Proceedings of the 15-17 October 1986 Joint Meeting of the Internet Engineering and Internet Architecture Task Forces

Prepared by:

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Joint IETF and INARC

15-17 October 1986

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MITRE Corp.

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1. Introduction

A joint meeting of the DARPA Internet Engineering and Internet Architecture Task Forces was held Wednesday through Friday, 15-17 October 1986, at SRI in Menlo Park, California.

The meeting was hosted by Jake Feinler and the Network Information Center.

2. Attendees

Name	Organization	Net Address
Bob Braden	ISI	braden@venera.isi.edu
Hans-Werner Braun	U of Mich	hwb@gw.umich.edu
Scott Brim	Cornell	swb@devvax.tn.cornell.edu
Robert Broberg	U-Bass	robert%ub.com@csnet-relay
Ross Callon	BBN	rcallon@bbn-unix
Noel Chiappa	Proteon,MIT	jnc@proteon.com
Dave Clark	MIT	dclark@mit-multics
Dave Crocker	U-Bass	dcrocker%ub.com@csnet-relay
Mike Corrigan	OSD	corrigan@sri-nic
Barbara Denny	SRI	denny@sri-tsc
Kevin Dunlap	DEC/UCB	kjd@berkeley.arpa
Jake Feinler	SRI	feinler@sri-nic
Jose Garcia-Luna	SRI	garcia@sri-tsc
Marianne Gardner	BBNCC	mgardner@bbncc5
Phill Gross	MITRE	gross@mitre
Ken Harrenstien	SRI	klh@sri-nic
Jim Herman	BBN	herman@ccj.bbn.com
Robert Hinden	BBNCC	hinden@bbnccv
Ole Jacobson	SRI	ole@sri-nic
Mike Karels	UCBerkeley	karels@berkeley.edu
Mark Lottor	SRI	mkl@sri-nic
Stan Mantiply	U-Bass	stan%ub.com@csnet-relay
Milo Medin	NASA/Ames	medin@orion.arpa
David Mills	Linkabit	mills@isid.arpa
Paul Mockapetris	ISI	pvm@isi.edu
John Moy	Proteon	jmoy@proteon.com
Tassos Nakassis	NBS	nakassis@nbs-vms
Ron Natalie	BRL	Ron@brl
Carl-Herbert Rokitanski	DFVLR	roki@isid
Marshall Rose	Northrop	mtr@nrtc.northrop.com
Mary Stahl	SRI	stahl@sri-nic
Mike St. Johns	DCA/B612	stjohns@sri-nic
Zaw-Sing Su	SRI	zsu@sri-tsc
Dave Van Belleghem	NSF	vanb@nrl-acoustics.arpa
Lixia Zhang	MIT-LCS	lixia@xx.mit.edu

3. Agenda

Prior to the meeting, it was agreed that IETF would meet Oct. 15-16 and INARC would meet Oct. 16-17. On the joint day (Oct. 16), IETF would set the agenda for the morning and INARC would set the agenda for the afternoon. The agenda for IETF is below. The agenda for INARC was less structured and centered around open discussion of future IAB and Task Force activities.

Wednesday, October 15

9:00 am	Opening Plenary
9:15 am	Workshops
	- Routing and EGP, M. StJohns (DDN)
	- DoD/ISO Interoperability, P. Gross (MITRE)
	- Name Domains for Milnet, M. Karels (UCB)
5:00 pm	Recess

Thursday, October 16

9:00 am	Presentations and Workshop Reports
	Premises Technology Study, J. Herman (BBN)
	Arpanet Congestion, M. Gardner (BBN)
	Workshop Reports
	- Routing and EGP, M. StJohns (DDN)
	- DoD/ISO Interoperability, P. Gross (MITRE)
	- Name Domains for Milnet, M. Karels (UCB)
12 noon	Lunch
1:30 pm	Presentations (Continued)
	Cluster Mask RFCs, C-H. Rokitanski (DFVLR)
	NSFnet Status, H.W. Braun (UMich) and S. Brim (Cornell)
	Multiple Satellite System Overview, D. Mills (UDel)
	IAB Report, Dave Clark (MIT)
5:00 pm	Recess

Friday, October 17

INARC

4. Meeting Notes

4.1 October 15, 1986

The first day of the joint meeting opened with a brief plenary, which included an overview of NASA networks by Milo Medin. The remainder of the day was devoted to three parallel workshops on

Routing and EGP, led by M. StJohns (DDN)
DoD/ISO Interoperability, led by P. Gross (MITRE)
Name Domains for Milnet, led by M. Karels (UCB).

The results of the workshops were reported to the full group on the following day.

4.2 October 16, 1986

The first presentation of the morning, titled Premises Technology Study, was made by Jim Herman (BBN). The goal of this study was to provide DCA planners with information about local (i.e., premise) communications and, conversely, to provide military planners with information on DDN. It turns out that many local planners have little or no knowledge of DDN and the Internet. Herman described large communication architectures for each of the three military services. One mildly suprising result was that all of the services had a long term committment to ISO and/or ISDN, and in some cases preferred their use to DDN. As a result, one of his conclusions was that DDN needed a clear ISO migration path. In addition, he stressed that developments at the premises level will effect all aspects of DDN. Therefore, coordination between DDN and local users is essential.

Marianne Gardner then brightened our day with some sobering news on Arpanet congestion. She noted the interesting facts that data are going farther through the net these days (3.5 hops in June 1986, as opposed to 2.7 hop the previous year) and 5% of the communicating pairs account for 50% of the traffic. Although there are other influencing factors, she contended the current Arpanet congestion problems are due primarily to it's being underconfigured. Based on simulations that showed a reduction in link utilization from 75% to 50%, she recommended the addition of three lines and upgrading five nodes to C-300's. A question, that remained unanswered, was how this proposed upgrade would interact with the NSFnet upgrade.

Mike Karels summarized the results of the Name Domain Workshop. Although their primary focus was to explore the transition to Domains in the Milnet, he cited the following general problems:

- caching of negative replies
- longer TTLs
- sorting of addresses
- retransmission strategy
- unknown effects on mail
- need to extend set of types
- need stable top-level server for Unix

His group proposed a three step transition for Milnet:

1) deploy root servers across Milnet; remove non-Domain names from the host table,
2) assist Milnet in installing standard resolvers and servers; use only domain-style names available from servers,
3) NIC no longer supports Host table

For the first step, they proposed a DDN Management Bulletin directing the NIC to remove all non-Domain aliases from the host table and for users to begin using primary host names.

(Note: Ron Natalie and Mike Karels produced an excellent set of notes from their meeting, as well as provided a number of relevant documents. Their notes and documents are distributed with the Proceedings.)

Mike StJohns reported on the Routing Workshop. He listed several concrete proposals such as:

- Version Negotiation
- Split Updates
- Fixed Metric Routing

He also cited the desparate need for routing cycles and suggested an SPF-type algorithm. He gave proposed packet formats for the first two items above (included in the Prcoeedings) but stopped short of an implementation schedule.

Phill Gross summarized the results of the DoD/ISO Interoperability workshop. He began by repeating some of his talk from the previous IETF meeting in which he described the standards process and gave the status of the relevant ISO standards. He was able to distribute copies of the proposed ANSI X3S3.3 Routing Architecture that is being edited by Paul Tsuchiya of MITRE.

Gross reported that there had been a long discussion in their group concerning interoperability between two pure stacks and between mixed stacks as embodied by Marshall Rose's ISODE work. Although ISODE is clearly important, some in the group felt that the DoD intention of buying off-the-shelf ISO products would lessen ISODE's impact in a DoD transition scheme.

Three alternate approaches were presented for interoperation at the IP level:

1) Separate virtual Internets
2) Mutual encapsulation
3) IP translation

In the first case, certain gateways would have the capability to switch both DoD and ISO IP datagrams. Since there are no ISO routing protocols at the moment, the ISO IP would use either static routing or share the DoD routing tables. In either case, there would be addressing and routing issues to consider. In the second scheme, gateways would encapsulate datagrams of one protocol family when transiting systems of the other type. Neither of these two schemes actually provides interoperation between the families; it provides only for closed communities to use the same facilities. Gross described dual protocol hosts and application layer bridges which could provide such interoperation in the first case.

There were a number of concerns with mutual encapsulation and the group was not able to convince itself that the trouble was worth the value-added. IP translation would be useful only if the two protocol groups were using the same protocols at the higher levels and therefore may have use in an ISODE-type approach. This was not pursued in detail.

Rokitanski presented an overview of two proposed RFC's on his cluster mask scheme. The text is online and he solicited comments from the group. They RFC's, which are in his directory at A.ISI.EDU, are titled:

"Clustering Addressing Scheme" (<roki>rfcclu.txt) and

"Application of the Clustering Scheme to Public Data Networks" (<roki>rfcpdn.txt).

Scott Brim and Hans-Werner Braun presented a status report on NSFnet and related activities. Brim noted that the NSFnet backbone and USAN have been installed. A network based on USAN and NYSERnet, a New York state regional network, are still the process of installation. He cited several other efforts in various states of readiness and drew a picture in which the Arpanet/Internet was a small bubble. Braun gave an overview of Merit and other University of Michican network connectivity. He also had a picture of NSFnet (produced beautifully on a Diamond system), which showed Arpanet as a somewhat larger bubble. He used these pictures to argue pursuasively for Type-of-Service routing.

Dave Mills gave a presentation on the Multiple Satellite System. This is a system of 240 satellites randomly positioned in 800 Km orbits. In such a system, each satellite has about 37 crosslinks at any time. These crosslinks would be changing constantly but for now only the static case was investigated. The large number of nodes and high degree of conectivity makes this a very complex problem. Mills presented four alternative routing algorithms and gave simulation results.

Dave Clark gave a report of the Internet Activity Board (IAB) meeting from the previous day. He said that there is a new task force proposed to coordinate activities on the proposed Inter-agency Research Internet (IRI). He reported that a new chair had been designated for the Autonomous Systems Task Force. He also reported on the Network Program Advisory Board (NPAG), chaired by Dave Farber, that will assist NSFnet into existence. It will have three subcommittees dealing with policy, operations and technical issues. It was suggested that the technical group might never meet but, if it did, it might very well coordinate activities with the IETF. Clark mentioned a proposed newsletter by Dan Lynch and a proposed effort called the Coalition for Working Systems. He finished with an interesting discussion in which he said that the IAB is not purely a DARPA vehicle but rather has inter-agency responsibilities.

4.3 October 17, 1986

Friday was an INARC day and was spent discussing long range requirements. It was a rapid paced, far ranging discussion, in which the realities of funding and level of contributions by current participants was never far from the central issue. It was hard for this Scribe to both keep notes and participate (believe me, you had to be there).

Both Mills and Clark pitched new ideas and new management. Clark, in particular, returned to the idea of a new "Blue Sky" Task Force to help set future long term directions. When Mills made a list of the topics that INARC had attacked (which included subnetting, congestion control, routing and EGP, partitioned nets and host-to-gateway requirements), it was pointed out only subnetting had reached any sort of resolution. Clark responded with a list of both mid-range issues for an "IRI Task Force" and long term topics for a "Blue Sky Task Force"

Mid Range IRI Issues

- minimum delay routing
- multi-path routing
- dial-up links
- type-of-service routing
- ISO transition
- null networks
- open management architecture
- congestion control
- size
- speed

Long Range Blue Sky Visions

- speed (1-100 Gbps medium, 10-100 Mbps to application
- size (up to 200 million endpoints, i.e. approaching telephone)
- dynamics (cf, cellular telephones and human moblity)
- security
- robustness
- resource control
- cost ($100 - $1000 per endpoint)

Clark pointed out that the highest TCP speed today was about eight megabits per second for a Cray to Cray transfer over a Hyperchannel. He contrasted this with the backplane needed in the entire net if you want to do full screen video page updates rapidly (eg, .1 - 1 second). He said that you can't afford a lot of queuing with that type of speed so he envisioned that pure packet switching is not the answer. As examples of applications that would require that type of networking capability, he cited three projects proposed by Cerf and Kahn. They are a National Library System, a National Knowledge Base and and an Information Infrastructure.

It was pointed out that there are at least three good opportunities for experimentation within the present Task Force activities. These were

- congestion control using Nagle and Zhang's proposals,
- type-of-service routing using the NSFnet topology and
- Rokitanski's very well thought out Cluster Mask scheme.

This led to another discussion of IETF and INARC goals and how objectives can be reached, during which Clark reiterated the need for two new Task Forces (IRI and Blue Sky). The meeting was finally adjourned by the airline schedule.

Appendix A - Presentation Slides

1) Premises Technology Study, J. Herman (BBN)

2) Arpanet Congestion, M. Gardner (BBN)

3) Workshop Reports

- Routing and EGP, M. StJohns (DDN)
- DoD/ISO Interoperability, P. Gross (MITRE)
- Name Domains for Milnet, M. Karels (UCB)

4) Cluster Mask RFCs, C-H. Rokitanski (DFVLR)

5) NSFnet Status, H.W. Braun (UMich) and S. Brim (Cornell)

6) Multiple Satellite System Overview, D. Mills (UDel)

Presentation Slides

1) Premises Technology Study, J. Herman (BBN)

Presentation Slides

Premises Technology Study

Jim Herman

Director, Telecommunications Consulting

BBN Communications

Note to Reader: Beware, some of these slides ~~are~~ look better with the accompanying briefing

Outline

- Goals for the Study
- Service-Wide Architectures
- Current Environment
- Conclusions So Far

Goals for the Study

- Provide DCA Planners with Information and Insight on Local Level Communications
- Provide MILDEP Planners with Information and Insight on DDN
- Recommend Changes to DDN to Better Accomodate Future Military Premises Communication Systems
- Recommend Guidelines for Military Premises Architectures that Promote Full Function Interoperability with DDN

Planners on Premises have little knowledge of DDN + Internet

Interviews

- USAISC - Ft. Huachuca
  Plans, Systems and Technical, Reqs.
- Starnet PMO and ISEC - Ft. Belvoir
- NAVDAC - Wash. Navy Yard
- AFCC -Scott AFB
- USAF/SIT - Pentagon
- USAF/ULANA PMO - Hanscom AFB
- OSD/ASD (C^3I)/IS
- Commands:
  USAF ASD, USAF AFLC - WPAFB
  NARDAC, NAVSEA - DC
- DCS Integration Directorate - DCA HQ
- Pentagon - Defense Telecom. System
- Ford Motor Company

White Papers Produced

- Service-Wide Architectures
- DoD Internet Architecture
- LAN Technology
- PBX Technology
- Datakit Technology
- FDDI Standard
- LANs vs ISDN

Outline

- Goals for the Study
- **Service-Wide Architectures**
- Current Environment
- Conclusions So Far

Service-Wide Architectures Info Systems

- Existence of Service-Wide IS Planning is a Significant Finding — Since ~82
- Service-Wide Architectures Still in Very Early Stages of Development
- Service-Wide Architectures Have Little or No Effect on Today's Procurements
- Services Planning for Common-User Local Communication Systems (LANs and ISDN)

Service-Wide Architectures

Local Communication Systems

- Air Force, Army, and Navy Committed to ISDN for Long-Term (Late 1990's) for Voice + data
- Air Force and Navy Include LANs as Well
- Efforts Underway to Assess Requirements for Common User Local Comm. Systems
- Complex Multiple LAN Environment Seems To Be Most Likely Outcome for Early 1990's
- Long-Term Commitment to ISO Protocol Standards by all Services — Navy + Army prefer ISO
- Long-Term Commitment to Optical Fiber Cable for Base Backbone Wiring — 56KB DDN backbone will be too small when bases have fiber local nets
- Air Force Pushing DoD Standards for Near-Term
- Army and Navy Showing Little Support for DoD Protocols

Question: what is DDN for? How to plan for it?

"ISO is only chance for service inter-op. DoD has no chance."

→ Not looking at Tactical Comm.

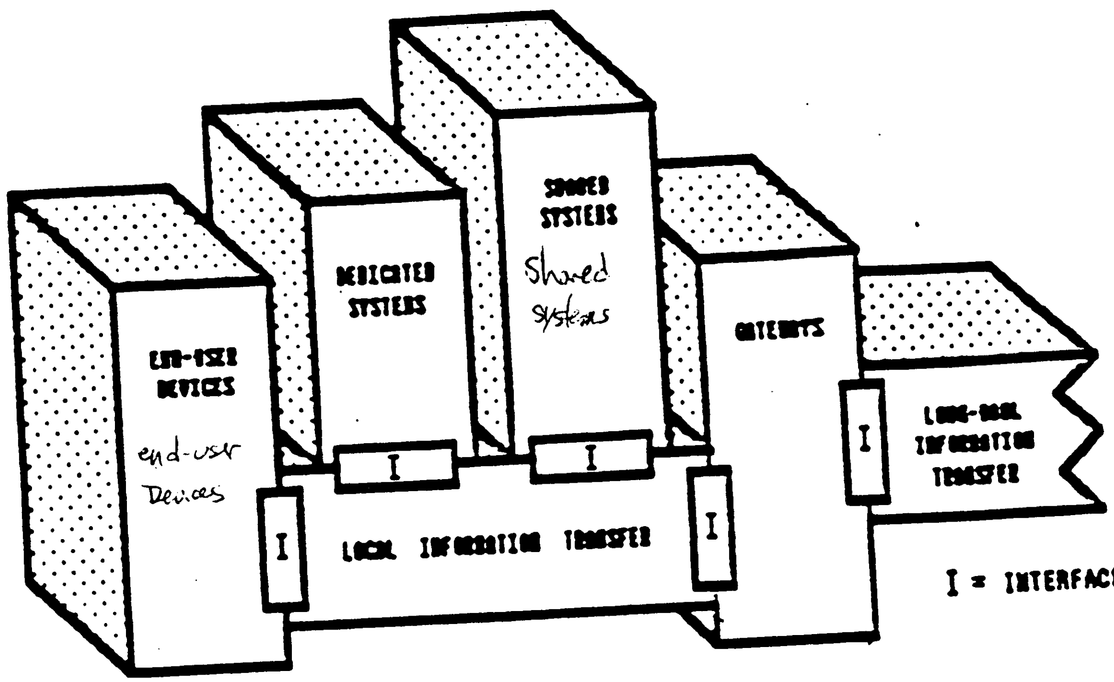
Air Force

Air Force Target Architecture - LITA
Local Information Transfer Architecture

Next 3 pages of figures

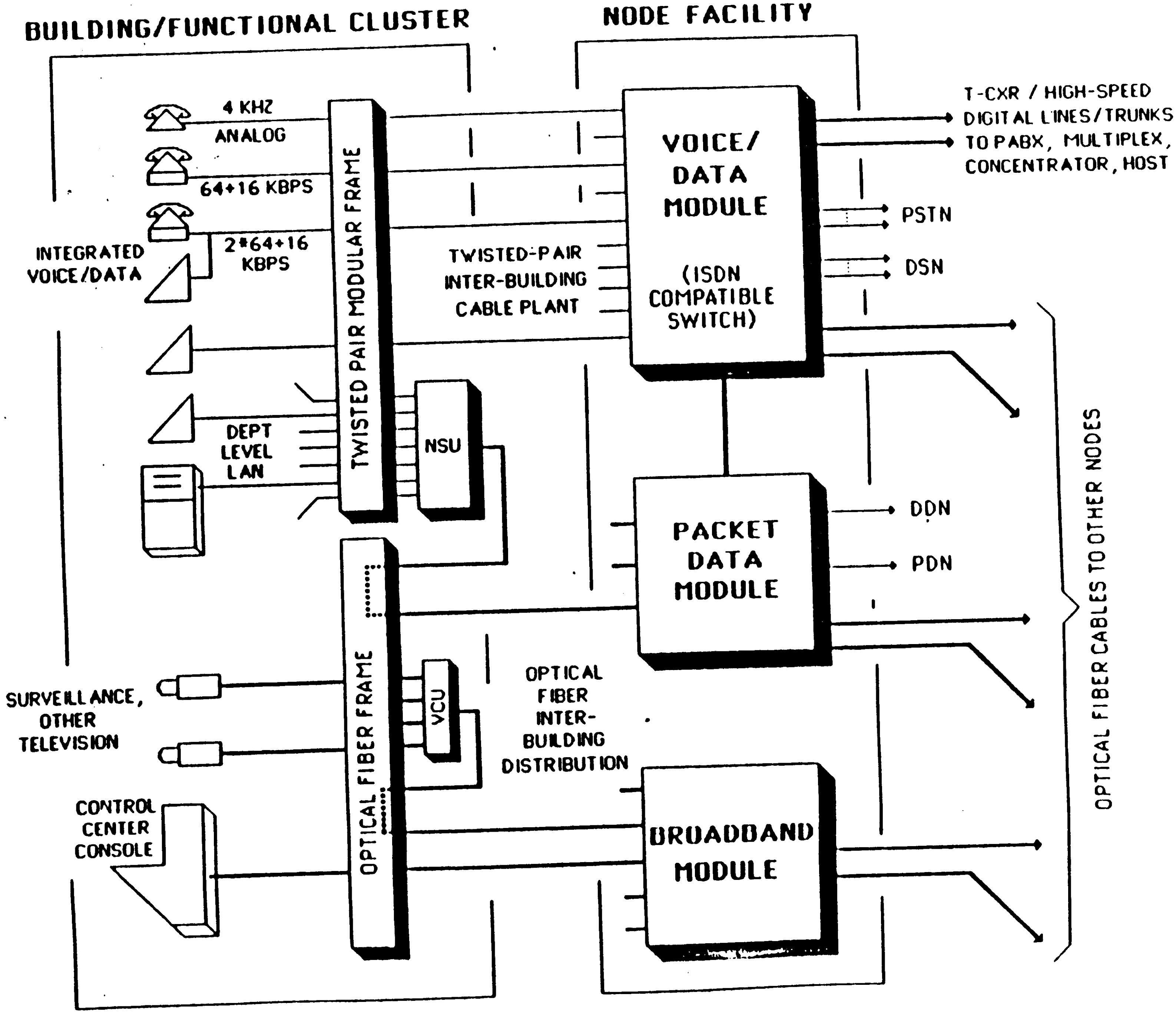
- One or More Information Nodes Containing ISDN Switch and Packet Data Module
- Low-Speed Data Access (<64 Kbs) to Packet Data Module via ISDN Switch Over Standard Twisted Pair
- High-Speed Data Access (Several Mbs) Through Departmental-Level LANs Connected to a Packet Data Module
- Packet Data Modules will Interface to Long-Haul Services — some sort of gateway
- Fiber Optic Cable Used to Interconnect Information Transfer Nodes and to Connect LANs to Packet Data Module
- IEEE Standards Adopted for LANs (802.2,3,4,5)

Ulana becomes a component of LITA

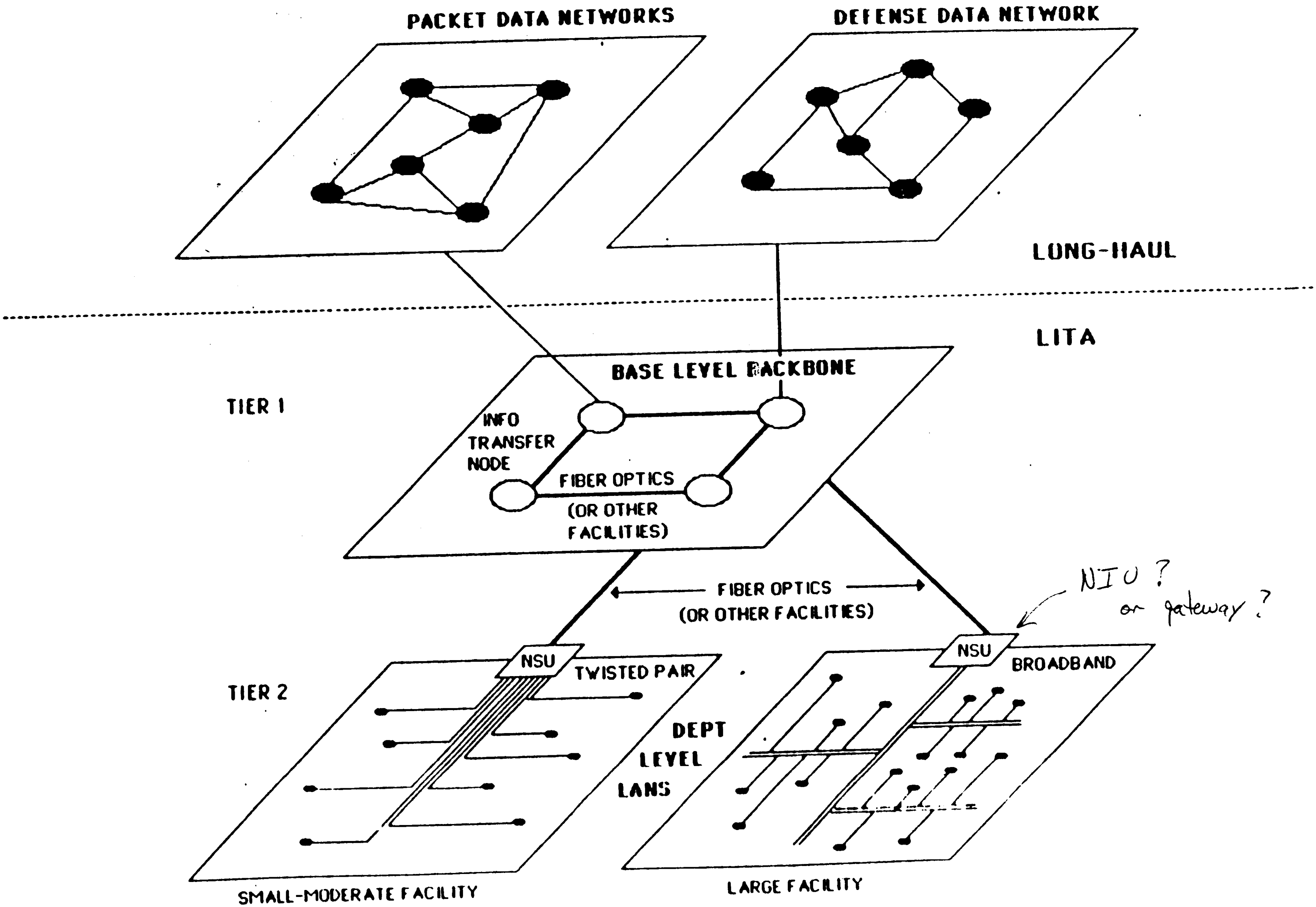


- management + control } blocks not shown on above picture
- Security

Information Systems Conceptual Building Blocks



LOCAL INFORMATION TRANSFER SYSTEM



LITA - PACKET DATA ARCHITECTURE

Next 3 pages

ARMY Information Architecture

- Three-Tier Architecture

means until ISO is commercially available

- SNA is Chosen as Near-Term Communication Architecture for Tiers 1 and 2
- Long-Term Architecture is ISDN and ISO Protocols, FDDI For Host-Level LANs

