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Status of (U.S.) High Energy Physics Networking*

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Abstract

The current status of Networking to and between computers used by the High Energy Physics community is discussed. Particular attention is given to developments over the last year and to future prospects. Comparison between the current status and that of two years ago indicates that considerable strides have been made but that much remains to be done to achieve an acceptable level of functionality.

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Introduction

This report is an attempt to summarize the current status of the evolution of the wide area computer networking services available to the high energy physicist. Particular emphasis will be placed on the situation in the United States, a complementary report[1] of the situation in Europe was also presented at this conference. Although also an area of significant improvement, this report does not cover internal networking in the laboratories and universities.

It will not be possible to discuss in any detail the uses to which the networks are put. However it should be stated that the ambitions of the efforts are to provide appropriate access by all high energy physicists to the computing resources which they need, independent of the physical distance between physicist and resource. In this sense the networks are an integral and major part of the Computing Environment which is the chosen theme for this conference.

More specifically we find that the networks are used to provide:

a) software management and distribution. In the context of a large collaboration it is the only method of coordination which survives teaching schedules and the diverse commitments of physicists.

b) analysis management, data base access, distributed processing. An experiment is a complex beast which, as we have seen in several contributions to this conference, requires information management. The results, all this information and its time dependence, cannot be maintained and distributed by conventional postal methods. The task of analysis itself demands the application of all possible resources no matter where they are. There are interesting examples of how idle computers may be exploited. At Fermilab it is possible to submit a job on a central Vax cluster[2] and to have it execute on some other machine on the local area network and the results returned without the user knowing anything about the worker machine.

c) experiment on-line monitoring. The time scales involved in setting a value on a high voltage unit are not radically different when the operator is 5000 miles distant than when he is 20 feet. This opens the possibility of remote control of a running experiment. Usually such a possibility evokes a religious discussion as to whether the remote operator should or not be given the power to intervene. There is however general acceptance of remote monitoring followed by advice to the local crew.

d) mail and conferencing services which enhance the efficiency of the physicist interaction. It may even be argued that without them the modern large collaborations could not function.

e) direct login. Despite the increased functionality of network services, the ability to login to the appropriate system is still and may well remain, for some time, the base capability offered by the networks.

Recent History

At the Amsterdam Conference in 1985, Paul Kunz reviewed the status of networking[3]. At that time the basic topology, which is still current, was already in place. The U.S., HEP dedicated, networking is dominated by leased lines; in general funded by the individual University contracts and used for either Login or for more general network services. In addition an important component was, and is, provided by BITNET, a cooperative network, which encompasses a large fraction of academic institutions in the U.S., Europe (EARN) and Canada (NETNORTH).

At about the same time the HEPAP sub-panel[4] examined the role of networking and concluded that it was of such importance that there should be a move to some measure of central organization to ensure the appropriate development of capability. As a result, the HEPNET Technical Coordinating Committee[5] was formed in Spring of 1986 and this reports to the DOE through Fermilab. It does not establish the requirements, rather concentrating on the coordination of daily operations and implementation of enhancements. This body may be approximately compared to the European HEP networking sub-group, SG5, and contacts between the two groups have been established in an effort at more global coordination.

In the wider context of Energy Sciences, within the U.S. Department of Energy, an effort is under way to coordinate the networking needs of several research communities among them Fusion Energy which has had for some time a network(MFENET) to provide access to the Supercomputer facilities at Livermore (NMFECC) and, more recently, Florida State University (FSU). An ESnet review body has been formed and has two High Energy Physics representatives[6].

On an even wider footing there is, currently under way, a Congressional Study into Computer Networking which is, in some sense, a corollary to the recent initiatives in both DOE and, more visibly, in NSF to provide wide access to Supercomputing resources for academic researchers. As a part of this study, High Energy Physics was asked to document it's networking needs, covering the next 5 years. The request was received in Fall 1986 and the report[7] was submitted on Dec. 19, 1986. It represents significant effort on the part of the HTCC membership and also on the part of several other physicists with long histories of involvement in networking initiatives. It forms the source material for much of this report.

Current Status

Table I contains an inventory of High Energy Physics associated leased lines in the U.S., taken from Ref. (7). Predominantly they are 9600 bps and in many cases they are multiple use, for example DECNET and Login sharing the same line by use of a statistical multiplexer. These lines are perhaps more rationally examined by considering some major components.

There are a number of lines devoted to login to the data switches at the laboratories; they provide access from the home universities to most of the computer systems at each site. In addition there is a connection between the SLAC and Fermilab switches.

