M.I.T. LABORATORY FOR COMPUTER SCIENCE
Computer Systems Research Division

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LOCAL NETWORK: Research Proposal Submitted to ARPA
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Attached is the section on the Local Net development from the proposal that the Laboratory is submitting to ARPA for the 1978 calendar year.

10. COMPUTATIONAL RESOURCES - LOCAL NETWORK

10.1 Introduction

The Laboratory for Computer Science is currently constructing a local network to tie together the various machines installed or planned within the laboratory. The purpose of this network is to better share our resources and to act as an experimental test bed for our distributed systems research. Our vision of this network encompasses not only a hardware mechanism for interconnection, but a compatible set of protocols integrated into the various machines to allow easy communication at a high level. The network has been designed from the beginning so that it can serve as a component of a larger interconnection of subnets that can span all of the M.I.T. campus, and that can provide interconnections between local machines and geographically longer networks such as the ARPANET.

10.2 Uniqueness of Our Approach

While development of local network hardware is currently going on at several research sites, our development work appears to be unique, in that it encompasses not only hardware development, but protocol development and integration of the network into a variety of existing operating systems. As such, it constitutes a total package whose utility is greater than that of network hardware alone. In fact, our particular project is only loosely coupled to the data transmission technique being used for the initial implementation; if a new strategy for transmission is developed that is more desirable than those that we are initially exploring, we believe that it will be easy to convert our network to such a new direction.

10.3 Relevance to the Department of Defense

The advent of low cost computers is rapidly increasing the number of sites that provide their computing services through a number of small computers rather than one large central machine. While the need to interconnect these machines is sometimes discovered after the fact, the need is real, and is easily discovered in all aspects of the military, as well as in commercial installations. While low-level mechanisms can be constructed for this purpose on an ad hoc basis, the project here draws on the ARPANET protocol development to provide a level of coherence not previously available. Interest in this network has been expressed by a number of groups, including the Naval Underwater Systems Laboratory, the Air Force Academy, and ERDA.

10.4 Accomplishments During 1977

By the end of the 1977 calendar year, we anticipate that the initial component of this local network will be fully operational, with perhaps eight hosts, including several PDP 10s, one PDP/11 running UNIX, the ARPANET gateway, some terminal equipment, and other I/O gear. The work we propose to do during the 1978 calendar year will increase the overall utility of the network, and will make the network a product more easily and directly exportable to other sites interested in taking advantage of our local networking experience.

10.5 Proposed Work

During calendar year 1978, we propose to do a variety of projects in the area of protocol development. First, we will continue to coordinate the interconnection of additional computer systems to our network. The most important operating system that we expect to add to our network during 1978 is TENEX. Second, we will continue our efforts to reintegrate the low level

protocol being used on our network, Data Stream Protocol or DSP, with its close relative Transmission Control Program or TCP, now being used for experiments in internetworking in the ARPANET. We view the eventual recombination of these two protocols as important to the overall utility of our network. Third, we will address certain protocol issues left unanswered by the current implementation of DSP or TCP, e.g. how two networks with different communication speeds can be connected together, without the high speed network totally clogging the gateway between the two. For example, when our local network is connected to the ARPANET, messages can arrive from the local net to the ARPANET almost a hundred times faster than they can depart. Since the gateway is an intermediate rather than an end point in the transmission, it does not have direct access to the fields in the TCP headers that can be used to cause the sender to slow down. Thus, the currently defined protocols provide no mechanism for the gateway to cope with an overload other than by discarding packets, which, while acceptable, is very inefficient. Another protocol problem that seems most pressing is the issue of generalized routing and addressing in a large interconnected collection of networks. The currently defined TCP header does not seem rich enough to cope with the full range of problems that we foresee arising in practice, but it is not now clear what alternative would be most appropriate.

As we have already stated, one of the purposes of this local network is to provide a testbed for practical experimentation with ideas related to our longer-range research in distributed systems. A project of this sort that is of great utility to the operation of the newtwork is the development of a uniform protocol for naming of services and facilities in a distributed system. Examples of services that might be named using this mechanism are the delivery of a message to a specified mailbox, the updating of a file, or the

remote login to a system. The mechanism uses decentralized active agents to provide an environment that is robust in the face of system failures. The names used are tree structures in order to deal in the natural way with name conflicts and to allow the easy definition of new services in a given context.

In the hardware area, the most important project for 1978 is the continued comparison of the RINGNET and the ETHERNET. We are currently exploring the possibility that a hybrid of the two can be constructed that will provide the good features of both. Another project that is important to the eventual success of our network is the development of a useful and inexpensive packaging for the Local Network Interface (LNI). We are currently investigating the possibility of producing an LSI version of the LNI as part of this repackaging. While it is not clear how much effort on our part will be required in order to achieve this repackaging, we are prepared to undertake the task as necessary.

In 1978 we also plan to complete the development of a terminal controller for the network. By the end of 1977 we expect to have an operational microprocessor connected to the network, complete with preliminary software for the support of an attached computer terminal. Additional work during 1978 will be required to generalize the microprocessor hardware and software to make this controller fully functional.

A hardware project that may increase the speed of the network is the use of fiber optics as the transmission medium. It appears that the use of fiber optics over 1 km distances at speeds of 20 to 40 million bits per second is a realistic possibility. The current LNI should be able to operate at this speed with minor modifications, so that a minimal hardware redesign is required for this alternative. The speeds achievable, which represent perhaps a factor of ten over those we currently propose to run, may soon be needed if

some of the applications currently being considered for the network are implemented. Since the philosophy under which we have designed our local network is that bandwidth is inexpensive, this project seems a logical extension of the work already done, and seems directly relevant to the goal of discovering and developing new applications well suited to the local network environment.

The combination of the several hardware and protocal projects described above is expected to produce a significant result on the advancement of our network. In particular, they should combine to transform the network from a working prototype to a well-developed package that demonstrates the capabilities of a local network in a directly exportable form.