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545 TECHNOLOGY SQUARE INTERNET STATUS

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Substantial parts of both the hardware and the software of the internet configuration at 545 Technology Square are now operational. The current status of the various components is described on the following pages, in eight sections:

- I. Recent milestones
- II. Host protocol software status
- III. Gateway software status
- IV. Forwarding node hardware status
- V. Internet connectivity and forwarding node arrangement
- VI. Example of internet communication
- VII. Host attachments
- VIII. Nomenclature of network components

Figure one, to be found on page ten, illustrates the overall arrangement of networks with 545 Technology Square. Figure two illustrates a typical example of the way in which the various software and hardware components listed here interconnect. Although this report is primarily of L.C.S. facilities, the A.I. Laboratory CHAOSNET interconnect status is also included wherever it is useful.

In order to facilitate discussion, each subnetwork and packet forwarding node is assigned a name. (Note that a forwarding node is a piece of hardware, while a gateway is a piece of software.)

This summary of status is, by itself, not a complete description of the internet plan. The reader who is unfamiliar with the overall internetwork plan whose status is reported here will find the overview description of Network Implementation Notes 8 and 9, by David Clark, to be a useful prerequisite. For the most part, those notes still accurately describe the general software and hardware strategy being used. Some minor changes will be apparent from the status summary.

I. Recent Milestones

1. The version two (10 megabit/sec.) ring network was brought up between two PDP-11 computers, transferring continuous test packets for several days. A second test with six repeaters was also passed. These benchmarks provide some much-needed confidence in the design and implementation.
2. The TOPS-20 machine (MIT-XX) implementation of internet forwarding code came into service, allowing that host to operate as a temporary, low-bandwidth internet gateway between the ARPANET and the 545 Technology Square local networks.
3. Internet-based Trivial File Transfer Protocol implementation for most machines used by LCS (CSR- and RTS-UNIX, TOPS-20/XX, MIT- and Dev- Multics, VAX/VMS, and the Altos) have been placed in service, allowing casual file transfer among any of these nodes.
4. Internet/TCP-based remote login (TELNET) protocol implementations have been checked out for all the same machines with the exception of the Alto and VAX/VMS. These implementations make remote terminal access via the local networks, rather than via telephone lines or hardwired connections, feasible.
5. Forwarding node Magellan, which provides a gateway among the Ethernet, the ringnet, and the CHAOSNET was upgraded to provide high-availability service. An apparent hardware problem with the Xerox-provided Ethernet interface was programmed around, the machine itself was moved out of an experimental laboratory into a stabler environment, and maintenance features such as echo service were added to software. The result is that it has run as long as nine days between failures. An automatic rebooting system is in preparation; when installed it should provide an extra margin against failure.

II. Host protocol software status

A. Link level protocols (network drivers)

Protocol	Host operating system	Status
V.1 ring	UNIX, TOPS-20, MOS, VMS	in operation
V.2 ring	MOS	in test
	TRIX, UNIX	adaptable from V.1 version (CSR)
	VMS	planned
	TOPS-20	adaptable from MOS version
CHAOSNET	UNIX, TOPS-20, ITS, LISPM, VMS, MOS	in operation
	Multics	planned
ARPANET	Multics, TOPS-20, ITS, MOS	in operation
Ethernet	MOS, Alto, AI-11	in operation

B. Lower-level protocols

Protocol	Underlying Protocol	Host operating system	Status
Network Control Protocol (NCP)	ARPANET	ITS, TOPS-20, Multics	in operation
PARC Universal Packet (PUP)	CHAOSNET	LISPM	in operation
	Ethernet	Alto	in operation
Internet (IP)	ARPANET	TOPS-20, Multics	in operation
	Ethernet	Alto (BCPL)	in operation
		Alto (MESA)	in implementation
	CHAOSNET	UNIX	planned
	V.1 ring	UNIX	partial implementation in operation
	V.2 ring	TRIX	being adapted from UNIX (CSR)

Protocol	Underlying Protocol	Host operating system	Status
User Datagram Protocol (UDP)	IP	TOPS-20, Multics, Alto(BCPL)	in operation
		TRIX	being adapted from UNIX (CSR)
		Alto(MESA) ITS, LISPM, VAX	in implementation (CSR) not planned
Transmission Control Protocol (TCP)	IP	UNIX, TOPS-20, Multics, Alto	in operation
		VMS, LISPM, IPS	not planned
		TRIX	being adapted from UNIX (CSR)
		MOS	in operation

