MICROPROCESSOR-BASED EXCHANGE CONTROLLER STRUCTURES

G. NÉMETH

Institute of Communication Electronics,
Technical University, H-1521 Budapest

Summary

Theoretical design problems of modern distributed digital microprocessor-based exchange controller structures are discussed. Analyzing the problems, it can be concluded that a controller with multiprocessor structure and queuing organization is desirable. After discussing the two extremes of the multiprocessor structures (dynamic and static task allocation) two experimental systems are described. One of these is a purely dynamic task allocation dual-bus organization (MULTIBUS is used as the system bus). The second experimental system is based on the joint application of the static and dynamic task allocation. The microprocessors and communication-oriented LSI circuits make this latter organization more desirable nowadays.

Introduction

One of the significant trends of the last decade is the integration of communications and computer techniques. This could basically be attributed to three factors: introduction of stored-program control, promotion of digital PCM switching techniques, and merging of speech and data transmission.

The progress is based mainly by advances in three areas: the advances of microprocessors, communication-oriented LSI ICs, and exchange architectures. As a result of these advances the application of distributed systems has become economical, the solution of the redundancy problems has changed significantly (the application of self-testing and mutual testing, the reconfiguration of the system in the case of a failure, and self-testing have come into prominence). It is important that the man-machine relationship has become user-oriented.

Organization principles

First of all, let us examine in what respects the control of the electronic digital exchange differs from the control structures of other fields. 1) High level of modularity is desirable in functions/services; 2) the effects of failures should remain as confined as possible; 3) the accomplishment of services is not strictly required. These characteristics raise the possibility of a control system with multiprocessor structure (1) and 2), and task queuing (3)).

We define the multiprocessor system as a structure, in which the independent tasks of the same system algorithm are concurrently executed. Theoretically any organization between two extremes may be chosen.

In the case of *dynamic task allocation* one processor provides all functions for a portion of the capacity of the exchange. Its advantage is that the failure of a processor affects only a portion of the exchange; its disadvantage is that the capacity of the processor restricts the realizable functions/services, and requires complicated software.

The other extreme of the architectures is the purely *static task allocation*. In this case a processor provides a certain function for the whole exchange. Its advantage is minimal interaction between the tasks of the processors, thus the software is more simple. Its disadvantage is that the workload of the processors may differ significantly.

Experimental system

A relatively simple dual-bus highly modular multiprocessor system was developed as a typical example of the dynamic task allocation (Fig. 1).

The modules communicate with each other through the system bus. For the normal mode of data and control communication the mail-box principle was selected. The loading and extraction of data is organized by testing and setting of suitable semaphores. It is indifferent for the module receiving the data which module has filled the mail-box. Similarly, for the module sending the data it is indifferent which module will receive it. This is a significant advantage with respect to software and redundancy. A further advantage of the system is that during MULTIBUS operations all master modules other from the one just communicating with the MULTIBUS may operate with their private resources. The disadvantages are: the MULTIBUS is the bottleneck of the system; the capacity of the system is reduced as compared to the point-to-point communication.

The tasks may exchange not only data, but control information as well. To increase the flexibility of the system a separate programmed interrupt bus has been developed (Fig. 2).

The interrupts of each master module are determined by the status of the interrupt bus according to the interrupt interpretation of the corresponding modules. The interpretation of the interrupts may be arbitrarily altered any time by modifying the contents of the IT RAMs of the master modules. This

