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ABSTRACT

Minicomputer networking can be an alternative solution to the problem of implementing various computer systems in universities. In its simplest case, networking takes the form of multiple small computers communicating over telephone lines to a larger host minicomputer which in turn communicates with the central mainframe. Using computers in this manner allows the small user to share the centralized peripherals on host minicomputers and to access the computational power of the central mainframe. (CH)

21st Annual College and University Machine Records Conference

"Networking—A Solution to the Campus Minicomputer Problem"

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Networking - A Solution to the Campus Minicomputer Problem

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In a university environment rarely a month passes in which no new minicomputer is proposed for some application. There is an evolving substitute or supplement for this diverse base of small-to-medium sized computers - networking. In its simplest case, networking takes the form of multiple small computers communicating over telephone lines to a larger host minicomputer which is in turn communicating with the central mainframe (see Figure 1). Using computers in this manner allows the small computer user to share the centralized peripherals on the larger or host minicomputers and to access the tremendous computational power of the central mainframe.

One basis for understanding networking is an examination of the history of the industry and the events that are forcing a re-appraisal of policies concerning minicomputers.

The minicomputer industry has shown phenominal growth from its starting point in the early 1960s. The first machine was not researched, built, and marketed but resulted as a quotation in response to a customer's request for a special machine to perform a process control function. The machine was built from then available logic modules and purchased memories. This machine was programmed in full binary via its front panel switches. This was a very humble beginning for an industry that was to make such tremendous contributions to computing in the next fifteen years. Even though this machine by today's standards was extremely slow and cumbersome and lacked software, its fabricators (not designers) realized that embodied in it was tremendous future potential. When they revised the design, wrote an assembler for it, and started to market it they soon found out that their growth predictions were correct. Shortly thereafter, orders were coming in so fast that economies of scale allowed prices to start to fall. Further development of new hardware and software made the machinery applicable to an ever increasing market.

This viscous circle effect is still seen in the current minicomputer industry. However today the trend is toward much larger systems because (1) the individual parts of the system are less expensive and (2) the cost of programmers has risen in real terms and as a percentage of the hardware cost which makes it much less expensive to buy another hardware device if it will save programming time.

Even though the minicomputer industry is currently operating with an extremely elastic demand curve, the overall economies to the university or college have been reversed. Today, the university can employ networking as a very cost effective computing tool. Current pricing reveals the advantages of concentrating peripheral requirements into one larger unit - one eighty-eight million byte disc unit costs around $40,000 and the equivalent capacity in the small 2.5 million byte disc units costs $436,000. This leads to the contention that some consolidation and sharing should take place.

Several vendors support a medium sized host system which is capable of handling all communications with the small satellite systems. The host will also handle most peripheral requests from the satellites. In the satellite processors program, I/O requests are coded as calls to the satellite's operating system which intercepts them and sends the request along with the associated data to the host processor. For instance, if the satellite has acquired a buffer full of data from an experiment, it merely sends it to the host processor which stores it on its disc.

Further processing is accomplished by the satellite's invoking a program in the host processor to analyze his data if this is appropriate. However, if the user chooses, he may execute a program on the host processor which will format his data as a batch job to the central mainframe, add any appropriate job control language, and submit it for further processing by means of an RJE emulator. This flexibility allows the user to choose the appropriate computing power to match the amount of analysis that he plans to do.

Satellite processors do not need to have peripherals such as disc, mag tape, and line printers (but may have). They use the facilities of the host minicomputer for this type of operation. The limitation of no disc on these small satellites does not limit their software generating capabilities. Any satellite can call for system software from the host minicomputer to be sent down for execution in the satellite processor. Thus a user can call in an editor package from the host and build a program in any supported high-level language storing the source file on the host's disc. Subsequent compilation takes place on the host with the object or binary file sent back or downline loaded into the satellite where it is executed. Truely, it is the lack of peripherals that gives networking cost advantages as well as its superior flexibility. Using networking the user can gain greater computer power than he probably could have afforded by himself.

Many of the advantages of networking are quantifiable. They basically fall into four categories: (1) cost, (2) convenience, (3) performance, and (4) flexibility.

