invest even a greater sum of money on a more powerful mini or mainframe. Hence it was important that a clear and good planning was required.

Fourthly, it should identify the strategy and resources required for the computerization. The strategy of control, i.e. centralized or distributed control, should



be determined and it should be in line with the corporate strategy of centralization/decentralization. Depending on the operational requirements, on-line or batch processing strategy should be determined which would definitely affect the design, operation and cost of the system. Moreover, by examining the real needs of the users, the requirements of any of the following resources should be identified and assessed: Disk servers, File servers, Printers and Communication Facilities. Achieving resource economy by spotting areas where users could share resources as dedicated resources were very expensive.

The next consideration was on the user group growth rate in terms of personnel and computer usage. This was one of the toughest, yet the most important, questions one would face when planning for computerization. Most work groups discovered that once a system was installed, user demand far exceeded expectations. It was required to prepare for at least some 40 per cent growth per year in computer usage, and planned accordingly for any participated personnel increases.<sup>7</sup>

Furthermore, the company should take careful consideration in selecting a system supplier or vendor who could carry out the computerization project for the company. Though computerization involves both hardware and software, it was always recommended for the strategy of "Single point of Contact". It was important to seek for a

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<sup>7</sup>"LANs : Look Before You Leap", Asia Computer Weekly, (July, 1990) pp:18



computerization included the accounting systems, inventory control and production control in both Hong Kong and PRC plants. Tickets for the production lines were printed out by the computer and the collected tickets were scanned into the system using a optical bar code scanner. He reckoned that the technology involved was rather advanced in such application, however, he stressed that more and more similar companies were planning to fully automate the operation in the coming one or two years.

#### Unix Installation

Even though the PC and PC LAN were so popular in the market, minicomputers could find their buyers. Some companies still preferred to install minicomputers. It was partly due to the speed and the processing power requirements and partly because of the pride of owning a minicomputer. As there were many minicomputers manufacturers/vendors who were offering similar, if not identical, computer systems in terms of features, capacities and cost, a standard operating system or development platform was required for the application software to run on. This gave rise to the popularity of Unix system and many applications running under Unix were available in the market.

One of the reasons why UNIX had become the most widespread operating system was that it was written in a



high-level language. This facilitated the portability of application systems under Unix. As more powerful systems came into existence, notably RISC, parallel and distributed architectures, one could bet that people would port and modify UNIX to run on those machines.

Some people would consider the upgrade path and the system expansion requirements when they decided to computerize their firms. They would select to install Unix applications on PC which could be directly portable to Unix environments in minicomputers at the latter day when required. Such migration process could be made transparent to the end users which was a definite advantage.<sup>9</sup>

It was estimated that there would be fifty percent growth for the Unix Operating System in Asia. When comparing the projected proprietary and Unix hardware revenue of 1993 with 1987, it was clear that the gap between them was narrowing. A chart showing the Unix hardware sales in 1987 and 1983 is shown in Figure 4 on next page.

The future was looking promising. A recent report produced by Price Waterhouse showed that 81% of the top 200 UK Information Technology executives said that they were likely to move to Unix within five years, and 25% planned to move to Unix soon. The presence of IBM in the UNIX market would open the door for many UNIX software suppliers to the commercial sector where Unix had not been very

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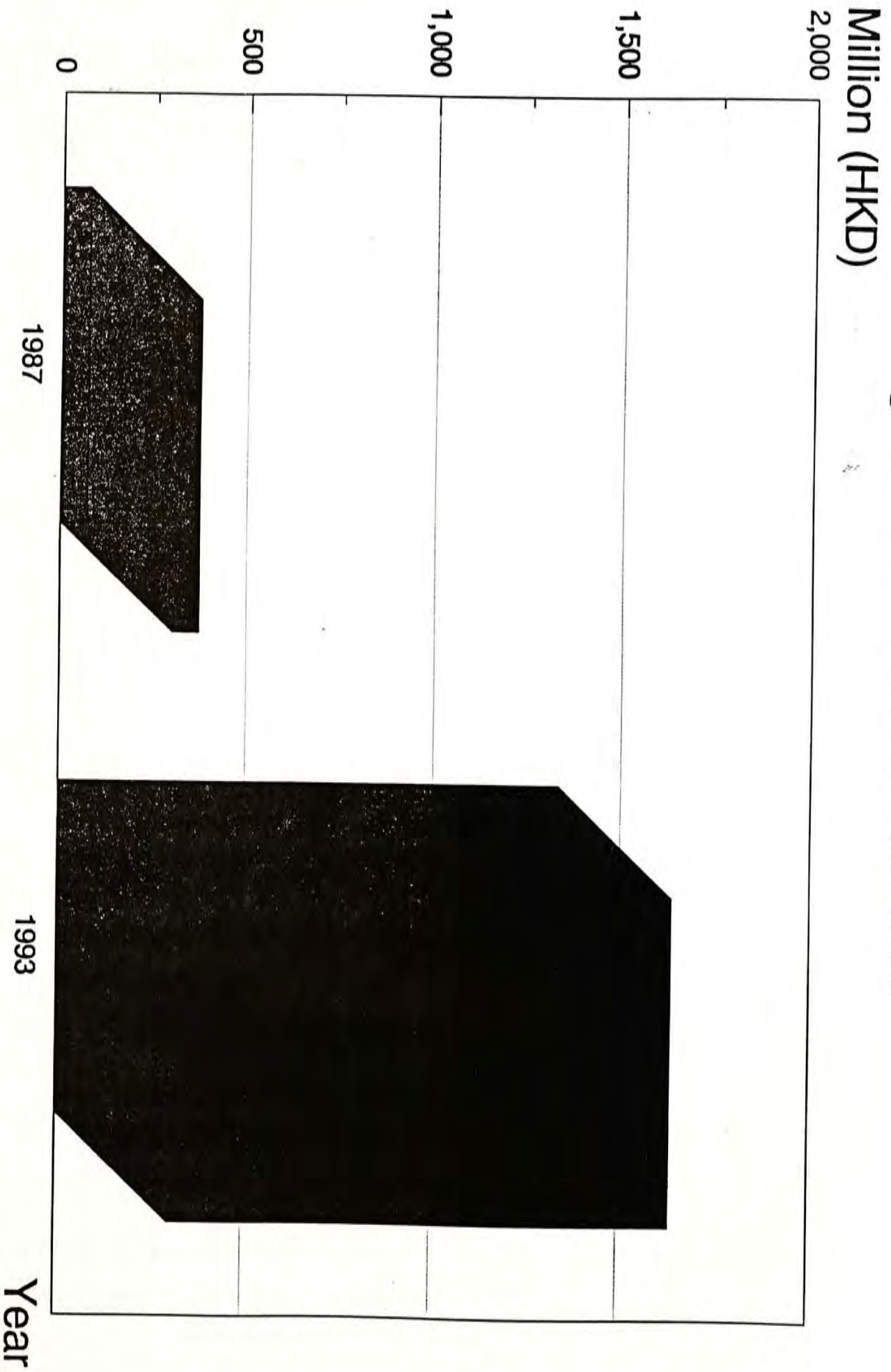
<sup>9</sup>"Choosing Unix for the Office", Basil, (1989)pp:71-93.



strong. Many customers in this sector would start to look at UNIX because of IBM'S adoption of it.