Fiber Dist. Data Interface

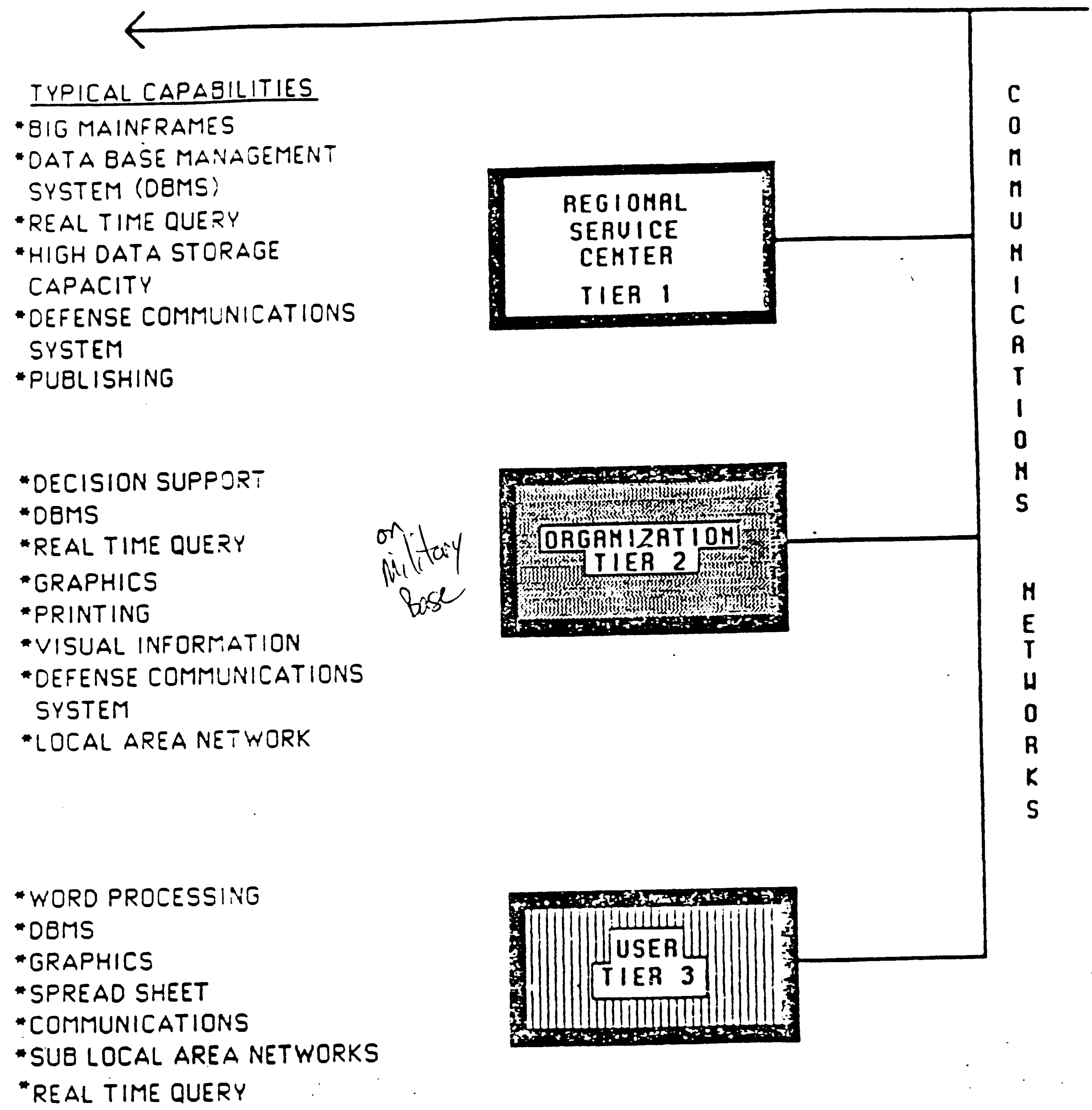
- IEEE 802.3 LAN a Near-Term Standard But ISC Reviewing Existing LAN Programs
- Strong Commitment to Fiber as Opposed to Coaxial Cable - Coax Viewed as Mistake

All fiber by year 2000

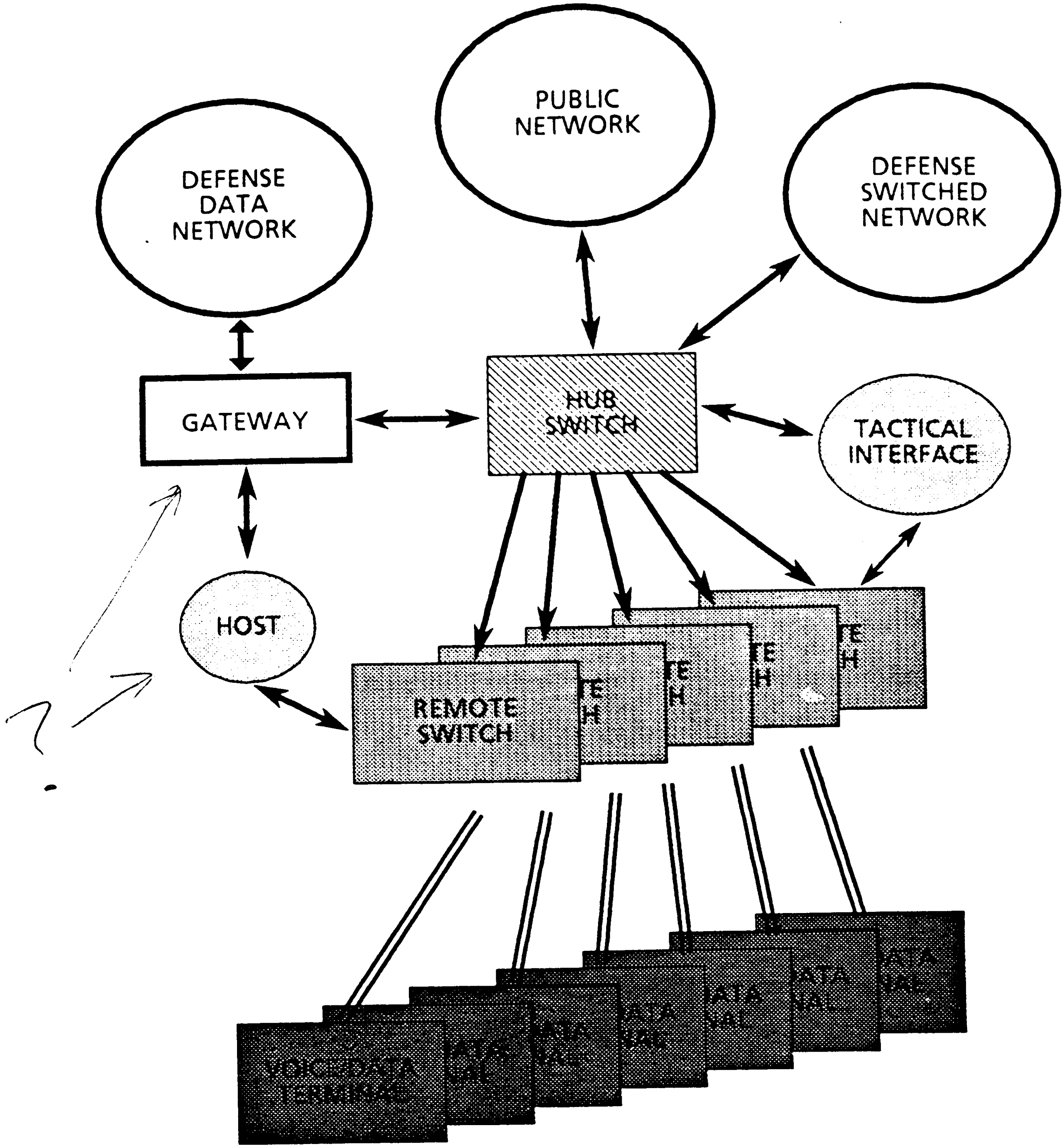
Info. Sys. Com ? Army Phone Company

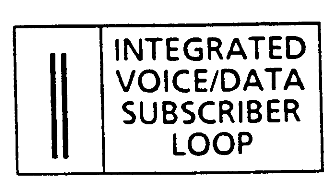
- ISC Prefering Data Switching (RS232) to LANs For Office Communication
- Proposing Use of Data Concentrators/Switches Located at Planned Locations for ISDN Switching Elements and Interconnected by Fiber Optics

- Most planners have voice background.



Three tier structure capabilities

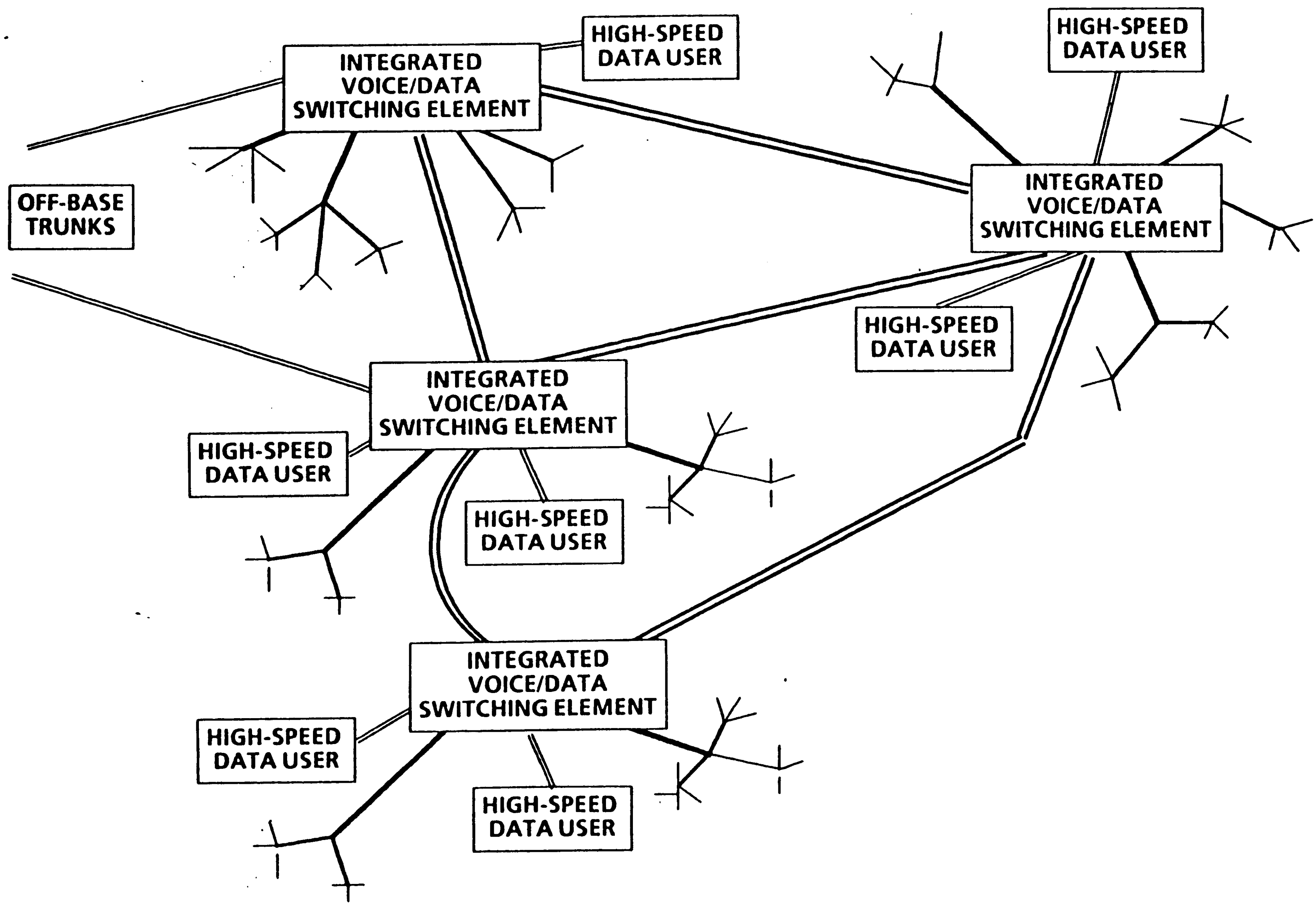




Long-term Architecture

somewhat conflicts with next page

INTEGRATED VOICE/DATA TELEPHONE SYSTEM

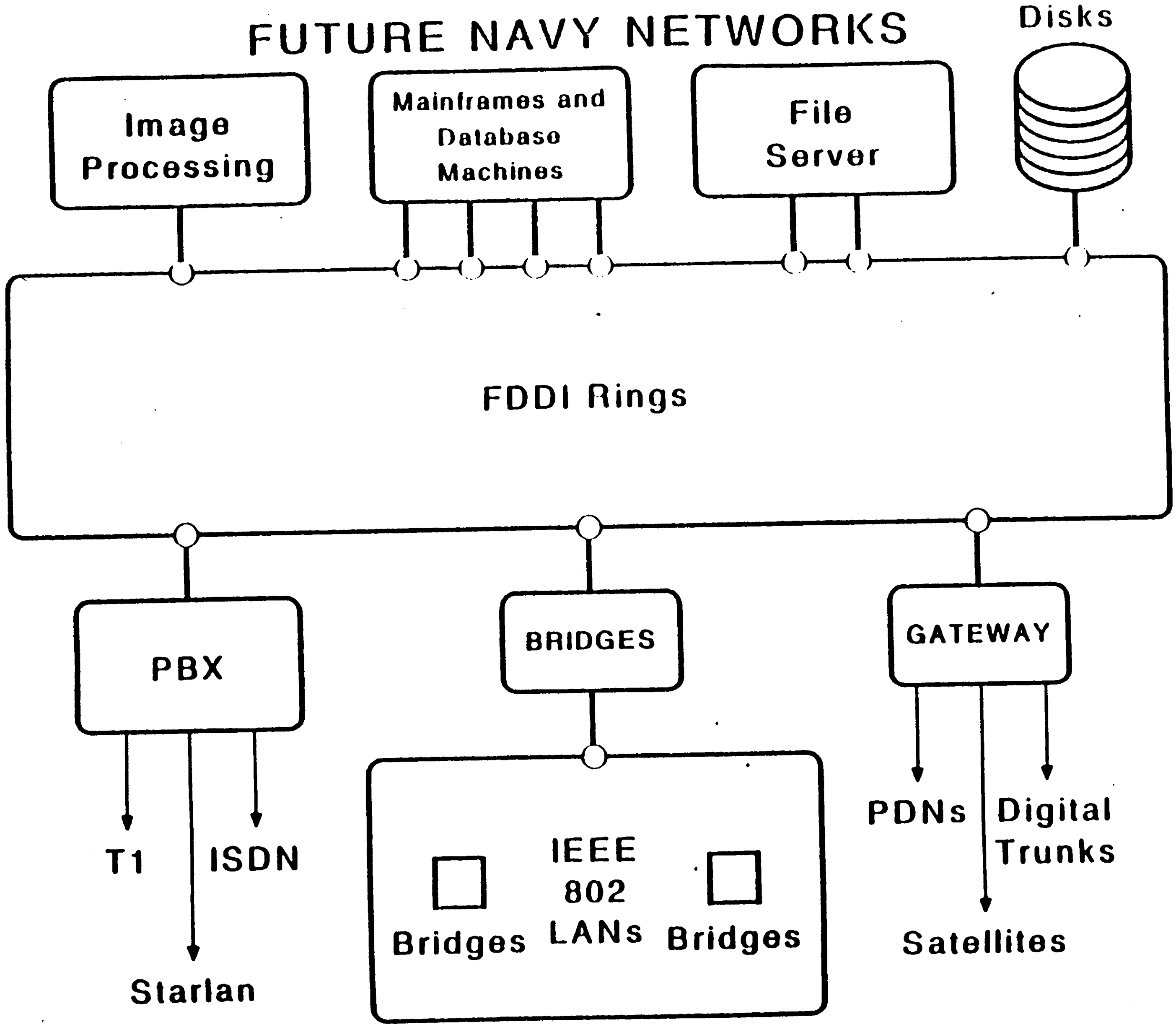


Next 2 pages

Navy Network Program

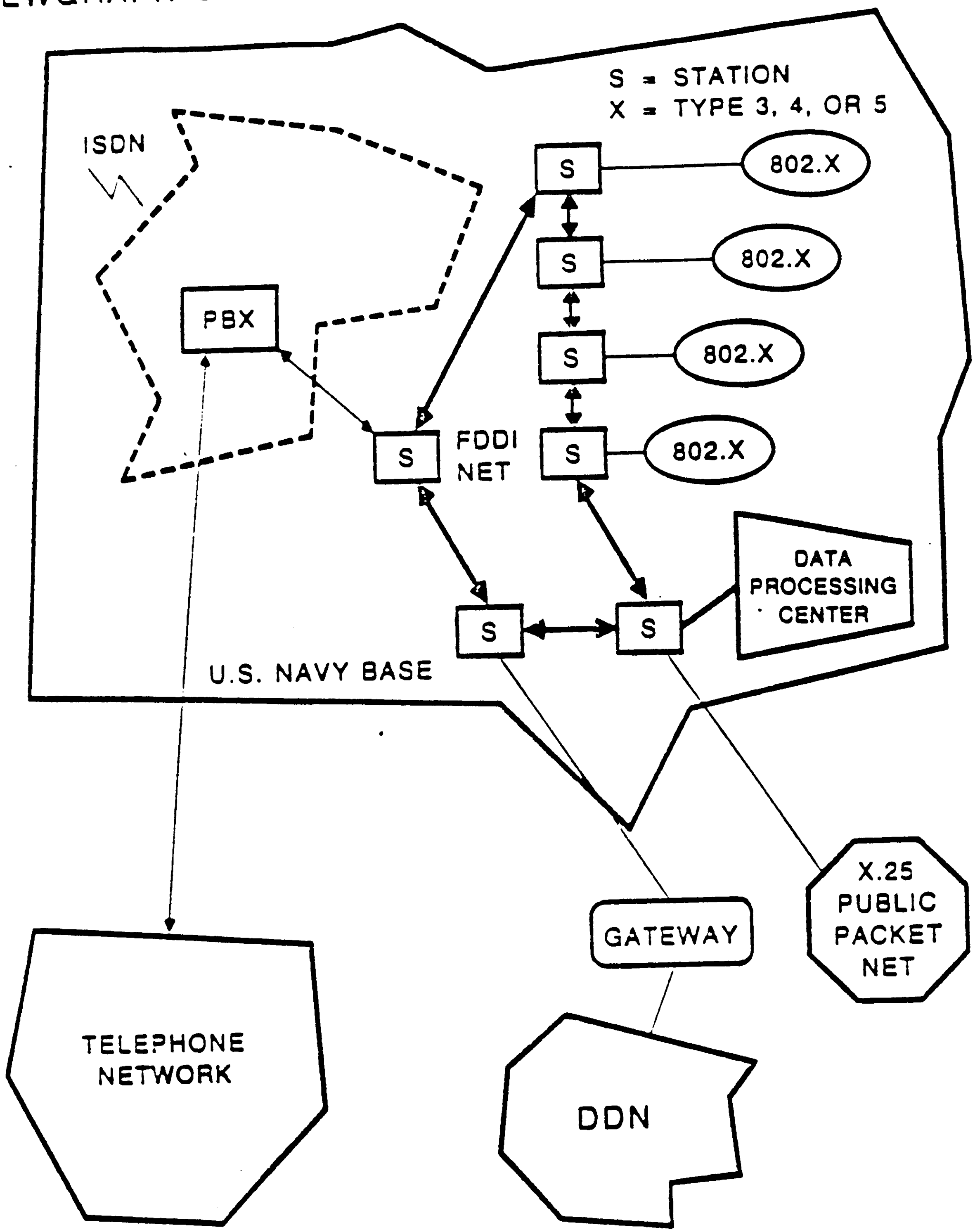
- ISO Protocols - only lukewarm interest in DoD protocol
- LANs and ISDN
- Promoting Fiber Distributed Data Interface (FDDI) as LAN Backbone
- IEEE LANs (802.3,4,5)

FUTURE NAVY NETWORKS



Land Based Arch.

VIEWGRAPH OF FULLY EVOLVED NAVY ARCHITECTURE



Service-Wide Architectures and DDN

- Service-Wide Architectures Call for Significant Use of DDN
- DDN Becomes Wide-Area Interconnect Between Local Comm. Systems rather than Interfacing Individual Hosts
- Gateways Between DDN and Local Comm. Systems Will be Services Responsibility

  Services want GW, means very distributed control of GWs + Internet

- Local Comm. Architectures Do Not Seem to Recognize DoD Internet Architecture

Army - ISDN more than ~~over~~ LAN

Navy - LAN more than ~~over~~ ISDN

AF - more Balanced

DoD Internet Architecture

- The DoD Protocol Suite (TCP/IP in Particular) Anticipates a Complex, Multi-Network Environment

- The DoD Internet Includes an Addressing Scheme which Should Apply to ALL DoD Common User Communication Systems

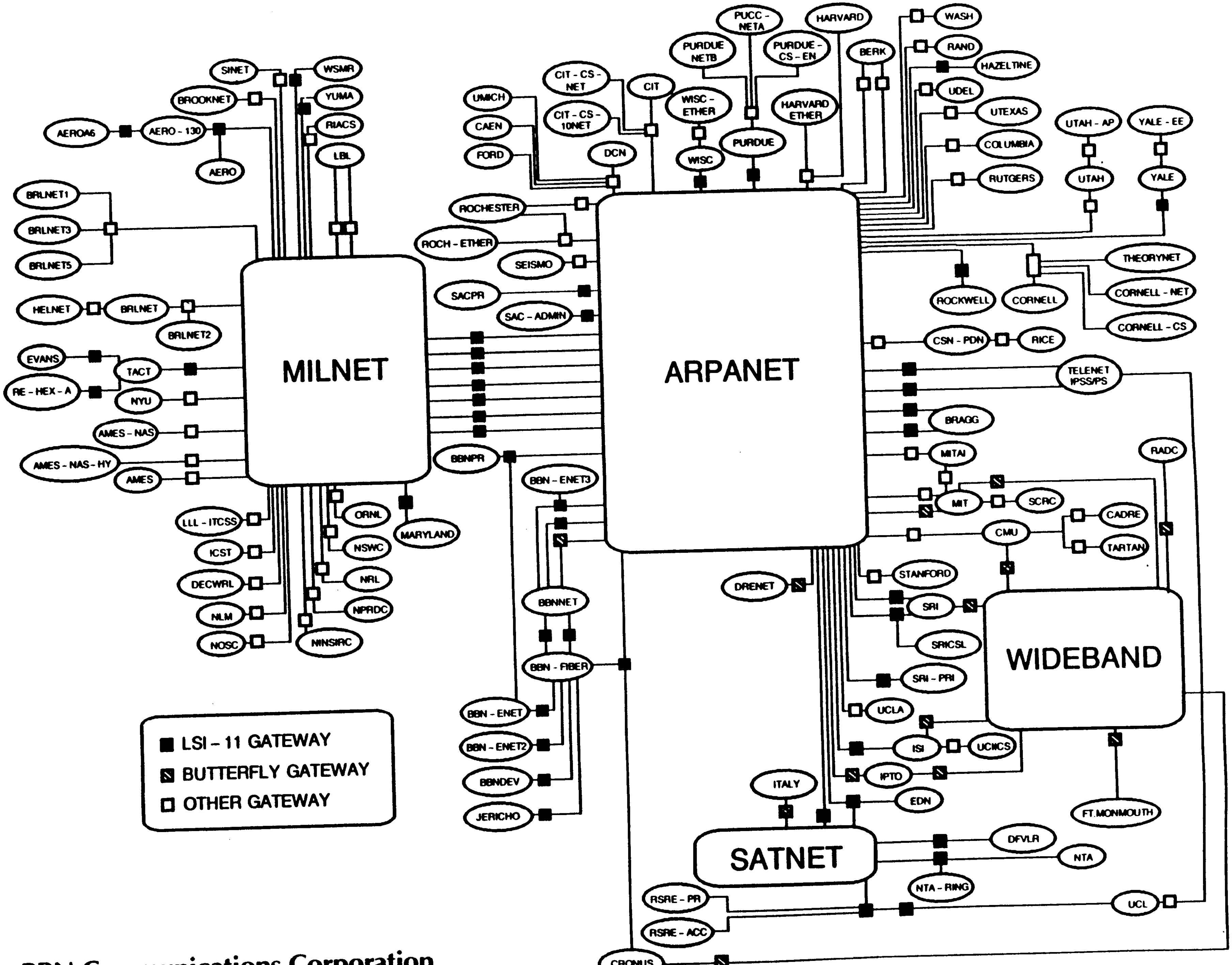
- Addressing and Directory Services Do Require DoD-Wide Coordination

- The DoD Internet Systems Today Services Over a Hundred LANs Connected to Either MILNET or ARPANET

- Today's Internet Gateways Implement Standardized Protocols That Allow for the Connection of Common User Local Comm. Systems To DDN

- The DoD Internet Requires Significant Evolution to Meet the Growth in Base-Level Common User Comm. Systems

    - Access Control
    - Addressing
    - Directory Services
    - ISO Migration



BBN Communications Corporation

Outline

- Goals for the Study
- Service Architectures
- **Current Environment**
- Conclusions So Far

Current Environment

- Dominant Local Communication Technology is Twisted Pair, Point-to-Point Circuits
- Significant Purchases in LANs are Taking Place in All Services
- Most LAN Purchases Today are for Wire Replacement Rather than True Networks
- Many LANs Offer only RS232 to RS232 and Provide Terminal-to-Host Connectivity
- Most LANs Use Vendor Proprietary Protocols Rather than TCP/IP
- Migration to Host-to-Host Transfers and Use of TCP/IP over LANs Likely In Next Two Years

Current LAN Technologies

- Broadband LAN (CATV) is Dominant For Military Base Applications

- Ethernet Popular In DEC-oriented Environments

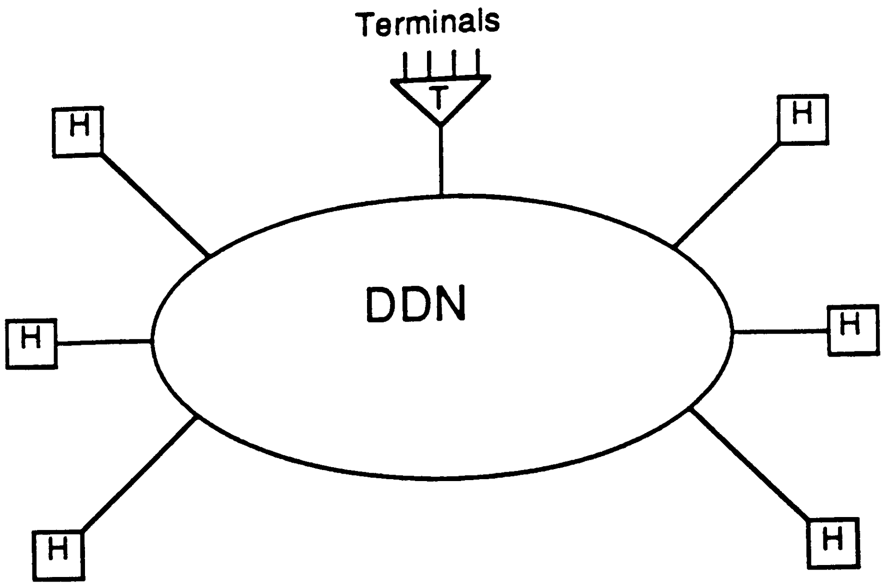
- Most Vendors Still Concentrating on Proprietary LAN Protocols

