The Handbook of Data Communications and Computer Networks

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Introduction

This handbook has been written as a graduate and professional text to help computer scientists and practitioners in the expanding field of data communications and computer networks. Prime importance has been given to interleaving theory with examples, thus allowing the reader to progress smoothly from concept to concept and one new term at a time.

We are living in an age when human knowledge doubles every 15 years. Every 10 years technology makes tremendous jumps, and the life cycle of 50 percent of our expertise is only 5 years. We must work and produce in this fast-changing environment, but our job is not to operate large machines or to build elegant systems. It is to solve business problems. Providing the most efficient software or hardware is only part of the problem. The *real* issue is how to make information work for the people who need it.

The starting point is understanding how information capabilities are received by and delivered to the end users. To do this requires a profound knowledge of the business—how it operates, and what the important issues are.

The implementation process of computers and communications includes:

Gaining management's recognition and acceptance.

Obtaining a commitment to the tangible and intangible costs of change.

Involving the end user in the design of change (he won't change unless he wants to).

Acquiring technologies that match needs and that people will accept.

Designing man-machine interfaces and limiting the impact on organizational structures and relationships.

Planning the gradual evolution of information technology within the organization.

Assuring that the benefit from computers and communications is tangible, factual and documented.

Keeping costs low so that benefits always exceed costs.

Implementing the change effectively (with the appropriate training and sales effort).

Training the user to the new system and demonstrating costs/benefits in a simple, efficient, understandable manner.

This handbook is divided into seven parts. Part One is devoted to microprocessor-based engines. It introduces the concept of distributed information systems; reviews the most advanced R&D efforts in semiconductor technology; shows how to gain cost/benefit; and leads the way to data processing and data communications.

Part Two is devoted to telecommunications. It explains the requirements; treats technologies such as space, frequency and time division multiplexing; examines switching technology and computer-based private branch exchanges (PBX); and includes such topics as transmission media (from coaxial cable to satellites), terminals, modems, multiplexers, concentrators, and frontends.

The theme of Part Three is protocols. What is a protocol; circuit switching and the polling/selecting option; bit-oriented protocols; the nesting of protocols; networking functions; X.25; session and presentation control; and the new standards for PLP.

Part Four concentrates on networks. Three generations of networks are presented; competitive offerings and international standards are explained; a discussion on backbone operations is followed by basic definitions for architectural design; functions and objectives in network architecture—including tradeoffs—are outlined; emphasis is placed on circuit, message, and packet switching.

Messages and transactions are the subjects to which Part Five addresses itself, including transaction-based systems, message theory, electronic mail, electronic funds transfer, videotex and its impact in the 1980s, and an American application of retail banking through Videotex.

Part Six underlines the software prerogatives: communications software, network operating systems, error detection and correction, and journaling.

Finally, Part Seven is devoted to network maintenance. The issues are life cycle maintainability, systems maintenance, the functions of a network control center, and network diagnostics and monitoring.

This choice of subjects has been made in the understanding that the rapid increase in the demand for data communications and computer networks has elicited a need for more efficient structures than those presently available.

Though we still learn on databases, we know beyond doubt that data communications, databasing, and data processing are converging. Before long, there will be no distinction between them at all. The common ground is distributed information systems. Its impact will transform our professional and personal interests.

Let me close by expressing my thanks to everyone who contributed to this book, from my colleagues for their advice, to the organizations I visited in my research for their insight; and to Eva-Maria Binder for the drawings and typing of the manuscript.

Valmer and Vitznau
Dimitris N. Chorafas

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Distributed Information Systems

Technology has advanced to the point where computer power is economically available at all levels of company operations. Distributed information systems are tools which enhance the productivity of organizations with widespread operating facilities. Productivity gains can only be expected, however, if system tools are used easily, by authorized individuals, for a variety of purposes, and can be adapted readily as requirements change.

Distributed information systems, DIS, increasingly draw attention, yet have a meaning that is not totally understood. DIS is an evolution from centralized processing, which in turn evolved from "free-standing" modes. Although it combines certain strengths of its two predecessors, DIS is unique in its own right. It represents a break from the past.

The implementation of a distributed information system rests both on Logical and on Physical premises. The logical functions center on the procedural design for channeling the flow of information, and controlling the physical faculty throughout the projected systems configuration. The object of the physical functions is the engineering of the hardware and hard software devices to provide a specific level of capability.