BITNET[8], as mentioned earlier, is a rather extensive academic network which required only that the joining institution finance a line to the nearest institution on the network and run the software. It started in 1981 and with its sibling networks outside the U.S. has more than 1000 nodes at more than 500 sites. As well as North America and Europe there are nodes in Asia and in total 21 countries. Within the U.S. the IBM funding of management and the network information center, BITNIC, ceased at the end of 1986. There are now modest membership fees which cover these costs. At the end of 1987 the IBM funding for the transatlantic line will cease, and so far, there are no definite plans for meeting this. Currently HEP accounts for a significant fraction of this traffic.

DECNET is the proprietary networking product produced by Digital Equipment Corporation; however, the almost universal use of DEC machines in experimental data acquisition and as departmental computers in the universities has led to the explosive growth of an HEP DECNET network. Since it operates between like machines its functionality is high because of its integration with the operating system and some of the most sophisticated uses of networking are to be found within its boundaries. It provides a rather smooth transition from local area to wide area which is extremely important; for example, Fermilab now has more than 50 nodes on site. Contact with other networks, SPAN, and the European HEP DECNET gives it an extent that exceeds 1000 nodes and some limitations in its management capabilities manifest themselves with this number of nodes, given the loose structure of the communities. A set of mutually agreeable guidelines have been established between HEP in the U.S and Europe and SPAN to try and address these problems.

LEP3NET[8] is a different entity entirely from DECNET; it is the network built to address the needs of the L3 experiment at CERN which has several collaborating institutes in the U.S. It is X.25[9] based over which Colored Books[10] and DECNET are transmitted. It is currently the only HEP-dedicated means of communication between the U.S. and Europe. Topologically it is based on primary switches at MIT and CalTech and at CERN; there is also a switch at U. Michigan and other members have leased lines into these switches. Over the last year it has begun to accommodate membership and traffic from other collaborations; however, its resources are stretched to the limit at this point. It should be remarked that the first funding for this enterprise was requested in 1983 and formally it started operation in January 1986.

Future Prospects

The plan[7] submitted in December 1986 talked in terms of initial implementation of a 56kbps backbone capability based on X.25 protocol. The primary motivations were:

a) It seems possible to preserve all the currently available capability and, importantly, to permit international connections (Europe is strongly X.25 dominated).

b) It is compatible with the subsequent integration of the HEP capability with the ESnet efforts since the MFENET II plans call for a trunk service with gateways at each major node which will support the transport of both X.25, TCP/IP and the MFE private protocol traffic across the network.

c) Since X.25 is in many senses part of the plans for the standard International Standards Organisation Open Systems Interconnection (ISO/OSI), a migration to this standard is facilitated.

The plan also called for a 56kbps link to CERN and such a proposal[10] has been submitted by Florida State University. The current planned implementation has Fermilab as the U.S. termination of the transatlantic satellite link. With the installation of an X.25 switch at Fermilab, interconnection with the backbone of HEP networking would be permitted. This proposal has been accepted.

A proposal[11] has been submitted for a pair of 56kbps links from MIT to BNL and from BNL to FNAL in order to improve the networking services available to a number of east coast universities. Such a link would provide good access, both to the HEP laboratory centers, BNL and FNAL and to the LEP3NET transatlantic link. A proposal, similar in concept, is under preparation[12] for a 56kbps link from the west coast SLAC/LBL to FNAL, and a lower speed line from CalTech to LBL is under consideration. The latter is important since currently a large volume of DECNET traffic to CERN through the Caltech X.25 switch shares a Caltech-SLAC line with logon traffic to SLAC, to the detriment of both.

All these proposals are considered by the DOE HENP program office and by the ESnet Review Committee. The most recent news[13] is that that body has viewed favorably the HEP proposals and that a call is out for detailed implementation. This puts the timescale at months, rather than years, before operation.

On a slightly shorter timescale it is expected that a leased line link, initially running pure DECNET, will be installed between Japan (KEK) and LBL in response to a Proposal[14] from 1985; the recent emphasis on this link has come from the CDF experiment at Fermilab which is currently taking test data and has many Japanese collaborators. In a similar spirit, a line from Italy to FNAL will be installed in the very near future on the initiative of the Italian INFN[15] which has very significant collaborative participation at both FNAL and SLAC.

An important feature of the main proposals and of many discussions over the last year is the importance of management at the major nodes and co-ordination network wide. The current resources of all the laboratories are stretched to the limit since all have major on-site local area networking to address. Without the allocation of sufficient manpower to manage the implementation and operation, the services available to the community will suffer accordingly. There is no networking design which can survive a totally anarchical attitude nor is it reasonable to expect that the small fractions of physicists normally allocated to look after the Physics Department computers can keep abreast of the rapid developments without help.