- Open Systems LANs Generally Cost Significantly More than Vendor-Specific

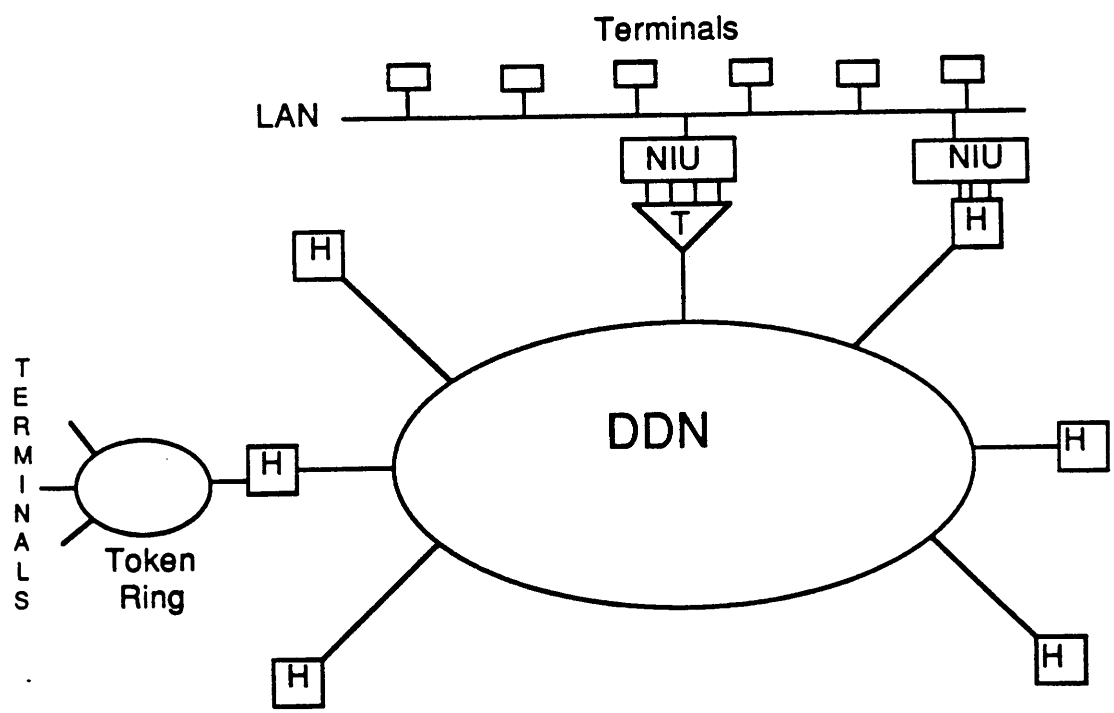
Current Environment and DDN

- Gateways to DDN Must Provide Full Set of DoD Protocols
- LANs Viewed Largely as Backend Terminal Connection Mechanism
- Few Hosts Expect to Connect to DDN Over a LAN Today
- LAN-TAC Connections Very Important

Most have misguided idea of "gateway"



Original DDN



→ Misguided Usage today

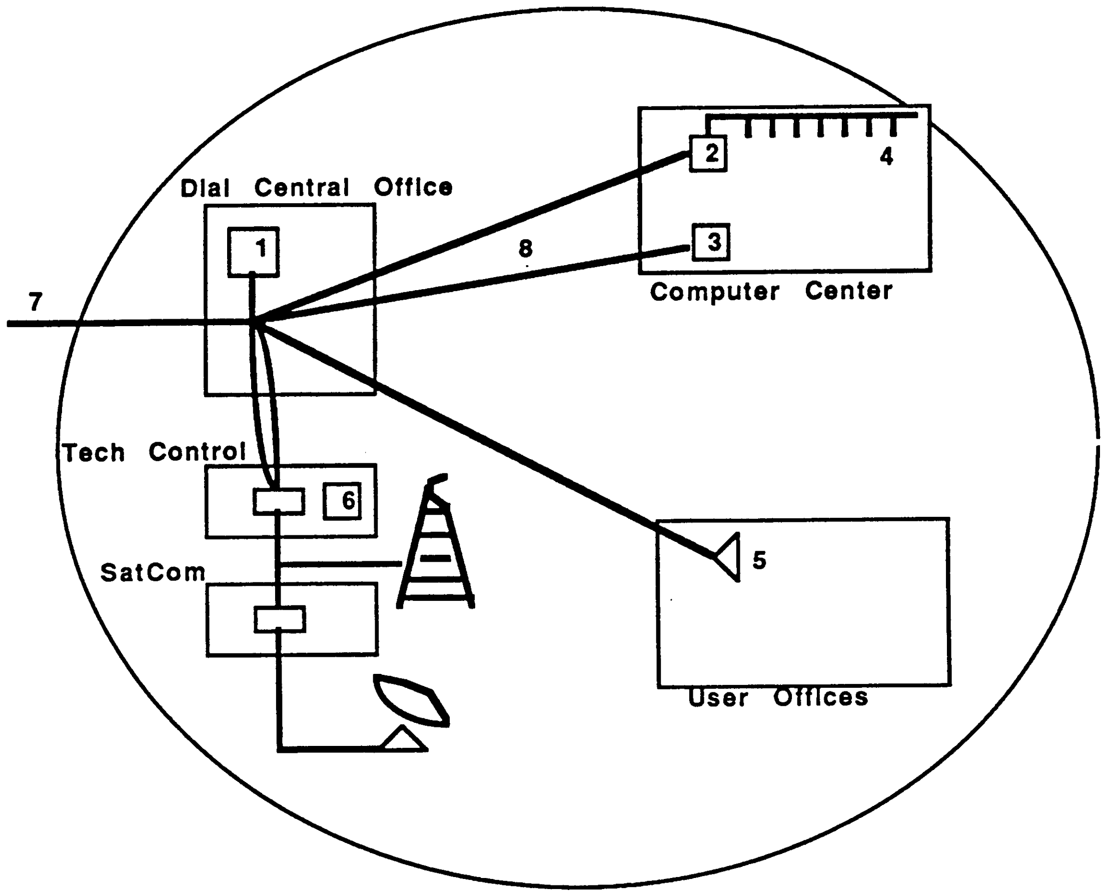
LAN Use on DDN Today

Current Environment

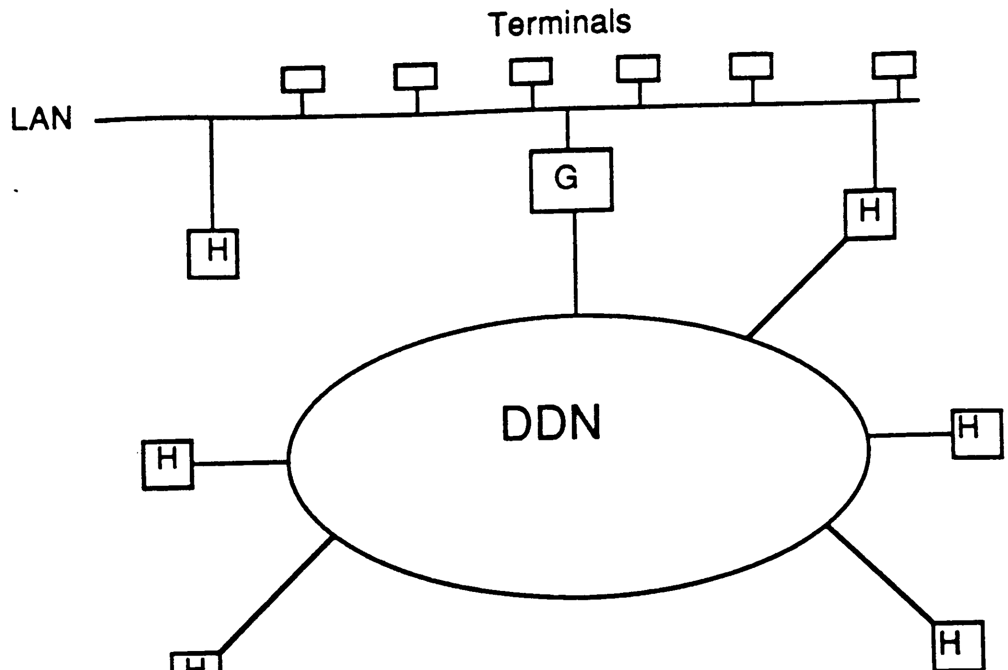
Example Military Base

- Tech Control is Hub for Premises Communication
- Personnel in Tech Control Understand Cables, Modems, Etc. And They Have Test Equipment
- Dial Central Office Serves as a Wire Hub But Personnel Not Oriented Towards Data
- Computer Centers are User Oriented and Do Not Have Proper Test Equipment
- Putting the PSN in Tech Control Would Simplify Troubleshooting Wide-Area Circuits
- On-Base Circuits Remain Troubleshooting Problem
- Could Use Multiplexors to Use Fewer Wires Between Tech Control and Other Buildings
- Future Developments
    - Multiple Entry Points for Wide-Area Circuits
    - Architectures May Distribute Wire Hubs
    - Base Information Management Centers Planned
    - BIMC May Need Status Link to DDN MC
    - Base Will Increasingly Take First Responsibility for User Support Function

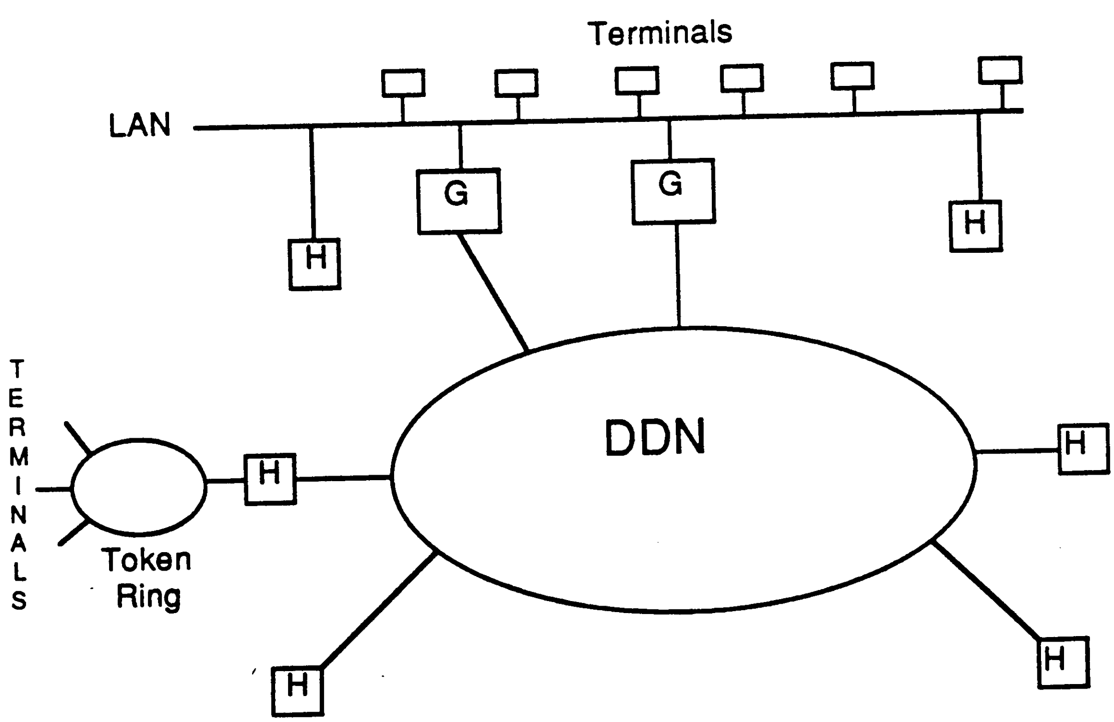
Example Military Base Today



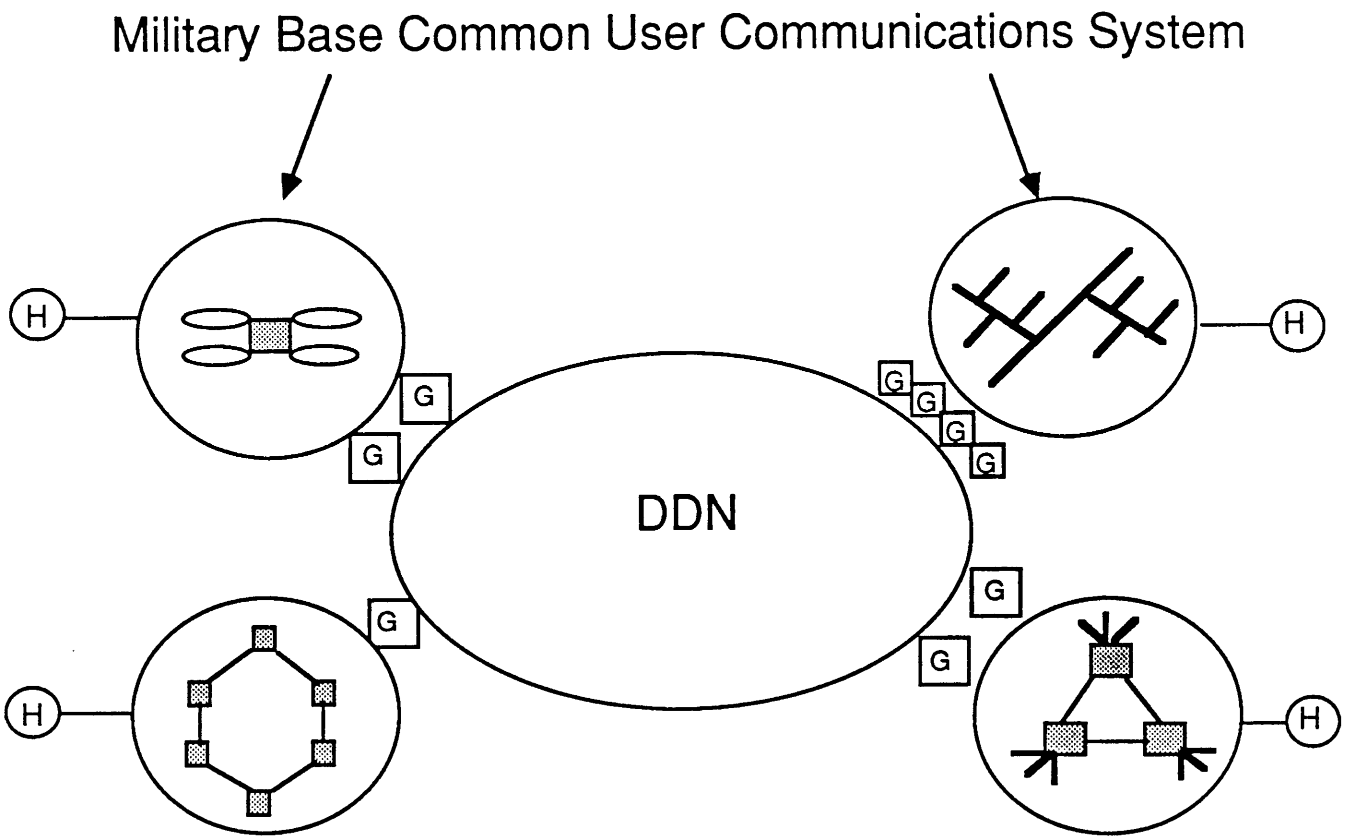
1. Central Office Telephone Switch
2. Gateway to LAN
3. Host Computer
4. Local Area Network (LAN)
5. TAC
6. PSN
7. Wide-Area Terrestrial Circuits
8. On-Base Twisted-Pair Circuits



LAN As Network



Reliable Connection of LAN



Eventual DDN

Outline

- Goals for the Study
- Service Architectures
- Current Environment
- **Conclusions So Far**

Conclusions

- DDN Must Prepare for Attachment of Common User Communication Systems
- Developments at the Premises Level Will Effect All Aspects of DDN's Architecture
  - Interface Speeds, Protocols
  - Types of Services Required
  - Management Procedures and Relationships
  - Tariff and Access Control
- Gateways to LANs, ISDN Data Modules will be Primary DDN Subscribers
- DDN Migration to ISO Standards Essential
- Access Control, Addressing, Directory Services, and DoD-Wide Network Management are Key Issues to Resolve
- Service-Wide Planning Should Factor the DoD Internet Architecture Into Their Architectures
- Coordination Between Local-Level and DDN Planning is Essential for Effective End-to-End DoD Communications
- Common-User Systems Will Improve the Reliability, Survivabilty, and Manageability of All DoD Systems

2) Arpanet Congestion, M. Gardner (BBN)

Presentation Slides

ARPANET CONGESTION:

Background

- Traffic up
- Traffic Patterns changing

  data going farther

last year	June '86
2.75	3.54

  (weighted min hop mean)

- Small percentage of host pairs dominate

  5% of communicating pairs → 50% traffic


% total
# host pairs
# com pairs

- gateway traffic dominates

ARPANET

HTM STATISTICS PARTITIONED BY THE PRESENCE OF ONE OR TWO GATEWAYS IN THE HOST PAIR (Based on 5-day collection June zz to zz, 1986)*
20 26

	TOTAL TRAFFIC	NO. OF PAIRS
GWY-GWY	50,641,512	1503
GWY SOURCE	18,943,512	2185
GWY DEST.	17,821,290	1907
HOST-HOST	15,247,823	2405
ALL PRS	102,653,943	8000 15.6% of poss

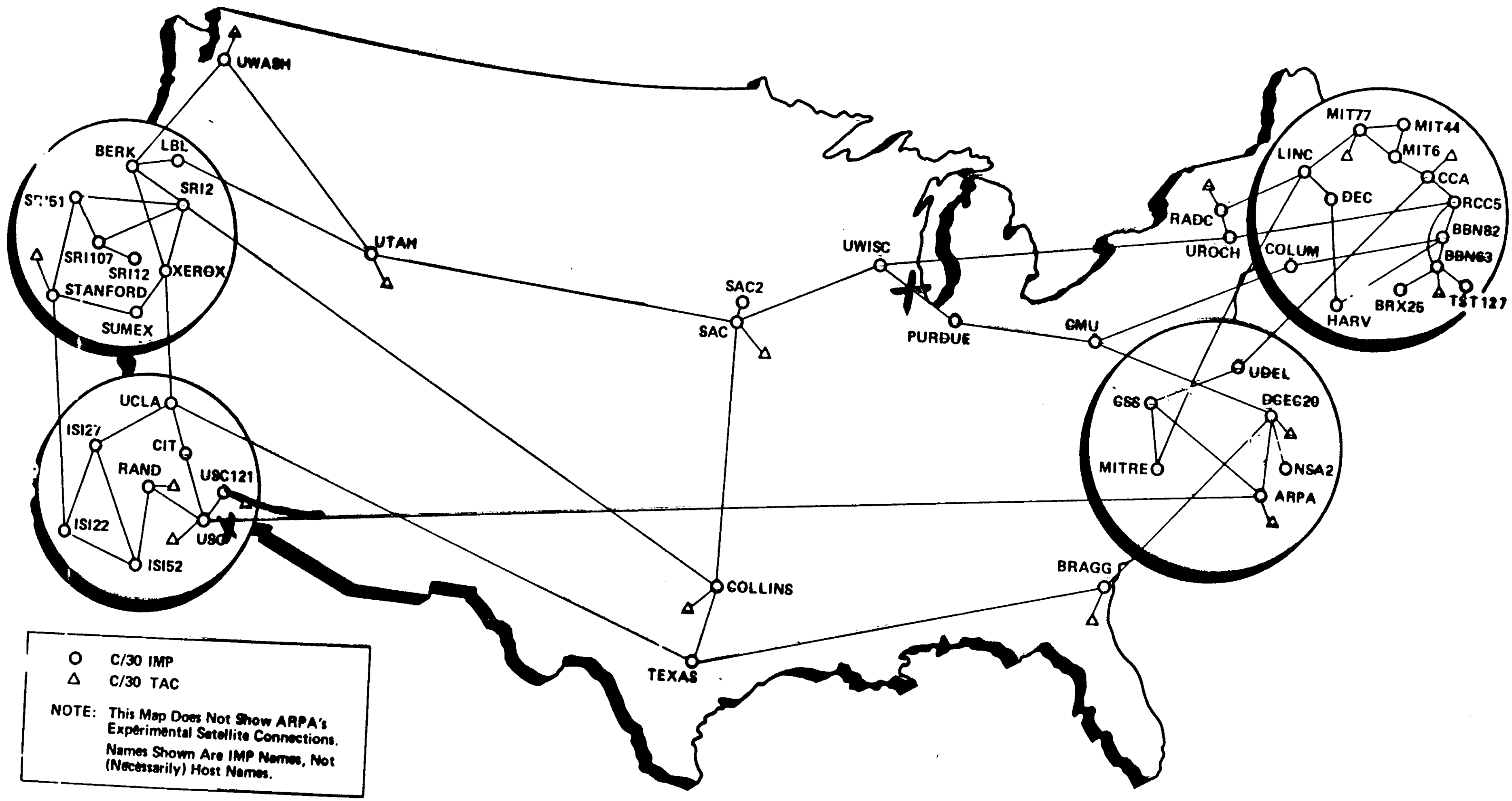
	% OF TOTAL TRAFFIC	TOP 5% OF THIS TRAFFIC
GWY-GWY	49.33%	42.55%
GWY SOURCE	18.45%	63.72%
GWY DEST.	17.36%	64.32%
HOST-HOST	14.86%	70.21%
ALL HOST PRS	100.00%	48.31%

*corrected for gateway test-host traffic

- Topology unchanged since 1984

Except for the worse

ARPANET Geographic Map, 31 March 1986



Problem:

underconfigured

modelling shows that with the addition of 3 lines, upgrade of 5 nodes:

	before	After
max link util	75%	51%
max node util	69%	41%
diameter	11	8

Recommendations:

MIT77 – SRI 51

COLUM – ISI 22

5 upgrades to C300 s:

ISI 27

UCLA

RCC5

UWIS

SRI 51

Other factors:

- microcode bug
- new mailbridge release
- new loadsharing
- Parameter tuning

There are problems here because of the congestion because ARPANET is under-configured.

3) Workshop Reports

- Routing and EGP, M. StJohns (DDN)
- DoD/ISO Interoperability, P. Gross (MITRE)
- Name Domains for Milnet, M. Karels (UCB)

Presentation Slides

3) Workshop Reports (Con't)

- Routing and EGP, M. StJohns (DDN)

Presentation Slides

Accomplishments

1) Version Negotiation

2) Split updates

- info tagged with seq #
- poll requests info later than seq #
- update sends data, highest + lowest seq # in packet + highest seq # avail
- Neighbor allowed to repoll if more data available

3) Fixed Metric Routing

Problems

1) Desperate need for cycles
- NSF Net!

2) If cycles + old algorithms, may have count to infinity problems

Suggestions

1) SPF?

2) Cheat

Discussion

1) Implement short solution as other (longer-term) fix

2) Who does basic research?
   - Cycles
   - Multipath

3)

Acquisition/Response

header	
Chksum	AS #
Seq #	Hello
Poll	Fast Poll

Hello

header	
Chk sum	AS #
Seq #	
Data Seq #	

0 = Not Providing Info

N = last significant topology change

Poll

Vers	Type	Code	Status
Chksum		AS#	
Seq#		~~Flag~~ ~~Alt entries~~	
IP source Network			
Req Seq #			

Update

header			
Chksum		AS#	
Seq#		# Entries	
IP source Network			
Start Seq #			
End Seq #			
Top Seq #			
TTL			

~~Int/ext Gwy~~ ~~lowl Gwy Addr~~

Flag	Local Gwy Addr
Destination Net	Distance

3) Workshop Reports (Con't)

- Routing and EGP, Associated Slides

Presentation Slides

Some current problems in implementations which need to be fixed:

- ARP caches without timeout
- Incorrect ICMP Redirect handling
  - Redirect ignored
  - no chang in real time but only on the next connection
  - ARP cache entry not flushed as a result of a Redirect
- "Reintroducing" ICMP Source Quench?

(Not unique to) NSFnet backbone problems:

- 2 Minute holddowns and n-minute route reconstruction leads to net unreachables

  ⇒ user timeouts, connections break

- Link declared "good" too early

Need for:

- Throughput leveled measured over time
- delay measured over longer time
- Route changes without hold-downs
  - ⇒ continuing as degraded service via
    - 2nd best path
    - nth best path
- detection of down links and switch to alternative in real time, i.e. < 1 minute.

Routing metrics:

- Delay vs. hopcounts
- Throughput vs. delay

NEED FOR

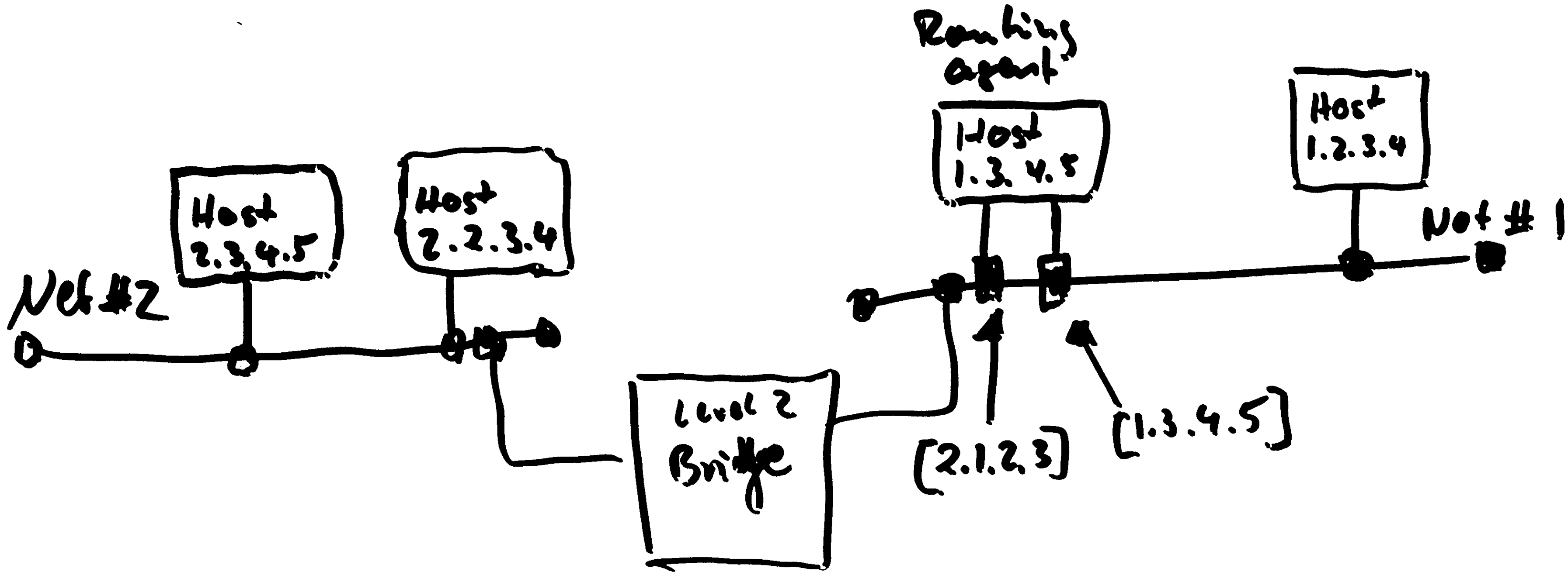
⇒ Routing for high speed networks, but without taking over significant amounts of bandwidth.