Since both Unix and PC-LAN environment offered multi-user and multi-tasking functions that medium-sized companies required, these two systems generated severe competition in the computer market.

Figure 4 Unix Hardware Revenue



Source : ResearchAsia 1990.



## CHAPTER V

### SYSTEM OVERVIEW

#### LAN System Overview

According to a research company<sup>10</sup> for the computer market, it was found that the PC-LAN market in Asia was growing in a number of ways. Most countries, including Hong Kong, had seen growth of 80 to 125 percent and growth rates in excess of 30 percent were projected to continue over the next three years.

More importantly, the PC-LAN market was maturing, which would lead to greater sophistication and appreciation of network capabilities using PC-LANs.

Another trend, as reported by the research company, was that PC-LANs were being the preferred computing solution as they enabled PCs which offered inexpensive and easy-to-use computing, to take on certain multi-user and resource-sharing capabilities currently provided only by minicomputers and mainframes.

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<sup>10</sup>"South-East Asia's PC-LAN Market", ResearchAsia, (Dec., 1989).

advantages. While PCs were more expensive than dumb terminals, PC servers and software were less expensive than mini-computers and their software applications. But because PCs were already being acquired for use within both PC LAN and mini-computer environments, such cost comparisons were somewhat of a moot issue. But even if the cost of the PC workstation was thrown out the PC LAN won almost every time. And although price should never be the primary deciding factor, it would always be a major consideration.<sup>11</sup>

### Proficient PC Users

As the power and the popularity of PCs and PC-LANs increased, so was the number of PC proficient users. More and More PC experts were blossoming daily in colleges and businesses. PC hacking expertise grew to be considered valid and worthwhile by the technical community. It was an important shift in perception that had had, and would increasingly have, an important and positive effect on PC-based business system success.

### Standardization

Another advantage was the fact that standardization coming to network operating system technology was a feather

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<sup>11</sup>"How to Choose a Computer Network", Facilities Design & Mgmt, (Apr., 1990):pp38



in the cap of all PC-LAN vendors. The proprietary solutions of past years certainly did not shine as brightly in this age of standardized platform and protocols. No matter what came, the user community would benefit from all the technological nitpicking at the network operating system level.<sup>12</sup>

### Psychological Advantages

Finally, there were psychological advantages to PC LANs. Departments had grown accustomed to controlling their own information systems. In many respects, a micro-computer represented to them a movement backward the day of centralized control and authority. The autonomy of the PC LAN was a valuable commodity for departmental profit centres and its implementation was easier than mini-computer based solutions. Thus the less time it took to implement a solution, or to have a new user learn how to say off the ropes and on the network, the better off everyone was.<sup>13</sup>

### Disadvantages in using LAN System

Having discussed so much about the advantages in using

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<sup>12</sup>"LAN Standards : Matter of Protocol", Systems International(UK), (Dec. 1988):pp41-49.

<sup>13</sup>"Bring on the Alternatives", Computer Decision, (May, 1988):pp47-50.

the LAN system, it was time to move to the other side of the table and go through the disadvantages of using the system.

#### Diminishing Performance

Many users were looking for greater computing power. While a PC- LAN enables many users to access a single application and common data in a less costly way, it did not increase the processing speed of the application itself. In fact, in many cases the overall performance of the application was diminished as the number of users on the network increases.

#### Immature Multi-user Applications

Truly multi-user applications in PC-LAN environment were still in their infancy. As users required more from them, PC LANs would require more from the applications software. Some packages developed for LANs left much to be desired when compared to their mini-computer based counterparts.

#### Complex System Management

In the situation where a lot of users were involved, a PC-LAN configuration could be too complex to manage effectively. In many cases, the disk storage needs, user



population and raw CPU power requirements for a large organization simply required the large computer configuration. With the multi-user architecture already optimized, the mini-computer/mainframe had served users simultaneously since its introduction. The scheduling algorithms, context switching and communication drivers were all designed with the multi-user configuration in mind.<sup>14</sup>

### Primitive Database Management System

Another major advantage in the mini-computer/mainframe world was the capability of the database management system. PC LAN database were just now becoming more than single user packages with locking functions added, their functionality still paled in comparison to what had been available in large systems for many years.

### Intensive Support Required

One final drawback of the PC-LANs was that they were besieged with inherent technical difficulties. Thus supporting networks was a tough business and the greater the number of users in the network, the more intensive the support was required from the supplier. As the direct and widespread contact that mini-computer/mainframe vendors

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<sup>14</sup>"How to Choose a Computer Network", Facilities Design & Mgmt, (Apr. 1990):pp38.

provided was significant and effective particularly in cases in which large procurement called for a unified support system, the services provided from the local network vendor was in general much less direct and responsive causing dissatisfaction among the PC LAN users.

### UNIX System Overview

The most important feature of UNIX was its portability. Other features that were touted were 1) the unification of file, device and interprocess I/O, 2) the ability to initiate asynchronous processes, 3) the ability to replace the default shell with another, and 4) a hierarchical file system.

There were other attributes that made UNIX great, but the preceding attributes were considered absolutely unarguable. What was amazing was not that most systems in the '70s did not have these attributes, but that many recent systems in the '80s did not.

Some other noteworthy attributes on Unix are:<sup>15</sup>

- 1) The consistency of the commands and libraries. This allowed the building-block approach, as already noted, to work easily. Libraries and system calls provided one way of doing things, typically the simplest that would solve most of the problems. This carries over

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<sup>15</sup>"The Design of the Unix Operating System", Prentice-Hall, (1986).



from the kernel, which was so small that it could be read and understood in its entirety by a single programmer.

- 2) The dominant file type was text. For example, /etc/password could be modified with a text editor. On most other systems, it was required to use a special program to read and write the data files required for each part of the operating system.
- 3) The shell could be used for programming, since it had rudimentary control structures and parameter passing. Many people never bothered to learn C because the shell and existing programs could be combined so easily. Interestingly, the shell control structures were actually implemented as separate programs.

### Advantages in using UNIX Systems

The use of Unix-based multi-user system bore the following advantages.

#### Wide area and Remote Connectivity

For the connection of dumb terminals to the UNIX systems, only a simple piece of serial cable with asynchronous communication protocol was required.

The loading requirement of this simple serial connection was rather low, especially in text mode

operation, as it was only responsible for transferring character strings from the terminal to the Unix system and vice versa. For a typical connection, 1200 baud to 9600 baud transfer rate was usually more than sufficient.

Such simple connection enabled the UNIX terminals to be wide-spread geographically by simply connecting them through modems and telephone lines without severely downgrading the system performance.<sup>16</sup>

### Centralized System Administration

The UNIX system was designed to be administrated by professionals through the system console. The end-users, in general, could not interfere the system operations via the dumb terminals. The system could be rigidly controlled by the system administrator.

