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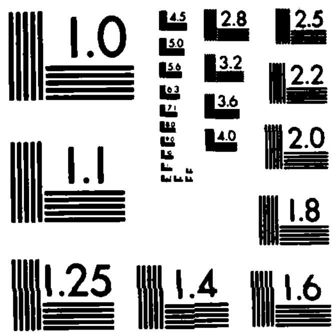

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by

Janusz W. Sowinski

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A

ON SOME APPLICATIONS OF MICROCOMPUTERS IN TELEINFORMATICS

Janusz W. Sowinski

One of the characteristic features in the current state of development of teleinformatics equipment is the widespread use of large scale integration systems, particularly with possibilities for programming and storing data, otherwise called microcomputers. The present article is an attempt to outline the place and role of microprocessors and microcomputers in teleinformatics equipment and systems. Selected applications are discussed, and the architecture and characteristic features of microcomputers are presented in the context of data transmission.

The use of microcomputers in telecommunications is a natural extension of the application of digital technology in this field. Just as in many other applications, in telecommunications the final products are more and more saturated by electronic digital systems. The reason for this situation is that the current applications of telecommunications for voice and digital data transmission are in constant development, which continually requires new equipment of higher automation with a constantly lower unit cost.

As a result of increasing the degree of integration of electronic elements, their price (according to western sources) drops by about 50% annually. During the past 15 years the number of logic gates in an integrated system has risen from 1 (transistor) to about 10,000 (Figure 1). During the same period of time the cost for a single system has basically remained at the same level. Application of large scale integration systems (LSI) in telecommunications equipment and systems has become possible and is economically justified. LSI systems perform such functions as coding and decoding voices, repeated selection, functions of universal asynchronous transmitters and receivers, etc. However, such equipment is not very flexible (not suitable for changes), and only the implementation of microprocessors made it possible to solve many problems in a simple way.

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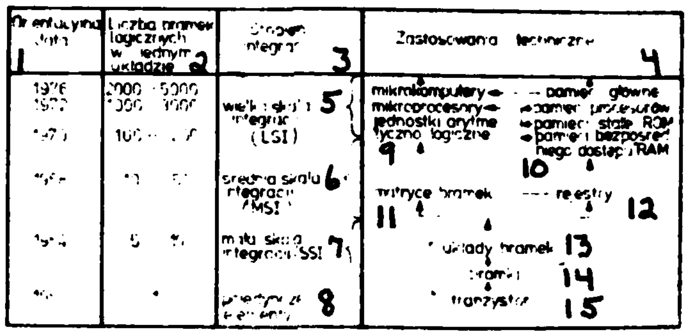

Figure 1. 15-year period in the development of compacting and applying electronic digital systems. Key: 1-date guide, 2-number of logic gates in each system, 3-degree of integration, 4-technical applications, 5-large scale integration, 6-medium scale integration, 7-small scale integration, 8-individual elements, 9-microcomputers, microprocessors, arithmetic-logic units, 10-main memory, processor memory, ROM, RAM, 11-match gates, 12-registers, 13-gate systems, 14-gates, 15-transistor.

The microprocessor is the central unit of a computer, found in one large scale integration system and capable of following various sets of instructions and different types of data manipulation. The data can be either numerical or voice information, or any other digital representation of information. In order for a microprocessor to be useful, it must cooperate with a memory which stores both programs

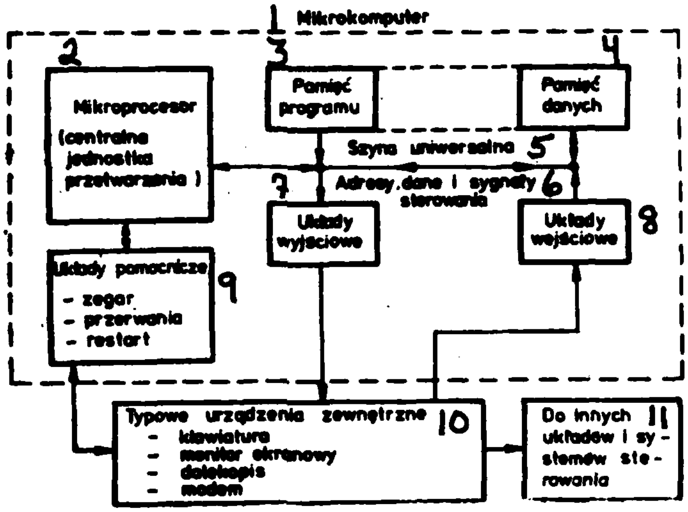

Figure 2. Block diagram of a typical microcomputer system. Key: 1-microcomputer, 2-microprocessor (central processing unit), 3-program memory, 4-data memory, 5-universal track, 6-addresses, data and control characters, 7-input systems, 8-output systems, 9-auxiliary systems, clock, interrupt, restart, 10-typical external equipment, keyboard, screen monitor, printer, modem, 11-to other control structures and systems.

