M.I.T. Laboratory for Computer Science Network Implementation Note No. 25
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545 TECHNOLOGY SQUARE INTERNET STATUS

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Both the hardware and the software of the planned internet configuration at 545 Technology Square are becoming operational. The current status of the various components is described on the following pages, in seven sections:

I. Significant events
II. Host lower-level protocols--software status
III. Higher-level services--software status
IV. Gateway and Bridge software status
V. Forwarding node hardware status
VI. Internet topology and forwarding node arrangement
VII. Nomenclature

Although this report is primarily of L.C.S. facilities, the A.I. Laboratory CHAOSNET interconnect status is also included wherever it is known.

In order to facilitate discussion, each subnetwork and packet forwarding node is assigned a name. For reference, a list of names and their assignments will be found on the last page of this note, identified as part VII.

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. Significant Events

1) Forwarding node Magellan was placed in service with an Internet Protocol (IP) gateway connecting the L.C.S. Ring net Baltic, the Ethernet Atlantic and the Chaosnet Mediterranean. With this installation, all of the high speed local networks in 545 Technology Square are now tightly linked with an IP packet-forwarding gateway.

2) An implementation of the Trivial File Transfer Protocol (TFTP) using IP was completed for the Alto. This user program permits files to be transferred between any Alto and any host at M.I.T. (or elsewhere) that implements TFTP/IP. (Currently these hosts include UNIX and Multics; soon TOPS-10 will also provide TFTP.) TFTP is the basis for mail exchange software, in progress, we well as other services.

3) An Interim Dover Queuer (IDQ) for the Alto was placed in service, based on TFTP. This service permits any host that has a TFTP/IP implementation to send files to the Dover printing server without having to implement the Xerox EFTP/PUP protocol, and equally important, without tying up the Dover port for the time required to complete the file transfer. (Dover tie-up is proving to be a problem with time-shared hosts.)

4) A complete package of internet software for UNIX was demonstrated on the MIT-CSR PDP-11/40. This package includes implementation of Internet Protocol, TCP, Telnet, TFTP, a process dispatcher for UNIX. and some UNIX system modifications needed for better network operation. With this package, any UNIX system attached to any subnetwork providing IP has the ability to use any IP-based service available anywhere.

5) The strategy for providing internet connection between the ARPANET and the local networks was changed. The former strategy involved attaching a gateway to a virtual ARPANET port provided by an LSI-11 acting as a "port expander" and placed in the path between an existing ARPANET port and some L.C.S. host computer. This approach proved more fragile than hoped, as limitations of both the hardware and software of the available port expander were uncovered. To replace the port expander, two techniques will be used, one short-term, the other long-term. The short-term approach is to make the XX DecSystem-20 host a temporary internet

gateway. This approach allows an immediate, low-bandwidth path through which internet packets can flow. The long-term approach is to order and install a third ARPANET IMP, so as to provide a dedicated port for use as a higher-speed gateway between the ARPANET and the local networks. This new port will provide a gateway path that does not depend on availability and resources of a time-sharing host. The original strategy of installing a "port expander" computer has been reduced to a contingency plan.

II. Host lower-level protocols--software status

Host Operating System	Trivial File Transfer Protocol	Internet Protocol	Telnet for TCP	TCP	net drivers		other
UNIX (MIT-CSR, MIT-RTS)	done	done	done	done	ring	done	Includes UNIX mods, installed on MIT-CSR not yet on MIT-RTS
TOPS-20 (MIT-XX)	in debug (Sollins)	ready for integration (Reed)	done	done	Chaos ARPA NET ring	done done ready for integration	TOPS-20 Release 4 contains needed fixes for IP and TCP
ITS (MIT-AI, ML, DM, MC)	not assigned	not assigned	not assigned	not assigned	ARPA NET Chaos net	done done	
Multics	done	done	done	done	ARPA NET	done	
Alto	done	done	in design (Clark)	in design (Clark)	Ether	done	
LISPM	not planned	?	not planned	not planned	Chaos	done	PUP, EFTP for Dover — done
Terminal Interface Unit	not needed	done	done	done	ring	done	Some software upgrades needed
VAX/VMS	derivable from UNIX	not assigned	not assigned	not assigned	ring	done	