C. Basic services

File Transfer Protocol (FTP) Server and user	NCP	ITS, TOPS-20, Multics	in operation
Elementary File Transfer Protocol (EFTP) user	PUP	LISPM, Alto	in operation
EFTP Server	PUP	Alto	in operation
Trivial File Transfer Protocol (TFTP) Server and user	UDP	UNIX, TOPS-20, Multics, Alto(BCPL)	in operation
		PDP-11 Bootload system	in implementation
		ITS, LISPM, VAX	not planned
		TRIX	being adapted from UNIX (CSR)
	V.1 ring	VMS	old version with UDP/IP built-in usable for limited applications
Simple File Access Protocol (SFAP)	UDP	Alto	in debug
		UNIX	in implementation
		TRIX	planned

D. Higher-level services

Service	Underlying Protocol	Operating System	Status
Mail receipt	FTP/NCP	Multics, TOPS-20, ITS	in operation
	TFTP	Multics	being coded (CSR)
		UNIX	in operation
		VMS	(?) (RTS)
		TOPS-20, ITS	not planned
	FTP/TCP	Multics	being coded (CSR)
Mail forwarding	to FTP/NCP	Multics, ITS	in operation
	to TFTP	Multics	interim version being coded (CSR)
	n-way	Multics	being coded (CSR)
	Laurel/PUP	Alto	not in use; no plan to integrate with other services
	to CHAOS mail	ITS, TOPS-20	in operation
Remote login	Telnet/NCP	Multics, TOPS-20, ITS	in operation
	Telnet/TCP	Multics	in operation
		UNIX	in operation, but not installed everywhere
		VMS	(?) (RTS)
	TOPS-20	in experimental use	
	ITS	not planned	
Terminet printer	mail	TOPS-20	in operation
	TFTP	UNIX	ready (CSR)
Dover printer	EFTP	Alto	in operation
Dover queuer	TFTP	Alto	in operation (CSR) on dedicated Alto
Remote file store	PUP	Alto	in operation
	IP	(?)	needed, not yet planned
	2-phase Commit/IP	Alto	Research Project (Reed) (CSR)

Higher-level services (continued)

Service	Protocol Used	Operating System	Status
Authentication	Verify/IP	(temporary) TOPS-20	Research Project (Reed) (CSR)
Name resolution	PUP	Alto	in operation
	IP	Multics	in operation
		Alto	being coded
Time of day	PUP	Alto	in operation
	IP	Multics	in operation
Xerox Graphic Printer	FTP/NCP	IPS	in operation

Services under discussion:

Mailbox locator

Yellow pages (service finder)

Telex gateway

Accounting

III. Gateway Software Status

Gateway function	Forwarding node	Links nets	Status
IP/MIT Subnet gateway	Magellan (5th floor bridge)	V.1 ring Baltic Ethernet Atlantic	primitive version in operation
	Corinth (MIT-XX frontend)	V.1 ring Baltic MIT-XX host*	in operation
IP Internet gateway	MIT-XX	ARPANET Arctic MIT-XX host*	in operation
	Bering (LSI-11 at IMP)	ARPANET Arctic V.1 ring Baltic	primitive version ready to operate
PUP gateway	Gibraltar (MIT-AI frontend)	CHAOSNET Mediterranean Ethernet Atlantic	primitive version in operation
	Corinth (MIT-XX frontend)	MIT-XX host* CHAOSNET Mediterranean	no longer in use, may be removed
ARPANET IP diverter	Panama (Port Expander)	--	Imported software, low confidence
CHAOS Subnet gateway	Magellan (5th floor bridge)	CHAOSNET Mediterranean V.1 ring Baltic	primitive version in operation
	ITS front ends (MIT-AI, MC)	CHAOSNET Mediterranean ITS host*	in operation
	Corinth (MIT-XX frontend)	CHAOSNET Mediterranean MIT-XX host*	in operation
	Multics frontend (IPS 11/34)	CHAOSNET Mediterranean MIT-Multics host*	planned
TELENET (X.25) gateway	Multics frontend (IPS 11/34)	TELENET MIT-Multics host* CHAOSNET Mediterranean	being implemented (X.25 path to CHAOSNET planned)

* Hosts that interface to a local network through a front-end machine generally appear in the network structure as another local network with two nodes, the host and the front-end machine.