### Tight Data Security Control

With the flexible CHMOD command in UNIX, the system administrator could have full control of user access to the files in the central computer as compared with the relatively loose security control implemented in most PC networks. Besides, as all the files were processed in the central computer, there was no need to download the data to the PC for local processing eliminating the risk of data

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<sup>16</sup>"Unix Finally Catching On in the Commercial Market", Infoworld, (Mar. 1988):pp44.



leakage.

### True Multi-tasking System

The UNIX was designed to be multi-tasking right from the root of the system with multi-tasking capability, jobs could be run in background or submitted to job queue, releasing the front-end terminals for other tasks.<sup>17</sup>

### Expandability

By making use of the newly developed standard protocols, such as Network File Servers (NFS), remote procedure calls, several central computers could be linked together to form a cluster and acted as a very large and powerful virtual computer to the end-user.

With such feature, the UNIX system could provide virtually unlimited expandability in both storage and processing power.

### Technological Advantage

The Unix System had been available in the market for a few years. It was a rather mature system. This implied that there were fewer hidden problems and higher data processing efficiency. Moreover, with the continuous

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<sup>17</sup>"Unix - The Complete Reference", McGraw-Hill, (1988).

improvements on the system, it gave better processor power utilization and resource allocation.

### Disadvantages in using UNIX Systems

#### Lack of Standard

As we had revealed in the history of UNIX, the UNIX operating system was just a collective name for, if not just philosophy of, a number of variants existed in the market and various institutions.

Although recently there were various bodies, namely Open System Foundation, Unix International and some others, established aiming for a "standard" version of UNIX, the result was not that promising at this moment, mainly because each body was working for one's own "standard".

Even when a standard version had come out, the level of compatibility of different versions of UNIX remained as a mystery.

#### Comparatively Fewer Application Softwares Available

As with the reason stated above, the lack of industrial standard in UNIX reduced the interests and imposes obstacles for the software developers.

Also, the public resistance to UNIX discouraged developers from working on applications for the system and



because there were few applications, users were unable to see the system's benefits. Figure 5 on next page showed the application availability under Unix Systems.

#### High Upgrading Cost

The most expensive part of a UNIX solution was the Central Processing Unit (CPU) which was usually designed for a certain number of workstation connection, say 32. Any upgrade beyond the designed limits would result in a total replacement of the central unit.

The cost for such upgrade process could be very high, especially when the existing peripherals, say the main storage might not be re-usable in the upgraded model. Besides, data and program conversion also incurred cost that was often beyond estimation.

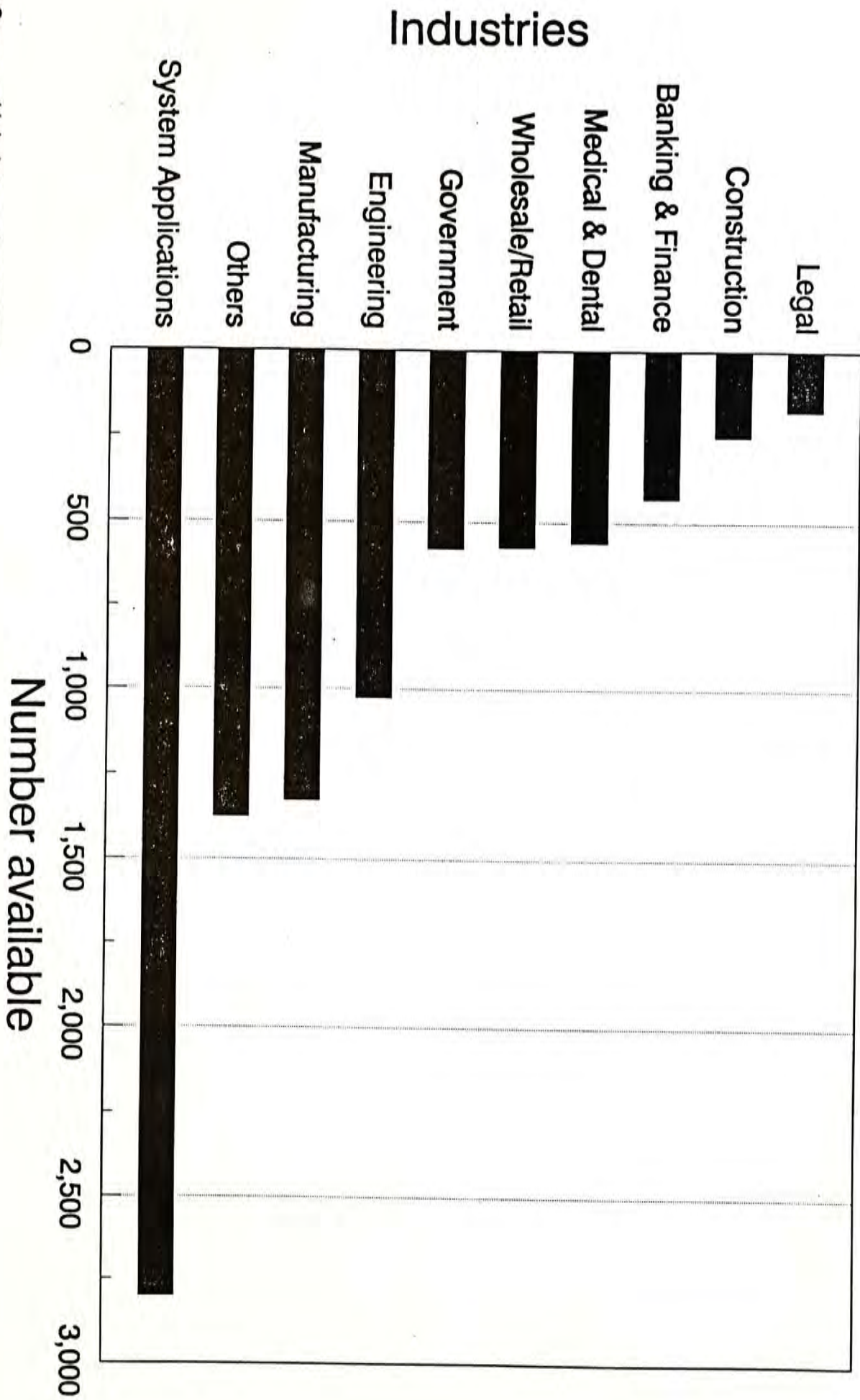
#### High Initial Investment

As the upgrading cost of the CPU was relatively high, user normally had to purchase a larger start-up unit to cater for future expansion. This resulted in comparatively large initial investment.

#### High Administration Cost

As the UNIX operating system was so complex that it was very risky to let the system be administrated by

Figure 5 Applications Available for Unix Systems



Source : Unix International 1990



non-professionals. Generally, centralised control with the employment of high-salaried EDP professional was required for normal system operation.

### Poor User Interface

User friendliness was one of the major criticism of UNIX. UNIX had a reputation of complex and difficult-to-remember command syntax hindering user to operate the system, in particular for the beginners. It was generally perceived that UNIX was not a simple operating system and it was designed more for program writing, rather than anything else.