Beyond the current year the topology of the backbone network should be expected to expand to include the remaining High Energy Physics accelerator in the U.S. at Cornell and subsequently the SSC site. Corresponding improvements in end node connections should be vigorously pursued and the existence of the backbone is expected to facilitate this process. It will also be necessary to pursue the inclusion of high speed land lines since, at least currently, there continue to be difficulties for efficient direct access to remote computers by satellite, in part because of the long time path and delay.

Concluding Remarks

Networking in High Energy Physics arose in a very pragmatic way through the recognition, by individual research groups, that investment in the lines which form the basis of good communications with their experiments, analysis centers and colleagues, gave a tangible return in the form of improved Physics output. None of the installations are oversized and many are so modest as to be limiting at the present time. There are signs that the need for networking is being recognized, and will be supported, more broadly. This is a necessity and it is to be hoped that the current plans materialize into reality over the next months and years.

Acknowledgments

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5. HTCC Current Membership: ANL: E.M. May, BNL: G. Rabinowitz, FNAL: G. Chartrand, LBL: A.X. Merola; L3 Collaboration: M. Kaletka (MIT-LNS) and SLAC: R.L.A. Cottrell.

6. ESnet; Current High Energy Physics representatives are G. Brandenburg, Harvard and S. Loken, LBL.

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15. Istituto Nazionale per Fysica Nucleare, the Italian HEP funding agency.

TABLE I

Leased Lines for High Energy Physics
Compilation by Paul Kunz <PFKEB@SLACVM>
25 November 1986

Amended by members of H.T.C.C.
Latest Revision 16 December 1986

To be included in this list the line must meet the following conditions:

- Line is used by HEP.
- Line goes off site or campus
- Lines are paid (at least in part) by HEP, Physics Dept, DoE, or NSF.

Notes:
- Many physical lines are used with multiple protocols, they are grouped together with a '/' and '\' near the line speed.
- Under 'type' of line: LL= Land Land, uW = MicroWave, Sat. = Satellite, and PPSN = Public Packet Switching Network.

From	To	Speed	type	Protocol	node	node	Use
ANL	U.Ill-Chi	9600	LL	RSCS	ANLOS	UICVM	BITnet
ANL	Purdue	4800	LL	DECnet	ANLHEP	PURDUE	DECnet
ANL	MFECC	56K	LL	MFEnet	?	?	MFEnet
ANL	U. Minn.	9600	LL	DECnet	ANLHEP	MINN	DECnet
ANL	Mich	9600	LL	DECnet	ANLHEP	MICH	DECnet
ANL	TymNet	9600	PPSN	X.25	ANNEX	terminals	Login
ANL	TymNet	9600	PPSN	X.25	IBMsw	terminals	Login
ANL	ArpaNet	56K	LL	TCP/IP	ANL-MCS	?	various

From	To	Speed	type	Protocol	node	node	Use
BNL	Yale	9600	LL	RSCS	BNL	YALEVM	BITnet
BNL	Brown	9600	LL	DECnet	BNLDOR	BRHEP1	DECnet
BNL	Boston U	9600	LL	DECnet	BNLRS2	BUPHYC	DECnet
BNL	Columbia	9600	LL	DECnet	BNLRS2	NEVIS	DECnet
BNL	Columbia	9600	LL	Statmux	Micom	Terminals	Logon(plan)
BNL	Cornell	9600	LL	DECnet	BNLDOR	LNS61	DECnet
BNL	John Hop.	9600	LL	DECnet	BNLRS1	JHUP	DECnet
BNL	NYU	9600	LL	DECnet	BNLDOR	NYUHEP	DECnet
BNL	U of Penn	9600	LL	DECnet	BNLDOR	UPENN1	DECnet
BNL	MFECC	9600	LL	MFEnet	BNLCL2	Princeton	MFEnet
BNL	SUNY-SB	9600	LL	Statmux	Gandalf	Terminals	Logon
BNL	SUNY-SB	/9600	LL	DECnet	BNLRS2	SBNUC1	DECnet
		\	LL	RSCS	SUNYSBNP	BNLDAG	BITnet