Although the initial start up costs of a network are somewhat higher than installing a single medium-sized minicomputer it soon becomes cost jusitified. After the initial system is installed it becomes very inexpensive to install a satellite in a research lab, admissions office, or any other facility. Of course the satellite price will vary depending upon the hardware it requires to acquire its data and whether or not it requires an intermediate storage device such as magnetic cassettes or floppy discs, but it usually is very inexpensive; usually between sixteen and twenty five thousand dollars. Satellites gain full large system capabilities for their purchase price which is approximately one third the price of their equivalent large system. When the cost of the host processor is split among several satellites it becomes a very feasible expenditure.

Further cost advantages accrue due to the minimization of lost time in the user's supporting an operating system. Programming goes much faster as the user relies on the host system with its advanced capabilities for programming aids. He may also elect just to write a program to collect and format his data and pass it to an existing program on the mainframe for analysis. Under networking the user with an inexpensive satellite minicomputer is free to direct his total efforts toward getting his application running and not spend substantial time and effort supporting the system software.

Minicomputer networking is very convenient for the user. At start up time for his application he need not go through extensive research on all available systems but merely order a fairly small minicomputer system with the associated communication equipment. This item is inexpensive enough to be stocked at the university in a small quantity. Lead time on acquisition could be minimized on the basic processor and terminal so program development could start almost immediately. Each application would require some special hardware to perform its job. This hardware (A/D, D/A, DIO, MULTIPLEXOR AND TERMINALS) could easily be installed in the field after the satellite is running. Even if immediate delivery of the satellite is impossible, application programming could begin using a terminal connected to the host minicomputer system.

Another convenience to the user is his not having to involve himself with system software or operator functions. Only the central host staff need install patches to the operating system, dump discs to magnetic tape, or control their humidity and temperature. This, of course, frees the user of these tasks and allows him to devote full concentration to his application.

A centralized support staff could help the individual with technical aid in the application programming and not have to wait for or rely on vendor support. Again, this becomes very convenient for the user.

The satellite can also call in a package from the host system which will simply allow the user to build a file and send it to the mainframe for execution thus allowing him to use his system as a conversational remote job entry terminal. Besides being easy and convenient for the user, this can reduce the number of ports required on the mainframe.

In certain cases networking can offer the user significant performance advantages. Data acquisition applications can usually acquire data faster due to the fact that the satellite processor's operating system is a core-only version inflicting less overhead into his operations. Certain minicomputers can incur fifty percent operating system overhead when operating in a disc environment. It is important to remember, however, that without peripherals the communication line to the host substitutes for the I/O lines to the peripherals and this presents some speed limitations. These limitations can be removed by adding a small mass storage device to the satellite for intermediate spooling of data. For this purpose a dual "floppy" disc drive can be purchased for around four thousand dollars. After this limitation is resolved the performance of the system is much better than multiple stand alone processors. This is attributable to: (1) more CPU power directed toward data acquisition, (2) a larger processor performing the data communication functions and, (3) the mainframe with superior processing power and a vast amount of existing software is employed to perform the extensive data manipulation. Restated, networking uses the core-only minicomputer, the larger host minicomputer, and the mainframe for the purpose which they were intended.

Another main advantage to the user is flexibility which can take several different forms. Application programs can be written that will collect the data and use either of the larger systems for further analysis. This flexibility allows the user to choose the system with the best hardware/software combination to solve his particular problem.

The central staff could provide flexibility by programming the satellite processor for the user at a cost to him but the user would circumvent having to either learn programming or hiring a programmer. This, coupled with a much lower hardware cost, would free up his funds and time to purchase other equipment or perform other functions.

The case for networking is very strong but the problem areas must be addressed before deciding to follow the networking approach to minicomputers.

On practically every university or college campus there already exists a rather large and diverse base of minicomputers. The diverseness implies that several different vendors' computers are already installed. Problems arise when one vendor's satellite is used with another vendor's host. Operating systems are not compatible but they can be made to work together by two different methods. The first method is by using a device originally used by the European atomic energy computer users society. The device, called the CAMAC system, has been approved and adopted by the United States Atomic Energy Commission. It is basically a universal computer I/O bus and the user supplies his own computers for each end of the circuit. This approach is a workable solution but can become very expensive as it forces the central staff into developing hardware and each computer's operating system software must be modified. More information may be acquired by ordering United States Atomic Energy Commission booklets number TID-25875 and TID-26488 from the Superintendent of Public Documents, Washington, D.C.