## CHAPTER VI

### SYSTEM DEVELOPMENT AND APPLICATION

#### Recent Development in LAN System

As the PC-LAN technology had been improved over the past two to three years, PC-LANs had become reliable and easy enough to be installed and run. The introduction of optimized PC-LAN software and of various PC-LAN specific peripherals, such as multi-channel disk drive controllers and disk packs, had greatly boosted PC-LAN performance and reliability. This had given rise to a dramatic growth in sales. According to a research report<sup>18</sup>, the sales of LAN in 1993 would amount to US\$600,000 in South East Asia. A comparison of the sales in year 1989 and 1993 was shown in Figure 6 on next page.

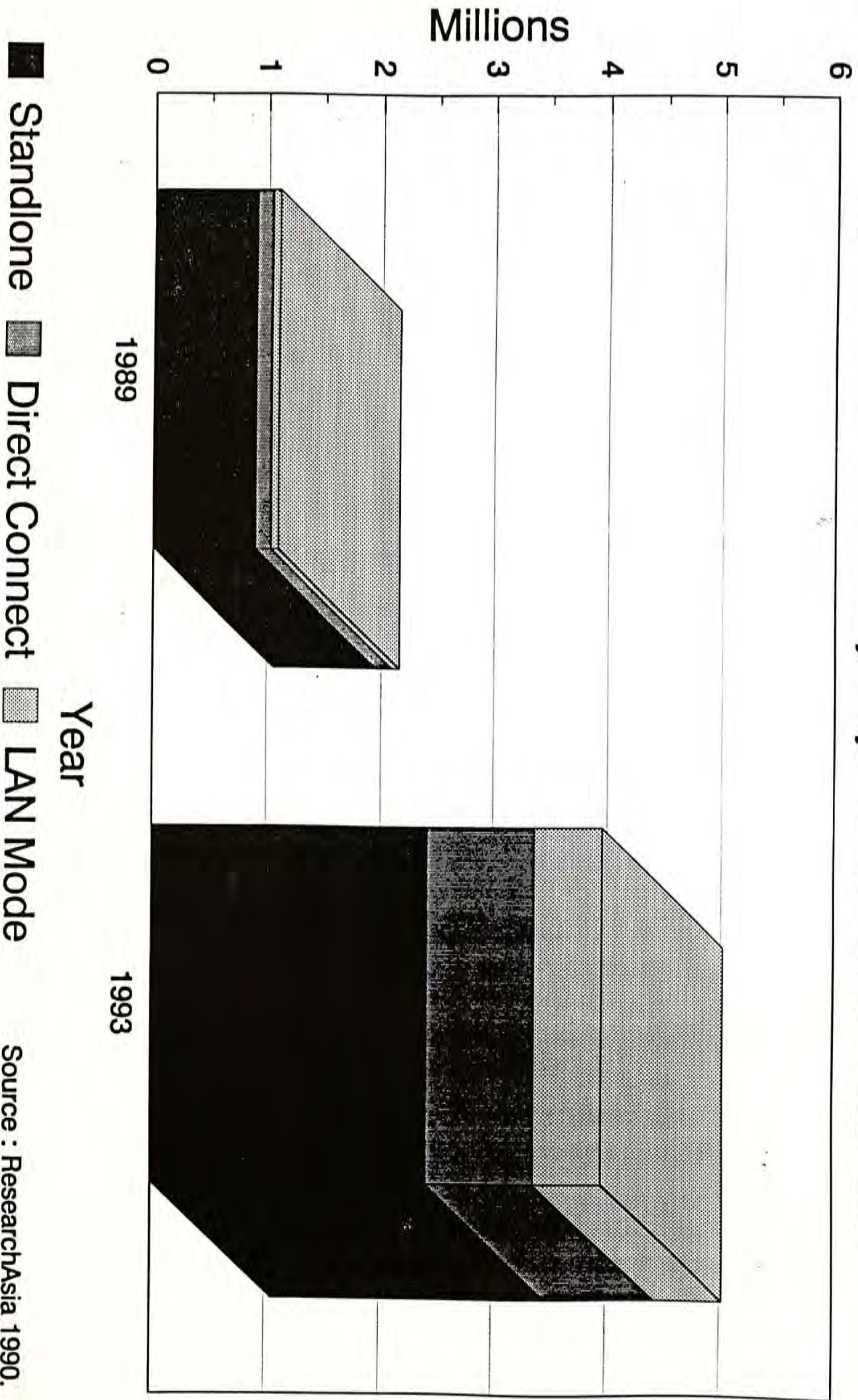
In 1983, a typical LAN linked four to seven personal computers and allowed them to share a printer or simple software such as word-processing package. Today, typical LANs connected about 15 computers each. They were evolving

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<sup>18</sup>"South-East Asia's PC Market", ReasechAsia, (1989).



Figure 6 PC Connectivity Projection for South East Asia



Source : ResearchAsia 1990.

from corporate islands to a digital lattice work that linked LANs with other LANs, LANs with minicomputers and mainframes and LANs with computers in other buildings. It was estimated that about 45 per cent of all the personal computers used in business had been linked into a LAN and this figure was expected to increase to 70 percent by 1994. There were two common topologies used in LAN configuration: Bus and Ring. Among the bus structure, ethernet was the most popular protocol whereas token ring was the favourite choice for the ring structure. IBM adopted the Ring architecture making token ring a defacto standard for IBM LAN System. Digital adopted ethernet for its own DECENT LAN system and its CSMA/CD (Carrier-sense Multiple access/collision detection) protocol for ethernet became the most popular LAN configuration in the area.

Many PC network vendors supported this protocol. The most common PC networks included NOVELL, 3-COM, Banyan and Top. Among them, Novell was the market leader which had 73 per cent of the PC LAN market.<sup>19</sup>

### Wireless LAN System

For all its high-tech glitter, the most important parts of a LAN were the wires that tied it together. Choosing the right cabling was fraught with uncertainty,

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<sup>19</sup>Source - International Data Corp. : 1989.



and installing it could be very expensive and disruptive to an operation. Eliminating the need for expensive cabling was the main attraction of wireless LANs.

Wireless LANs provided a flexible alternative to traditional, cable-bound networks. They allowed the network nodes to be freely moved, instead of having to hard-wire the configuration once the cable was installed.

They also provided networking where cable installation was too expensive and impractical. Finally they provided portable nodes for the network so that the power of the network could be brought where it was needed.

Two major technologies were employed in the channel access and data transfer functions of the wireless LANs. They were Spread Spectrum and Photonic Communications. Differences in the technologies employed in these methodologies carried over into their areas of application. Spread spectrum technology was simple radio communications. It had the ability to penetrate obstacles, such as walls and closed doors and it linked computers even if they were located in different (but not too distant) rooms. Photonic devices needed a line of sight; they operated best in large, wide-open areas where they had an unobstructed line of sight to a common reflective surfaces.<sup>20</sup>

With the increase in the number of LAN installations and the massive number of existing computers including micros, minis and mainframes, connecting them together via

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<sup>20</sup>"On the Radio", Bytes, (June, 1990):pp224A-228.



a standard interface protocols in the LAN system is required. This gave rise to the Transmission Control Protocol/Internet Protocol (TCP/IP) which was originally created by DoD, Department of Defense of United States of America. TCP/IP was getting its popularity and it became an industrial standard for connecting up computer systems of different brands. PC-LANs such as Novell, 3-COM and Banyan supported this protocol allowing the PCs to be connected to their host computers.