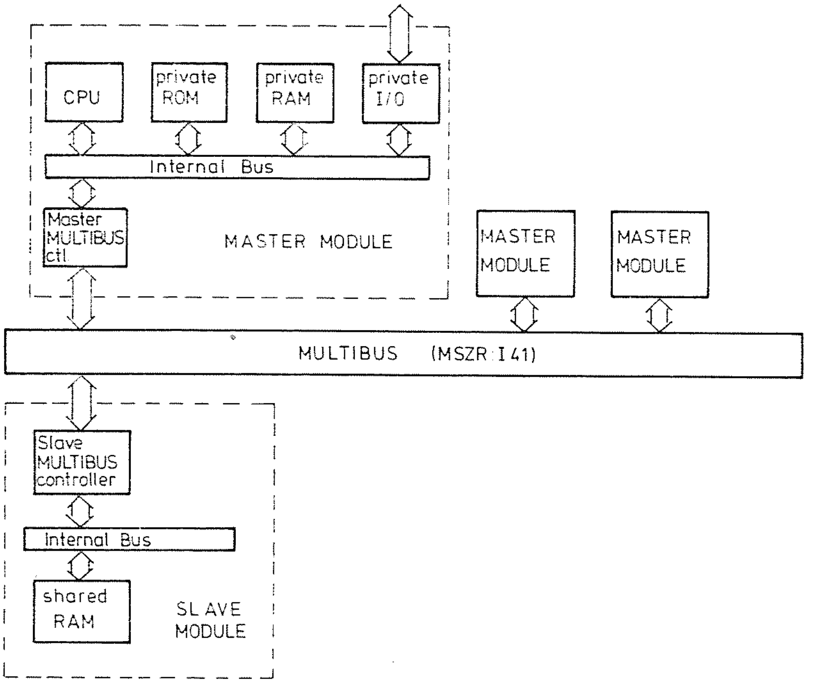


Fig. 1. Dual-bus multiprocessor system

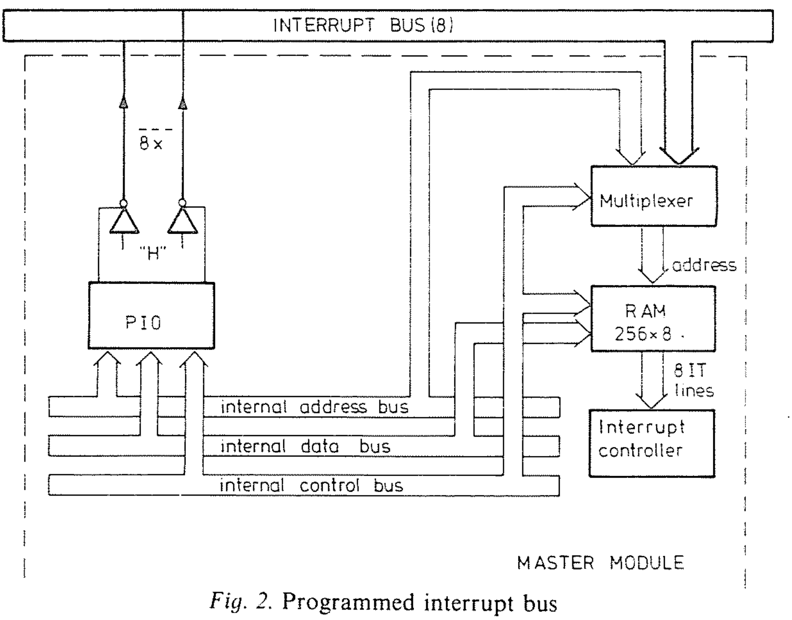


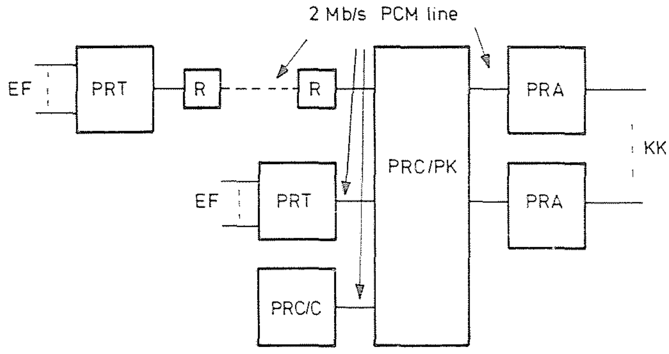
Fig. 2. Programmed interrupt bus

method makes the modification of the configuration of the system significantly easier, and makes it consistently modular as well.

Our experimental system may contain up to 8 Master Modules, up to 8 software priority levels on each Master Module, and up to 8 tasks may be queued on each software priority levels [1].

The rapid increase of the capabilities of the microprocessors, and decrease of their prices make the static task allocation nowadays preferable. By its usage, the principle of digital system design, according to which the algorithm for the solution of a problem must be concentrated upon, may be utilized fully, and the tasks of the algorithm can be implemented either in hardware, software, or with a suitable combination of both.