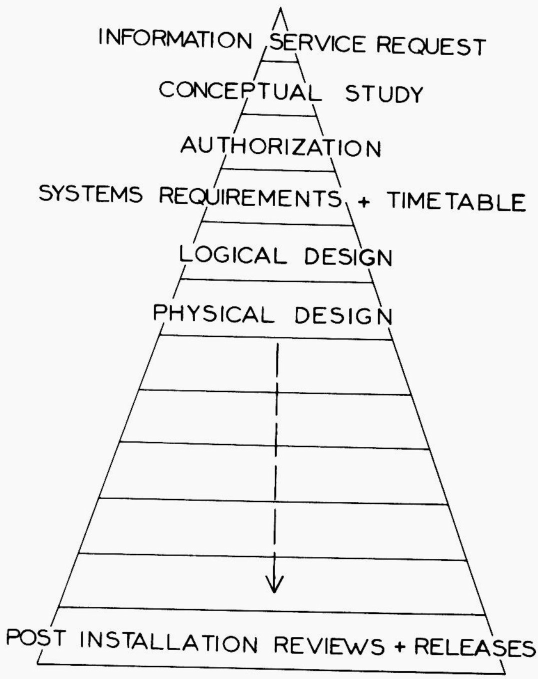
Figure 1.1 outlines the chronological order of development from the information service request to the logical and the physical design phases. The information service request can be motivated by the need for cost reduction in data processing, clerical operations or other sectors, and/or by requests for improving the current information handling service and bringing it nearer to the user.

We shall take factual and documented examples to back up these references.

One Microcomputer per Desk

Typically, in the 1950s and 1960s, information handling was centralized, batch-oriented and costly, and encountered an inordinate number of errors and delays.

Figure 1.1

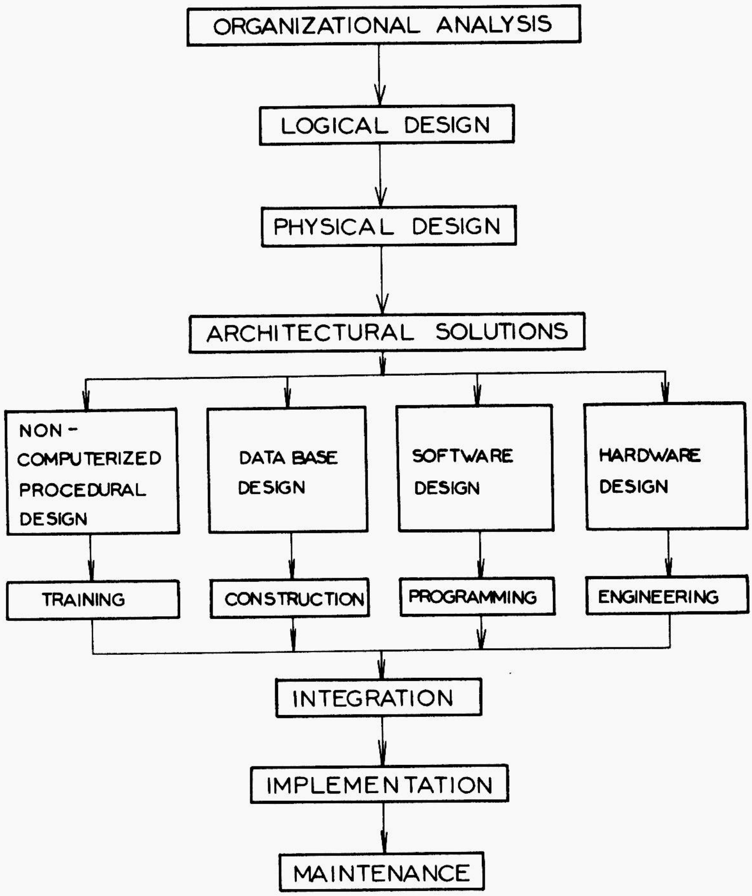


By the late 1960s there was plenty of evidence that this state of affairs was not satisfactory. Management needed to do something about this situation, and knew it. It was assisted in opening a new frontier by the system analysts' own realization that new ways were badly needed to master complex information systems.