III. Higher-level services--software status

Service	Protocol Used	Host	Status
Mail receipt	FTP/NCP	MIT-Multics, XX, AI, DM, MC, ML	in operation
	TFTP	MIT-Multics	being coded
		MIT-CSR	in operation
		MIT-RTS	in operation
		VAX-11/780	?
		MIT-AI, MC, DM, ML, XX	not planned
	TCP	MIT-Multics	in design
Mail forwarding	NCP to NCP	MIT-Multics	in operation
	NCP-TFTP	MIT-Multics	interim version being coded
	NCP-TFTP-TCP	MIT-Multics	in design (UG project)
	Laurel/PUP	Alto Seal	not in use; no plan to integrate with other services.
Remote login	Telnet/NCP	MIT-Multics, XX, AI, DM, MC, ML	in operation
	Telnet/TCP	MIT-Multics	in operation
		MIT-CSR	demonstrated, requires system change to install
		MIT-RTS	ready, requires integration with system
		VAX-11/780	(?)
Terminet printer	mail	MIT-XX	in operation
	mail (?)	MIT-CSR	planned future service
Dover printer	EFTP	Alto Tremont	in operation
	TFTP	Alto Tremont	under discussion, requires PARC release of software source
Interim Dover Queuer	TFTP	Alto (#?)	ready, needs host
Dover Queuer	TFTP	Alto Tremont	integration with IFS planned (Clark)
Remote file store	PUP	Alto Seal	in operation

Experimental file store	2-phase Commit/IP	Alto XFS	Research Project (Reed)
Authentication	Verify/IP	MIT-XX (temporary)	Research project (Greif)
Name resolution	PUP IP	Alto Seal Alto (#?)	in operation in design (UG project)
Time of day	PUP IP	Alto Seal (?)	in operation proposed
Xerox Graphic Printer	FTP/NCP	MIT-AI	in operation
Mailbox locator	(?)	(?)	under discussion
Yellow pages	(?)	(?)	proposed
Telex gateway	(?)	(?)	UG project

IV. Gateway Software Status

(n/n means this function is not needed)

Forwarding Node	IP Subnet Gateway	IP Network Gateway	PUP Gateway	CHAOS Gateway	ARPANET diverter for IP and PUP	PUP address remapper
Magellan (MOS)	done	n/n	to be designed (Chiappa)	to be designed (Chiappa)	n/n	n/n
Gibraltar	(McMahon)	n/n	done	done	n/n	n/n
Corinth/XX	n/n	in checkout (Travers)	in checkout (Travers)	n/n	n/n	in checkout (Travers)
Panama	n/n	n/n	n/n	n/n	done	n/n
Bering	n/n	done	possible future extension	n/n	n/n	possible future extension

V. Forwarding node Hardware Status

Forwarding node	Status
1. Magellan	In operation using borrowed TIU-LSI-11 pending delivery (May) of new LSI-11
2. Bering	LSI-11 in place
3. Panama	Port expander, on hold, to be replaced by additional ARPANET IMP. (Could use LSI-11 scheduled for June delivery.)
4. ARPANET MBB IMP	Scheduled for June 1 delivery
5. Gibraltar	A.I. CHAOS-11 in operation
6. Corinth	XX Network-11 in trial operation

VI. Internet Topology and Forwarding node Arrangement

Following are a set of figures that illustrate the current and planned arrangement of the 545 Technology Square internet.

In the first figure, only those computers that serve as forwarding nodes are shown. There are currently some forty additional computers that use the internet. Dashed lines indicate anticipated future interconnections, networks, and forwarding nodes.

Figures 2-4 illustrate the software components of certain forwarding nodes. Danny Cohen's notation is used to identify the format of packets flowing from one component to another as follows: X(Y) means that a packet of protocol Y is encapsulated with Protocol X; for example E(PUP) means that a Xerox internet packet (PUP) is encapsulated with the Ethernet protocol (E). The following protocol abbreviations are used:

E	Ethernet local transport protocol
A	ARPANET transport protocol
C	Chaosnet local transport protocol
R	Ring net local transport protocol
CI	Chaos internet protocol
PUP	Xerox internet protocol
IP	ARPA internet protocol
NCP	ARPANET host-to-host protocol

A software component that encapsulates a packet of the Y protocol inside the X protocol is labeled "X<Y", and is understood to encapsulate packets going one way and unwrap packets going the other way. Note that the encapsulation operation involves placing an address in the outer wrapper. Instructions as to the correct address to use are provided by the gateway that hands the packet to the encapsulator.