and data undergoing processing (Figure 2). In addition input and output systems are necessary, making it possible to exchange data with external equipment, and auxiliary systems to control the activity of the entire assembly called the microcomputer.

The concept of "microcomputer" usually means computers which:

--Have all features proper to typical computers,

--Have the basic purpose of use without an operating system or have their own simple operating system located in the so-called read-only memory, i.e., in that part of the computer memory which can only be read,

--Possess external equipment (input-output equipment and memories) adapted to the task performed or with special control organs without the cooperation of traditional input-output equipment,

--Use large scale integration technology,

--Limit the physical dimensions of basic configuration to 1-2 packs,

--Do not require air conditioning or any other special environmental conditions, and

--Provide simple service which establishes new bases for communication between man (user) and computer, thanks to the partial or complete possession of prepared programs, the use and range of which can be easily and rapidly learned.

Thanks to the programming, microcomputer functions can be changed without any need to design new LSI systems. In this way, while maintaining all of the virtues of LSI systems, the microcomputer provides the designer with telecommunications equipment of unprecedented flexibility.

The first microcomputers, developed in 1971-1972, immediately found wide application in telecommunications equipment and systems, including teleinformatics. The range of applications extends from control of subscriber equipment and administration of message transmission in systems with information commutation to the control of local telephone offices and of large electronically automated telephone offices.

The rest of this article will be devoted exclusively to microcomputers used in teleinformatics equipment, systems and networks.

The Place of Microcomputers in Teleinformatics

Specialized processors are used more and more in modern networks for transmitting and processing digital information. In these systems the data transmitted undergo various types of transformation in passing from the source to the addressee. Computer points at which small specialized computers can be used to transform information are (Figure 3):

1) Data bank,

2) Arithmetic unit,

3) Data transmission equipment,

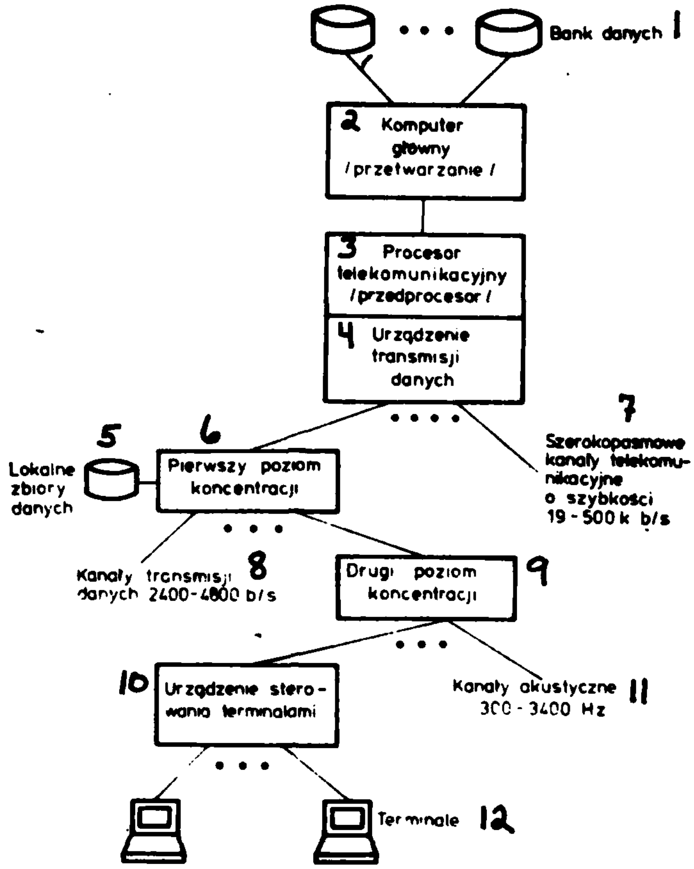

Figure 3. Structure of teleinformatics network with respect to places where specialized processors are used, mainly microcomputers. Key: 1-data bank, 2-main computer, (processing), 3-telecommunications processor (front-end processor), 4-data transmission equipment, 5-local data sets, 6-first concentration level, 7-wideband telecommunications channels with speed of 19-500 K b/s, 8-data transmission channels, 2400-4800 b/s, 9-second concentration level, 10-terminal control equipment, 11-acoustic channels, 300-3400 Hz, 12-terminals.