#### LAN Applications in recent years

Nowadays, microcomputer-based networks were stealing a lot of business from large-system vendors. The key to the popularity of any hardware platform was the software, such as the complex accounting systems, that ran on it. Thousands of accounting packages available in the PC-LAN system in Hong Kong had attracted three types of buyers.

First, there were those who had to upgrade from a single-user accounting system. As a company grew, it discovered at some point that data entry required seven or eight hours a day, and perhaps even more during peak periods. A network nearly removed the one-person-to-an application bottle neck, and gave managers the ability to query the database and get current information whenever they wanted it.

The second group was those users who had decided,



because of all the advantages of LAN mentioned in the previous chapter, that it was time to replace their bulky mini-computer systems.

The third group was divisions or subsidiaries of large organisations that were in the throes of decentralization. It might be due to the fact that management at the remote locations got fed up with waiting for the central office to provide sales and financial data and decided to process its own transactions.<sup>21</sup>

A lot of multi-user accounting systems were made available by local and international software houses. These programs, consisting of a fairly standard range of features, include General Ledger, Accounts Receivable, Accounts Payable, Payroll and Personnel, Inventory Control, Order Entry and Purchase Order. The cost of these programs ranged from a few thousand to over two hundred thousand Hong Kong dollars each. Some suppliers offered low cost off-the-shelf standard packages while others provided relatively expensive but powerful tailor-made systems. In most of the cases, the packages cost much less than their minicomputer/main-frame counterparts.

To thrive in an increasingly competitive growing market, accounting software vendors were also now beefing up the data integrity and network performance of their programs and the next few years would be very demanding for these companies.

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<sup>21</sup>"How to Access LAN Need", Asia Computer Weekly, (Feb. 1990):pp11.

## Document Management System

Apart from the general accounting systems, LAN had to address the application requirements of combining the data, text and image using a consistent and common architecture and wiring topology. This gave rise to the Document Management/Control system which allowed the documents to be stored in the computer systems and to be retrieved very quickly and easily in fractions of second. The documents denoted electronic files which contained data and text as well as graphic, image and voice information. This thus required Document Content Architecture (DCA) and Document Interchange Architecture (DIA) which provided a logical framework to permit the essentials of an office system communications network.

Document Management Systems from the large computer vendors were available in the market, e.g. Wang, Olevetti and IBM offered this kind of systems. The cost of these systems were significant and there were still some limitations in these systems. However, as the concept was getting popular, the features of the systems would be enhanced and the cost would eventually drop to an acceptable level.

## Wide Area Networking

As the number of LAN installations increases and the



computing power of the micro-computers/PCs grew dramatically, there was a trend towards wide area networking. Increasingly, users of all types of computers were attaching modem links via leased or dial-up lines to expand their own network's access to systems based in other countries to gather or exchange information. Because of this trend, major computer manufacturers, such as Digital, Hewlett Packard, NCR and Data General were introducing new multi-tasking, multi-terminal systems to form networks that were almost transparent to the user. Most micros now had communications ports or modems or both fitted as standard and the software either built-in or supplied bundled with the system.

Having this networking system set up, use of large scale local and international data base information systems and electronic mail services was rising rapidly and local privately run bulletin board systems were appearing on the scene supplying free public domain software and generating on-line discussion between users. With the Executive Information System (EIS) installed under PC-LAN environment, the executives could access various information system for data as well as reports and they could pass messages and information around the world using electronic mail boxes<sup>22</sup>. By integrating telex and fax facilities into the LAN System, they could send and receive telex messages and could even send a text message with

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<sup>22</sup>"Pitney Bowes' Billings Put IS in Users' Reach", Computerworld, (Nov 1988):pp69, 77.



graphics to a facsimile user. The Hong Kong Bank's Hexagon electronic banking services provided a facility for the executives to view the up-to-date stock situation in the local stock market and to manipulate currencies on a worldwide basis.

### Groupware, Database servers and Multi-media

The future of LAN applications should involve a union of three of today's hottest application areas: groupware, database servers and multi-media.<sup>23</sup> Each of these areas held a key component that the others lack. Alone, each would undoubtedly enjoy a great deal of success, but together, either united into standalone applications or as pieces in a Cooperative System, they had the potential to help LANs take that next step forward.

Groupware was a software system which helped people work together better. Electronic mailing was typically the cornerstone of most groupware packages. Different groupware packages would concentrate on different aspects of group interaction. For example, Syzygy focused on project scheduling, whereas Notes concentrated on managing shared documents.

Database servers, the usual centre of the oft-touted "client/server" architecture, had played the role of LAN

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<sup>23</sup>"Unite or Die", Bytes, (Sept. 1990):pp113-116.



saviour for some time. Apart from the file locking or manual record- locking capabilities, LAN server could also provide integrated transaction management systems that correctly handled multiple simultaneous users.<sup>24</sup> Moreover, it was possible to have a large part of the application processing off the server to the client systems. This would hence improve the efficiency of the overall system performance.

Multimedia, as discussed earlier, was the combination of text, voice and video graphics into one single entity so that it could be stored and passed around under a common LAN system.

Tying these applications to a network would be natural and crucial to the successful business in the future. Personal computers, and the networks that linked them, would become information appliances much like telephones and phone networks, and they would be just as essential. With such systems, the question about LANs would not be who needs them, but rather, who could afford not to have one.

### Recent Development of Unix System

The period from 1980 to 1983 saw an explosion of new UNIX companies. This was a result of two factors. One was that a growing number of graduating students who were

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<sup>24</sup>"OLTP Migrates to PC LANs", System Integration, (May 1990):pp40-48.



extremely unwilling to give up the enjoyable UNIX environments that they had used all through school. The second was that the introduction of several low-cost 32-bit CPUs allowed the design of low cost personal UNIX workstations.

One of the attractive features of UNIX was its portability. It was written in C, a high-level system programming language, not tied to one computer. By comparison to other operating systems, porting UNIX to a new machine was easy. However, it typically required several months for an experienced porter to do this task. Porting was a specialized and short-term task.

UniSoft Corporation began in 1981, producing a UNIX port called Uni-Plus+. Unlike XENIX, UniPlus had stayed very compatible with the AT&T versions of UNIX. It was estimated that UniSoft had performed 65 percent of all UNIX ports to date.