⇒ utilizing lower bandwidth links, too.

⇒ ICMP extensions, e.g., to detect gateways

Concatenated Ethernets (e.g. USAN)

ARPs from foreign nets



Host 1.2.3.4 to Host 2.3.4.5

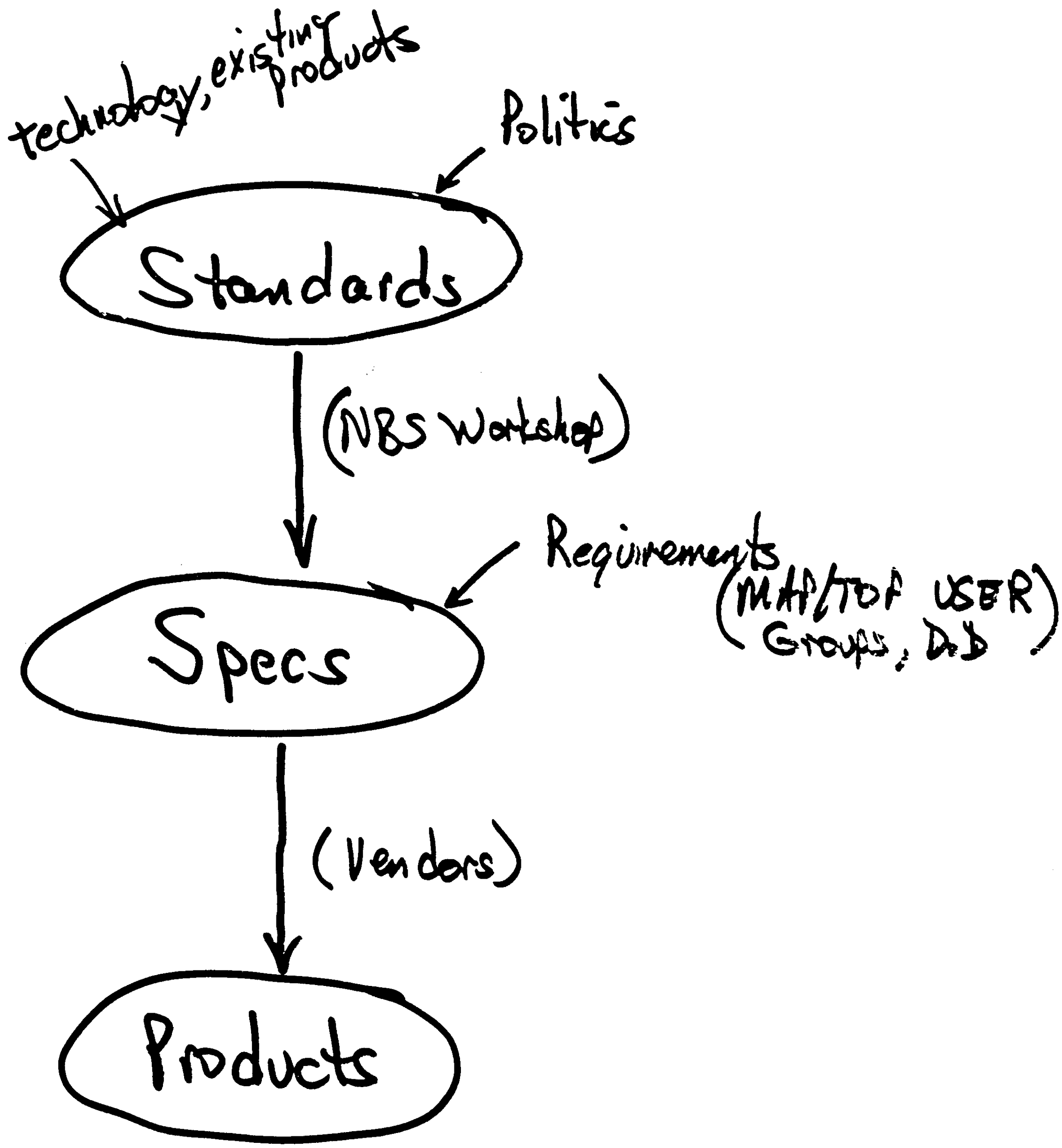
ARP for:

- final destination on different net?
- routing agent "who knows" on local net

3) Workshop Reports (Con't)

- DoD/ISO Interoperability, P. Gross (MITRE)

Presentation Slides


technology, existing products
Politics
Standards
(NBS Workshop)
Requirements (MAP/TOP USER Groups, DoD)
Specs
(Vendors)
Products

Proposed Architecture

Level 0 : ES-IS

Level 1 : Intra-Domain IS-IS

Level 2 : Inter-Domain IS-IS

Differences + Issues

- Domains are Political + administrative
- Networks are part of Domains
- Have yet to address reachability vs. routing
- Not extensible past 3 Levels

Status of ISO Standards

Complete

ISO 8473	IP
ISO 8473/DAD1	Underlying Service
ISO 8473/PDAD2	Formal Description (ESTL)
ISO 8348	Network Services Def.
ISO 8348/AD1	Connectionless NSD
ISO 8348/AD2	NSAP Addressing
ISO 8648	Internal Org. of Net. Layer
SC6-N4053	ES-IS Protocol (DP in 10/86)

Status (Cont)

In Progress

→ Routing Framework
- Exact Def of Routing
- Intersection of Routing Framework with Management Framework
  - When to use Net layer vs. Appl. layer for routing
  - Motivation for ES-IS vs IS-IS split

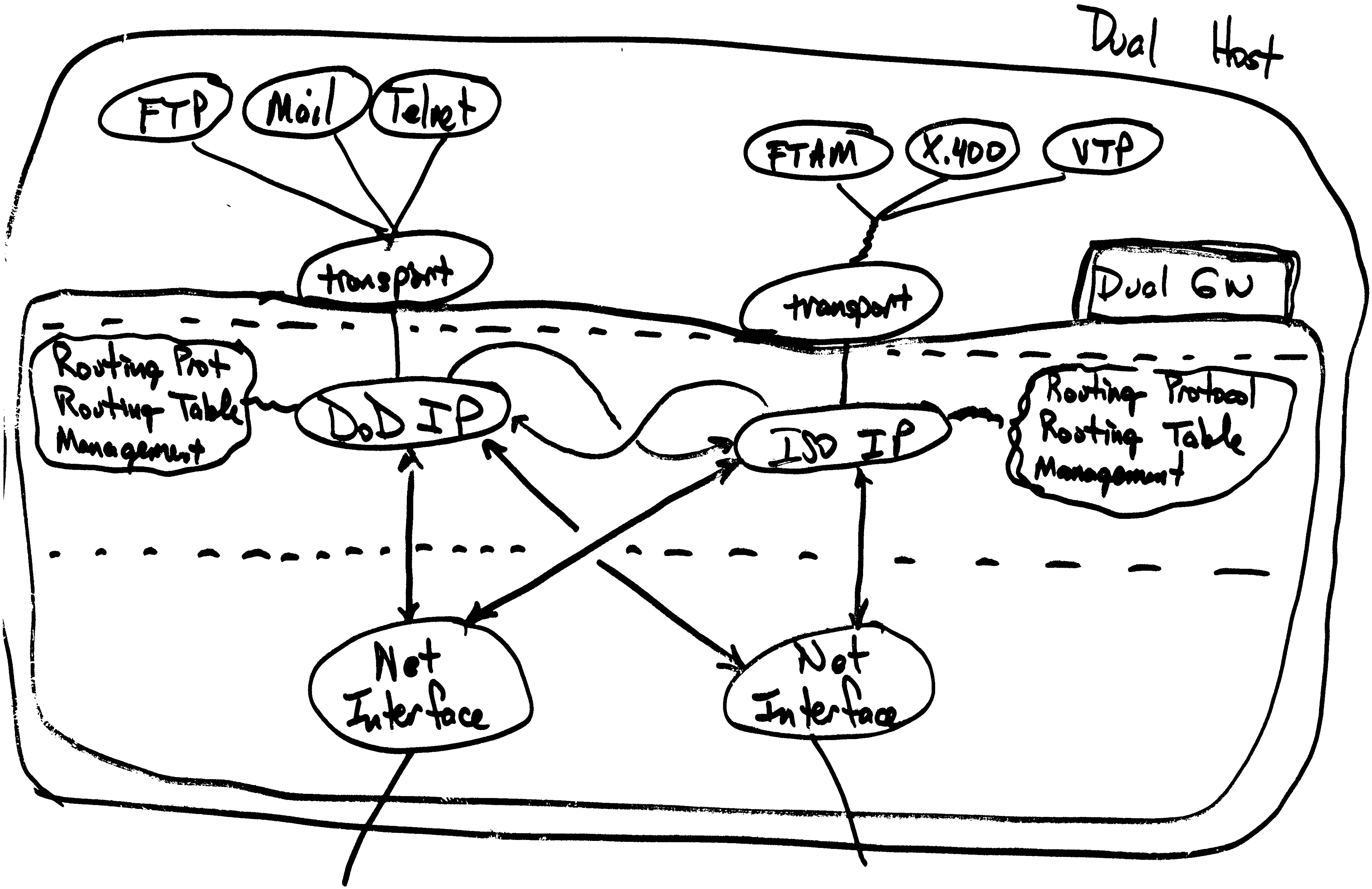
→ Routing Architecture
- technical and administrative framework for Routing

→ IS-IS Protocol(s)
- The routing protocol itself (finally)

DoD/ISO Interoperability

Alternate Approaches

1) Seperate Virtual Internets / Same Phys.
   a) Same Routing Tables or Parallel Routing Procs.
      - Addressing
   b) AS's and EGP?
2) Mutual Encapsulation
   a) Multiple Encaps. vs intermediate stripping
   b) Fragmentation
   + c) ES's/IS's need more knowledge of Sys.
   + d) Worth trouble for value-added ??
3) IP Translation
   a) Useful only as alternative to Encaps ?
   b) Facility / Address mapping
   + c) above
   + d)



Dual Host
FTP
Mail
Telnet
transport
FTAM
X.400
VTP
transport
Dual GW
Routing Prot
Routing Table
Management
DoD IP
ISO IP
Routing Protocol
Routing Table
Management
Net Interface
Net Interface

3) Workshop Reports (Con't)

- Name Domains for Milnet, M. Karels (UCB)

Presentation Slides

Administrative Problems

NCD bottleneck

Distributed backups (login hosts)

Host table size

Military naming
ISO transition?

Gameplan for .MIL domain

Current Problems of Name-Domain System

- caching of negative replies
- longer TTL's
- sorting of addresses
- retransmission strategy

- mail, new usage - unknown effects
- need to extend set of types
- need stable top-level server on UNIX

MILNET Transition

Stone Age - now
- phase out non-domain names from host table
- deploy root servers across MILNET (login hosts?)

Bronze Age
- use only domain-style names available from servers
- provide standard resolvers and servers; assist MILNET with installation

Iron Age
- hosts.txt not supported.

DCA Management Bulletin

1. NIC is directed to remove non-domain aliases from the host table by ______. (Nov. ~~86~~ - June 87)

2. To avoid problems, systems should use primary host names.

3. <u>Interoperability</u>

DOMAIN WORKSHOP, 15-OCT-86

MIKE KARELS, UCB
KEVIN DUNLAP, UCB/DEC
RON NATALIE, BRL
PAUL MOCKAPETRIS, USC-ISI
JAKE FEINLER, SRI-NIC
MARY STAHL, SRI-NIC
SUE ROMANO, SRI-NIC
MARK LOTTER, SRI-NIC
DAVE CROCKER, UNGERMANN-BASS
ROBERT BROBERG, UNGERMANN-BASS

ADMINISTRATION OF HOST TABLE AND DOMAINS

- SEE VIEW GRAPHS,

- ALL HOST TABLE CHANGES FOR HOSTS ON NET 10 OR 26 REQUIRE NCR/NCD FROM DCA.
- OTHER HOSTS AUTHORIZED BY NIC.
- SECOND LEVEL DOMAINS APPLIED TO AND AUTHORIZED BY NIC.
- NET NUMBERS ASSIGNED BY ISI (REYNOLDS)

PROBLEMS:

NCD BOTTLENECK
DISTRIBUTED BACKUPS
HOST TABLES SIZE UNMANAGEABLE.
MILITARY NAMING, COMPLIANCE WITH ISO
GAMEPLAN FOR .MIL DOMAIN

SOLUTIONS:

SOLUTIONS:

NCD: ADMINISTRATIVE DELEGATION BY PMO
UNCOUPLE DYNAMIC CHANGES FROM URDB
BETTER COORDINATION AND AUTOMATION

BACKUP: NIC MAINTAIN MASTER DB.
DOWN LOAD TO LOGIN HOST
BACK UP HOST TABLE SERVERS

SIZE: TRANSITION TO DOMAINS.
REFRESH BY PROTOCOL (PORT 101) NOT FTP
PARTIAL TABLES w/ NIC SERVICE BACKUP

MILITARY TRANSITIONS?
STRUCTURE OF MILITARY DOMAIN?
PLAN: NIC/PMO/MIL COORDINATION
PUBLISH PERTINANT DOCUMENTS
ANNOUNCE SCHEDULE

LOGIN HOST FOR SERVERS
· CURRENTLY PLANNED FOR TAC AUTHENTICATION
· MICROVAX? UNIX?

IS THE ARPANET TRANSITION
MOCKAPETRIS: NO

· HOST.TXT MUST COMPLY WITH DOMAIN NAME FORMAT
· SHOULD HAVE HAPPENED ALREADY, WAS COVERED IN PREVIOUS MANAGEMENT BULLTIN.
· PLAN: PEOPLE WHO USE DOMAINS SHOULD NOT BE AT A DISADVANTAGE BECAUSE THERE IS NO WAY TO REPRESENT THESE "NIC NAMES"

IN THE DOMAIN SYSTEM.

- PLAN TO EITHER DELETE THESE NIC-NAMES OR MAKE THEM PART OF SOME DOMAIN.

- ENCOURAGE MAJOR NON-(ARPA, MIL) NET SITES TO CHANGE IMMEDIATELY TO PROVIDE MOMENTUM (EX. BRL, MIT, UCB)

- NEED TO PROVIDE SOME MORE RELIABLE SERVERS ON MILNET. (TOPS-20) AS TOP LEVEL SERVER! STL-HOST 1, GUNTER?

- PAUL'S STATS INDICATES 75% OF ALL ROOT SERVER TRAFFIC IS UNNECESSARY.
  REASONS:
  - LACK OF NEGATIVE REPLY CACHING.
  - POOR RETRANSMISSION STRATEGY.
  - ADDRESS SORTING IS WRONG
  - RESPONSES IGNORED TO PREVIOUS QUERIES DURING RETRANSMISSION (BIND)
  - ~~MX AND AD~~

OTHER PROBLEMS

- HOW TO HANDLE MX AND ADDITIONAL RECORDS
- 8 BITS TOO SMALL FOR TYPES + CLASSES.
- HELP TO PEOPLE IN DISTRIBUTING THEIR DISTRIBUTED DATABASES
- YES/NO VS YES/NO/DON'T KNOW DIFFERENCES.
- TTL'S NEED TO BE LARGER

SURPRISES:

- BAD DATA TRAVELS FAST
- NO STANDARD FOR MATCHING SHORTHAND

R • CONFLICTINY DATA IN DISTRIBUTED DATA BASES
· MYSTERY HOSTS (NEITHER IN HOSTS.TXT OR DOMAINS).

RECOMENDATION FOR MILNET.

- TRUSTED NAME SERVERS FOR MIL TO HANDLE RECURSIVE REQUESTS FOR MIL HOSTS.
- AUTHORITATIVE INFO USED ONLY
- USE AUTHORITATIVE INFO OVER CACHED INFO.

PHASING:

STONE: MORE TOP LEVEL SERVERS.

BRONZE: INSTALL TRUSTED SERVERS (LOGIN HOSTS?)
BEGIN EFFORT TO TRANSITION

GOLDEN: REMOVE HOSTS.TXT.

ISO: SETTLING DOWN ON TREE STRUCTURE FOR NAMING BUT NOT DONE YET.

DON'T THINK THAT ISO ISSUES ARE YET A CONCERN FOR DOMAINS (.US DOMAIN).

WORK:
DRAFT MANAGEMENT BULLTIN ON FIXING HOSTS.TXT.

3) Workshop Reports (Con't)

- Name Domains for Milnet, Associated Papers

Presentation Slides

This file contains the format for submitting new internet host entries to be included the DoD Internet Host Table. It may be retrieved via FTP by getting the file NETINFO:IHOST-TEMPLATE.TXT.

The format for entries is:

HOST : ADDR : HOSTNAME,NICKNAME : CPUTYPE : OPSYS : PROTOCOLS :

Where:

ADDR = internet address in decimal, e.g., 128.18.0.201
HOSTNAME,NICKNAME = host name and nickname (See NOTE, below)
CPUTYPE = machine type (PDP-11/44, VAX-11/780, LSI-11/23, C/70, etc.)
OPSYS = operating system (UNIX, VMS, MOS, TOPS20, etc.)
PROTOCOLS = transport/service (TCP/TELNET,TCP/SMTP,TCP/FTP, etc.)
: (colon) = field delimiter
:: (2 colons) = null field

Example -
Host : 128.18.0.201 : SRI-TSCA,TSCA : PDP-11/44 : UNIX : TCP/TELNET,TCP/FTP,
TCP/SMTP,TCP/TIME,TCP/FINGER :

NOTE: The purpose of nicknames is to allow for a smooth transition when name changes take place. No nicknames will be accepted for new hosts, and old nicknames will be gradually phased out. User programs may use whatever name abbreviations they wish locally, within their own system.

We would also appreciate receiving the name, address, phone number, and electronic mailbox for a point of contact. This information will be added to our data base, if not entered already, and that person will be designated as a liaison for any questions regarding this internet host.

Requests may be sent to the mailbox HOSTMASTER@SRI-NIC.ARPA.

To establish a domain, the following information must be provided to the NIC Domain Registrar (HOSTMASTER@SRI-NIC.ARPA):

Note: The key people must have computer mail mailboxes and NIC "Handles", unique NIC database identifiers. If they do not at present, please remedy the situation at once. A NIC Handle may be established by contacting REGISTRAR@SRI-NIC.ARPA.

1) The name of the top level domain to join.

For example: EDU

2) The name, title, mailing address, phone number, and organization of the administrative head of the organization. This is the contact point for administrative and policy questions about the domain. In the case of a research project, this should be the Principal Investigator. The online mailbox and NIC Handle of this person should also be included.

For example:

Administrator

```
Organization  USC/Information Sciences Institute
Name          Keith Uncapher
Title         Executive Director
Mail Address  USC/ISI
              4676 Admiralty Way, Suite 1001
              Marina del Rey, CA. 90292-6695
Phone Number  213-822-1511
Net Mailbox   Uncapher@USC-ISIB.ARPA
NIC Handle    KU
```

3) The name, title, mailing address, phone number, and organization of the domain technical contact. The online mailbox and NIC Handle of the domain technical contact should also be included. This is the contact point for problems with the domain and for updating information about the domain. Also, the domain technical contact may be responsible for hosts in this domain.

For example:

Technical Contact

```
Organization  USC/Information Sciences Institute
Name          Craig Milo Rogers
Title         Researcher
Mail Address  USC/ISI
              4676 Admiralty Way, Suite 1001
              Marina del Rey, CA. 90292-6695
Phone Number  213-822-1511
Net Mailbox   Rogers@USC-ISIB.ARPA
NIC Handle    CMR
```

4) The name, title, mailing address, phone number, and organization of the zone technical contact. The online mailbox and NIC Handle of

the zone technical contact should also be included. This is the contact point for problems with the zone and for updating information about the zone. In many cases the zone technical contact and the domain technical contact will be the same person.

For example:

Technical Contact

Organization	USC/Information Sciences Institute
Name	Craig Milo Rogers
Title	Researcher
Mail Address	USC/ISI 4676 Admiralty Way, Suite 1001 Marina del Rey, CA. 90292-6695
Phone Number	213-822-1511
Net Mailbox	Rogers@USC-ISIB.ARPA
NIC Handle	CMR

5) The name of the domain (up to 12 characters). This is the name that will be used in tables and lists associating the domain and the domain server addresses. [While technically domain names can be quite long (programmers beware), shorter names are easier for people to cope with.]

For example: ALPHA-BETA

6) A description of the servers that provides the domain service for translating name to address for hosts in this domain, and the date they will be operational.

A good way to answer this question is to say "Our server is supplied by person or company X and does whatever their standard issue server does".

For example: Our server is a copy of the server operated by the NIC, and will be installed and made operational on 1-November-84.

7) Domains should provide at least two independent servers for the domain. A description of the server machine and its back-up, including:

(a) hardware and software (using keywords from the Assigned Numbers)

(b) host domain name and net addresses (what host on what net for each connected net)

(c) any domain-style nicknames (please limit your domain-style nickname request to one)

For example:

(a) hardware and software

VAX-11/750	and	UNIX,	or
IBM-PC	and	MS-DOS,	or
DEC-1090	and	TOPS-20	

(b) host domain name and net address

BAR.FOO.EDU 10.9.0.193 on ARPANET

(c) domain-style nickname

BR.FOO.EDU (same as BAR.FOO.EDU 10.9.0.13 on ARPANET)

8) Planned mapping of names of any other network hosts, other than the server machines, into the new domain's naming space.

For example:

```
FOO2-BAR.ARPA (10.8.0.193) -> BAR.FOO2.EDU
FOO3-BAR.ARPA (10.7.0.193) -> BAR.FOO3.EDU
FOO4-BAR.ARPA (10.6.0.193) -> BAR.FOO4.EDU
```

9) Delegation for networks in your domain for inclusion in the IN-ADDR.ZONE files, and the fully qualified domain names for the IN-ADDR server sites for each network. (If the IN-ADDR servers are omitted, the servers specified for the domain will be used as the default when the IN-ADDR.ZONE file is generated.)

For example:

Address	Network Name	IN ADDR Servers
41.IN-ADDR.ARPA	(BBN-TEST-A)	
52.128.IN-ADDR.ARPA	(MIT-AI-NET)	PREP.AI.MIT.EDU, HERMES.AI.MIT.EDU, GUTENBERG.AI.MIT.EDU

(In the above example, a delegated IN ADDR Server was not specified for network 41.0.0.0, so delegation will default to the domain servers for the domain submitting the application. Whereas, the network at 128.52.0.0 will be delegated to the IN ADDR servers specified.)

10) An estimate of the number of hosts that will be in the domain.

(a) initially,
(b) within one year,
(c) two years, and
(d) five years.

For example:

```
(a) initially  =  50
(b) one year   = 100
(c) two years  = 200
(d) five years = 500
```

11) A date when you expect the fully qualified domain name to become the official host name in HOSTS.TXT.

Please note: If changing to a fully qualified domain name, e.g. FOO.BAR.EDU, causes a change to the official host name of an ARPANET or MILNET host, DCA approval must be obtained beforehand. Allow 10 working days for your requested changes to be processed. ARPANET sites should contact ARPANETMGR@DDN1.ARPA. MILNET sites should contact HOSTMASTER@SRI-NIC.ARPA, (800) 235-3155, for further

Domains registered with the NIC as of 10/7/86:

Top level domains:

ARPA, AU, COM, EDU, FR, GOV, IL, JP, KR, MIL, NET, NL, ORG, SE, UK, US

Second level domains:

AC.UK	ADELIE.COM	ARIZONA.EDU	ATT.COM
BBN.COM	BELL-ATL.COM	BELLCORE.COM	Berkeley.EDU
BGSU.EDU	BOEING.COM	BRL.MIL	BROWN.EDU
BU.EDU	BUCK.COM	BUFFALO.EDU	CALTECH.EDU
CARLETON.EDU	CCA.COM	CMU.EDU	COLGATE.EDU
COLORADO.EDU	COLUMBIA.EDU	CORNELL.EDU	CS.NET
CSC.ORG	CSS.GOV	DARPA.MIL	DARTMOUTH.EDU
DEC.COM	DEPAUL.EDU	DSPO.GOV	DU.EDU
DUKE.EDU	EMORY.EDU	FMC.COM	GATECH.EDU
GE.COM	GMR.COM	GREBYN.COM	HARVARD.EDU
HOUSTON.EDU	HP.COM	IBM.COM	INDIANA.EDU
INTEL.COM	ISC.COM	ISI.EDU	ITCORP.COM
LEHIGH.EDU	MCC.COM	MCNC.ORG	MECC.COM
MERIT.EDU	MICH-STATE.EDU	MIT.EDU	MITRE.ORG
MORAVIAN.EDU	MOSIS.EDU	NASA.GOV	NBI.COM
NEXT.COM	NORTHEASTERN.EDU	NORTHROP.COM	NOSC.MIL
NSC.COM	NTSU.EDU	NYU.EDU	OGC.EDU
OKSTATE.EDU	OLIVETTI.COM	PITTSBURGH.EDU	PROTEON.COM
PSU.EDU	PURDUE.EDU	PYR.COM	RCA.COM
RIACS.EDU	RICE.EDU	ROCHESTER.EDU	RPI.EDU
RUTGERS.EDU	SDSU.EDU	SIEMENS.COM	SJU.EDU
SRC.ORG	SRI.COM	STANFORD.EDU	STARGATE.COM
SUN.COM	SUNYSB.EDU	SUPER.ORG	SYMBOLICS.COM
SYR.EDU	TEK.COM	THINK.COM	TI.COM
TMC.COM	TMC.EDU	TORONTO.EDU	UAB.EDU
UB.COM	UCAR.EDU	UCDAVIS.EDU	UCHICAGO.EDU
UCI.EDU	UCLA.EDU	UCSD.EDU	UCSF.EDU
UDEL.EDU	UFL.EDU	UIOWA.EDU	UIUC.EDU
UKANS.EDU	UMASS.EDU	UMB.EDU	UMD.EDU
UMICH.EDU	UNC.EDU	UNLV.EDU	UNM.EDU
UOREGON.EDU	UPENN.EDU	USC.EDU	USD.EDU
USF.EDU	USL.EDU	UTA.EDU	UTEXAS.EDU
UWP.EDU	VILLANOVA.EDU	VIRGINIA.EDU	VSE.COM
VT.EDU	WANGINST.EDU	WASHINGTON.EDU	WATERLOO.EDU
WELLESLEY.EDU	WFU.EDU	WILLIAMS.EDU	WISC.EDU
WKU.EDU	WRIGHT.EDU	XEROX.COM	

To find out the administrative, technical and zone contacts for a domain, do "whois DOMAINNAME", e.g.

```
@WHOIS CALTECH.EDU <Return>

  California Institute of Technology (CALTECH-DOM) --@-- --
  CIT-PHYSCOMP (NET-CIT-PHYSCOMP) --@--             --
  CIT-SUN-NET (NET-CIT-SUN-NET)   --@--             --
  CIT-NET (NET-CIT-NET)           --@--             --
```

```
  CIT-CS-10NET (NET-CIT-CS-10NET) --@--            --
  CIT-CS-NET (NET-CIT-CS-NET)    --@--             --
```

To single out any individual entry, repeat the command using the argument "!HANDLE" instead of "NAME", where the handle is in parenthesis following the name.