4) Wideband communication channels,

5) Concentrators of discrete channels of average transmission speed,

6) Concentrators of acoustic (telephone) channels,

7) Terminal control equipment,

8) Interactive terminals, and

9) Collection and preliminary data processing points, so-called intelligent terminals.

The information transformation functions, especially at points 3, 5 and 7, can be successfully performed by microcomputers. In general, these functions include: message commutation, initial transformation of information at input and transmission, control of terminals, time division (multiplication) of communication channels, restriction on channel band frequency and concentration of data flow.

The reduction in the cost of large scale integrated systems forms an additional economic basis for the use of microcomputers in establishing message commutation links on their basis. Their use is particularly expedient in cases where functionally simple processing of large sets of information occurs, for example, in controlling various kinds of terminals.

Speaking in general about the functions performed in the transformation of information in teleinformatics networks (e.g., message commutation), it is necessary to keep in mind the fact that they are associated with heavy losses in machine time and consequently require the use of a computer characterized by high functional capability and considerable speed. However, complex data processing processes can be subject to a great number of simple operations which microcomputers can perform with even a limited set of instructions. These include a specialized set of arithmetic and logic commands, flexible addressing with developed indexing systems, an effective interruption system, special commands for access to individual bits, and operations on them.

Moreover, the microcomputer architecture in teleinformatics applications should guarantee the effective performance of such functions as: rapid exchange of data between individual parts of the computer, the detection of errors in data transmission, the decoding of control signals in information processing, simple connection and operation of synchronization functions in cooperation with communication channels, operations on indexing registers, and direct access to the microprocessor memory.

Preliminary Data Processing and Concentration

The operations of preliminary information processing performed by microcomputers includes:

--The formation of blocks or the extraction of characters from blocks,

--The transformation of information from a serial form into a parallel form, and vice versa,

--Message formation,

--Increasing transmission reliability, and

--Transformation of codes and information compression.

The so-called intelligent interactive terminal of the American Applied Systems Corporation can serve as an example of realization of preliminary data processing on a microcomputer basis. They have used the INTEL 8080 microprocessor, equipped with a programmed operational memory, input-output systems, and a data transmission interface. In this system the microcomputer performs the following functions: formation of desired formats for data input, verification of an entire message, control of information exchange in the data transmission link (so-called communication protocol) and error detection. In addition it services equipment of a peripheral type: copiers, printers, screen monitors, and small tape and disc memories. This microcomputer can handle a maximum of 8 input-output and memory assemblies, and a data transmission link at a rate of 4800 b/s on standard or switched telephone lines.

Message Commutation

Information processing operations can also be successfully performed by means of microcomputers in message commutation centers; these include:

--Selection of message route in conformity with route selection indices,

--Determination of the route choice index on the basis of the message address,

--Organization of lines, and

--Control of correctness of the message format and a number of other operations.

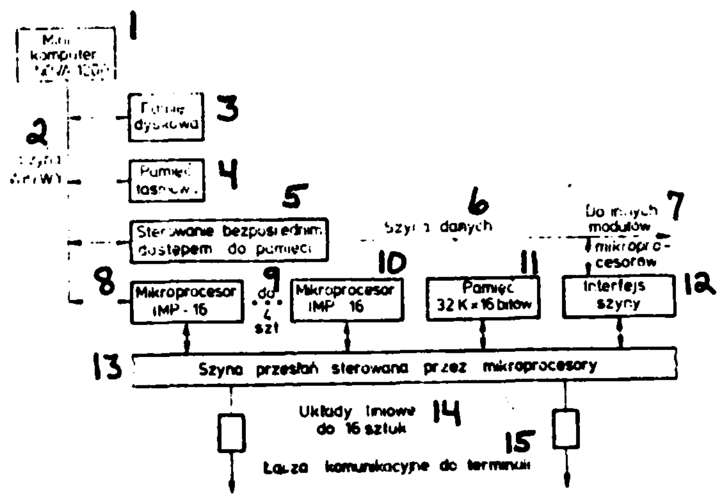

Figure 4. Microprocessors in a message commutation node. Key: 1-minicomputer NOVA 1200, 2-input-output track, 3-disc memory, 4-tape memory, 5-control of direct access to memory, 6-data track, 7- to other microprocessor modules, 8-microprocessor IMP-16, 9-to 4 devices, 10-microprocessor IMP-16, 11-memory 32 K x 16 bits, 12-track interface, 13-transmission track controlled by microprocessors, 14-line systems up to 16, 15-communication links to terminals.