At the same time, SCO (The Santa Cruz Operation) collaborated with Microsoft on XENIX, which was the first implementation of UNIX on the Intel 8086 and many other microprocessors. Today, XENIX remained the most popular microcomputer implementation of UNIX. It received a particularly helpful boost when Tandy shipped 14,000 XENIX-based systems to small businesses in 1985. The second largest shipper of UNIX systems, Altos, shipped approximately 13,00 XENIX-based systems during the same



period.<sup>25</sup>

It was worth noting that at the time of IBM's announcement of UNIX for the PC, there were already approximately 70,000 computers running UNIX. 2500 of them were inside the Bell System. About 1,300 universities had UNIX licenses, of which 750 were in the U.S. or Canada. AT&T estimated that there were 100,000 programmers writing UNIX software, and about 300 application packages were available from more than 90 companies.

Currently, it was unusual to find a computer for which one could not get a UNIX implementation. Popular computers such as the IBM PC-AT line had half a dozen ports available. Even systems such as Apple's Macintosh and Atari's ST with their more modern user interfaces had UNIX ported to them.

Due to the proliferation of companies and products, it became difficult to decide what was UNIX and what was not. Would product X run on UNIX from vendor Y? In source form? Binary? With 2 users? 10 users? 100? How about on a UNIX clone? Just what did it mean to be a UNIX clone?

### Unix Institutions

Recently, two commercial UNIX bodies had been established. They were Unix International (UI) being led by

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<sup>25</sup>"Unix Finally Catching On in the Commercial Market", Infoworld, (Mar. 1988):pp44.

AT&T and Open System Foundation (OSF) being led by IBM. Both parties claimed that they were aiming at proposing a standard UNIX by unifying the previous versions and provided a solid foundations for future development.

As the companies involved in these UI and OSF include Motorola, DEC, HP and virtually all major computer hardware players in the market, the final proposal of such bodies would definitely affect the development of UNIX.

We could hope that once all the various UNIXes were merged into one "ultimate" standard version , the result would not be so cumbersome that a supercomputer would be needed to run it.

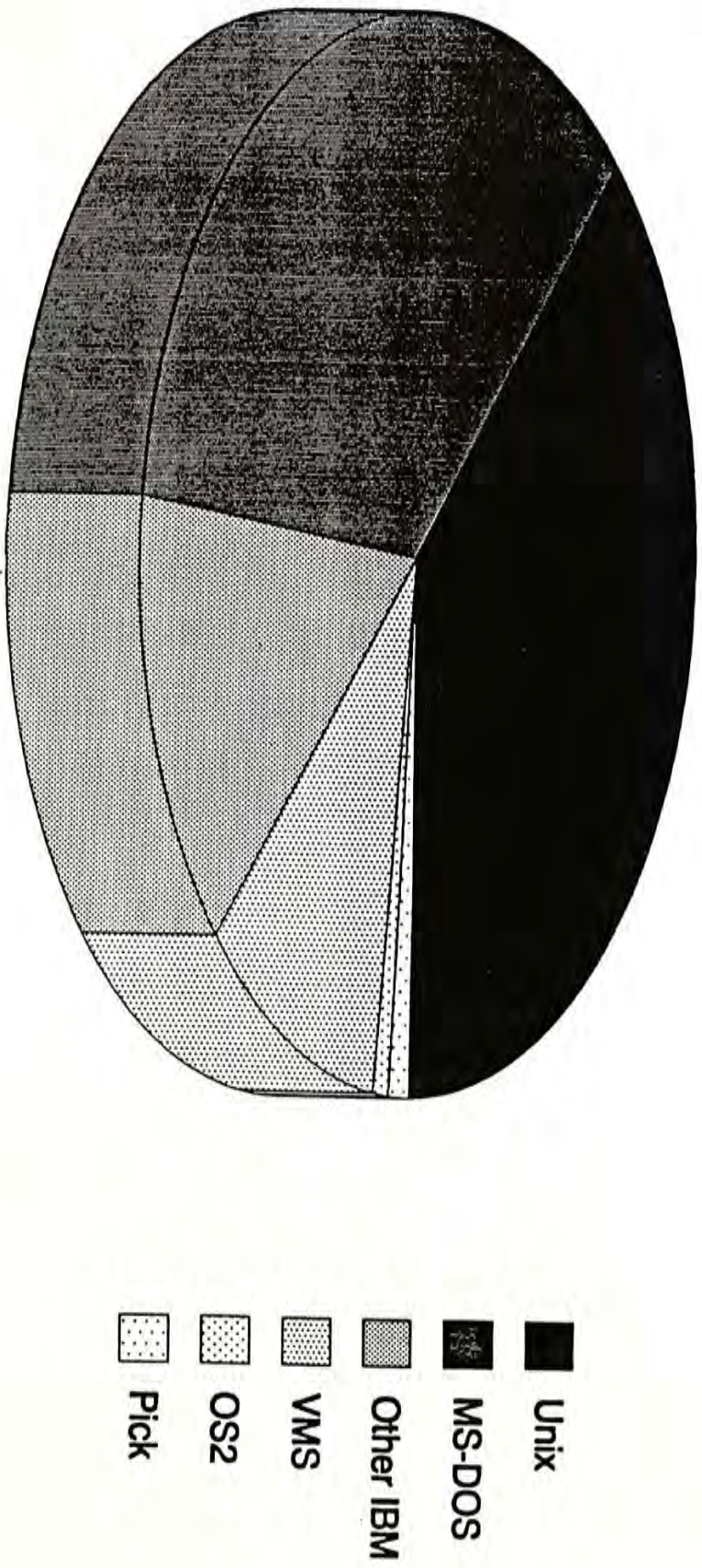
The Unix industry was feeling pretty good about itself. Generally accepted as the de-facto operating system for mid-range open systems, Unix had become the main area of activity for just about every hardware and software vendor.

### Unix Applications

Of the Unix systems shipped, half of the purchase decisions were due to user requirements while the other half were due to the required solution being already established as a Unix offering by the vendor. The growth of Unix-based solutions would be largely vendor generated. The Unix System application proportion compared to some other popular proprietary systems was shown in figure 7 on next page.



Figure 7 Unix System Applications compared to Proprietary Systems



Source : Computer Weekly 1990

## CHAPTER VII

UNIX/LAN APPLICATION IN MEDIUM-SIZED COMPANIES  
IN HONG KONGGeneral Configuration of a LAN-based Application

As the number of LAN-based Systems installed for the medium-sized companies increases, it was found that a basic configuration for the PC-LAN System could be formulated for general applications.

A consultant and expert<sup>26</sup> on LAN system from an international LAN system integrator (Hong Kong Office) stated that about 70 percent of his clients had LAN system set-up with a common basic configuration.