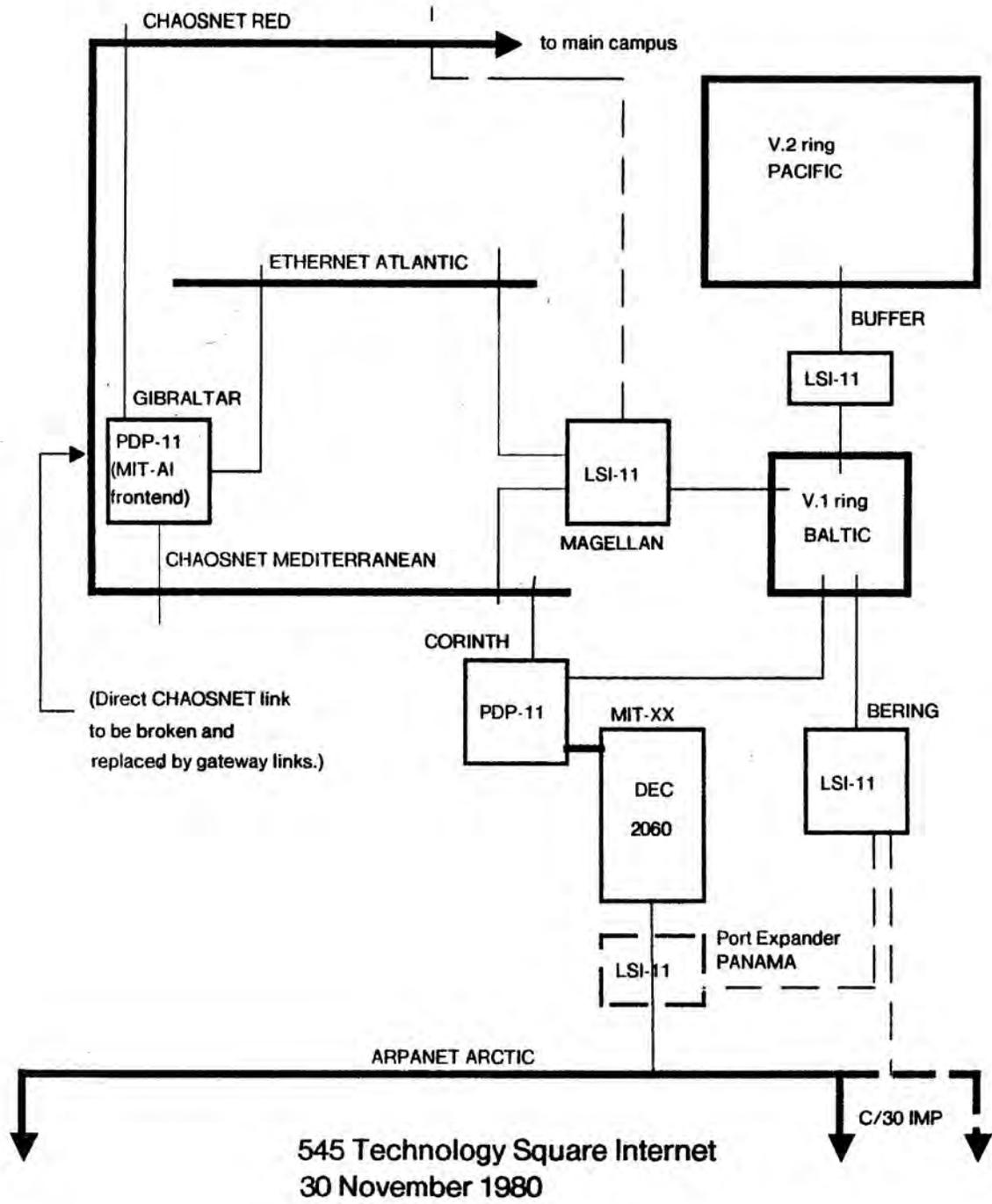
IV. Forwarding node Hardware Status

Forwarding node	Status
1. <i>Magellan</i>	In operation
2. <i>Bering</i>	LSI-11 in place, awaiting path to ARPANET.
3. <i>Panama</i>	Port expander, on loan, to be replaced by additional ARPANET IMP. (Seems to work)
4. <i>ARPANET C/30 IMP</i>	Scheduled for January, 1981, delivery.
5. <i>Gibraltar</i>	MIT-AI front end in operation.
6. <i>Corinth</i>	MIT-XX front end in operation.
7. <i>MIT-XX</i>	ICS host, temporarily acting as ARPANET gateway, in operation.
8. <i>Buffer</i>	LSI-11 used to separate V.2 ring from rest of internet during checkout, in operation.