From	To	Speed	type	Protocol	node	node	Use
FNAL	Argonne	/48K	uW	RSCS	FNALVM	ANLOS	BITnet
		* 9600	uW	DECnet	CDFRTO	ANLHEP	DECnet
		* 9600	uW	DECnet	FNALR6	ANLPHY	DECnet
		\48K	uW	MFEnet	CCP/NAP	FNAL	MFEnet
FNAL	BNL	9600	LL	DECnet	FNALRO	BNLDOR	DECnet
FNAL	Columbia	/9600	LL	Statmux	Micom	Terminals	Logon
		\4800	LL	TCF	Cyber	printer	Printer
FNAL	U. Chicago	4800	LL	Statmux	Micom	Terminals	Logon

FNAL	U. Chicago	9600	LL	DECnet	FNALR4	UCHEP	DECnet	
FNAL	U. Colo.	/1200	LL	Statmux	Micom	Terminals	Logon	
		\4800	LL	TCF	Cyber	printer	Printer	
FNAL	U. Florida	/2400	LL	Statmux	Micom	Terminals	Logon	
		\9600		DECnet	FNALR4	UFHEP	DECnet	
FNAL	Harvard	9600	LL	DECnet	CDFRTO	HUHEPL	DECnet	
FNAL	U. Ill.UC	/1200	LL	Statmux	Micom	Terminals	Logon	
		* 2400	LL	DECnet	FNALR4	UIHEPA	DECnet	
		\4800	LL	TCF	Cyber	printer	Printer	
FNAL	U.Ill-Chi	9600	LL	RSCS	FNAL	UICVM	BITnet	
		9600	LL	DECnet	FNALR5	?????	DECnet	(1/87)
FNAL	U.Indiana	/4800	LL	DECnet	FNALR5	IND	DECnet	
		\9600		Statmux	Micom	Terminals	Logon	
FNAL	LBL	9600	Sat.	DECnet	FNALR4	LBLR1	DECnet	
FNAL	MIT	/2400	Sat.	Statmux	Micom	Terminals	Logon	
		\4800	Sat.	TCF	Cyber	printer	Printer	
FNAL	Mich St.	/4800	LL	Statmux	Micom	Terminals	Logon	
		* 2400	LL	DECnet	FNALR4	MUHEP	DECnet	
		\4800	LL	TCF	Cyber	printer	Printer	
FNAL	N.Western	9600	LL	DECnet	FNALR5	NUHEP	DECnet	
FNAL	Princeton	/1200	Sat.	Statmux	Micom	Terminals	Logon	
		\9600		DECnet	FNALR5	PUPHEP	DECnet	
FNAL	Rochester	9600	Sat.	DECnet	FNALR5	URHEP	DECnet	
FNAL	Rutgers	/2400	Sat.	Statmux	Micom	Terminals	Logon	
		* 9600		DECnet	FNALR4	RUTNPL	DECnet	
		\4800		TCF	Cyber	printer	Printer	
FNAL	UCSB	/1200	Sat.	Statmux	Micom	Terminals	Logon	
		\4800	Sat.	TCF	Cyber	printer	Printer	
FNAL	TymNet	9600	PPSN	X.25	Micom	Terminals	Logon	
FNAL	Vanderbilt	/4800	LL	Statmux	Micom	Terminals	Logon	
		\4800	LL	DECnet	FNALR4	VUHEP	DECnet	
FNAL	VPI	9600	LL	Statmux	Micom	Terminals	Logon	
FNAL	Wisconsin	4800	LL	DECnet	CDFRTO	PSLA	DECnet	
FNAL	YALE	/4800	LL	DECnet	FNALR4	YALPH2	DECnet	
		\2400		Statmux	Micom	Terminals	Logon	

From	To	Speed	type	Protocol	node	node	Use
SLAC	LBL	/9600	uW	RSCS	SLACVM	UCBCMSA	BITnet
		/		(Backup to BOC line)			
		* >56K	uW	DECnet	TPCS	LBLR1	DECnet
		\ 9600	uW	T1	Micom	Develcon	Logon
		\9600	uW	T1	TPCS?	Develcon	Logon
SLAC	UCB	9600	LL	RSCS	SLACVM	UCBCMSA	BITnet
SLAC	UCSB	/9600	LL	RSCS	SLACUCD	SBHEP	BITnet
		\9600	LL	DECnet	UCD	UCSB	DECnet
SLAC	Argonne	9600	Sat.	DECnet	HRS	ANLHEP	DECnet
SLAC	BostonU	9600	?	Statmux	Micom	terminals	Logon
SLAC	Caltech	/4800	LL	DECnet	SLD	CITHEX	DECnet
		/ 9600	LL	Statmux	Micom	Terminals	Logon
		\ 2400	LL	RSCS	SLACVM	CTECHPR1	Printer
		\9600	LL	RSCS	SLACVM	IMCTECH	Laser
SLAC	UC Davis	/9600	LL	Statmux	Micom	Terminals	Logon
		\2400	LL	RSCS	SLACVM	IMUCD	Laser
SLAC	TymNet	9600	PPSN	X.25	Micom		Logon
SLAC	MFECC	9600	LL	Statmux	GUSS	Micom	Logon
SLAC	U. Cinn.	9600	Sat.	Statmux	Micom	Terminals	Logon
SLAC	U. Colo	/9600	LL	Statmux	Micom	Terminals	Logon
		\2400	LL	RSCS	SLACVM	UCOLOPR1	Printer
SLAC	Fermilab	9600	Sat.	Statmux	Micom	Micom	Logon