Figure 4 presents an example of using microprocessors in a message commutation node. Here 4 microprocessors from the National Semiconductor Company are used, type IMP-16 with a semiconductor memory with a capacity of 32 K x 16-bit words. The role of the microprocessors is based on control of synchronous and asynchronous data transmission in 16 communication channels. Questions sent from the user terminals are transmitted in the original form to the node. Here the IMP-16 microprocessors exercise data control and conversion to the form required by the data bank programming administered by a NOVA 1200 minicomputer. Responses from the data bank are transformed in the microprocessor to the form required for the terminal to whose address they are to be transmitted, and are then transmitted in the link under IMP-16 control. Each microprocessor can handle a maximal transmission rate equal to 19.2 K bit/s in the following groups: 2 lines at 9600 bit/s, 4 lines at 4800 b/s or 1 line at 9600 bit/s and 2 lines at 4800 bit/s. The use of lines at a rate of 2400 bit/s makes it possible to form other combinations.

Modems

The use of large scale integrated digital systems in data transmission modems provides a number of tangible benefits,,and the same is true of microprocessors and microcomputers. In particular,the flexibility of the modem is increasing rapidly and radically, since all of its essential functions can be programmed, including modulation, spectrum formation and demodulation. Secondly, the size and costs of modems are dropping considerably, while all of the useful parameters are being kept at the same level as analogous modems. In addition,the use of universally available microprocessors makes it possible to increase the production of this equipment, necessary in every teleinformatics system.

Characteristic Features of Micropomputers in Teleinformatics Applications

The family of microcomputers including, for example, the IMP-16 and IMP-8 microprocessors, has been developed and is used most in teleinformatics systems. They belong to the so-called second generation of equipment of this type. The first generation includes relatively slow-responding microprocessors with a word length of 4 or 8 bits and simple architecture.

The basic functional elements of microcomputers used in teleinformatics are: (Figure 5):

--Command register,

--Microprogram memory,

--Central control apparatus used for interruption signals,

--Control tracks,

--State register,

--Intermediate result registers,

--Control apparatus which forms and checks control bits,

--Memory address register,

--Memory buffer register,

--Very rapid 16-word capacity memory,

--Arithmetic-logic and shift equipment,

--Equipment to control data exchange and data exchange tracks between functional blocks of the microcomputer,

--Buffer registers,

--Channels for an information exchange controlled by external equipment, and

--Tracks for data exchange between different processors in the system.

Usually microprocessors in teleinformatics applications contain 2 types of LSI systems with a MOS structure. The first of these, the so-called Control and depending on the kind of tasks to be solved. This essential property makes it possible for microcomputers of a definite type to perform various logic functions with great uniform efficiency. The second type of LSI systems, called Registers and Logic Unit (RALU),consists of arithmetic-logic equipment intended to interact with bytes and half-bytes. The use of these two types of LSI systems makes it possible to build microprocessors with a word length from 4 to 32 bytes.

The capacity of the IMP-16 microprocessor is 1.04 M bit/s. This number means the amount of information transmitted by the computer from the peripheral equipment of the network to other equipment,(e.g., systems memory) with modification of the addresses of the data transmitted. Understood in this way, the capacity of first generation microprocessors amounted to 75 K bit/s, while those of the second generation have an average of 840 K bit/s (e.g., INTEL 8080).

An increase in the efficiency of using microprocessors meets limitations associated with the number of functional elements found in one system. As their number rises, there is a drop in the efficiency of using the elements of the system when a microprocessor is used in different parts of the network.

A further increase in microprocessor speed is possible by improving the structure and performing such operations as parallel implementation of commands, streamlining the organization of data exchange bettween memory and peripheral equipment, etc. etc. An improvement in microprocessors will make it possible to increase their capacity to 3 M bit/s, making it possible for them to be used to control data transmission in wideband channels, and thus transmission at a very high rate.