In the late 1960s information system designers started to realize that software projects could not (and should not) always be behind schedule, taking more memory than planned, costing several times more than the original estimate, and performing less than projected. But it took another ten years to bring into perspective the fact that such results were the direct effect of underestimating complexity: there is no one-dimensional way from systems analysis to programming, but a four-dimensional approach past the architectural level involving noncomputerized procedural design, data base (DB) organization, software design, and hardware engineering. Figure 1.2 gives a snapshot of this organization. We shall return to it later at greater length.

The second vital element in opening the new frontier has been brought about by the cutting edge of technology which made it possible to bring computer power to the workplace at a lower cost than the previous mammoth solutions. Incorrectly called "minicomputers," this generation of information equipment made feasible both the division and the multiplication of computer power. Introduced in the mid-1960s, the minicomputer (based on semiconductors) exploded in the 1970s into three families each with its own market and price range: the maximini (or

Figure 1.2



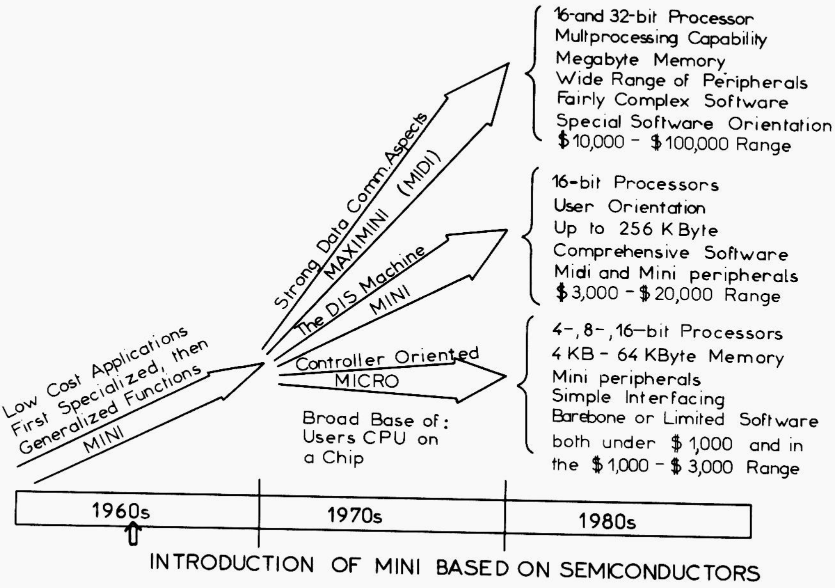
midi), the mini proper, the micromini. Figure 1.3 shows the perspectives for the 1980s, and the specific orientation of each of these markets.

Technologically, the evolution of the maxicomputer resembled the "big motor" approach with the main drive shaft which we had in factories at the beginning of the Industrial Revolution. The evolution of the mini can be considered as a data handling counterpart to that of small motors (fractional power): "one motor per tool," "one mini per office."

For the 1980s, the master of the marketplace is the personal computer (PC). Microprocessor-based, with capabilities which exceed those of 1960 mainframes (and, in some cases, of big computers of the 1970s), the PC has gone through an evolution characterized so far by two generations.

1. The first generation of PCs came onto the market between 1976 and 1979, but began to receive major attention only since 1980.

Figure 1.3
Introduction of minicomputers based on semiconductors



Typically, these are 8 bit-per-word (BPW) engines; have a central memory (CM, high speed memory, semiconductor memory) of 16 kilobytes (KB); use for external storage a cassette, eventually changing to floppy disc; have native support for a 40-column video, or 80 columns through a special printed circuit board (PCB); and have no capability for networking. (The latter can also be added through a PCB.)

2. The second generation of PCs entered the market after 1981 and attracted immediate market interest.

The central processing unit (CPU) of this generation is characterized by two types of commercially available microprocessors, though a few machines feature special LSI (large scale integration) semiconductor units or other than the two leading microprocessors:

the Intel 8086, with 16 BPW and a 16-bit bus (though some PCs have the Intel 8088 with 16 BPW and an 8-bit bus), and

the Motorola 68000, with 32 BPW and a 16-bit bus.

Though comparisons in terms of CPU power are quite abstract unless one knows and considers the machine's internal design, there is as an order of magnitude—a 30% rule—for comparison, with other things being equal. Benchmarks which I have done tend to indicate that, for currently available microprocessors,