The significant decrease in prices of the microprocessors and of their support circuits nowadays make the distribution of call processing and maintenance functions economical and desirable with respect to operation and installation, even for exchanges of very small capacities. The spreading of single-channel PCM codecs and other communication-oriented LSI circuits make the introduction of PCM transmission principles possible, down to the level of the subscribers [2]. Thus the distribution of the exchanges into smaller cooperating units, and the installation of these units as near to the subscribers as possible has become feasible. This is extremely advantageous with respect to cableing and floor space requirement. Such a distributed architecture digital exchange is shown in Fig. 3 [3].



EF = Subscriber line
PRT = Remote Terminal (up to 500 subscriber lines)
R = Repeater
PRC/PK = PCM (TST) switching circuit
PRC/C = Central controller
PRA = Network adapter
KK = Trunks

Fig. 3. Structure of the PRS (*PCM Rural System*) exchange

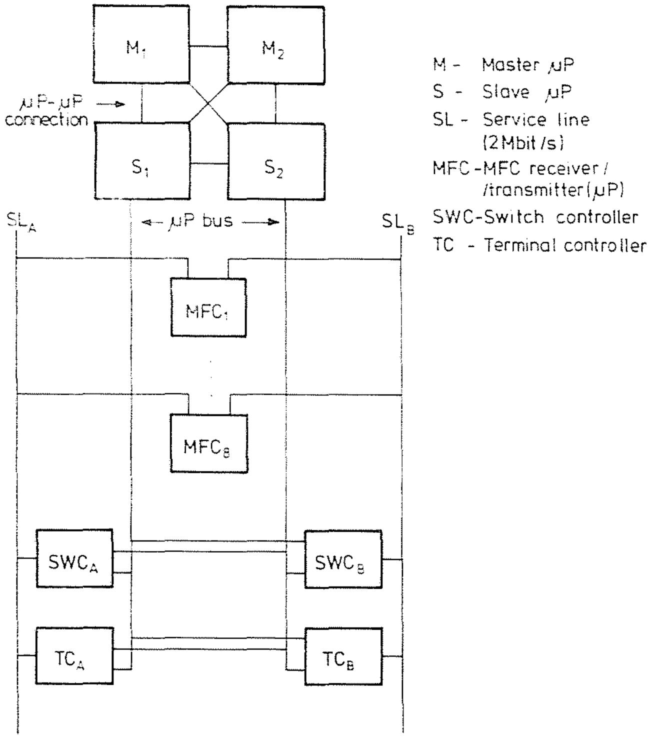


Fig. 4. Structure of PRC/C

The terminal unit PRT preprocesses the subscriber lines. To increase its availability, its common functional units, thus also the microcomputer controlling it, are duplicated. Every functional unit is separately duplicated, thus the system is flexibly reconfigurable, and has no critical parts.

The central controller of the system is the PRC unit. It communicates with the units PRT and PRA through 2 Mb/s PCM lines (duplicated towards the PRTs). The switching stage PRC/PK performs time-space-time switching on the 2 Mb/s lines.

The control of the switching stage, and the majority of the call processing functions are performed by the control unit PRC/C [4]. It should be noted that a part of the interprocessor communication is made through the switched 2 Mb/s lines.

The control unit PRC/C is an interesting example of the joint use of the static and dynamic task allocation. Its (simplified) structure is shown in Fig. 4.

The global functions of control are performed by the active MASTER processor (the other MASTER performs self-testing and mutual testing). The peripheries are controlled by the active SLAVE processor.

The signalling with the conventional exchanges is performed by microprocessor controlled MFC receivers and transmitters. The number of active MFCs depends upon the current traffic conditions.

Such a structure of the system provides high reliability, and flexible reconfigurability in case of failures.

Conclusions

The development of microprocessors and communication-oriented LSI circuits make the economical realization of small capacity, distributed exchanges possible. The application of multiprocessor systems could improve the services provided and the availability of the system as well. The experiences gained with the two systems described have proven this unambiguously. At the current technology level joint application of static and dynamic task allocation seems to be desirable.

References

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Dr. Gábor NÉMETH 1521 Budapest