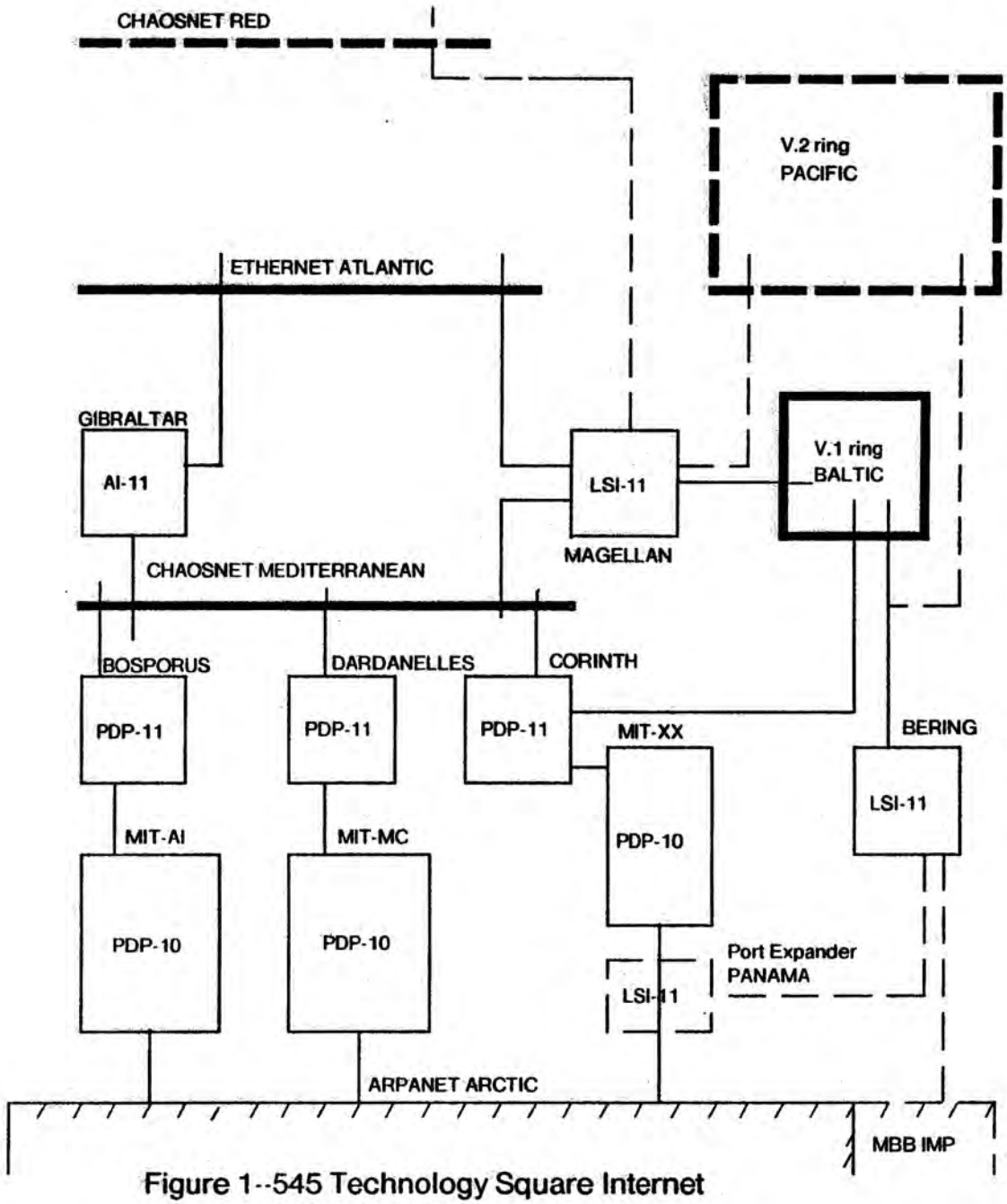

Figure 1--545 Technology Square Internet
10 March 1980 plan

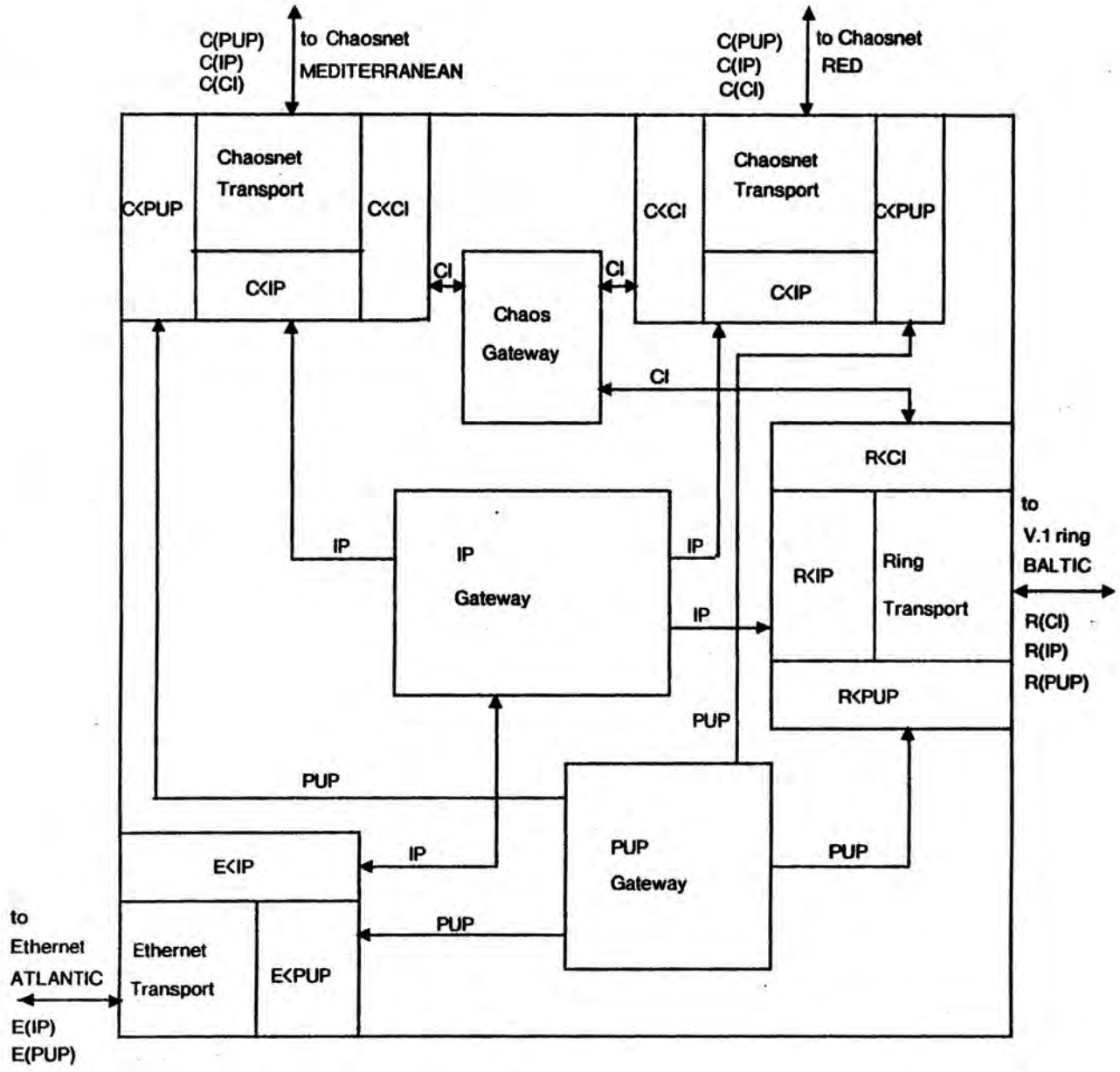

Figure 2--PDP-11 Forwarding node MAGELLAN, 10 March 1980 plan

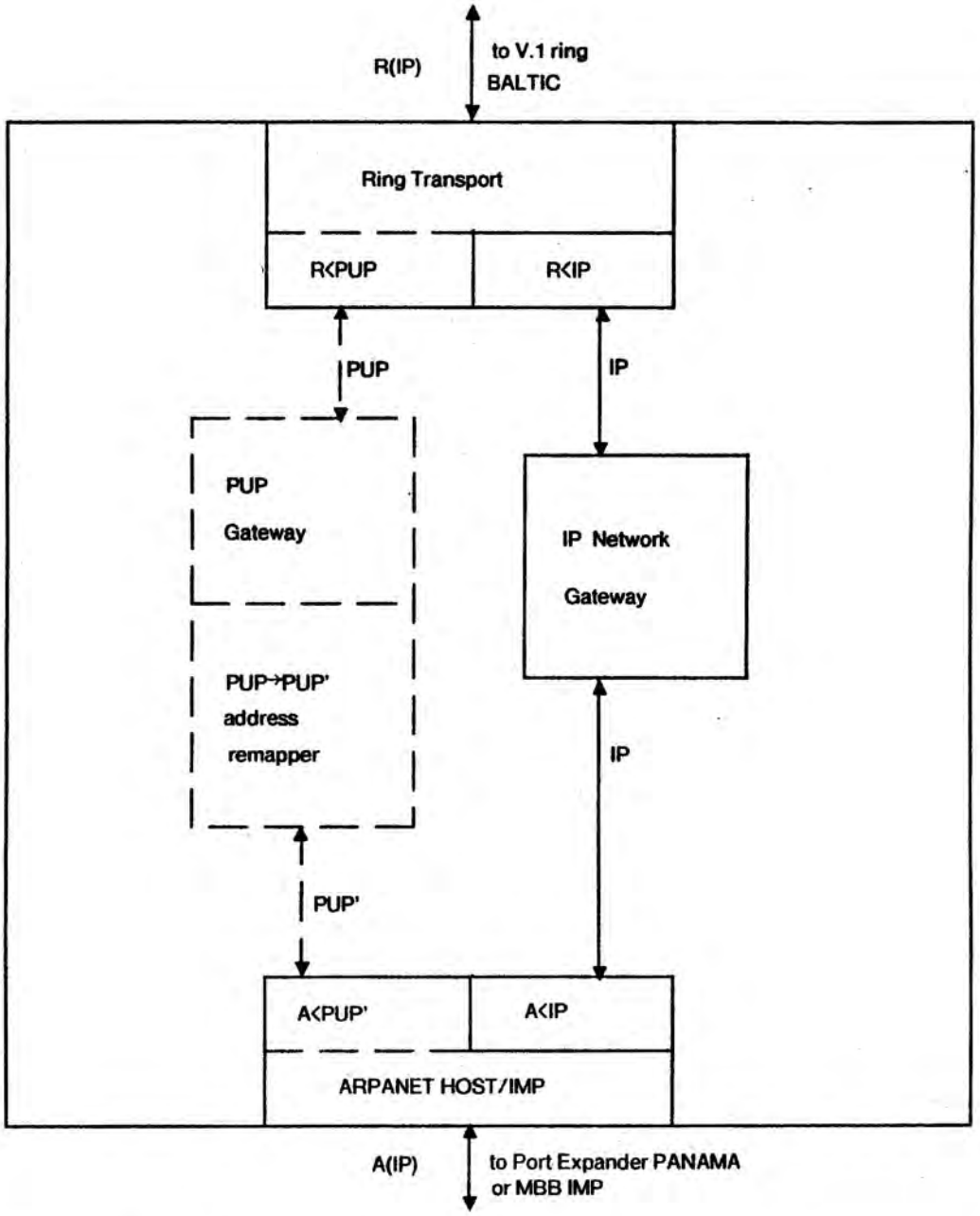

Figure 3--LSI-11 Gateway BERING, 10 March 1980 Plan

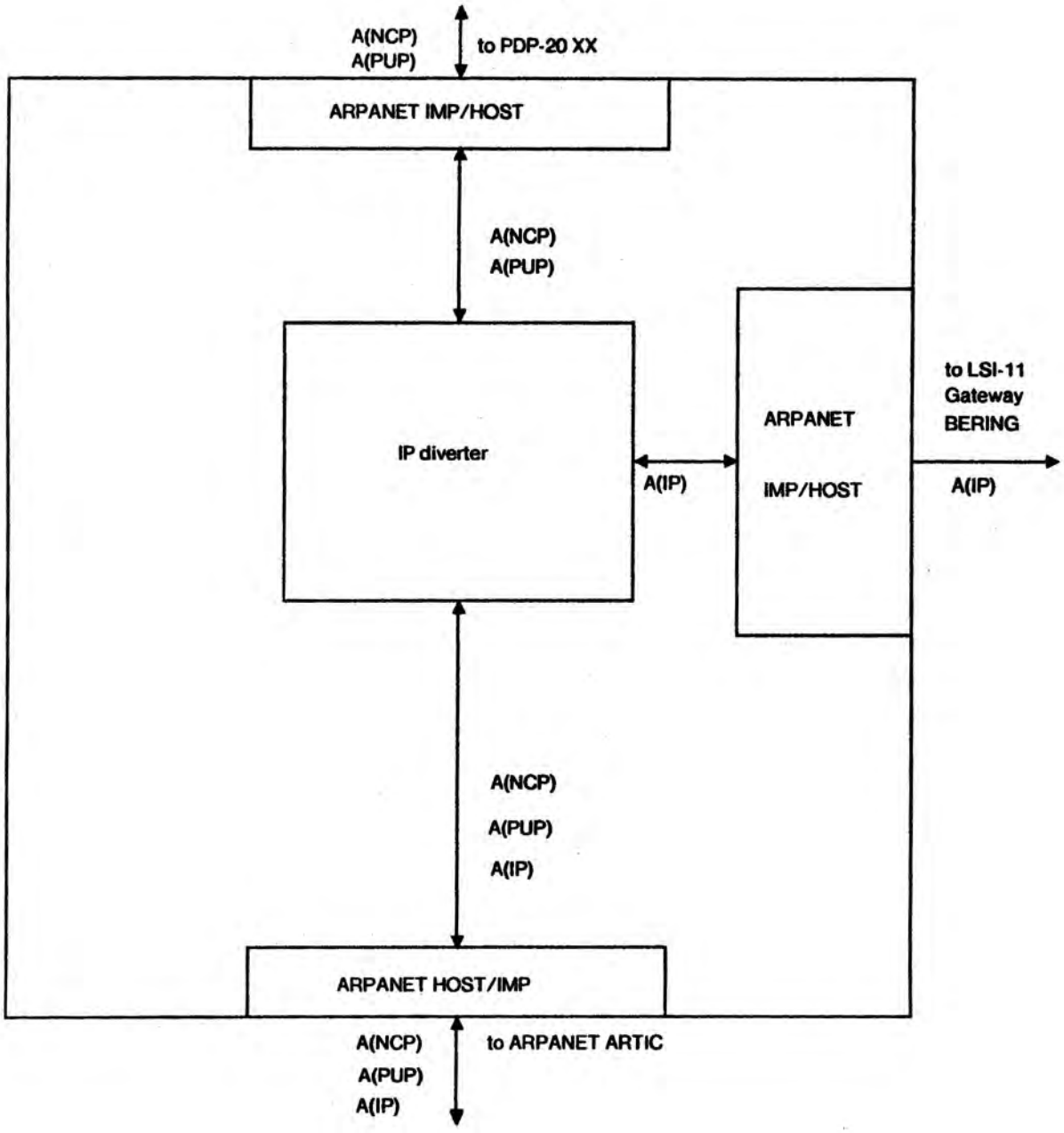

Figure 4--LSI-11 Port Expander PANAMA