The other alternative is for the satellite to communicate with the host processor by means of a standard Teletype port on each processor, a voice grade communication line and two acoustic couplers. Since each processor can have a multiplexor to control these ports, the operating system does not need to be altered. When the satellite wants to send a message or data to the host, it merely formats the message and/or data and outputs it in ASCII code to the port that is connected to the host. Functioning in this mode the satellite processor would look like an extremely inetlligent terminal to the host minicomputer. This approach is probably best as it is simple, and inexpensive.

The second problem with networking is that it seems to dictate that one vendor be selected and all subsequent minicomputers be purchased from that vendor. Even though this would be fairly attractive from a quantity discount standpoint, this is not the case. A different vendor's minicomputer could be acquired and brought into the network just as the original non-standard minicomputers were brought in. The vendor of the host system would, however, have a competitive advantage for future satellite minicomputers.

The third most important problem area is handling the campus politics. This has different ramifications for different environments and must be dealt with accordingly. The point which must be made here is that these problems must be addressed and resolved before networking can be effective. Included in these problems are:

1. who will purchase and control the host?
2. where will the initial money come from?
3. how are the users to be charged?
4. does anyone feel that this approach intrudes upon his right to purchase and operate the machine of his choice?

Convincing the user community that this is the best approach could be the most difficult part of implementing a minicomputer network.

The ever increasing population of minicomputers is forcing a re-appraisal of implementation policies. The tendency today is for these policies to be determined by higher officials in the university structure because of the ever increasing amount of money involved. It is time to step back from the individual user and take a campus wide look at minicomputing. From this vantage point, networking makes a lot of sense and should be considered. This is not to infer that all universities should implement a network but it is an emerging substitute or supplement.