To single out the entry for the domain:

```
@WHOIS !CALTECH-DOM &lt;Return&gt;

  California Institute of Technology (CALTECH-DOM)
     Computer Science 256-80
     Pasadena, CA 91125

     Domain Name:  CALTECH.EDU

     Servers:  CIT-VAX CIT-VLSI

     Administrative Contact:
        Seitz, Charles  (CS2)  Chuck@VLSI.CALTECH.EDU
        (818) 356-6569
     Technical Contact:
        Lichter, Michael I.  (MIL1)  michael@VLSI.CALTECH.EDU
        (818) 356-6767
     Zone Contact:
        Lichter, Michael I.  (MIL1)  michael@VLSI.CALTECH.EDU
        (818) 356-6767

     anticipated number of hosts:
     init. -   25
     one yr -  40
     two yr -  80
     five yr - 200
```

AC.UK
  AdminContact: PK   Peter Kirstein   PKIRSTEIN@A.ISI.EDU
  ZoneContact: AM40   Andrew McDowell mcdowell@CS.UCL.AC.UK
  TechContact: AM40

ADELIE.COM
  AdminContact: BAB7   Barry Burke   barry%adelie@HARVARD.HARVARD.EDU
  ZoneContact: JM214   Jeff Moskow   jeff%adelie@HARVARD.HARVARD.EDU
  TechContact: JM214

ARIZONA.EDU
  AdminContact: LLP   Larry Peterson   LLP@ARIZONA.EDU
  ZoneContact: BM40   Bill Mitchell   WHM@ARIZONA.EDU
  TechContact: BM40

ARPA
  AdminContact: HOSTMASTER   HOSTMASTER@SRI-NIC.ARPA
  ZoneContact: HOSTMASTER
  TechContact: HOSTMASTER

ATT.COM
  AdminContact: MH82   Mark Horton   cbpavo.cbosgd.ATT.UUCP!mark@seismo.CSS.GOV
  ZoneContact: MH82
  TechContact: MH82

AU
  AdminContact: RE18   Robert Elz   KRE@seismo.CSS.GOV
  ZoneContact: RE18
  TechContact: RE18

BBN.COM
  AdminContact: SGC   Steve Chipman   CHIPMAN@BBNF.ARPA
  ZoneContact: FD2   Frank DiPace   DIPACE@BBNF.ARPA
  TechContact: FD2

BELL-ATL.COM
  AdminContact: BE6   Bob Esposito   (215) 466-8143
  ZoneContact: LD5   Lee Daley   (215) 466-6828
  TechContact: BE6

BELLCORE.COM
  AdminContact: ML7   Michael Lesk   lesk@BELLCORE-CS-GW.ARPA
  ZoneContact: PK28   Phil Karn   karn@BELLCORE-CS-GW.ARPA
  TechContact: PK28

Berkeley.EDU
  AdminContact: RWH5   Robert Henry   rwh@UCBVAX.Berkeley.EDU
  ZoneContact: MK17   Mike Karels   karels@UCBVAX.Berkeley.EDU
  TechContact: MK17

BRL.MIL
  AdminContact: MJM2   Mike Muuss   MIKE@BRL.ARPA
  ZoneContact: DPK   Doug Kingston   DPK@BRL.ARPA
  TechContact: DPK

BUCK.COM
  AdminContact: DLB20   David Buck   (408) 972-2825
  ZoneContact: PA2   Patrick Allen   (498) 972-2825
  TechContact: DLB20

```
CALTECH.EDU
   AdminContact: CS2    Charles Seitz     chuck@VLSI.CALTECH.EDU
   ZoneContact: MIL1    Michael Lichter   michael@VLSI.CALTECH.EDU
   TechContact: MIL1

CCA.COM
   AdminContact: DEE    Donald Eastlake   dee@CCA.CCA.COM
   ZoneContact: AL6     Alexis Layton     alex@CCA.CCA.COM
   TechContact: AL6

CMU.EDU
   AdminContact: HDW2   Howart Wactlar    HOWARD.WACTLAR@A.CS.CMU.EDU
   ZoneContact: MA      Michael Accetta   MIKE.ACCETTA@A.CS.CMU.EDU
   TechContact: MA

COLUMBIA.EDU
   AdminContact: BC14   Bob Catani     CATTANI@COLUMBIA.EDU
   ZoneContact: BC14
   TechContact: BC14

COM
   AdminContact: HOSTMASTER     HOSTMASTER@SRI-NIC.ARPA
   ZoneContact: HOSTMASTER
   TechContact: HOSTMASTER

CORNELL.EDU
   AdminContact: JQJ1   John Johnson   jqj@GVAX.CS.CORNELL.EDU
   ZoneContact: BN9     Bill Nesheim   bill@GVAX.CS.CORNELL.EDU
   TechContact: BN9

CS.NET
   AdminContact RDE1    Richard Edmiston   Edmiston@SH.CS.NET
   ZoneContact: CP10    Craig Partridge    craig@BBN.COM
   TechContact: CP10

CSC.ORG
   AdminContact: DJ27   Dennis Jennings    jennings%pucc.bitnet@WISCVM.WISC.EDU
   ZoneContact: FH14    Felix Hou          (609) 520-2015
   TechContact: FH14

CSS.GOV
   AdminContact: CR11   Carl Romney    romney@seismo.CSS.GOV
   ZoneContact: RA11    Rick Adams     rick@seismo.CSS.GOV
   TechContact: RA11

DARPA.MIL
   AdminContact: SA2    Saul Amarel       amarel@A.ISI.EDU
   ZoneContact: JSG3    Joel Goldberger   joel@HOBGOBLIN.ISI.EDU
   TechContact: JSG3

DEC.COM
   AdminContact: FB6    Forest Baskett     baskett@GLACIER.STANFORD.EDU
   ZoneContact: RKJ2    Richard Johnsson   johnsson@DECWRL.DEC.COM
   TechContact: RKJ2

DSPO.GOV
   AdminContact: JH39   Jung Hong       hong@HC.ARPA
   ZoneContact: BT5     Bob Tomlinson   tomlin@HC.ARPA
```

```
   TechContact: BT5

EDU
   AdminContact: HOSTMASTER     HOSTMASTER@SRI-NIC.ARPA
   ZoneContact: HOSTMASTER
   TechContact: HOSTMASTER

GE.COM
   AdminContact: KC14    Keith Chambers   (804) 978-6132
   ZoneContact: TA2      Tom Allebrandi   (804) 978-5566
   TechContact: JO       John Owens       (804) 978-5726

GOV
   AdminContact: HOSTMASTER     HOSTMASTER@SRI-NIC.ARPA
   ZoneContact: HOSTMASTER
   TechContact: HOSTMASTER

GREBYN.COM
   AdminContact: KAN     Karl Nyberg      nyberg@ADA20.ISI.EDU
   ZoneContact: KAN
   TechContact: KAN

HARVARD.EDU
   AdminContact: GD30    Glenn Dudek      dudeK@HARVARD.HARVARD.EDU
   ZoneContact: NH5      Nike Horton      horton@HARVARD.HARVARD.EDU
   TechContact: NH5

IL
   AdminContact: SP21    Shmuel Peleg     peleg%hugo%israel@RELAY.CS.NET
   ZoneContact: DB53     Danny Brannis    danny%%hugo%israel@RELAY.CS.NET
   TechContact: DB53

ISC.COM
   AdminContact: GW5     Gary Nutt        (303) 449-2870
   ZoneContact: BE4      Bryan Edwards    (303) 449-2870
   TechContact: DM27     Doug McCallum    mccallum@NGP.UTEXAS.EDU

ISI.EDU
   AdminContact: VLG     Vicki Gordon       vgordon@A.ISI.EDU
   ZoneContact: JSG3     Joel Goldberger    joel@HOBGOBLIN.ISI.EDU
   TechContact: JSG3

ITCORP.COM
   AdminContact: GK36    Geoff Kuenning   (213) 545-4413
   ZoneContact: AH38     Allyn Hall       (213) 545-4413
   TechContact: GK36

MCC.COM
   AdminContact: JP77    John Pinkston    pinkston@MCC.COM
   ZoneContact: CBD      Clive Dawson     clive@MCC.COM
   TechContact: CBD

MECC.COM
   AdminContact CWC4     Craig Copley     (612) 481-3569
   ZoneContact: JLT14    James Thompson   (612) 481-3625
   TechContact: SPM1     Shane McCarron   (612) 481-3589

MERIT.EDU
   AdminContact: EMA1    Eric Aupperle     EMA%UMICH-MTS.MAILNET@MIT-MULTICS.ARPA
```

```
    ZoneContact: HWB      Hans-Werner Braun   HWB@MCR.UMICH.EDU
    TechContact: HWB

MIL
    AdminContact: HOSTMASTER     HOSTMASTER@SRI-NIC.ARPA
    ZoneContact: HOSTMASTER
    TechContact: HOSTMASTER

MIT.EDU
    AdminContact: JIS     Jeffrey Schiller        liaison@MIT-MULTICS.ARPA
    ZoneContact: JIS
    TechContact: JIS

MITRE.ORG
    AdminContact: TML     T, Michael Louden       louden@MITRE.ARPA
    ZoneContact: TML
    TechContact: TML

MOSIS.EDU
    AdminContact: VLG     Vicki Gordon        vgordon@A.ISI.EDU
    ZoneContact: JSG3     Joel Goldberger     joel@HOBGOBLIN.ISI.EDU
    TechContact: JSG3

NASA.GOV
    AdminContact: WPJ     William Jones    JONES@AMES.ARPA
    ZoneContact: MSM1     Milo Medin       MEDIN@AMES.ARPA
    TechContact: MSM1

NBI.COM
    AdminContact: WW2     Wally Wedel      wedel@NGP.UTEXAS.EDU
    ZoneContact: BA16     Brian Atkins     (303) 444-5710
    TechContact: KW3      Kirk Webb        (303) 444-5710

NET
    AdminContact: JAKE    Jake Feinler        FEINLER@SRI-NIC.ARPA
    ZoneContact: KLH      Ken Harrenstein     KLH@SRI-NIC.ARPA
    TechContact: KLH

NL
    AdminContact: PCB     P.C. Baayen      piet@seismo.CSS.GOV
    ZoneContact: JA       Jaap Akkerhuis   jaap@MOUTON.ARPA
    TechContact: PB13     Piet Beertema    piet@seismo.CSS.GOV

NORTHROP.COM
    AdminContact: SJL5    Stephen Lukasik     slukasik@NRTC.ARPA
    ZoneContact: RSM1     Robert Miles        rsm@NRTC.ARPA
    TechContact: RSM1

NOSC.MIL
    AdminContact: RLB3    Ron Broersma     RON@NOSC.ARPA
    ZoneContact: RLB3
    TechContact: RLB3

NSC.COM
    AdminContact: JF20    Jerry Foster     (408) 733-2600 ext 234
    ZoneContact: LP15     Les Pembroke     (408) 733-2600 ext 223
    TechContact: RSK5     Ronald Karr      (408) 733-2600 ext 212

NYU.EDU
```

AdminContact: EF5 Ed Franceschini franceschini@NYU.ARPA
ZoneContact: BJR2 Bill Russell russell@NYU.ARPA
TechContact: BJR2

OLIVETTI.COM
AdminContact: JM50 Jack Melnick (408) 996-3867
ZoneContact: JA13 Jerry Aguirre (408) 996-3867
TechContact: DC76 Dennis Chen (408) 996-3867

ORG
AdminContact: HOSTMASTER HOSTMASTER@SRI-NIC.ARPA
ZoneContact: HOSTMASTER
TechContact: HOSTMASTER

PITTSBURGH.EDU
AdminContact: HEP Harry Peple pople@SUMEX-AIM.ARPA
ZoneContact: SM6 Sean McLinden mclinden@RUTGERS.RUTGERS.EDU
TechContact: SM6

PROTEON.COM
AdminContact: JS28 John Shriver jas@PROTEON.ARPA
ZoneContact: MAR10 Mark Rosenstein mar@PROTEON.ARPA
TechContact: MAR10

PSU.EDU
AdminContact: SJS11 Steven Schroeder sjs%psuvm.bitnet@WISCVM.WISC.EDU
ZoneContact: MAC5 Michael Contino mac%psuvm.bitnet@WISCVM.WISC.EDU
TechContact: MAC5

PURDUE.EDU
AdminContact: DEC1 Douglas Comer dec@PURDUE.EDU
ZoneContact: PMA1 Paul Albitz albitz@PURDUE.EDU
TechContact: PMA1

PYR.COM
AdminContact: RB164 Roberta Byker (415) 965-7200
ZoneContact: CSG Carl Gutekunst (415) 965-7200
TechContact: ES44 Earl Stutes (415) 965-7200

RIACS.EDU
AdminContact: PJD1 Peter Denning PJD@ICARUS.RIACS.EDU
ZoneContact: RLB9 Robert Brown RLB@@ICARUS.RIACS.EDU
TechContact: RLB9

RICE.EDU
AdminContact: KK28 Ken Kennedy kennedy@LLL-CRG.ARPA
ZoneContact: VRR Vicky Riffle rif@RICE.EDU
TechContact: VRR

ROCHESTER.EDU
AdminContact: LB16 Liudvikas Bukys bukys@ROCHESTER.ARPA
ZoneContact: TGB3 Tim Becker becker@ROCHESTER.ARPA
TechContact: TGB3

RUTGERS.EDU
AdminContact: CLH3 Charles Hedrick hedrick@RUTGERS.RUTGERS.EDU
ZoneContact: RM8 Roy Marantz marantz@RUTGERS.RUTGERS.EDU
TechContact: RM8

```
SE
   AdminContact: BE10   Bjorn Eriksen   ber%enea.uucp@seismo.CSS.GOV
   ZoneContact: SF8     Sten Folkerman  sten%enea.uucp@seismo.CSS.GOV
   TechContact: BE10

SRI.COM
   AdminContact: JAKE   Jake Feinler    FEINLER@SRI-NIC.ARPA
   ZoneContact: MKL1    Mark Lottor     MKL@SRI-NIC.ARPA
   TechContact: MKL1

STANFORD.EDU
   AdminContact: LB3    Len Bosack         BOSACK@SU-SCORE.ARPA
   ZoneContact: PA5     Philip Almquist    ALMQUIST@SU-SCORE.ARPA
   TechContact: PA5

STARGATE.COM
   AdminContact: MH82   Mark Horton  cbpavo.cbosgd.ATT.UUCP!mark@seismo.CSS.GOV
   ZoneContact: LW2     Lauren Weinstein        lauren@RAND-UNIX.ARPA
   TechContact: MH82

sun.COM
   AdminContact: WER3   Wayne Rosing    rosing@sun.COM
   ZoneContact: BN4     Bill Nowicki    nowicki@sun.COM
   TechContact: BN4

SYMBOLICS.COM
   AdminContact: JLK2   John Kulp          jlk@SCRC-STONY-BROOK.ARPA
   ZoneContact: CH2     Charles Hornig     cah@MC.LCS.MIT.EDU
   TechContact: CH2

THINK.COM
   AdminContact: BJN1   Bruce Nemnich   bruce@ZARATHUSTRA.THINK.COM
   ZoneContact: BJN1
   TechContact: BJN1

TMC1.COM
   AdminContact: GSK2   Ginger Kenney      (617) 661-0777
   ZoneContact: FN4     Fred Nesserella    (617) 661-0777
   TechContact: RES29   Richard Salz       (617) 661-0777

TMC.EDU
   AdminContact: GAG9   G. Gorry        bcm5000!gag@RICE.EDU
   ZoneContact: KCA1    Kirk Aune       bcm5000!kca@RICE.EDU
   TechContact: KCA1

UCAR.EDU
   AdminContact: DM84   Don Morris      morris@SCDSW1.UCAR.EDU
   ZoneContact: DM84
   TechContact: DM84

UCI.EDU
   AdminContact: SH17   Scott Huddleston        scott@ICSE.UCI.EDU
   ZoneContact: RAJ3    Richard Johnson         raj@ICS.UCI.EDU
   TechContact: RAJ3

UCLA.EDU
   AdminContact: TEG1   Terence Gray    gray@LOCUS.UCLA.EDU
   ZoneContact: RBW     Rich Wales      wales@LOCUS.UCLA.EDU
   TechContact: RBW
```

UCSD.EDU
AdminContact: DWA1 Donald Anderson dwa%sdcc12@SDCSVAX.UCSD.EDU
ZoneContact: JM110 Jim Madden madden@SDCSVAX.UCSD.EDU
TechContact: JM110

UCSF.EDU
AdminContact: TF6 Thomas Ferrin TEF@CGL.UCSF.EDU
ZoneContact: TF6
TechContact: TF6

UDEL.EDU
AdminContact: DJF David Farber farber@HUEY.UDEL.EDU
ZoneContact: NMM N. Michael Minnich mminich@HUEY.UDEL.EDU
TechContact: NMM

UIUC.EDU
AdminContact: AKC Albert Cheng acheng@A.CS.UIUC.EDU
ZoneContact: RAA8 Ruth Aydt aydy@A.CS.UIUC.EDU
TechContact: PGR Paul Richards richards@A.CS.UIUC.EDU

UK
AdminContact: PK Peter Kirstein PKIRSTEIN@A.ISI.EDU
ZoneContact: AM40 Andrew McDowell mcdowell@CS.UCL.AC.UK
TechContact: AM40

UMD.EDU
AdminContact: AP7 Andrew Pilipchuck andy@CVL.UMD.EDU
ZoneContact: LAM1 Louis Mamakos louie@TRANTOR.UMD.EDU
TechContact: LAM1

UMICH.EDU
AdminContact: EMA1Eric Aupperle EMA%UMICH-MTS.MAILNET@MIT-MULTICS.ARPA
ZoneContact: HWB Hans-Werner Braun HWB@MCR.UMICH.EDU
TechContact: HWB

UNM.EDU
AdminContact: LW29 Lee Ward lee@MISER.ARPA
ZoneContact: EE3 Eric Engquist umn-cvax!eric@LANL.ARPA
TechContact: LW29

UPENN.EDU
AdminContact: IW5 Ira Winston ira@CIS.UPENN.EDU
ZoneContact: IW5
TechContact: IW5

US
AdminContact JBP Jon Postel postel@VENERA.ISI.EDU
ZoneContact JBP
TechContact: JBP

USC.EDU
AdminContact: JMP James Pepin pepin@USC-ECL.ARPA
ZoneContact: MAB4 Mark Brown mark@USC-ECLB.ARPA
TechContact: MAB4

UTEXAS.EDU
AdminContact: JSQ1 John Quarterman jsq@SALLY.UTEXAS.EDU
ZoneContact: SC18 Smoot Carl-Mitchell smoot@SALLY.UTEXAS.EDU

TechContact: SC18

VSE.COM
AdminContact: BC24 Barry Chapman (703) 769-2861
ZoneContact: GF16 Greg Foltx (703) 769-2882
TechContact: RF7 Ron Flax (703) 769-2865

WASHINGTON.EDU
AdminContact: LS27 Lawrence Snyder snyder@WASHINGTON.ARPA
ZoneContact: RA17 Robert Albrightson bob@@WASHINGTON.ARPA
TechContact: RA17

WISC.EDU
AdminContact: PB22 Paul Beebe beebs@CRYS.WISC.EDU
ZoneContact: DL38 Dick Leban genesis@RSCH.WISC.EDU
TechContact: DL38

XEROX.COM
AdminContact: BR13 Bob Ritchie ritchie.PA@XEROX.COM
ZoneContact: JNL1 John Larson jlarson.PA@XEROX.COM
TechContact: JNL1

Any information pertaining to the following domains should be directed to the CSNET Information Center, CIC@SH.CS.NET:

BGSU.EDU	BOEING.COM		
BROWN.EDU	BU.EDU		
BUFFALO.EDU	CARLETON.EDU		
COLGATE.EDU	COLORADO.EDU		
DARTMOUTH.EDU	DEPAUL.EDU		
DU.EDU	EMORY.EDU		
FMC.COM	FR		
GATECH.EDU	GMR.COM		
HOUSTON.EDU	HP.COM		
IBM.COM	INDIANA.EDU		
INTEL.COM	JP		
KR	LEHIGH.EDU		
MCNC.ORG	MICH-STATE.EDU		
MORAVIAN.EDU	NEXT.COM		
NORTHEASTERN.EDU	NTSU.EDU		
OGC.EDU	OKSTATE.EDU		
RCA.COM	RPI.EDU		
SDSU.EDU	SIEMENS.COM		
SJU.EDU	SRC.ORG		
SUNYSB.EDU	SUPER.ORG		
SYR.EDU	TEK.COM		
TI.COM	TORONTO.EDU		
UAB.EDU	UB.COM		
UCDAVIS.EDU	UCHICAGO.EDU		
UFL.EDU	UIOWA.EDU		
UKANS.EDU	UMASS.EDU		
UMB.EDU	UNC.EDU		
UNLV.EDU	UOREGON.EDU		
USD.EDU	USF.EDU	USL.EDU	UTA.EDU
UWP.EDU	VILLANOVA.EDU	VIRGINIA.EDU	VT.EDU
WANGINST.EDU	WATERLOO.EDU	WELLESLEY.EDU	WFU.EDUWII

Only top-level domains are listed. Information about subdomains should be acquired by asking the top-level domain servers.

Format of entries conforms to that of HOSTS.TXT (RFC952).
!!NOTE!! this is not the same as the original format!!

```
      DOMAIN: <addresses> : <name> : [possible extra fields]
```

The addresses given are those of Internet hosts which provide a Domain Name Server for that domain.

```
OMAIN: 10.0.0.51, 10.0.0.52, 10.3.0.52, 26.0.0.73, 192.5.25.82, 192.5.22.82, 128.20.1.2 : ARPA :
OMAIN: 10.0.0.51, 10.0.0.52, 10.3.0.52, 26.0.0.73, 192.5.25.82, 192.5.22.82, 128.20.1.2 : GOV :
OMAIN: 10.0.0.51, 10.0.0.52, 10.3.0.52, 26.0.0.73, 192.5.25.82, 192.5.22.82, 128.20.1.2 : EDU :
OMAIN: 10.0.0.51, 10.0.0.52, 10.3.0.52, 26.0.0.73, 192.5.25.82, 192.5.22.82, 128.20.1.2 : COM :
OMAIN: 10.0.0.51, 10.0.0.52, 10.3.0.52, 26.0.0.73, 192.5.25.82, 192.5.22.82, 128.20.1.2 : MIL :
OMAIN: 10.0.0.51, 10.0.0.52, 10.3.0.52, 26.0.0.73, 192.5.25.82, 192.5.22.82, 128.20.1.2 : ORG :
OMAIN: 10.2.0.52, 10.0.0.44 : US  :
OMAIN: 10.0.0.51, 10.0.0.52, 10.3.0.52, 26.0.0.73, 192.5.25.82, 192.5.22.82, 128.20.1.2 : NET :
OMAIN: 128.16.5.2, 128.16.5.1, 192.5.25.82, 192.5.22.82, 128.20.1.2 : UK :
OMAIN: 10.7.0.82, 192.1.7.31, 10.0.0.25, 192.5.11.5, 192.12.25.5 : IL :
OMAIN: 10.0.0.25, 192.5.11.5, 192.12.25.5, 10.2.0.78, 128.32.0.10 : AU :
OMAIN: 10.0.0.25, 192.5.11.5, 192.12.25.5, 128.20.1.2, 192.5.22.82, 192.5.25.82 : NL :
OMAIN: 10.4.0.5, 192.5.58.1, 128.89.0.93, 10.7.0.82, 128.89.0.92 : JP :
OMAIN: 10.4.0.5, 192.5.58.1, 128.89.0.93, 10.7.0.82, 128.89.0.92 : FR :
OMAIN: 10.0.0.25, 192.5.11.5, 192.12.25.5, 192.5.25.82, 192.5.22.82, 128.20.1.2 : SE :
OMAIN: 10.4.0.5, 192.5.58.1, 128.89.0.93, 10.7.0.82, 128.89.0.92 : KR :
```

DDN NAMING/ADDRESSING

15 OCTOBER 1986

NETWORK STATISTICS

	ARPANET/MILNET	INTERNET
HOSTS	559	3082*
TACS	126	-
GATEWAYS	102	144*
NETS	-	515
NODES	194	-
DOMAINS	158	

Total Internet hosts	3082*
Total networks	515*
Total Internet gateways	144
MILNET hosts	448
MILNET TACS	111
ARPANET hosts	111
ARPANET TACS	15
MILNET/ARPANET Gateways	102
HOSTMASTER mail	898 messages

*includes MILNET, ARPANET

NAMING/ADDRESSING PROCEDURES
DDN/ARPANET

```
                         New Subscriber Request
                                  |
                            DCA Code B641
                                  |
                         ARPANET Coordinator, DARPA
                                  |
                             Feeder TSR and HAF
                                  |
                             DARPA IPTO Approval
                                  |
                           DCA Code B651 Approval
                                  |
                               DCA Code B643
                                  |
        Requester <------- TSR Issued
         Notified          TSO Issued  --------> DECCO
                                  |
                               DCA Code B651
                            Provides Host Data
                                  |
                               DCA Code B642
                                  |
                                  NCR
                                  |
                               DCA Code B651
                                  Approval
                                  |
                                  NCD
                                  |
           _______________________|_______________________
           |                      |                      |
        SRI NIC               Requester                 AMC*
           |                   Notified                  |
   Host Table Change                                    NCAN
                                                         |
                                                   DCA Code B651
```

*(CMMC, EMMC, PMMC)

ARPANET New Subscriber Request Flow

NAMING/ADDRESSING PROCEDURES

INTERNET

- Net names/numbers
- Domain names
- Internet host tables

NETWORK NUMBERS

- Assigned Numbers by J. Reynolds under contract to NIC; transitioning to NIC soon
- Includes Classes A, B, and C
- Guidelines in RFC 796 and RFC 960

REGISTRATION OF DOMAIN NAMES

- Applications to Hostmaster
- Authorized by NIC
- Zone Tables prepared/distributed by the NIC
- Guidelines in RFC 920

INTERNET HOST TABLES

- Application via online template
- Data format approved by NIC
- Data integrity responsibility of Contributor
- Installation by NIC

INTERNET NAMING SERVICE

INTERIM PROCEDURE - for DDN interoperability

PROBLEMS

- NCD bottleneck
- Distributed back up needed
- Host table size
- Military domain-naming
  conventions needed (ISO compatible)
- Gameplan for .MIL needed

POSSIBLE SOLUTIONS

NCD BOTTLENECK

- Administrative delegation by PMO
- Uncouple dynamic data from URDB
- Speed up process by coordination and automation

DISTRIBUTED BACK-UP NEEDED

- NIC maintains master DB
- Download by protocol to login host
- Login hosts provide back-up name services
- Relieves load on NIC
- Relieves load on net
- System distributed, but under DDN control

LARGE HOST TABLE

- Proceed to naming domains
- All refresh by protocol, not FTP
- Hosts use partial tables with NIC name service as back-up

MILITARY NAMING CONVENTIONS

- Random?
- Standardized?
- ISO compatible?