V. Internet Topology and Forwarding Node Arrangement

The figure on the next page illustrates the current and planned arrangement of the 545 Technology Square internet. Only those computers that serve as forwarding nodes are shown. There are currently some fifty additional computers that use the internet, listed in section VII of this report.

- Legend:
- networks are shown as heavy lines
 - network attachments are shown as light lines
 - forwarding nodes are shown in medium lines
 - dashed lines indicate anticipated future interconnections, networks, and forwarding nodes.



VI. Example of Internet Communication

Figure two illustrates the path followed in a typical internet file transfer. In this example, a file from the Multics system is to be printed on the Xerox Dover laser printer at 545 Technology Square. At the application level, one might try a command such as "doverprint file name". We assume that the Multics application level program has prepared a file in the format expected by the printer. Below the application level are four levels of protocol:

- 1) At the file transfer level, the M.I.T. Trivial File Transfer Protocol (TFTP) is used to transfer the file from Multics to the Dover queuer on Alto Seal. The Dover queuer then uses the Xerox Elementary File Transfer Protocol (EFTP) to retransfer the file to the Dover printer. The intermediate stop is necessary because Multics and the Dover printer do not have a common file transfer protocol.
- 2) At the host-to-host level, TFTP uses the ARPA Standard User Datagram Protocol (UDP), while EFTP uses the Xerox PARC Universal Packet Protocol. UDP is a distinct layer in the ARPA Standard because there are several possible host-to-host protocols.
- 3) At the Internet Transport Level, UDP uses the ARPA Standard Internet Protocol (IP) to pass datagrams to an ARPA-MIT gateway, at MIT-XX. Based on internet addresses and local routing tables, that gateway forwards the datagrams through two more MIT subnet gateways, Corinth and Magellan, on their way to the Dover queuer.
- 4) At the local transport level, the datagrams traverse, in order, the ARPANET, a host-to-front-end link, the V.1 ring Baltic, the Ethernet Atlantic and, a second time, the Ethernet Atlantic.