POSSIBLE MINICOMPUTER NETWORK

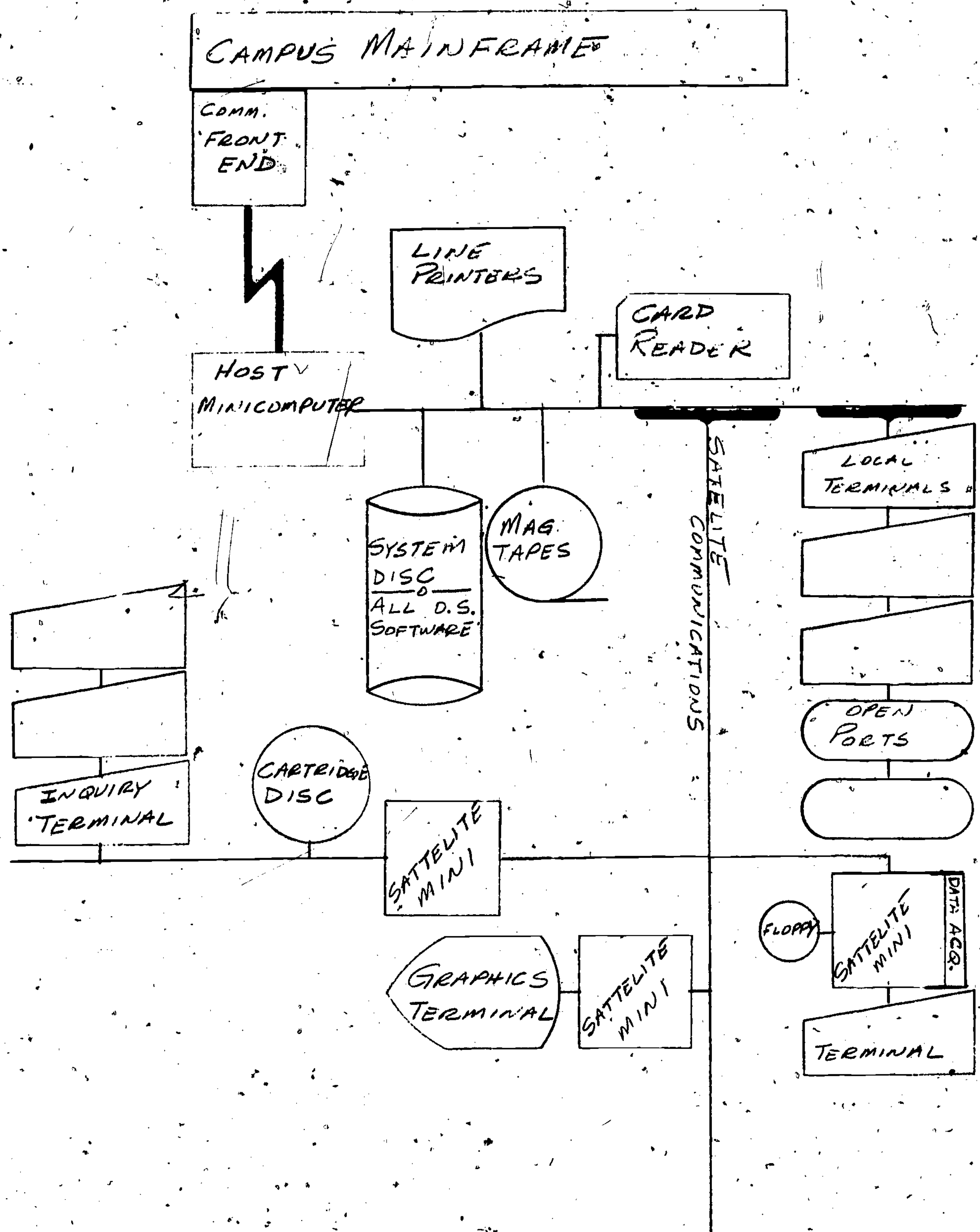

Figure 1

POSSIBLE SATELLITE INTERCONNECTIONS

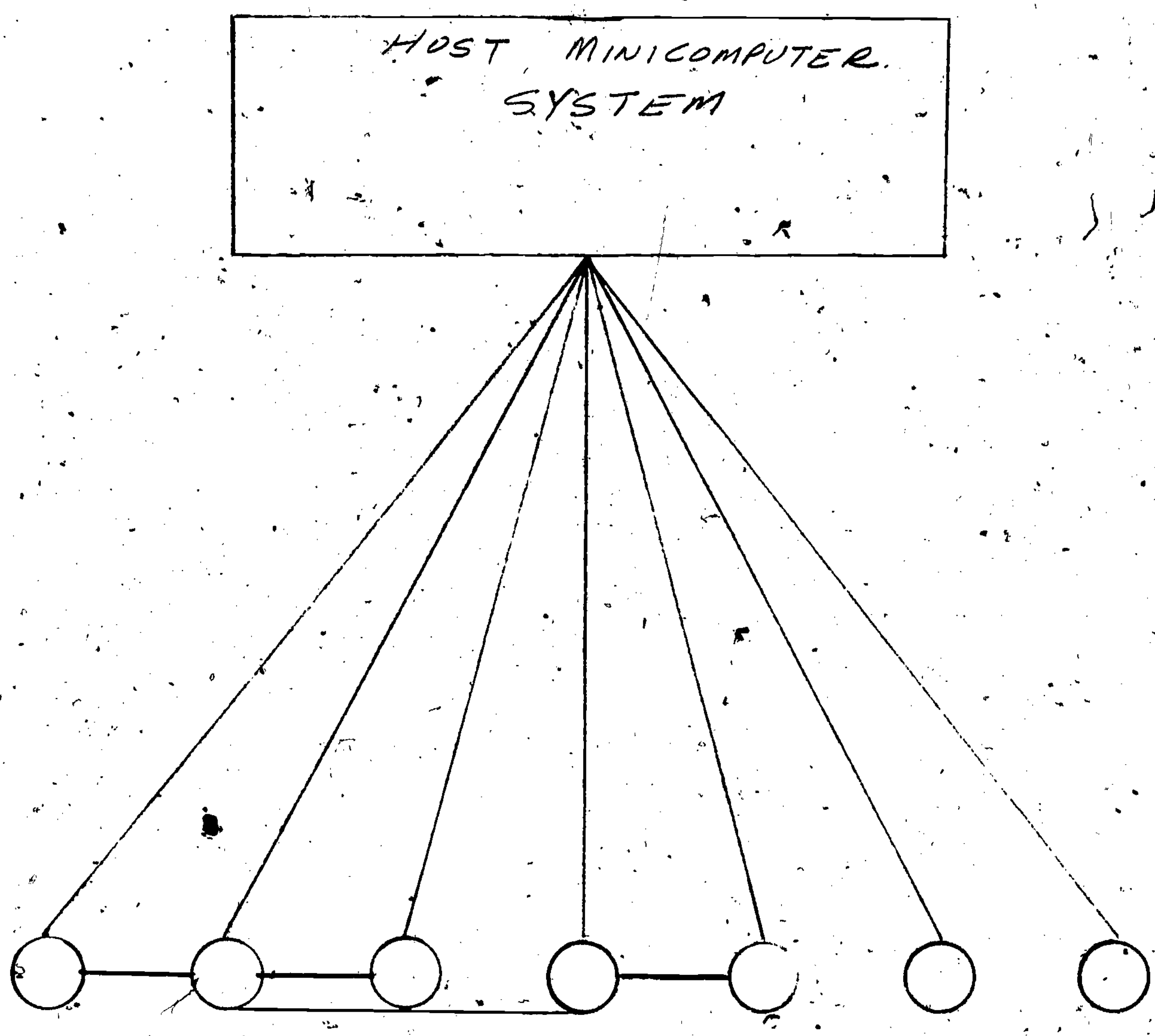

Figure 2