10 March 1980 Contingency Plan

VII. Nomenclature

Name	Type	Class	Identification
Artic	network	ARPANET	ARPANET (50 kb/sec.)
Atlantic	subnetwork	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
Bosporus	forwarding node	PDP-11/20	MIT-AI front end
Corinth	forwarding node	PDP-11/20	MIT-XX front end
Dardanelles	forwarding node	PDP-11/20	MIT-MC front end
Gibraltar	forwarding node	PDP-11/20	AI-CHAOS bridge
Magellan	forwarding node	LSI-11	fifth floor primary gateway
Mediterranean	subnetwork	Chaosnet	8-9 floor primary chaosnet (8 Mb/Sec.)
MIT-AI	host	PDP-10 (KA)	A.I. Laboratory general use
MIT-CSR	host	PDP-11/40	CSR network development system
MIT-DM	host	PDP-10 (KA)	Dynamic modeling
MIT-gateway	forwarding node	LSI-11	known locally as Bering
MIT-MC	host	PDP-10 (KL)	MACSYMA Consortium
MIT-ML	host	PDP-10 (KA)	MACSYMA Development system
MIT-Multics	host	HISI 68/80	IPC Multics service
MIT-RTS	host	PDP-11/70	RTS development system
MIT-XX	host	DecSystem 2060	L.C.S. general use
Pacific	subnetwork	V.2 ring	under development (8 Mb/Sec.)
Panama	forwarding node	port expander	current plan replaces this with new ARPANET port
Red	subnetwork	Chaosnet	Planned link between Tech Square and main campus (8 Mb/Sec.)