Such configuration consists of at least one network server which allowed all the users to share files, data and even application softwares. The server was usually a very powerful machine which was a dedicated computer on Intel 80486 or Motorola 68040 micro-processor(s). This central server configuration was very common in the LAN

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<sup>26</sup>Messer, W. 3COM Hong Kong Ltd., Hong Kong.



installation for these companies in Hong Kong. Through this server, some expensive peripherals such as laser printers, line printer, CD ROM reader and colour plotter were attached letting all the users in the network throughout the company access and share these peripherals. Some LAN systems had installed up to three to five servers, each carried out a unique server function. Such multi-server configuration also gave backup facility. As one server went down, the other would take up its responsibility leaving the system running at a degraded mode without driving the system to a dead stop.<sup>27</sup>

The number of workstations attached to the network ranged from some less than ten nodes to some over one hundred with an average of about thirty to forty. The type of computers employed as workstations ranged from the old PC XT which served as word-processing workstation to the very powerful 80486 PC serving as CAD/CAM workstation. Most of the LAN systems had at least one remote workstation linked up to it giving the extension to Wide Area Network (WAN). This was especially common for the companies with off-shore plants in PRC and in other cities in South East Asia. Local printers/plotters were attached to workstations for local printing/plotting on sectional or departmental basis.

Ethernet configuration was the most common topology adopted for these LAN systems, he claimed, while Novell

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<sup>27</sup>"Multiprocessor Servers Create Ideal Platform", Computer Technology Review, (Aug 1989):pp24, 27.



Netware was the best selling network system software in Hong Kong. Most of his clients had general accounting systems installed in the network enabling data entry from different departments be carried out in the most efficient and timely manner. Management information system generating different types of reports was a core portion of the system allowing the managers from different sections of the companies to access the reports via the network system.

Electronic mailing (E-mail) was another common feature of the LAN systems which provided another means for the staff of the company to communicate with each other. Computer Aided Design (CAD) application was also employed by these companies, especially for the manufacturers and architect firms, for product and building design.

Having visited a medium-sized company which manufactured optical components and equipments in Hong Kong with off-shore plant in England and PRC, its recent computerization project was a typical LAN-based system in the region.

This company had installed two servers supporting 25 users. The workstation employed in each node of the network consisted of both 80286 and 80386 PCs. The servers were 80386 based dedicated system with 200 MB hard disk running accounting systems including General Ledger, Accounts Receivable, Accounts Payable, Sales Order Processing, Purchase Order. Moreover tailored-made production control and inventory control systems were installed for the production plant in Hong Kong. According



to the Financial Controller of this company, who was in charge of this computerization project, it was a rather successful project dividing into three phases spanning over 18 months time from preliminary design to user training. He was satisfied with the performance of the computer system installed which he claimed would increase the productivity and efficiency by thirty percent and would decrease the threat from high turnover rate. The configuration of the system was attached in Figure 8 on next page.

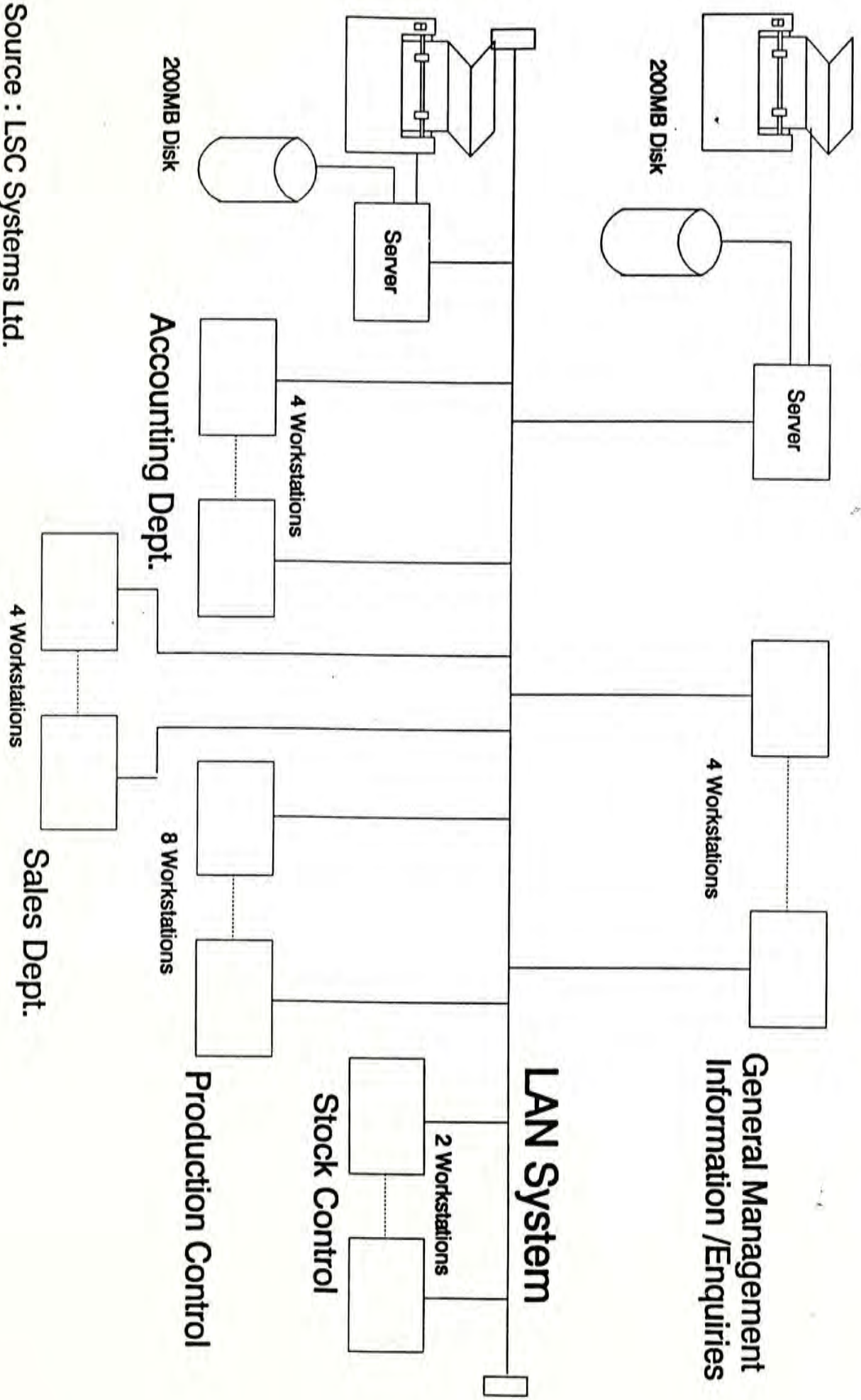
#### General Configuration of a Unix-based System

Similar to the LAN system, most of the UNIX systems for the medium-sized companies were very similar and bore little differences. A typical configuration of such UNIX system was presented in Figure 9 on next page.

The first, and the most important, component of a UNIX system was the Central Processing Unit (CPU). Like the server in the LAN system, this box was the central hub of access for the data. It consisted of disk storage and tape system for storing the corporate data.

However, the CPU box functions differently from the network server. It was not just the central storage of data, but was also the central unit for all data manipulation and computation. Therefore the processing

Figure 8 A Typical LAN Configuration in Hong Kong



Source : LSC Systems Ltd.



power of the CPU largely dictated the overall performance of the whole system. Whilst in contrast, the LAN server only acted like a data librarian, leaving the computation work to the CPU of each local workstation.