POSSIBLE MINICOMPUTER NETWORK

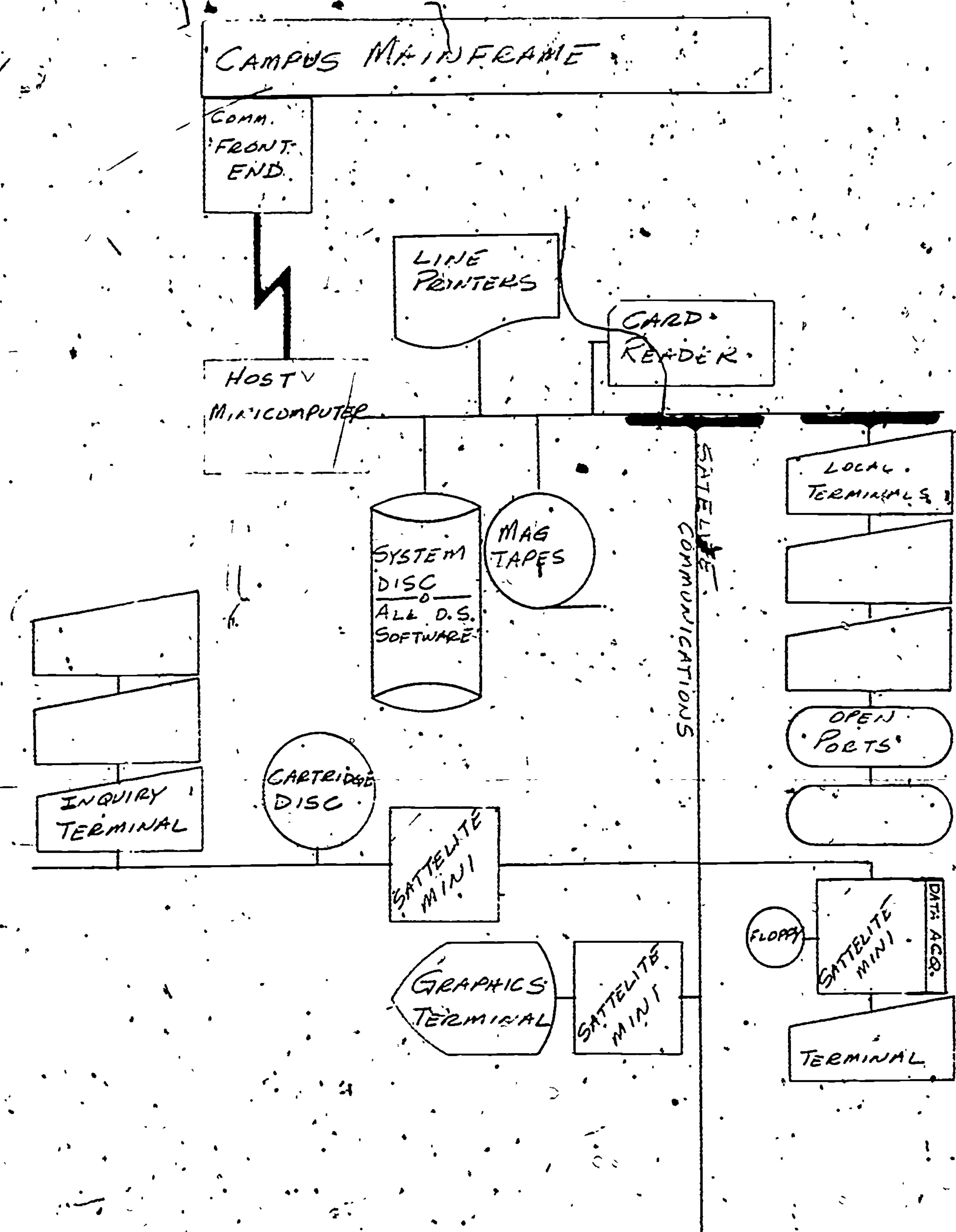

Figure. 1

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POSSIBLE SATELLITE INTERCONNECTIONS