NAMING CONVENTIONS - RANDOM

- Users' choice

NAMING CONVENTIONS - .MIL WITH KNOWN ACCEPTED ACRONYM

- Use acronyms of administrative divisions already in existence.

NAMING CONVENTIONS - .MIL WITH SERVICE ORGANIZATION AS PART OF THE NAME

A-BRL.MIL	or	BRL-A.MIL
AF-GUNTHER.MIL	or	GUNTER-AF.MIL
N-NOSC.MIL	or	NOSC-N.MIL
O-DIA.MIL	or	DIA-O.MIL

NAMING CONVENTIONS - .MIL WITH ARMY, NAVY, AF, USMC, O (Other) AS SECOND LEVEL DOMAINS

BRL.ARMY.MIL

GUNTER.AF.MIL

NOSC.NAVY.MIL

DIA.O.MIL

GAMEPLAN FOR .MIL NEEDED

- NIC/PMO/MILCOM coordination
- Pertinent documents - written/distributed
- Announcements
- Milestone schedule

UNANSWERED QUESTIONS

- Volunteer or mandatory?
- Who and how?
- Technical impact?
- Adopt .MIL Y/N?

Implementation of the Domain Name System

by

Paul V. Mockapetris, USC Information Sciences Institute
and
Kevin Dunlap, UC Berkeley & DEC

Goals

(RFC 881–883, November 1983)

Replace *HOSTS.TXT* file with a distributed database.

Allow local control of database.

Hierarchical name space and distribution of authority

virtually unlimited database size

Target for switchover: Sept 1984

Reality

Hosts can live without *HOSTS.TXT,* many do.

NIC delegates approximately 130 domains.

switchover became feasible fall 1986

Novel Aspects

(at least taken together)

DNS unites heterogeneous machines, authorities, operating systems, networks, philosophies, ...

Datagrams (UDP) as preferred mode for queries

delegation of authority (=anarchy, = autonomy)

binary format for messages

caching, together with explicit timeouts on each piece of information as essential element

Migration & Acceptance Aids

upward compatibility (emulate GTHST & gethostbyname)

Staged implementation: preserve *HOSTS.TXT* while advancing DNS from experimental to production use in ARPANET, then consider introduction into MILNET

policies can be "tuned" to local needs by adjusting TTLs

Issues left open:
user interface
dynamic updates
shorthands

Growth Paths

Type mechanism

No fundamentally new types defined, although mail binding was redone. New types currently require recompilation of software to add new "case clauses", so may simply be that cost is to high to encourage new type definitions. Many advocate new types and new applications of old types, but few agree on which problems should be addressed and how they should be addressed.

Class mechanism

Class is orthogonal axis to name, and separates by "protocol" family or some such. Never fully developed, only one class other than Internet assigned (CHAOS)

Options

Inverse queries

Completion queries

Mail agent vs mailbox binding

Recursive service (iterative standard)

Additional section processing

Current Status

"Full" implementations available for UNIX (BIND), and TOPS–20 (JEEVES). Subsets (usually user side) for MSDOS, XEROX Dandelion, MVS, others.

The root and top level domains (e.g. EDU, ARPA, GOV) are served by 4 redundant servers. In 2 years of operation, there have been 3 disturbances of top level service: one caused by a faulty database, one caused by a distribution of faulty user software, and a third by a coincidence of extended downtime on two of the four root servers together with transient failure in the other two.

The root servers average a query every 1–5 seconds, depending on how many root servers are up.

Typical query to class B or C address from the ARPANET takes 5–10 seconds during peak time, with worst cases in the 30–60 second range

Successes

(original decisions which were correct)

Variable depth hierarchy

Names are independent of network, etc.

UDP and datagrams – vast performance improvement over TCP connections

Binary format for queries – kept data standard

Caching – vast performance improvement, hid many network failures

Additional section processing – reduces queries by 50%

Cooperation between BITNET, CSNET, UUCP and DARPA Internet may lead to simple mail addressing among these internets

Omitting dynamic update mechanism

Failures

(original decisions which were wrong)

We would need lots of types and classes (8=>16 bits in specification). Current system uses 15 types, 1 class (2?).

Distributing authority for database does not distribute a corresponding amount of expertise in database management. Maintainers fix things until they work, rather than until they work well. System designers are not excited by writing clear, low–level, "how to" documentation.

Old services said (yes/no), new ones say (yes/no/can't find out now). This makes emulation difficult even if data formats are the same.

Data type structure should be part of distributed database, or at least data driven, rather than compilled into database programs.

Database administrators don't configure TTLs, they just copy the examples in the documentation. The documentation was written before the system was implemented, and hence had values which were too small.

Surprises

(things we didn't image were issues)

The reliability and performance of the Internet were not what we expected; this may be due to the gateway crises. We still don't have a good model for the performance applications can expect from the Internet. Similarly, name servers were put on heavily loaded machines on local networks behind slow gateways. The result was to eliminate most of the margin for error in caching effectiveness, etc.

The performance of the system is limited by network delay, OS level queueing and paging, and performance of the DNS software itself. The second appears to be the most significant factor.

DNS forced refinement of semantics for every data type in database. (e.g. addresses, well known services, mail)

Negative answers are much more common than expected; negative caching may be justified.

Using local data, the new systems were often *faster* than the systems they replaced, probably because the old systems were designed for much smaller databases than are in use now.

Efforts to define a shorthand standard are difficult. It seems that at least two modes are required: "batch" and "interactive"

Lessons

Distribution of control and function works, but you must ensure that that the newly powerful have the expertise required to use their new powers wisely

Replication and caching are essential in a distributed system

Programs must be written on the assumption that other programs will break, so provide make error detection and error recovery options clear

What you do not specify is almost as important as what you do specify

Large user communities are very reluctant to change to new systems

Distributed authority doesn't solve political problems; it distributes them.

(KLH, December 1985)

MILNET Domain Name Transition Plan

* Political questions
  - MAIN ASSUMPTION: DNS-form names to be adopted by MILNET.
  - Which domains to put MILNET sites in?
    - Suggest simply .MIL to begin with. Future changes are easy.
    - Adopt .MIL.US from beginning, or reserve for later?

* Timetable for name transitions
  - Treated just like normal name change; host need not use DNS!
  - Can be gradual (site by site); nicknames ensure no service disruption.
  - Suggest starting in Jan; complete by end of Feb.

* NIC will continue to produce normal host-table.
  - Survey program will collect information for sites NIC does not register, to help out sites which do not use DNS.
  - NIC may introduce a new host-table entry type for mail forwarding.

* MILNET software recommendations
  - Software must be able to handle hostnames with embedded "."s. This is already true, as far as is known. Name transition period will ensure that unwitting exceptions are flushed out.
  - Software must be able to handle large host-table. As above, already true to our knowledge.
  - Software does not need to know about DNS. Installation/integration of DNS software is up to individual sites. The only effect is that sites with no DNS software will have difficulty mailing to non-Internet addresses.
  - All DNS-using programs should first check normal host-table, and only if not found should use DNS resolution.
  - Non-DNS mailers could check for mail-forwarding entries in host-table.

* Full DNS use - currently indefinite
  - Once DNS has achieved operational reliability, we can consider setting a timetable for requiring installation of DNS software at all sites still without it.
  - However, no clear idea at moment of when DNS will be "proved". Still has problems, still being developed.

4) Cluster Mask RFCs, C-H. Rokitanski (DFVLR)

Presentation Slides

Drafts of two RFC's:

"Clustering Addressing Scheme"

"Application of the Clustering Scheme to Public Data Networks"

INENG/INARC - Meeting, SRI

Oct 15-17 '86

Carl-Herbert Rokitansky
(currently at the University of Kansas)

Files: RFCCLU.TXT
RFCPDN.TXT

<Roki>@A.ISI

Cluster of Networks - Concept:

- Several INTERNET networks form a "cluster of network
- Use of a "clustermask"
- Application to Public Data Networks (PDN)

- New use of the IP Source Route option
- Modified EGP
- X.121 Address Server / Resolution Protocol

Demands for „Wide Area Networks"

- Subdivision (if any) of a WAN (several "entry gateways") should be taken into account in *external* routing decisions

- *Internal* routing decisions: all hosts on a WAN should appear to be reachable *„locally"* (directly)

Proposed Solution:

- Assignment of different Internet network numbers to subdivisions of a WAN

- WAN → „Cluster of Networks"

- Use of a „cluster-mask" for the specification of the „cluster" and for internal routing decisions

INTERNET - Address:

<INTERNET-address> ::= <network-number><restfield>

<network-number> ::= <cluster-number> <cluster-net-numb

Cluster-Mask:

255. 0. 0. 0.

11111111 00000000 0000000000000000

<cluster-number><cluster-net-number>< rest field >

<network-number>< rest field >

- ICMP Address Mask Request
- ICMP Address Mask Reply

Public Data Networks (PDN) - Characteristics:

- "Wide Area Network"
- Complex of national public data networks
- International virtual circuits
- Different costs for international and national virtual circuits
- Costs depend on data volume and length of time of connection
- no broadcasting

Proposed Solution:

- INTERNET class B network numbers (with identical bits in the first (high-order) 8-bit field of the INTERNET address) are assigned to national public data networks.

- The national public data networks are assembled to form a cluster of networks ("PDN-Cluster")

- Use of a "Cluster-mark", thus all hosts within the "PDN-Cluster" appear to be reachable "locally"

- If necessary, WAN gateways are exchanging (modified) EGP messages on an "event driven" basis (i.e. No periodic updates (!))

- Mapping between the INTERNET address and X.121 address of PDN hosts is done by an "X.121 Address Server/Resolution Protocol"

Rec. X.121

DCC (Data Country Code) fixed at 3 digits

DNIC (Data Network Identification Code) fixed at 4 digits (first three digits = DCC)

DNIC: Z X X n

DCC: Z X X

Z ... denotes any digit from 2 thru 7 (resp. 8 telex 9 telephone)

X ... denotes any digit from 0 thru 9

n ... denotes any digit from 0 thru 9 (network digit)

→ Theoretical maximum of 6000 (resp. 8000) DNICs

DNIC Mapping (8 bits to specify the <cluster-net>)

- use cluster-mask <255.0.0.0>
- reserve network numbers 191.001 to 191.254 for the "PDN-cluster" (191.000 and 191.255 reserved)
- assign INTERNET network numbers to DNICs in order of request

Example:

DNIC	Public Data Network	INTERNET network #
3110	TELENET (USA)	191. 1
2342	IPSS (U.K.)	191. 2
2405	TELEPAK (Sweden)	191. 3
2041	DATANET (Netherlands)	191. 4
2624	DATEX-P (West Germany)	191. 5

New Use of the IP Source Route option

Problem: Multiple VAN Gateways on same "national PDN"

Due to the connection oriented PDN world (X.25) VAN gateways put their own IP address of that network (to which they are attached), which is NOT the „PDN-cluster network", as a Source Route in every IP-Datagram which they received from the „PDN-cluster" (IP/X.25-Tunnel) and ~~transmit~~ send it to that network.

Modified EGP over PDN

- topological restrictions
- distance metrics
- event driven updates (costs !)

X.121 Address Server / Resolution Protocol

- table lookup
- X.121 Address Resolution between two PDN - Hosts
- X.121 Address Resolution (UDP) from remote database
- dynamic updates

Advantages:

- The internal structure of a „cluster" (several INTERNET networks) is visible outside the cluster. (Important for exterior routing)
- The fact that a 'cluster of networks' has been formed is invisible outside the cluster. (→ No exterior changes)
- All hosts (gateways) within the same cluster appear to be reachable directly („locally")
  (Important for interior routing)
- No (or only minor) changes to host software that supports subnets
- ICMP Address Mask Request and -Reply
- ICMP Redirect messages can be used between gateways and hosts on different INTERNET networks, but in the same cluster.

Disadvantage:

- Specific INTERNET network numbers must be reserved for „clusters of networks"

However: Out of a maximum number of

126	class A	networks:	17	network numbers	(13 %)
16.382	B	:	77	-"-	(0.5 %)

5) NSFnet Status, H.W. Braun (UMich) and S. Brim (Cornell)

Presentation Slides

NET STATUS

Installed: BACKBONE
JVNC consortium
SDSC consortium (MFENET)
USAN
(Merit)

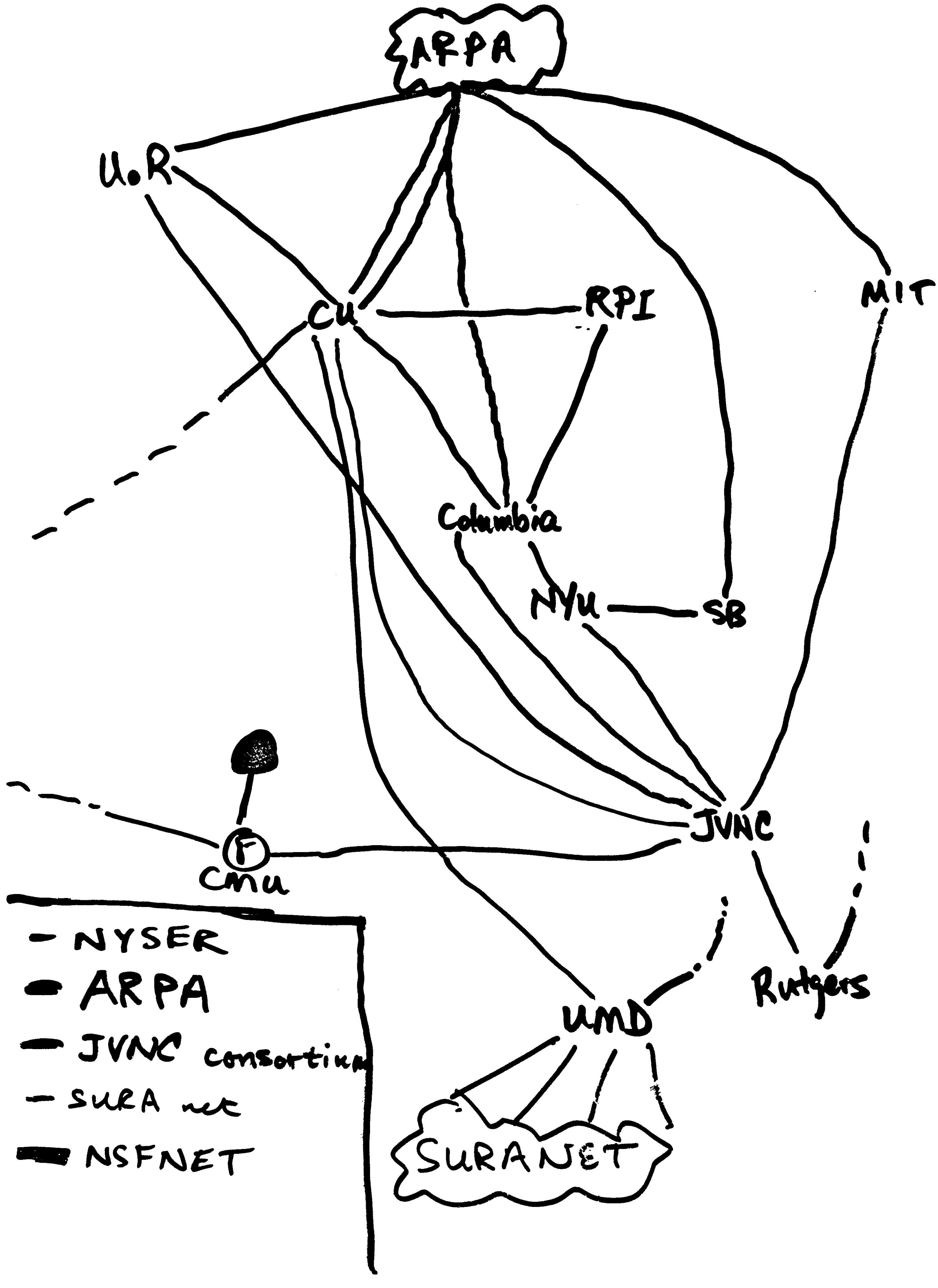
ORDERED/INSTALLING:
NYSERNET
SURANET

NEAR ORDERING: MIDNET
BARRNET

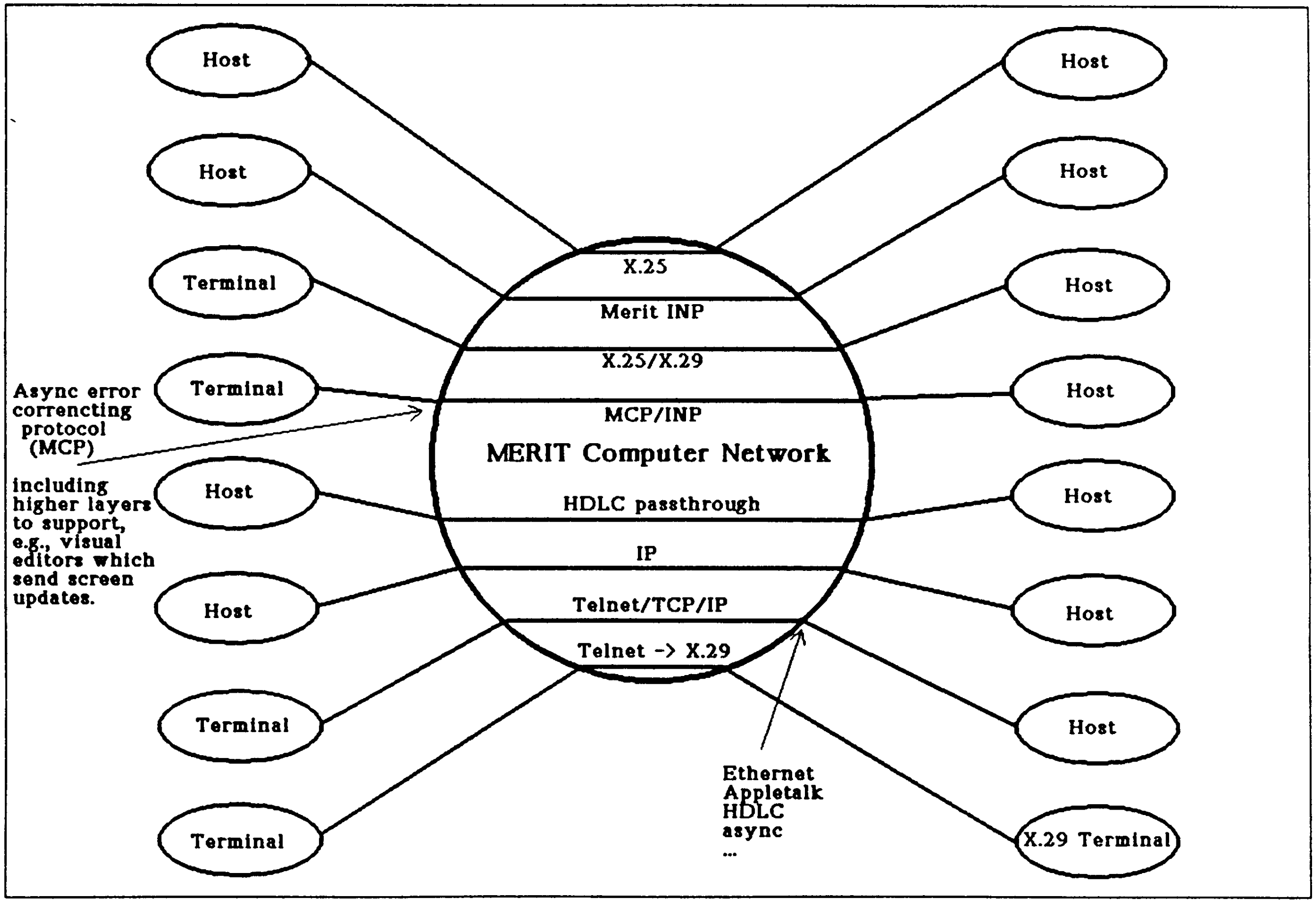
NOT READY: CICNET

???: PITTSBURGH-
SESQUINET
WESTNET

THE GREAT CHALLENGE OF COMPUTER NETWORKS IS USING THEM.

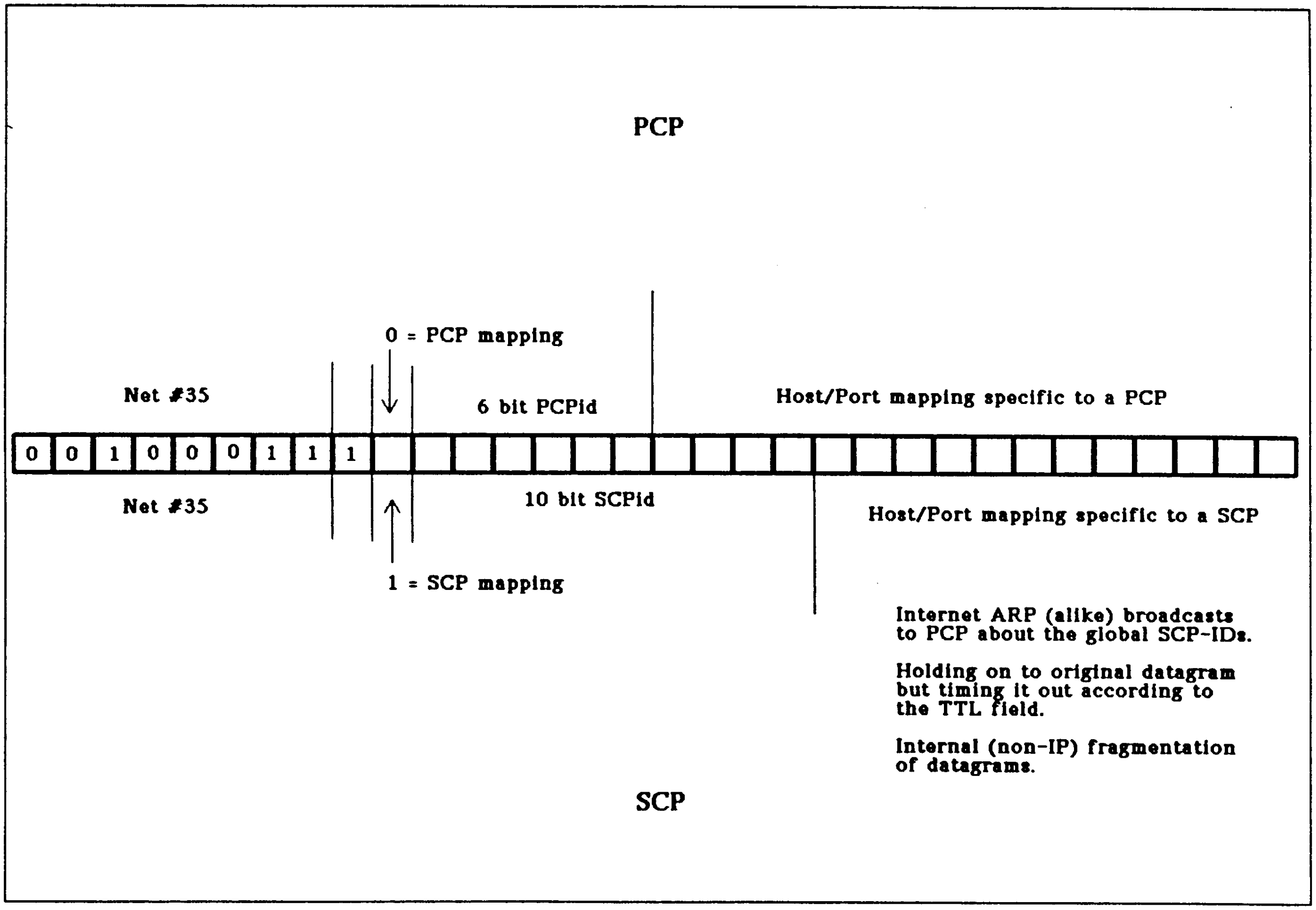

ARPA
U.R
CU
RPI
MIT
Columbia
NYU
SB
JVNC
F
CMU
UMD
Rutgers
SURANET
NYSER
ARPA
JVNC consortium
SURA net
NSFNET

From: <hwb@mcr.umich.edu>
Subject: Merit protocols
Date: 13 Oct 86 15:11-EDT



File: merit.prot
merit.prot read.

From: <hwb@mcr.umich.edu>
Subject: Merit addressing
Date: 13 Oct 86 15:45-EDT

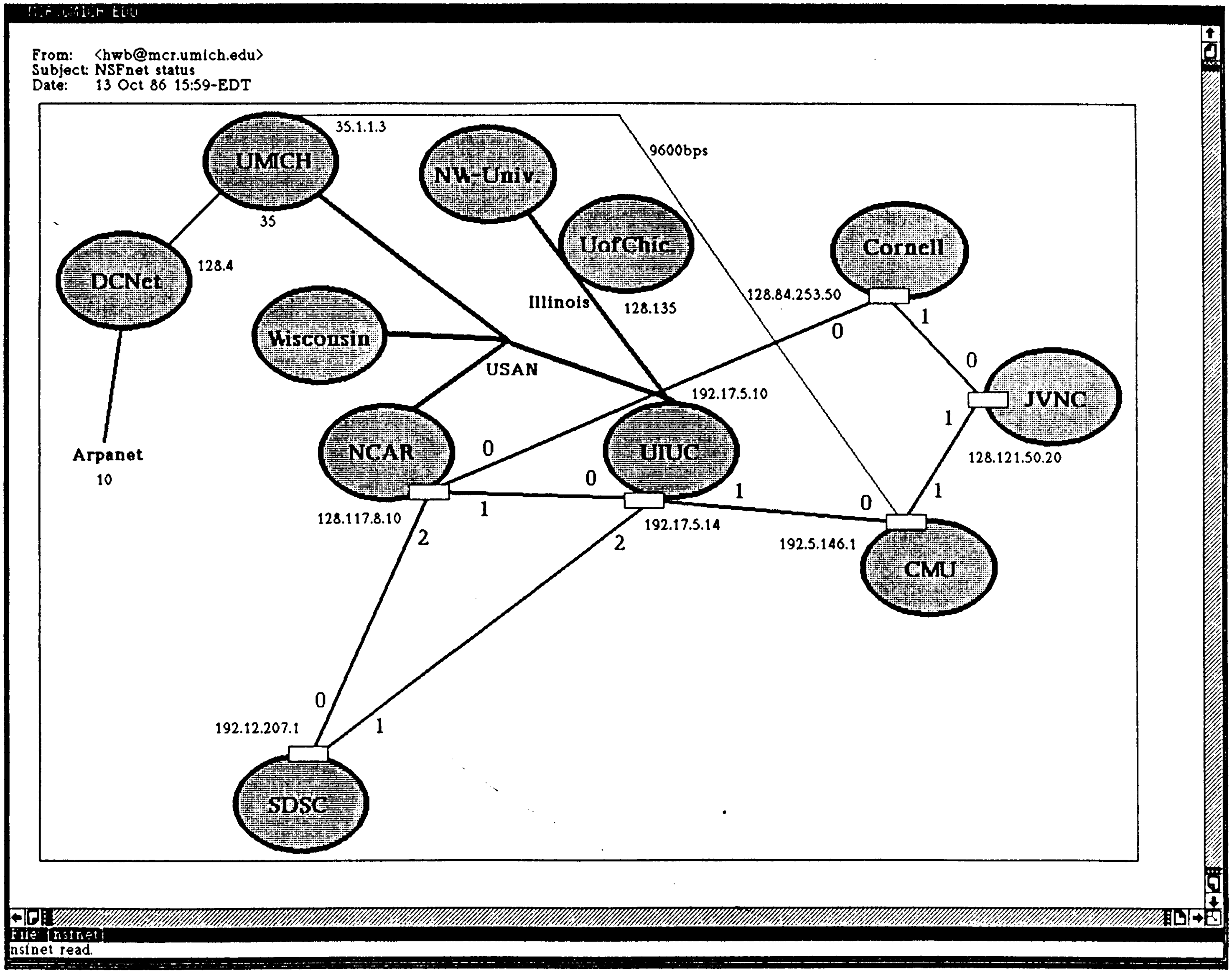


meritaddr read.