SLAC	U. Ill.	9600	Sat.	Statmux	Micom	Terminals	Logon
SLAC	U. Mich.	/9600	Sat.	Statmux	Micom	Terminals	(planned)
		+ 9600	Sat.	RSCS	SLDMKII	UMICH	BITnet
		\9600	Sat.	DECnet	MKII	MICH	DECnet
SLAC	Northrdge	9600	LL	Statmux	Micom	Terminals	Logon
SLAC	SF State	/9600	LL	Statmux	Micom	Terminals	(planned)
		+ ????	LL	DECnet	??	?	DECnet
		\2400	LL	RSCS	SLACVM	IMSFSU	Laser(plan)
SLAC	UCSD	9600	LL	DECnet	UCD	SDPH1	DECnet
SLAC	UCSC	/9600	LL	Statmux	Micom	Terminals	Logon
		\9600	LL	RSCS	SLACVM	IMUCSC	Laser
SLAC	Stanford	9600	LL	RSCS	SLACVM	STANFORD	BITnet
SLAC	U. Tenn	/9600	LL	Statmux	Micom	Terminals	Logon
		\2400	LL	RSCS	SLACVM	IMUTENN	Laser
SLAC	U. Wash	9600	Sat.	Statmux	Micom	Terminals	Logon

From	To	Speed	type	Protocol	node	node	Use
Boston U	NorthEast.	9600	LL	RSCS	BOSTONU	NEUVMS	BITnet
CIT	Telenet	4800	PPSN	ClrBooks	CITHEX	various	L3NET
MIT	CERN	/16800	LL	ClrBooks	MITLNS	many	L3NET
		\9600	LL	DECnetX25	MITLNS	?	DECnet
MIT	Caltech	/9600	LL	ClrBooks	MITLNS	CITHEX	L3NET
		\9600	LL	DECnetX25	MITLNS	CITHEX	DECnet
MIT	Princeton	/9600	LL	ClrBooks	MITLNS	PRINHEP	L3NET
		\9600	LL	DECnetX25	MITLNS	?	DECnet
MIT	U Mich	9600	LL	ClrBooks	MITLNS	MICH	L3NET
	Merit	9600	LL	ClrBooks	MITLNS	various	L3NET
MIT	JHU	/9600	LL	ClrBooks	MITLNS	JHUPHEP	L3NET(plan)
		\9600	LL	DECnetX25	MITLNS	?	DECnet
MIT	Harvard	9600	LL	ClrBooks	MITLNS	HUHEPL	L3NET
MIT	NorthEast	9600	LL	ClrBooks	MITLNS	NORHEP	L3NET(plan)
MIT	CMU	9600	LL	ClrBooks	MITLNS	CMUHEP	L3NET(plan)
ColoSt	Houston	9600	??	Statmux	????	Terminals	Logon
Harvard	Brandeis	4800	LL	DECnet	HUHEPL	BRND	DECnet
Harvard	Telenet	1200	PPSN	X.25	?		L3NET
LBL	UCLA	4800	LL	DECnet	LBLR1	UCLA	DECnet
LBL	UCR	4800	LL	DECnet	LBLR1	UCR	DECnet
U. Minn	Soudan	9600	LL	DECnet	MINN	MINE	DECnet
UMich	Telenet	1200	PPSN	X.25	??		L3NET
U. Pa.	Princeton	9600	LL	RSCS	PENNDRLS	PUCC	BITnet
			(The computer is mostly owned by Physics Dept.)				
UCB	CUNY	9600	LL	RSCS	UCBCMSA	CUNYVM	BITnet
			(SLAC contributes a fraction of this line's cost)				
UCB	LBL	9600	LL	RSCS	UCBCMSA	LBLGATE	printer
PSL	Wisconsin	9600	LL	RSCS	WISCPSLB	WISCVM	BITnet
Tx AC	Houston	9600	??	Statmux	?	Terminals	Logon
MFECC	NRL	1200	??	MILNet	????	??	