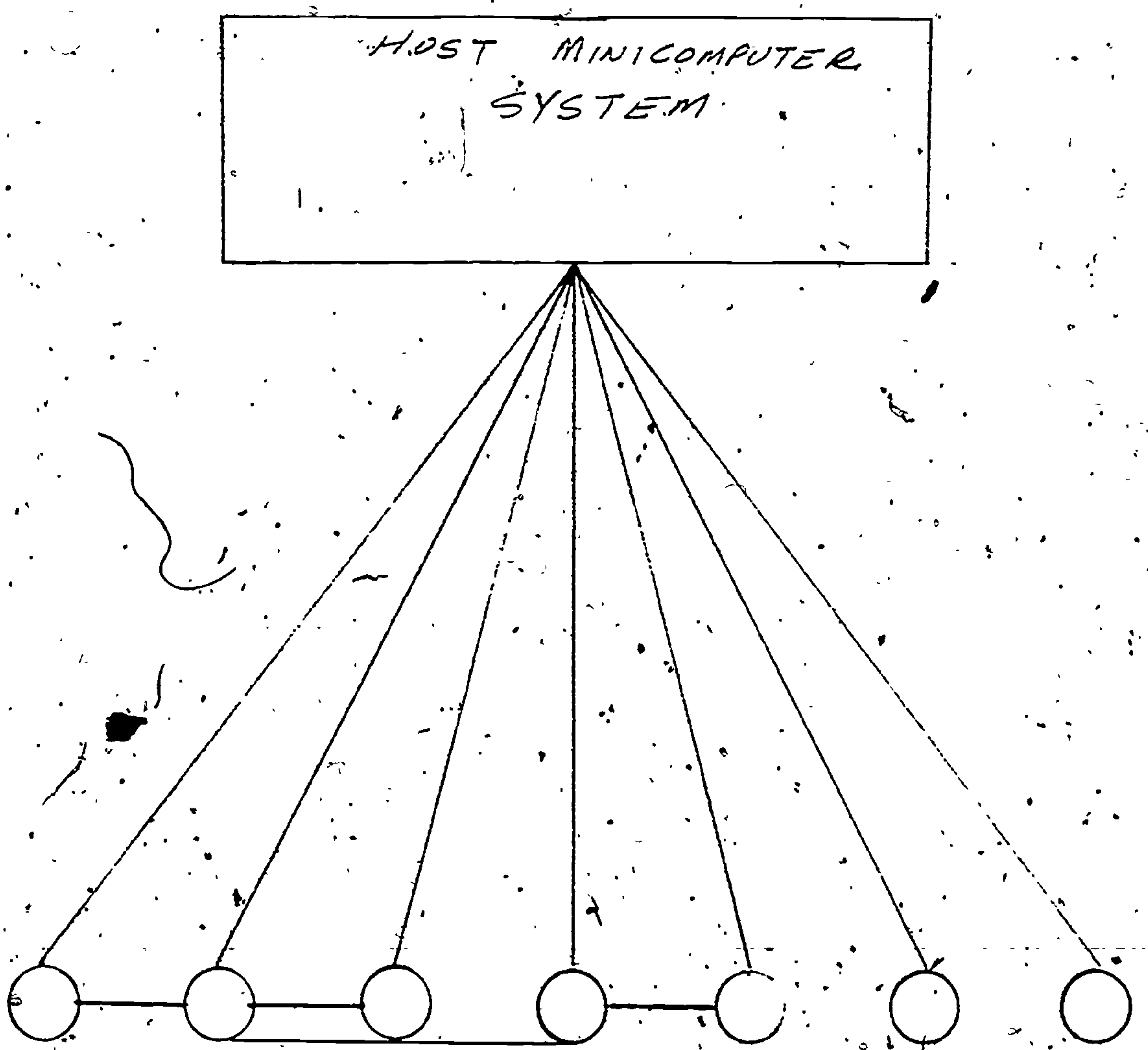

Figure 2