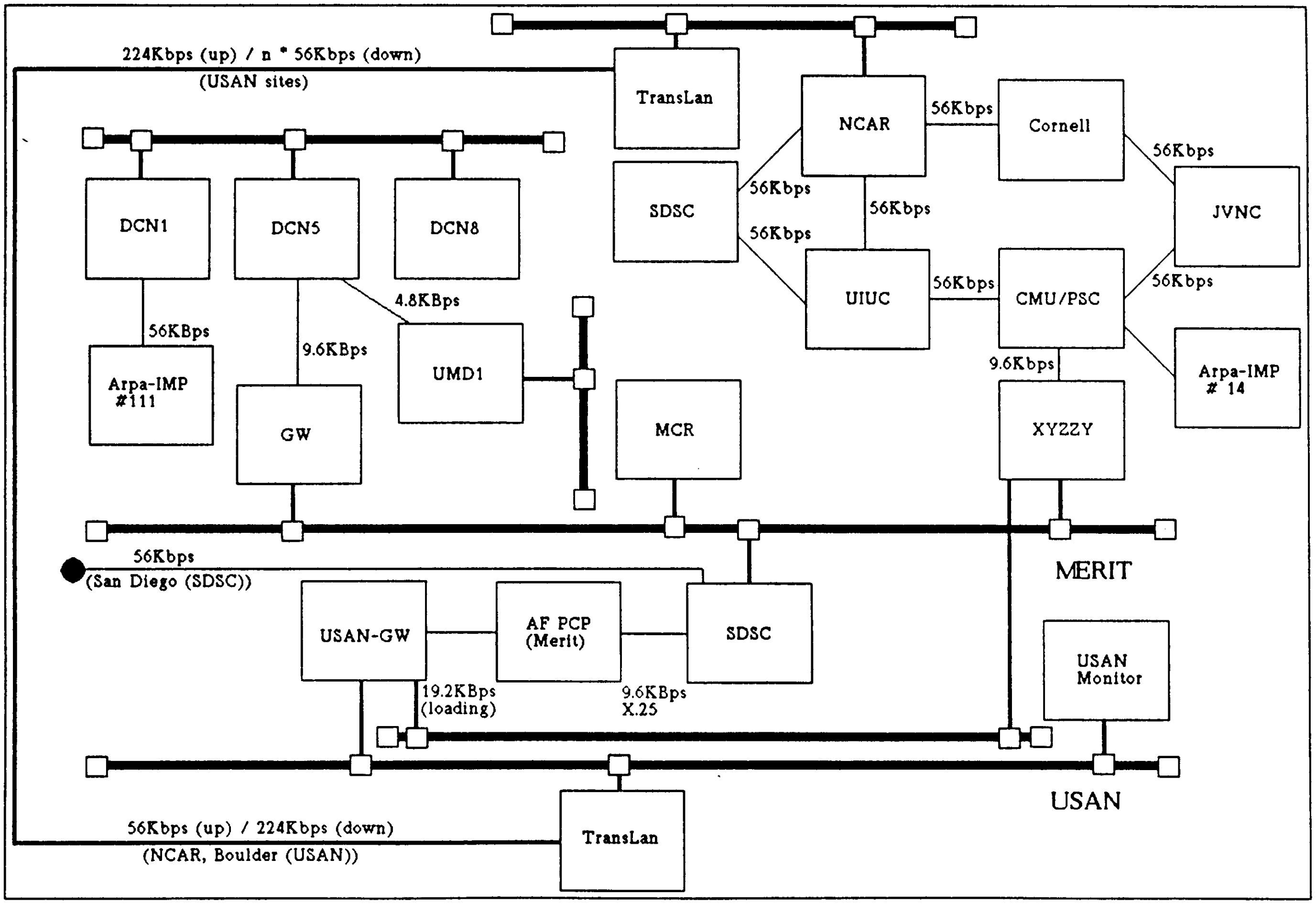
From: <hwb@mcr.umich.edu>
Subject: PSC consortium
Date: 29 Sep 86 17:43-EDT

File psc

psc read.

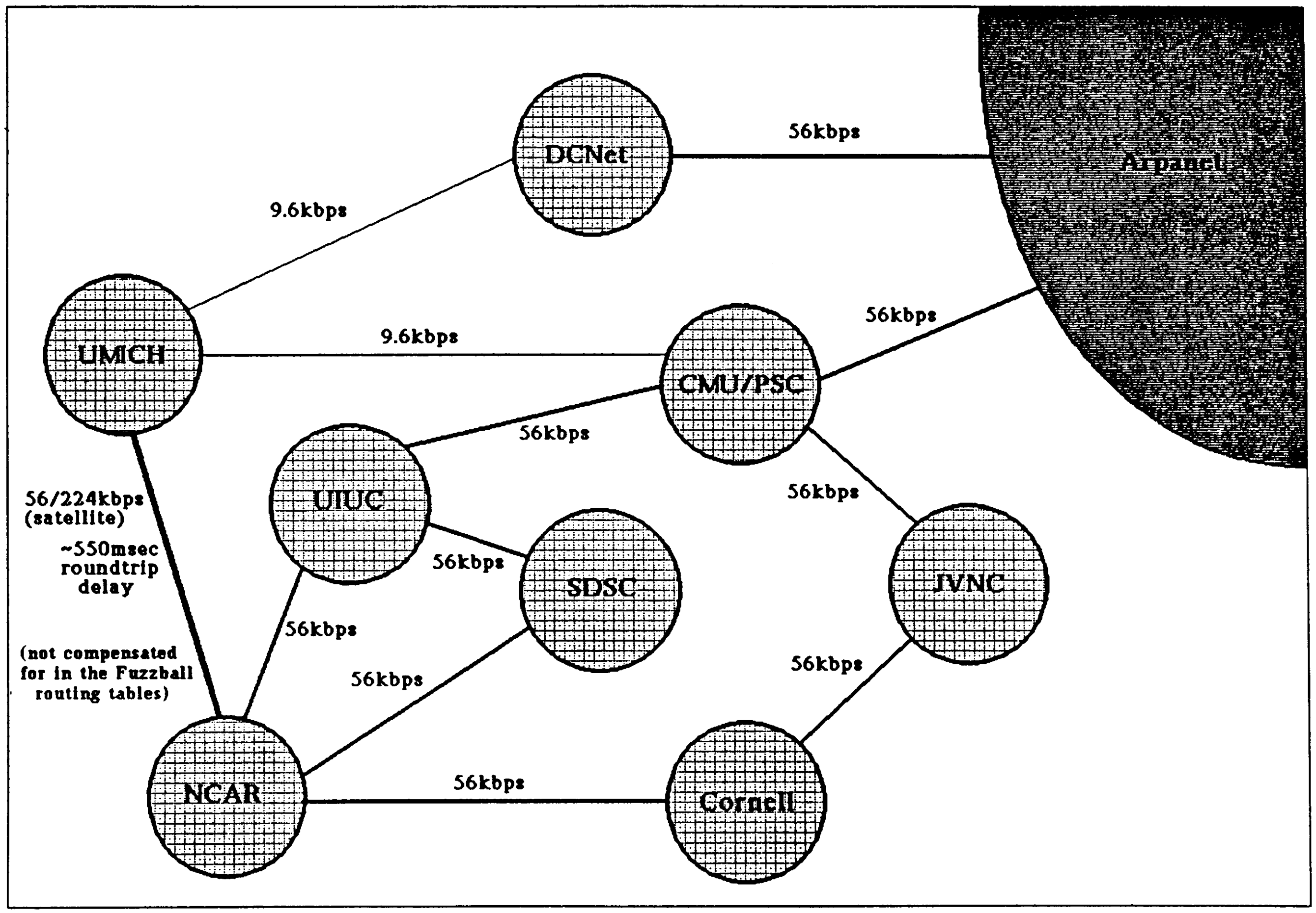

From: <hwb@mcr.umich.edu>
Subject: NSFnet status
Date: 13 Oct 86 15:59-EDT
UMCH
35.1.1.3
35
DCNet
128.4
Arpanet
10
NW-Univ.
UofChic
Illinois
128.135
Wisconsin
USAN
NCAR
128.117.8.10
UIUC
192.17.5.10
192.17.5.14
9600bps
Cornell
128.84.253.50
JVNC
128.121.50.20
CMU
192.5.146.1
SDSC
192.12.207.1
nsfnet read.

From: <hwb@mcr.umich.edu>
Subject: UMICH connectivity
Date: 10 Oct 86 14:34-EDT



File: umichnew
umichnew read

From: <hwb@mcr.umich.edu>
Subject: TOS requirements
Date: 13 Oct 86 13:43-EDT

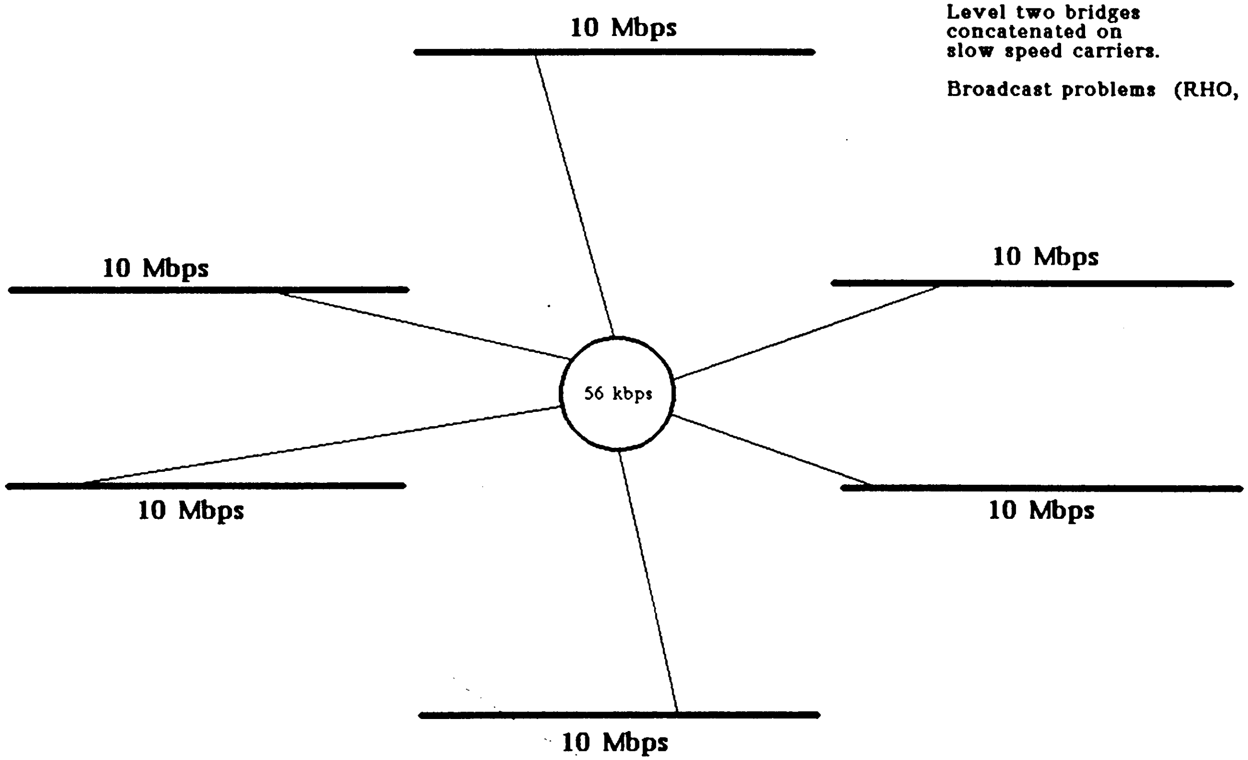


tos read

From: <hwb@mcr.umich.edu>
Subject: Level 2 bridges, e.g., USAN
Date: 13 Oct 86 15:22-EDT

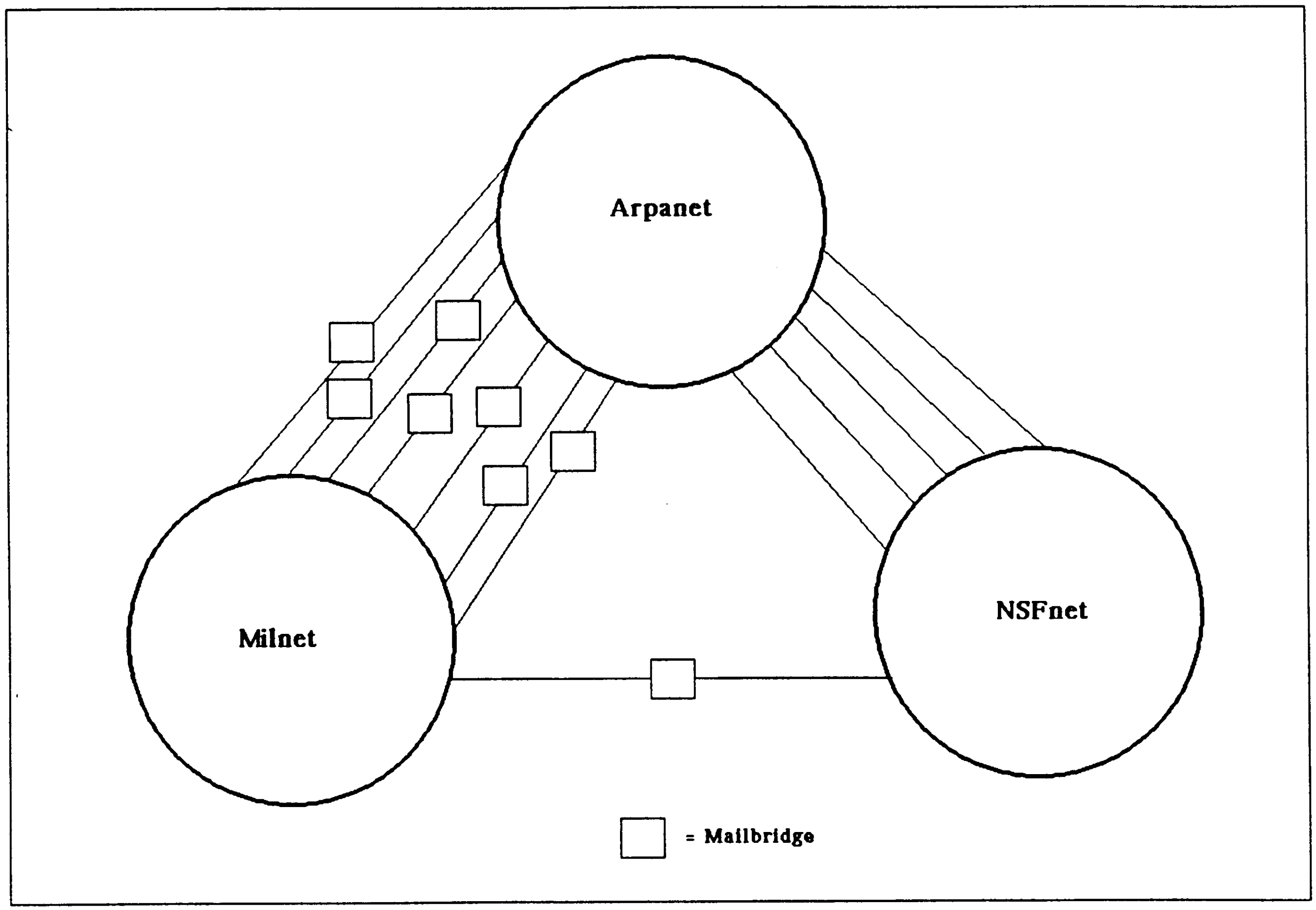
Level two bridges
concatenated on
slow speed carriers.

Broadcast problems (RHO, etc.)



12bridges read.

From: <hwb@mcr.umich.edu>
Subject: Arpa/NSF/Milnet
Date: 13 Oct 86 12:57-EDT



6) Multiple Satellite System Overview, D. Mills (UDel)

Presentation Slides

Assumptions

- 240 satellites randomly positioned in 800-km orbits
- 10 deg min uplink/downlink angle
- 300 km min crosslink altitude
- Static case only (dynamics for later)

Resulting Scenario

- About 9000 crosslinks, 37 per satellite
- About six up/downlinks per Earth terminal
- Max up/downlink range about 2500 km
- Max crosslink range about 5000 km

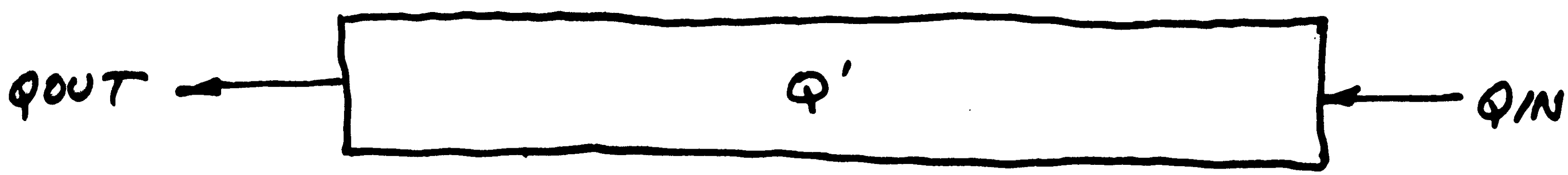
- Shortest Remaining Distance (SRD)
  Select next hop which minimizes remaining distance to destination, computed as the distance of next hop plus the great-circle distance to destination.

- Shortest Total Distance (STF)
  Sort Q by increasing total path distance, computed as the distance so far plus the next hop plus the great-circle distance to destination.

- Bellman-Ford-Moore (BFM)
  First-in-first-out Q (unsorted).

- Dijkstra
  Sort Q by increasing distance from source.

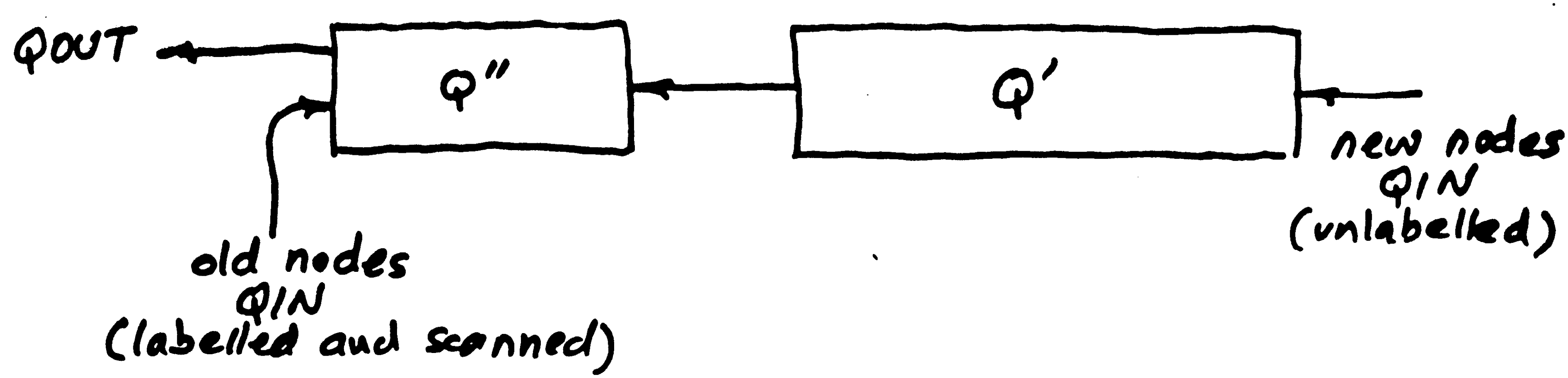
Algorithms Considered



Bellman-Ford-Moore: FIFO

Dijkstra: min-distance (sort) from dest

SRD: min-distance total path



D'Esopo-Pape Algorithm

```
procedure SPT(r);
  begin
    QINIT(Q, r);
    for i := 1 to n do D[i] := ∞
    D[r] := 0;
    repeat
      QOUT(Q, i);
      foreach j ∈ S[i] do
        if D[j] > D[i] + L[i,j] then
          begin
            D[j] := D[i] + L[i,j]
            QIN(Q,j)
            end
      until Q = ∅
  end;
```

SPT Algorithm

W3HCF University Park 38.97N 76.93W

Station	Dist	240	60	30
WCC Chatham 42N 70W	676	1373	2833	nu
WAX Ojus 26N 80W	1470	2539	2539	2539
NMR San Juan 18N 66W	2560	2737	3439	3439
NBA Balboa 8N 79W	3450	3458	3458	3458
KOK Los Angeles 34N 118W	3682	4889	6691	6691
KLB Seattle 48N 122W	3715	4467	7064	7064
TFA Rejkjavik 64N 23W	4449	5347	nu	nu
GKB Portishead 51N 3W	5713	5872	5872	nu
CTV Lisboa 39N 9W	5724	5883	9504	nu
6VA Dakar 15N 17W	6381	7403	nu	nu
SAG Goteborg 57N 12E	6409	6526	6526	15590
IAR Roma 42N 13E	7236	7333	7487	nu
PPR Rio de Janeiro 23S 43W	7743	9045	np	np
LPD General Pacheco 34S 59W	8322	8504	np	np
4XO Haifa 34N 35E	9299	9351	10074	17597
TJC Douala 4N 9E	9377	9893	nu	nu
FJA Papeete 17S 149W	9721	10897	nu	nu
CQW Luanda 9S 13E	10630	11436	nu	nu
JCS Chosi 36N 141E	10816	11183	12379	15046
ASK Karachi 25N 67E	11974	12027	12027	19980
ZSC Capetown 34S 18E	12679	12972	25154	np
NRV Guam 13N 145E	12784	13256	nu	nu
VWB Bombay 19N 73E	12850	12926	13120	19965
VPS Hong Kong 22N 114E	13141	13344	nu	nu
TXZ Djibouti 12S 43E	13419	16094	nu	nu
FJP Noumea 22S 166E	13823	15041	24317	nu
5RL Diego Saurez 12S 49E	13927	16464	nu	nu
ZLW Wellington 41S 175E	14065	15460	np	np
9VG Singapore 1N 104E	15570	15893	16879	nu
VIS Sydney 39S 152E	15839	17556	nu	nu
VID Darwin 13S 131E	16032	16548	20860	np
VPC Fort Stanley 52S 58E	16288	16540	25315	np
VIP Perth 32S 116E	18614	19403	20851	np

Typical SPT Paths

240 satellites

Station	Dist	Time	Space
NMR San Juan	2560	482/482/482	2/5/5
ZLW Wellington	18404/15460	1682/4310/25580	7/65/160
4XO Haifa	9299	962/962/3591	4/57/101
KLB Seattle	3715	722/1200/1678	3/53/53
NBA Balboa	3450	482/482/482	2/3/3
GKB Portishead	8195/5872	962/1917/1200	4/51/56
WCC Chatham	676	482/482/482	2/6/6
WAX Ojus	1470	482/482/482	2/4/4
KOK Los Angeles	3682	722/961/961	3/35/35
SAG Goteborg	6409	722/722/1200	3/56/70
CTV Lisboa	np/5883	np/1439/1439	np/42/58
IAR Roma	7236	722/722/961	3/52/55
VWB Bombay	12850	1202/1680/7894	5/84/124
ASK Karachi	11974	1202/1441/8133	5/75/120
JCS Chosi	10816	1202/3114/5742	5/74/93
VIP Perth	19403/19324	1682/6701/?	7/114/>200
VIS Sydney	15839	1682/6462/?	7/78/>200
VPS Hong Kong	13141	1442/5027/11718	6/83/123
NRV Guam	12784	1202/3353/15781	5/79/139
9VG Singapore	19435/15893	1682/3354/?	7/103/>200
5RL Diego Saurez	16684/16464	1682/6461/22473	7/81/185
FJA Papeete	13656/10897	1442/1919/13152	6/41/124
FJP Noumea	13823	1442/4310/?	6/63/>200
VID Darwin	16032	1442/5027/?	6/97/>200
6VA Dakar	7622/7403	962/961/1200	4/31/39
TJC Douala	10113/9893	1202/2157/8610	5/39/123
CQW Luanda	11656/11436	1442/3353/9566	6/49/127
ZSC Capetown	14501/12972	1682/2158/20083	7/57/169
TXZ Djibouti	16314/16094	1682/4788/22473	7/63/185
PPR Rio de Janeiro	9045	962/962/5503	4/25/99
LPD General Pacheco	8504	962/1201/4786	4/28/99
TFA Rejkjavik	np/4347	np/1200/1917	np/49/45
VPC Port Stanley	16540	1442/3354/33229	6/82/186

Comparison of Algorithms

SRD / STD / BFM

Appendix B - Additional Material

Status of European Research Networks, Provided by H.W. Braun (UMich)

ORGANISATION EUROPEENNE POUR LA RECHERCHE NUCLEAIRE

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

For 10/15 Minutes

CERN
CH 1211 GENEVE 23
SUISSE/SWITZERLAND

TELEX: 419000 CER CH
Tel.: 022 - 83 2394

Dr. E.Auperle
Computing Centre
1075 Beal Avenue.
Ann Arbor
Michigan 48109-2112
USA

29 April, 1986

Dear Eric,

Thank you for your letter of 18 April. I am at this time collecting a batch of papers which might be of interest to you on the progress towards integrated research networks in Europe, specifically the RARE project for coordination of the existing and planned national research networks like Janet and DFN, and the more political EUREKA activities.

There is an important RARE meeting of the present network managers and planners on this topic in Copenhagen at the end of May, where I am going to talk about high speed network developments, including some current satellite experiments in Europe. I will take the opportunity to mention your interests, and see what responses I get. Are there any particular subjects you would like me to raise, and could you send me any recent information on Merit and on your other interests, beyond what you gave me when we met last October?

My electronic mail address is:
MGH.C1@GEN.BITNET via Bitnet; GEN is the Cern IBM
or HINE@CERN.VXDEV via Janet in the UK.

I tried to find out how to send you this reply electronically, but your letter paper is silent on this point. This raises an interesting argument we are having here, on how to provide a service for sending mail to people without a mail address, but whose ordinary address you know. Have you tackled this problem, e.g. by having a Postmaster computer for the Centre, which puts such mail onto paper and delivers it like a telex? There are many human factors in mail systems which are far from being solved today.

Yours Sincerely,

Mervyn Hine

Mervyn Hine
DD Division

Your_Name%UMich-MTS.Mailnet@MIT-Multics.ARPA

[illegible]

personal correspondance between Mervyn Hine + Eric Aupperle.

Research Networking in Europe
RARE Networkshop in Copenhagen, 26-28 May 1986.