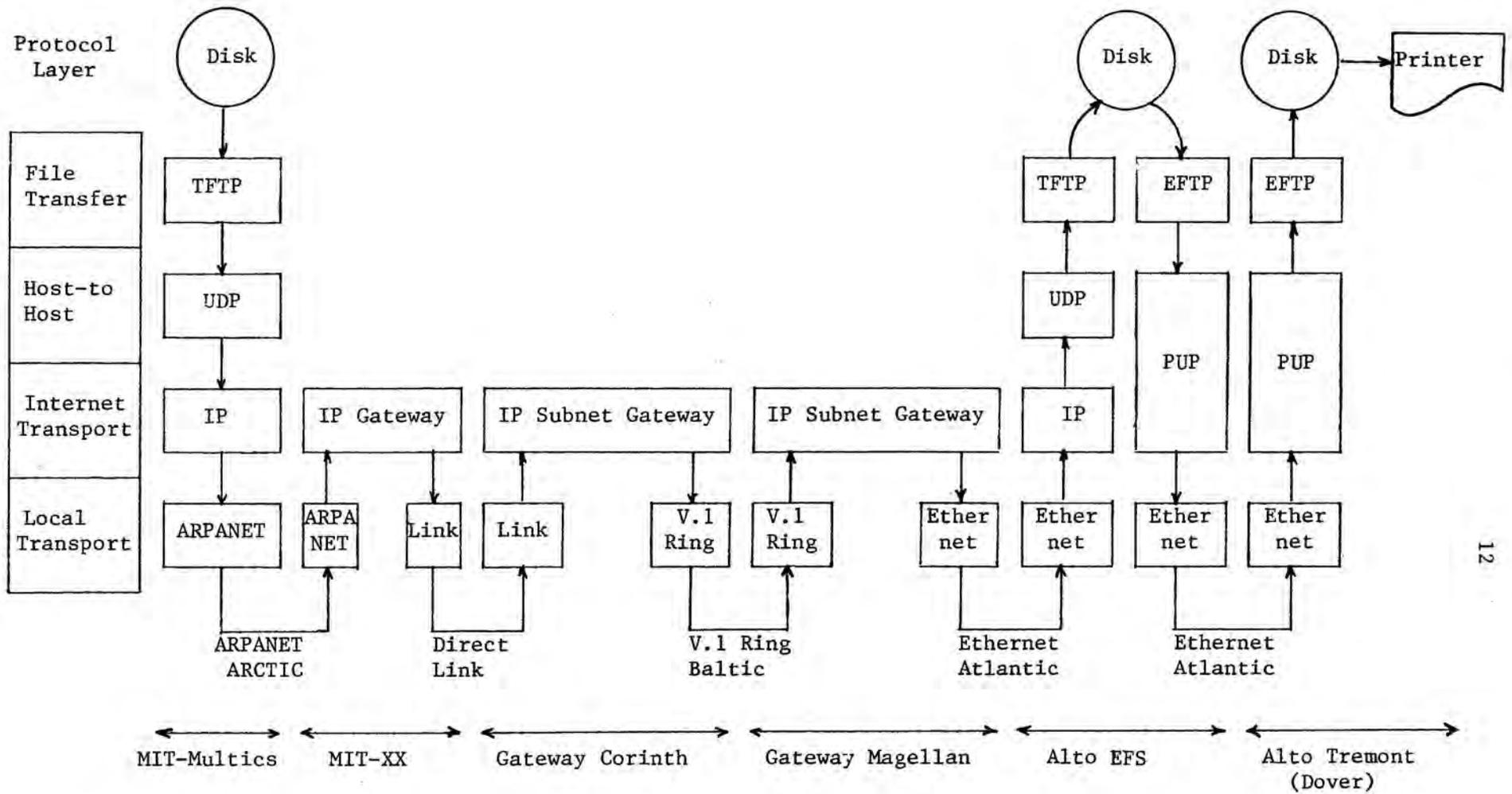


Figure 2: Path followed in sending a file from Multics to the Dover printer at 545 Technology Square via internet.

VII. Host attachments

Host identification	Class	attached to	node address
MIT-dev-Multics	HISI 68/80	ARPANET Arctic	4/31
MIT-AI	PDP-10(KA)	*CHAOSNET Mediterranean ARPANET Arctic	2/6
MIT-CSR	PDP-11/40	V.I.ring Baltic	
MIT-DMS	PDP-10(KA)	ARPANET Arctic	1/6
MIT-MC	PDP-10(KI.)	ARPANET Arctic *CHAOSNET Mediterranean	3/44
MIT-ML	PDP-10(KA)	ARPANET Arctic	3/6
MIT-Multics	HISI 68/80	ARPANET Arctic TELNET TYMNET	0/6 (617) 138/139 mitmul
MIT-RTS	PDP-11/70	V.I ring Baltic CHAOSNET Mediterranean	
MIT-RTS40	PDP-11/40	V.I ring Baltic	
MIT-TTU1	LSI-11	V.I ring Baltic	
MIT-VAX	VAX11/780	V.I ring Baltic CHAOSNET Mediterranean	
MIT-XX	DecSystem 2060	*V.I ring Baltic *CHAOSNET Mediterranean ARPANET Arctic	0/44
Tremont	Alto/Dover	Exp. Ethernet Atlantic	
Seal	Alto/IFS	Exp. Ethernet Atlantic	
(18 user Altos)	Alto	Exp. Ethernet Atlantic	—
(15 LISP machines)	LISPM	CHAOSNET Mediterranean	—
(10 Nu machines)	M68000	unattached at present, to be on V.2 ring Pacific	—

* via front end

VIII. Nomenclature of network components

Name	Type	Class	Identification
Arctic	network	ARPANET	ARPANET (50 kb/sec.)
Atlantic	subnetwork	Experimental Ethernet	Xerox university grant network (3 Mb/sec.)
Baltic	subnetwork	V.1 ring	Prototype ring net (1 Mb/Sec.)
Bering	forwarding node	LSI-11	MIT-gateway for ARPANET
Buffer	forwarding node	LSI-11	Temporary gateway between V2 and V1 rings
Corinth	forwarding node	PDP-11/34	MIT-XX front end
Gibraltar	forwarding node	PDP-11/10	MIT-A1 front end
Magellan	forwarding node	LSI-11	fifth floor primary gateway
Mediterranean	subnetwork	Chaosnet	8-9 floor primary CHAOSNET (4 Mb/Sec.)
MIT-gateway	forwarding node	LSI-11	known locally as Bering
MIT-XX	forwarding node	DecSystem 2060	Also a host for I.C.S. general use
Pacific	subnetwork	V.2 ring	Production ring net (10 Mbit/sec.)
Panama	forwarding node	port expander	current plan replaces this with new ARPANET port
Red	subnetwork	Chaosnet	Planned separate link between Tech Square and main campus (4 Mb/Sec.)