Data transmission speed was the bottleneck in LAN system performance, whereas the main CPU was obviously the performance bottleneck in the UNIX system as the number of users connected up was increased. In order to support more users with larger processing requirements, the computer vendors were competing for the powerfulness of the CPUs. Reduced Instruction Set Chip (RISC) and multiple processor architecture were the current trend.

Besides the CPU, the Random Access Memory (RAM) size inside the box also greatly affected the overall system performance. It was the working storage for the data manipulation and user session connection.

The RAM size was thus a direct function of the number of active terminals to be connected and the transaction processing requirements. Typically, 512 KB RAM was required for each general user while 1 MB to 2 MB RAM per user might be required for typical database applications.

The disk storage in the CPU box greatly depended on the applications run on the system. Generally, a 600 MB to 1 Giga byte capacity would be well sufficient for a typical medium-sized company.

Another component in a typical UNIX system was the working terminal. Looking like the personal computers connected in the LAN system, its functionalities differed

a lot. The basic difference was that there are usually no intelligence nor processing capability in the terminals as compared to the PCs. The terminals only acted as the data capturing device (the keyboard) and the information displaying device (the screen). However, as such terminals were "dumb", they could be purchased at a very low cost as compared with the LAN workstations.

Like the LAN system, the terminals were also connected to the main CPU via cables. Typically, the connection was in star topology with the main CPU as the central hub and each terminal was connected to the main CPU independently.

Unlike the LAN system, the data traffic within the cables involved only the keyboard input from the terminals and the screen display to the terminals. Hence the traffic loading was very limited. Normally serial cable running at 9600 bps was more than sufficient. While the cabling system was very important and sophisticated in the LAN system, the cabling in a UNIX system was relatively simple and bore comparatively little influence to the overall system performance.



## CHAPTER VIII

### FINDINGS

After having evolved for years, both Local Area Network and UNIX systems were mature in technology and full of applications for commercial use.

For a medium-sized company that required a multi-user solution, the followings were the major considerations.

#### Total System Cost

The total system cost for a local area networking system was normally lower when the number of users required was smaller, in particular when there were already some personal computers installed in the company. However, as the number of users grew, the hardware cost quickly exceeded that of the UNIX System.

On the other hand, the major drawback of the UNIX system was its relatively high initial investment cost for both hardware and software, in particular when consideration for future growth was required.

### System Security

The UNIX system bore better system security in comparison with that of the Local Area Network.

The greatest drawback of Local Area Network in this area was that the local PC workstations could easily download data from the server to the floppy diskettes, resulting in the leakage of corporate data.

### Office Automation

There were more office automation applications and tools in the Local Area Network environment than for the UNIX system. Besides, these tools were more normally user-friendly in LAN than in UNIX.

### Data Processing

Generally speaking, the data processing capability of UNIX system was better than LAN system of similar configuration. Therefore, if large transaction processing or heavy data processing loading was required, UNIX could well out-perform corresponding Local Area Network system.



### Summary

As the relative importance of the above considerations differed from different companies, no one solution fitted all cases. Basically, if the company stressed more on office automation, the system expandability and ease of system administration, Local Area Network would be a better choice.

On the other hand, if intense data processing and tight system security were the major considerations, UNIX system should be a better choice.

However, with the recent technology advancement, Local Area Network and UNIX systems were not mutually exclusive and could be integrated with one another. The details of the marriage of these two state-of-the art technologies were presented in the next section. By such technology, users could choose LAN today and installed UNIX later, or vice versa, and yet still provided a closely integrated system. Users could now have the freedom to make the best choice just based on the present requirements.

## CHAPTER IX

### CONCLUSION AND RECOMMENDATION

Due to the high labour turnover rate and current brain drain problem in Hong Kong, a series of major operational problems were affecting the business organizations in the region, the effect was even more pronounced in the medium-sized business sector. As a result, people became to understand the importance of computerizing their businesses in order to reduce the impact from such a abrupt change. Moreover, in this fast-moving commercial world, people were trying hard, in every possible means, to gain the competitive edge over their rivalries. Information management including precise and up-to-date information control became a necessity for the success of the business in Hong Kong. Computerization for these companies was one of the basic yet essential elements for their survival and growth.

With the advantages and disadvantages of Unix systems and LAN setup, both in terms of cost and features, installing either system alone might only be suitable to a small proportion of these companies. Most of them would,



sooner or latter, found out the bottleneck of either system and became fed up with the problems encountered.

In order to obtain the greatest possible benefits from computerization, these companies should consider a new system configuration which would maximize the advantages of both Unix and LAN systems.

### Recommendation : Marriage of UNIX and LAN Systems

With the respective benefits of UNIX systems and PC LANs, the marketing trend was that both would play dominant role in the coming future. However, a even more significant trend was that they were going to merge into some forms of hybrid system.<sup>28</sup>

There were various approaches of such a "marriage". Generally, they could be classified into the following categories.

#### Inter-system Connection

The UNIX and LAN could be connected together to give the optimal benefits to the users.

For example, a UNIX system could be connected to a DOS LAN through TCP/IP protocols for file transfer, terminal

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<sup>28</sup>"Bridging Unix and Dos", Mini-Micro Systems, (Aug 1988):pp58-78.

emulation. Adding the NFS protocols, the users could also share files across the network with UNIX system.

### Running DOS in UNIX

There were quite a number of software products recently appeared in the market that allowed UNIX to create a process to emulate DOS environment. It provided a virtual DOS platform for running the DOS applications. Such products included Merge 386, VP/ix, and some others.

Of course, with DOS running as guest operating system, the performance was not as satisfactory as a native DOS PC. Besides, in general, the emulation was only compatible with those very "well-behaved" DOS programs.

Nevertheless, it provided a means of transparent access to UNIX files for DOS users, and formed a virtual network allowing the Unix and DOS users to share the files to a certain extent.

### Running Network Operating System on UNIX machines

The representing product for this category included Portable Netware from Novell.

With the Portable Netware, the UNIX machine was running as a network server to the DOS end-users. However, the files they were using could also be accessed by the



UNIX users as UNIX files.

### Network based on UNIX

This was the closest type of marriage. The PCs were connected to the UNIX system the same as they were hooked up to the network server. The networking system was actually a re-director of DOS Input/Output requests to the UNIX system.

From the DOS users' points of view, it was absolutely a Unix server-based networking system, whilst from the UNIX users' point of view, the DOS applications were just running as normal UNIX tasks and processes.

The representing products in these categories included adLANtes and PowerLAN.

Having studied the requirements for the computerization of the medium sized companies and the pros and cons of the most popular computerization solutions, Unix and LAN systems, it could be concluded that benefits would be maximized by merging up these systems. As the benefit increased with degree of merging, Network based on Unix configuration was recommended.

Although the startup cost for such system was not the least among all other solutions, it was the solution which provided the greatest cost effectiveness to the buyers. Its high degree of versatility, upgradability and maintainability would make this type of configuration a

defacto standard in the next couple of years. Should anyone who wanted to obtain the greatest possible benefits from computerization and optimize the profit at the same time, the recommended configuration was definitely the one which was worth to be seriously considered.



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