Prospects

In examining the prospects for the development of microcomputer application in telecommunications in the next 10 years, two main aspects of this problem must be examined:

1) In the long run microcomputers will replace electronic and electromechanical equipment and control apparatus, and

2) To a greater and greater degree microcomputers will participate in expanding the use of informatics in daily life, contributing to rising demands for digital data transmission systems.

1 Lata	2 Długość słowa w bitach	3 Pojemność pamięci × 1024		4 Liczba obsługiwanych linii
		ROM*)	RAM**)	
1976—77	8	4	1	20
1977—78	16	4	1	20
1979—80	16	16	8	40
1981—82	16	32	32	40

Anticipated increase in microcomputer capability in one integrated system in tele-informatics applications. Key: 1-years, 2-word length in bits, 3-memory capacity x 1024, 4-number of lines serviced. *ROM (Read Only Memory), **RAM (Random Access Memory).

The use of microcomputer applications in telecommunications will be considerably greater than generally thought in view of the accelerated evolution of microprocessors in two directions:

1) Great increase in computing capabilities, and

2) Essential reduction in the total cost of microcomputer systems.

The time is near when an entire microcomputer (microprocessor with memory and input-output systems) is contained in one integrated system. It is anticipated that even before the end of the current decade, one such system will be able to control, for example, 40 data transmission lines.

Obviously, fulfilment of these predictions is based on the general development of microelectronic technology and elements, especially the newest ones, such as the D-MOS (Double Diffused MOS) and IIL (Integrated Injection Logic).

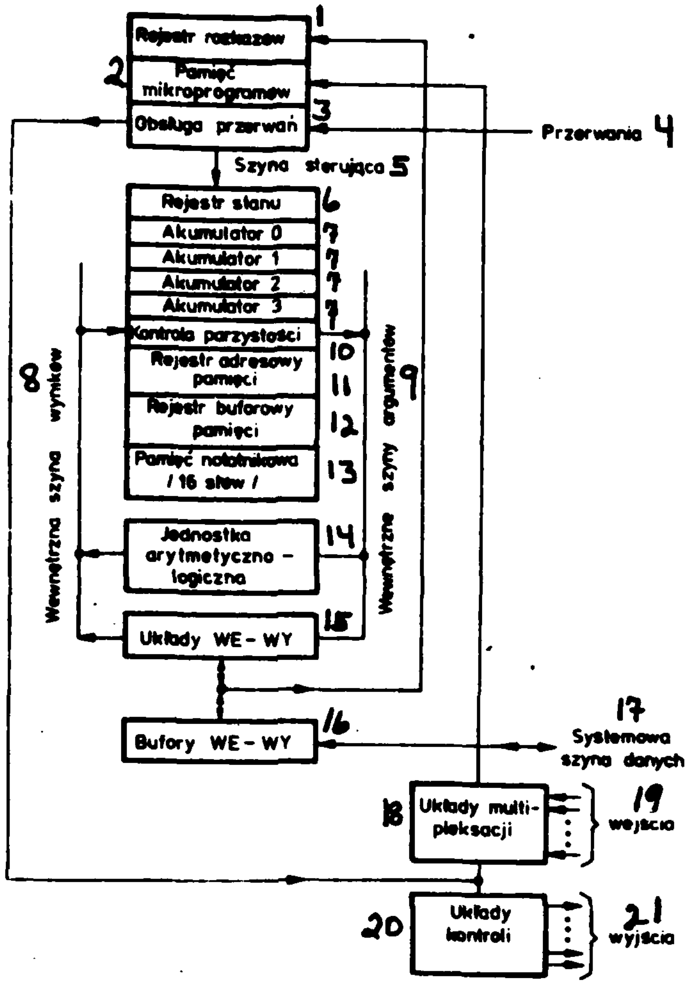

Figure 5. Functional structure of a typical microcomputer used in teleinformatics.
Key: 1-command register, 2-microprogram memory, 3-interruption provision, 4-interruptions, 5-control track, 6-state register, 7-accumulator, 8-internal result track, 9-internal argument track, 10-parity control, 11-memory address register, 12-memory buffer register, 13-notation memory (16 words), 14-arithmetic-logic unit, 15-input-output systems, 16-input-output buffers, 17-data systems track, 18-multiplexing systems, 19-input, 20-control systems, 21-output.

Read Only Memory (CROM), contains the microprogram memory and the systems to control this memory. In addition to the general assignment commands, special commands can also be written into the CROM systems, with their number and content (structure)

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