M.Hine
CERN, 15 June 1986.

Include in 10/15 Minutes

Recent History

Research networks in Europe have been set up on a national or local/sectorial basis, typically either by a national funding body like SERC in the UK or BMFT in Germany, or by groups such as high energy physicists or astromomers forced by the nature of their work to communicate electronically and exchange data beteen centres.

These origins led naturally to incompatibilties and absence of international connections to such an extent that in May 1985 various national networks and other interested parties like CERN met and agreed to found an Association, RARE (Réseaux Associés pour la Recherche Européene). It was incorporated recently in Holland with support from the Dutch government.

Its aims are to encourage convergence towards international (ISO) protocola by designing and implementing transition strategies, to present a united front towards the PTTs on questions of tariffs and licences, and to try to get more funding nationally and internationally to speed up the process.

In November 1985, the German government proposd to include a project for a European Research Network in the EUREKA programme which was then being launched by governments to provide a Europe-wide civil programme of technological development as an alternative to participation in SDI. In February 1986 the governments interested in this project decided to ask RARE to do the planning for the development of such a network, now called COSINE (Cooperation for OSI Networking in Europe). This in fact amounted to what RARE was already trying to do, with a label of governmental approval added, but no special funding (at least so far). The participation of industry in some way was also a condition of this approval, industry being almost anything but IBM.

Other General Research Networks.

IBM had, in fact, stimulated support for RARE by setting up and funding EARN, which immediately became popular, since at last IBM systems could talk to one another and to VAXs cheaply, and also because there was a transatlantic link to BITNET paid for by IBM.

EARN is, of course, a sin and a heresy in several ways. It is manufacturer specific, with limited and very non-standard protocols; IBM's way of introducing it broke a fundamental European PTT dogma that leased lines may be used only for the leaser's traffic, not for third parties, at least without bearing a volume charge on top of the line rental; by paying for it, IBM attracted into its web many innocent users who should have been pushing for the development of European industrial products and networks based on OSI with ISO protocols.

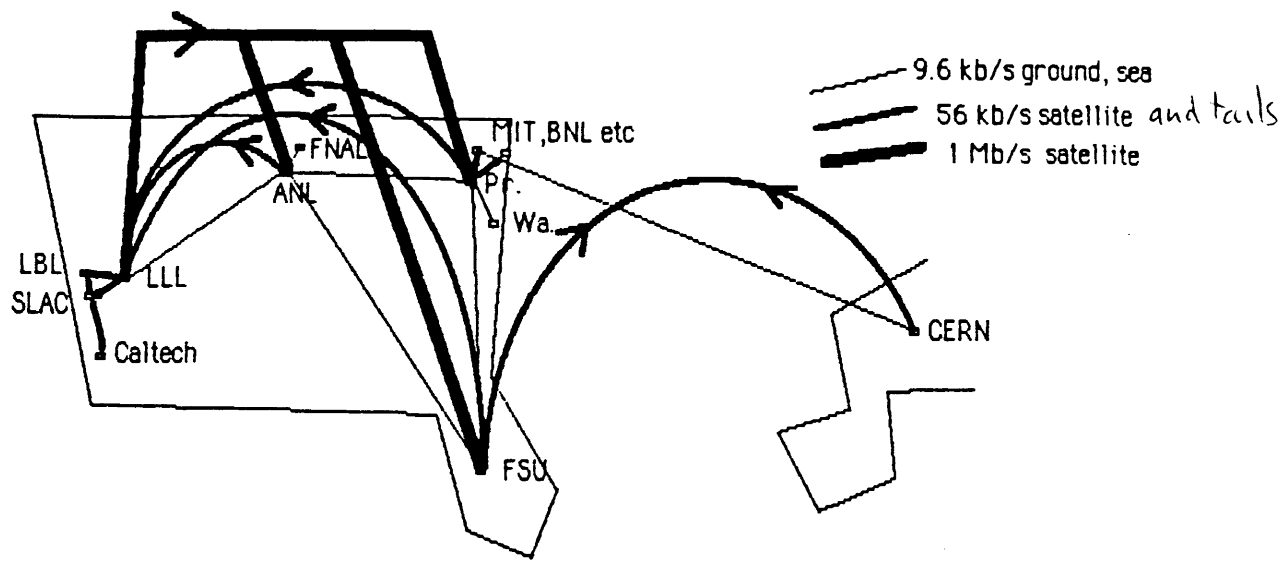
A PTT condition for allowing IBM to set up the international trunks and switches was that it should move towards ISO protocols within a few years. IBM also said its subsidy would stop at end-1987. What the first condition means has never been clear: perhaps that RSCS traffic should be carried over the public X25 networks at Level 3 and below. In addition the PTTs reserved the right apply volume charging, which IBM has refused to pay. This problem is somewhat unreal at present, since there seems so far to be no way of measuring volumes on the various lines and imputing charges correctly.

The other general Network in some way in competition with RARE/COSINE, but which does not seem to raise political problems, is EUNET/USENET. As with EARN, its connection with the USA and other countries is a reason for its popularity, along with its being based on UNIX, which makes it serve a different community from those mainly dependent on IBM and other mainframes or VAX VMS systems: the classical difference between those who compute and those doing computer science.

Transatlantic Communications.

The importance of transatlantic connections for the research community is higher than some people realize. In high energy physics, HEP, which is admittedly a field with wide research collaborations, 30% of the traffic leaving the CERN site goes to N.America, and 30% of SLAC's external traffic is for Europe. The EARN link has been essential here. HEP has been forced by the existence of only a few large accelerators to develop remote operations by large collaborations moving both people and data internationally, so networking came early: the UK JANET network started as a remote job entry system to the Rutherford centre from many UK Universities with HEP groups. In other fields there has not been this urgent need to work remotely, but the arrival of cheap computing and good electronic communications will most likely encourage day by day contacts between people who previously only wrote letters or met at conferences.

The US Dept. of Energy has been sufficiently impressed by the importance of transatlantic communications for HEP that Mr. Cavallini, who controls the budget for communications, will fund a 56 kb/s duplex transatlantic link for the US groups working with CERN, in addition to the 9.6 kb/s link already used for the US participants in one experiment, the L3 experiment now being prepared for LEP. This new link is part of the merging and updating of the present MFENET for US fusion work and various proposals for a HEP net to replace and complete the ad-hoc sets of links now used by HEP groups in the USA. For heavy data traffic, particularly for supercomputers, it would involve, as well as the link to Florida State Univ. from CERN, 56 kb/s simplex satellite links from FSU, Princeton and Argonne to Livermore, and a broadcast 1Mb/s return transmission from LLL to the other three. The other E.Coast labs, FNAL, LBL, SLAC and Caltech would be connected to the nearest earth station by land lines, with in addition a general 9.6 kb/s net for terminal traffic to avoid the satellite delay, which would involve two hops (or four for CERN) for the round trip.



The satellite net, which will replace the existing MFENET, would run DoD IP, with a policy to move to ISO IP at some future date. The gateways would however also allow X25 circuits to be set up, so that CERN's US collaborators could use equipment and protocols consistent with their CERN colleagues. This facility would not be quite so un-American as it might seem, despite TCP/IP becoming a defacto standard in the USA, since there seems to a strong X25 faction in DoD who think of the need to use world-wide rather than only domestic communications. The European PTT rules require that the USA traffic stops at CERN, and cannot be forwarded on to other laboratories. If, however, some protocol conversion above Level 3 has to be done, they seem to be less fussy; this may be relevant later on if ISO means TP4/IP in USA and TP2/X25 in Europe.

The RARE Networkshop.

The following documents, attached as an Annex, give a good picture of the Networkshop, which was attended by about 115 people from 21 European countries including Israel, Iceland, Turkey, and people from the CEPT and the EEC Esprit and Race programmes.

Conference Programme: four half days.

Abstracts of most presentations.

Status Reports on national networks.

Standards: CEN/CENELEC Functional Standards; Example for XXX.

MHS: Working Group Activity Report; Directory System; Distribution Lists.

File Transfer: Description of Working Group; FTAM Profiles and Implementations.

PTTs: Liason with CEPT; New PTT initiatives; ISDN Constraints and Opportunities.

Full Screen Services.

Transport Protocols: Performance comparison of ISO TP4 and DoD TCP.

Satellite networking experiments on ECS2.

Background on particular topics.

Standards: the basic aims of RARE are to move towards OSI/ISO networking, and how to live meanwhile and make the transition. ISO protocols are felt to be technically sound, but have so many options that a further process of agreeing on suitable Functional Standards, composed of a limited number of selections of options, is necessary to ensure interworking, and has been undertaken with some urgency by a body called CEN/CENELEC associated with the EEC, together with the CEPT, the European PTT "Club". It is hoped that these functional standards will become compulsory in public authority purchasing.

Message Handling Systems (MHS): these have been felt to be the most urgent generally needed facility by the research community, and one where the X400 CCITT international recommendations were well enough advanced to push for general use as soon as possible. The Univ. of British Columbia EAN quasi implementation has found favour in many places, and is being used as a stopgap solution till manufacturers produce their own. The Directory problem and the absence of Distribution lists are beeing tackled by EEC funded projects. In the interim, mail gateways are essential, such as the CERN MINT system, which interconnects most of the systems currently used by the HEP community.

File Transfer: the move to ISO FTAM is well agreed in principle, but its geeneral use is still some time away, particularly since the protocol for job entry and manipulation, which will depend on FTAM, is not so far advanced. General availablity of FTAM is expected at end-1987 only, with Job control perhaps one year later. Meanwhile protocol conversion is necessary, and CERN has taken the lead with its GIFT project, now operational, which does on-the-fly conversion between several File protocols now used in the HEP community, including DECNET, UK Blue Book. It works by translation into an internal common meta-protocol in a VMS VAX, and it is planned to add translators for TCP, the current DFN interim protocol and FTAM. Such convertors will be essential to allow FTAM to be introduced progressively, without cutting off its users from their collaborators still using e.g. DECNET.

PTT problems and Plans: the European PTT monopoly on telecommunications is slowly being eroded, but people are beginning to hear of the negative side of the ATT divestiture, so it is not clear how far or fast it will go in reality. End user equipment will be less controlled, and competitors to the PTTs for value-added networks will appear in some countries. Pure transmission will stay with the PTTs in most countries for some time yet. A major difficulty in dealing with the PTTs on international communications is that their "Club", the CEPT, has no power, it makes joint studies and proposals, but decisions remain with the individual PTTs, who make bilateral agreements not general ones for the whole of Europe. Prof. Kündig, who worked for the Siss PTT for 20 years, was, however, able to make useful contacts with CEPT committees at high level, and RARE has been asked to be the European research user voice in the CEPT discussions, which is a big step forward.

Future Services: the RARE short term plans have all been based on getting X25 networking going universally, and so far it has not begun to look at higher speeds or longer term issues. At the meeting the arrival of ISDN and the possibility of 64 kb/s switched voice/data circuits becoming available in the next few years was discussed, as was the present availbility and possible uses of leased satellite links at up to 2 Mb/s. The Satine-2 paper refers to the possibility of using the satellite as a switch under user control, not just for fixed circuits, and the fact that 2 Mb/s ISDN type switched circuits could also become operational in the next years, which would have similar properties to the satellite.

Conclusion.

The step towards efficent networking for research in Europe symbolized by RARE is getting support, e.g. via EUREKA, and people are working together who previously were more nationally bound. Some of the outstanding policy problems now include how to help along the decisions towards Functional Standards; how to get an evolutionary Directory Service going rapidly; how to bring EARN into the discussions more formally, so far it was kept at a distance; how to take account of the importance of communications with the USA and other continents; how to get cheaper large file transfer, since X25 volume charges are high; how to get industry, particularly IBM, quickly to bring out ISO communication software as a standard product; how to get governmental and PTT recognition that research networks must be international and not so much more difficult and costly to use than national ones; what to do to be able to make good use of ISDN and satellite systems.

This is a large and incomplete agenda, on which most of the items are equally of interest to the US research community. It was agreed to take advantage of the Dublin IFIPS meeting and the associated Landweber meeting to see how the non-European problems might be tackled.

USA HEP network situation

Author: B. Carpenter
Date: 17 Jun 86
Version: 1
Status: Draft

This is an extract from a report of my trip to the USA in May 1986, followed by the minutes of the meeting which I attended at LBL.

1. NETWORKING IN THE US LABS

I attended the first meeting of the US HEPNET Technical Coordination Committee (HTCC) at LBL, convened by Hugh Montgomery (Fermilab) and chaired by Sandy Merola (LBL). It is planned to establish liaison between this group and ECFA DPHG SG5. There was a useful presentation of general status by each institute represented. I give a summary of these reports, combined with information gained directly at SLAC and LBL.

1.1 Argonne (Ed May)

HEP users are connected to Fermilab via DECnet over a share of a microwave link. Internal networking will be rationalised by converting to a digital PBX for terminal switching and LAN use.

The VAX named ANLVMS is a new, not fully operational, machine which acts as an MFEnet/BITNET gateway and is also on DECnet (but not as a gateway; the BITNET–DECnet gateway for HEP is at LBL).

1.2 Brookhaven (George Rabinowitz)

Brookhaven has IBMs on BITNET and VAXes on DECnet, plus integration problems! They are considering a global switch to TCP/IP and will decide shortly. They are running the Fusion software ($7K for the first copy) and it looks 'reasonable', and they need access from VAXes to Suns and other Unix systems as well as to IBM.

1.3 Fermilab (Greg Chartrand)

Internally, they run interlinked Ethernets using DECnet routers over T1 links. They plan to move to bridged Ethernets when possible. They have about 2000 terminals on a MICOM switch (plus links to other labs via statistical multiplexers and T1).

Externally, they use DECnet, BITNET (on the IBM and the VAX cluster), MFEnet to Argonne (also on the cluster). They pay about $2K/month for Tymnet X.25 calls mainly to Hawaii and Europe (F, D, GB, etc). Their traffic is by no means dominated by large destinations such as CERN.

1.4 LBL (Sandy Merola)

The LBL Ethernet runs DECnet, XNS and TCP/IP. The latter is used among other things to support remote printers. They are interconnected to the Berkeley campus DECnet as well as the HEP DECnet. The VAX cluster is also on BITnet and MFEnet; another VAX (named LBL) is on ARPAnet and MILnet so LBL constitutes a major gateway site. Terminals are on a MICOM switch interconnected to MFEnet and Tymnet, which costs them about $5K/month (largely domestic traffic).

1.5 SLAC

Les Cottrell reported at the meeting, but I also spoke to Tim Streater, Charlie Granieri, and Howard Davies.

SLAC have about 1200 ASCII terminals plus a few hundred 327x terminals. The latter are connected direct to IBM, the former are on a mixed system of MICOM (1500 total ports) and Bridge boxes (250 total ports). Expansion of the Bridge side has been stopped because MICOM is cheaper (but only by use of "group termination" multiple connectors to reduce cabling costs). A management system for MICOM has been written (information was mailed to Gordon Lee).

There are about 27 VAXes and 2 IBMs. Networking is based on two Ethernets connected by a DEC LANbridge, which works well. The Excelan 'LANalyzer' Ethernet monitor on a PC is in use and seems excellent -- good documentation and user interface, good functionality, can easily track the 60 packets/sec which is typical traffic at SLAC. Howard Davies has personal experience of the ICL monitor, and says this is better. Incidentally about half the 60 packets are generated by the 250 Bridge terminal ports.

Protocols used are DECnet, XNS (for Bridge), and SLACNET, home-made protocols built on top of XNS for VAX-IBM communications. BITNET and JNET are also used. There is no TCP/IP.

1.6 MIT Laboratory for Nuclear Science (Mark Kaletka)

They have 3 VAX – 11/780s plus several microVAXes on Ethernet, running DECnet (with a DDCMP link to the HEP DECnet), plus a BITNET link and X.25 for L3 (see below). An MFEnet link and an IP gateway to the MIT "spine" are planned (thus they will also use the Wollongong TCP/IP package). This will give connectivity to ARPAnet and NSFnet.

1.7 LEP3NET (Mark Kaletka)

This summarised the known state of L3's private international network. The USA and Swiss parts are based on JANET protocols running over X.25 and the Italian part on DECnet; actually DECnet is also run across the Atlantic too. The CAMTEC switches in the USA are handling 1 Mbyte/day, or 400 calls/day. The cost using Tymnet would be several $K per day (leased line costs are in fact about $230K/year). Throughput peaks at 1 Kbyte/sec, very good performance on 9600 baud lines.

1.8 HEP DECnet problems (Greg Chartrand)

The US HEP DECNET, known as PHYSNET, faces severe organisational problems due to the limited number of area codes allowed by DECnet Phase IV and the multiple clashes with area codes used on various campuses and in Europe. Greg presented a proposed partial solution (partitioning of the area codes into 'local' and 'wide area' zones). This solution will be elaborated and analysed in the coming weeks. **This is a serious problem for European HEP too and ECFA SG5 needs to take it seriously.**

2. DOE NETWORKING AND TRANSATLANTIC LINKS

John Cavallini of the Energy Sciences programme of the Department of Energy has been mandated to rationalise networking for the various Energy Sciences research areas. The user community is dominated by MFE (Magnetic Fusion Energy) and HEP. The intention is that the Livermore networking team, headed by Jim Leighton, should put into place a replacement for the old MFEnet to serve the entire Energy Sciences community. This new network has been referred to as MFEnet – 2, MFEnet – II, ESNET, ERNET, and OERNET in various documents. I will stick to ESNET. The day before the HTCC meeting, Ben Segal and I attended a meeting at Livermore, chaired by Cavallini, with participation from US HEP sites, MFE, and DoE. Cavallini and Leighton outlined the following plans:

- The network will consist of a mesh of datagram switches (called CCPs for historical reasons) and 'gateways'. The users will not see the CCPs or the protocols used between them, but will either have a gateway on site or a line to a gateway.
- ESNET will offer two end – to – end services at equal priority: ARPA IP and X.25. Note that the (verbal) committment to X.25 is a radical change brought about by pressure from the HEP community in recent months.
- The gateways will be 32 – bit engines, the choice depending on a call for tenders which is underway. The IP software will be done by Livermore, the X.25 service might be based on board – level products such as those from ACC.
- The first service should be available in late 1987.

- The links will be dual: land lines up to 56 kbaud for interactive traffic and 56–256 kbps satellite links for bulk traffic where satellite delay is acceptable. The actual situation is a bit more complex since Livermore will act as a star–point for the satellite links and will use a 1 Mbps shared outbound link to reduce the number of dishes installed around the country.
- Cavallini is (apparently) prepared to fund both ends of a 56 kbps satellite link to CERN and to locate an ESNET gateway at CERN. It would have both an Ethernet/IP connection and an X.25 connection. Although we may never be allowed to make an X.25 connection from this link to the public network, the latest information from the Swiss PTT is that we can certainly connect ESNET to our own gateways and routers. Thus the link would allow us to offer transatlantic service to the HEP community, providing that new resources (manpower, capital, operating costs) are found.
- Once this is achieved, the existing 9600 baud terrestrial link installed by (and currently reserved for) L3 would hopefully be retained for interactive traffic.
- Cavallini and Leighton agreed to a transition phase in which the satellite link would be physically multiplexed, with part of the bandwidth reserved for ESNET tests, and the rest used for X.25 service.

Discussion and open questions: Ben Segal was satisfied that the Livermore people have understood the full requirements of providing an end–to–end IP service (inter–gateway and routing protocols as well as IP itself must be supported). They have relatively limited experience with X.25, and I requested that they circulate specifications for comment in the HEP community; this worry largely disappears if they indeed use ACC boards. But who solves interworking problems with CAMTEC?

There is a risk of X.25 traffic making 3 satellite hops (e.g. CERN to MIT; MIT to Livermore; Livermore to Fermilab). Will this work? Will ESNET support X.25–1984?

It is technically unclear how high–level protocols can ensure that interactive traffic uses the terrestrial links, and bulk traffic the satellite links.

The gateway throughput is not tightly specified but a figure of 500 packets/sec was mentioned.

We and most of the HEP participants were surprised by the large home–made content and had doubts about the proposed timescale. This is critical if ESNET is seen as a replacement for the free transatlantic service currently provided by EARN, which is due to stop at the end of 1987. Hence the 'transitional' solution may become vital!

In any case, the whole proposal depends on the 1987 US Federal Budget and may become accidentally linked to the political controversy about SDI funding – and hence to the 1988 election.

The conclusion of the HTCC's subsequent discussion of the ESNET proposal was essentially to welcome it cautiously, in view of the timescale doubts. Bob Woods, responsible for the HEP programme at DoE, will send a full set of comments to Cavallini. For CERN, the next stage is to get reactions from SG5 and CCC, which cannot be done until October.

I raised the general problem of transatlantic networking for the research community at the RARE Networkshop in Copenhagen. The RARE Executive is to follow up this issue. However, in view of the EARN timescale, HEP clearly has to develop its own solution in good time, without waiting for RARE.

APPENDIX A

MINUTES OF HTCC MEETING OF MAY 21, 1986

Sandy Merola
June 9, 1986

HEPNET Technical Committee Meeting May 21, 1986
Committee Members:

Name	Institution	Phone #	Electronic Mail
Greg Chartrand	FERMI	312-840-3727	GREG@FNAL
Les Cottrell	SLAC	415-854-3300 x2523	COTTRELL@SLACVM
Mark D. Kaletka	MIT-LNS	617-253-6065	KALETKA@MITLNS
Ed May	ANL	312-972-6222	ENM@ANLHEP.BITNET
Sandy Merola	LBL	415-486-4389	AXMEROLA@LBL.ARPA
Hugh E. Montgomery	FERMI	312-840-4708	FNAL::MONT
George Rabinowitz	BNL	516-282-7637	GR@BNL
Robert Woods	DOE-HQ	301-353-3367	DOEWOODS@SLACVM.BITNET

Additional Attendees:

Name	Institution	Phone #	Electronic Mail
Marv Atchley	LBL	415-486-5455	ATCHLEY@LBL.ARPA
Gerry Bauer	Harvard	617-495-9795	BAUER@HARVEP.BITNET
Brian Carpenter	CERN	+41 22 834967	BRIAN@CERNVAX.BITNET
Howard Davies	SLAC		DAVIES@SLACVM
William Jaquith	LBL	415-486-4388	WDJAQUITH@LBL.ARPA
Roy Kerth	LBL	415-486-7474	LTKERTH@LBL.ARPA
Stewart Loken	LBL	415-486-6915	LOKEN@LBL
Darrel Smith	UC Riverside	714-787-5623	SMITH@UCRPHYS

The first meeting of the HEPNET Technical Committee occurred on May 21, at the Lawrence Berkeley Laboratory.

\+ It was agreed that the HEPNET Technical Committee would have a rotating chair. Chairperson responsibilities would be assumed by the person representing the site at which the next meeting is scheduled, and those responsibilities would end upon the publication of the minutes of that meeting. Thus when these minutes are distributed, Mark Kaletka of MIT will be chairperson of this committee until after the September meeting at MIT is held and the associated minutes are published.

In addition to hosting the meeting and providing minutes, the chairperson would also be responsible to ensure that there was a meeting agenda, that any open items of the committee were proceeding to resolution, and assume all other duties typically associated with the chairperson of a working committee.

It was agreed that the format of the meetings would consist of a short meeting of committee members at which an agenda and internal committee issues can be addressed, with the remainder of each meeting open to interested members of the HEPNET community.

+ Les Cottrell agreed to set up a mailing list server, to which items of interests to this committee could me mailed and will be subsequently distributed to the entire mailing list.

+ It was agreed that there would be three meetings held per year, and that, when feasible, the winter meeting would be held at a west coast site.

+ University membership has not yet been resolved, pending announcement of the membership of the Review Committee.

+ It was agreed that the HEPNET community should represent itself to certain related networking groups. As a result, Les Cottrell will be our representative to the BITNET community and Greg Chartrand will be responsible for coordination with the SPAN networking community. Harvey Newman is a member of the NSF Technical Advisory Committee.

+ Hugh Montgomery agreed to inform James Hutton, Chairman of the SG5 working group of the European CCC, of the existance of HTCC.

+ A meeting of the European networking groups and management is scheduled for late October. Greg Chartrand agreed to disseminate any minutes or other documents which result from those meetings.

+ There were extensive site reports by all of the represented National Laboratories and LEP3 as well. Brian Carpenter made an extensive presentation of the European networking activities. Brian expressed some concern about the proposed NMFECC satellite link concerning issues such as the implementation timeframe, funding, engineering, and production related issues.

+ In discussing various aspects related to the satellite link to Europe and MFENET II, concern was expressed about the implementation of the lower levels of X.25 as they related to accounting issues and other needs of the European HEP.

+ A major part of the afternoon was spent in providing a summary report of Jim Leighton's presentation of MFENET II.

  The consensus of opinion is that the ESNET proposal which would provide interneting facilities to the HEP community as well as potential common carrier service for HEPNET/DECNET paths, is in the best interest of High Energy Physics. Bob Woods will be putting together representatives of the HEPNET community to participate on a steering committee for MFENET II. Members of the steering committee would need to address a number of technical concerns. Among them are:

  MFENET II allows for different physical paths for interactive verses file transfer traffic. Will DECNET provide a facility whereby interactive DEC-NET traffic can be separated from file transfer DECNET traffic?

  Members of this committee are very interested in the work that has gone on at NCAR with Vitalink bridges.

  Will X.25 file transfer be usable over three satellite hops? The number of outstanding of unacknowledged packets is the issue here.

  There was some concern expressed over the lower level protocols that will be used internal to MFENET, as they relate to throughput between the nodes.

  The HEPNET community needs to define the number of nodes it needs, their location, the response time that their users expect, etc. The consensus was that quantifying these needs might be useful to ensure that HEP needs are met.

  There was some concern about the time scale and documentation of the implementation.

  Which flavor of X.25 will be implemented?

While it is agreed that character by character editing between remote nodes may not be in the long term future of computing, it is the way things are done now. Any short term implementation would need to support that.

+ Greg Chartrand led a conversation concerned with area conflicts between our surrounding DECNET neighbors in both SPAN and the University world, and the current allocation of area numbers within HEPNET. If the known University and SPAN communities attempted to merge with any HEPNET host at this time, area number conflicts would result.

  Greg presented a proposal whereby area numbers 1 through 43 would be reserved for wide area networks, and areas above that would be reserved for local area networks. Thus universities would be placed in areas 44 to 63. As the current HEPNET occupies areas 41 through 43, surrounding universities would be able to use areas 44 through 63 without any detriment to HEPNET.

  It appears that this may be the only technically feasible solution to this issue. Greg and Jake will attempt to confirm this. Before any real implementation can occur, an RFC type document would need to get wide distribution throughout the US and European DECNET communities. If this remains our general consensus, this should be proposed to DEC and DECUS as a temporary solution for the area problem in the United States. Brian agreed to discuss this with his European networking peers. Administrative support would need to be given to this possible implementation plan as regards networking with non-HEPNET surrounding DECNET sites.

+ It was agreed that the next meeting would take place at MIT during the week of September 8th, chaired by Mark Kalekta. In addition to arranging about a day and a half of meetings, Mark agreed to attempt to arrange a wide area networking futures presentation by DEC. The general consensus is that by addressing networking issues with DEC (and others) as a large group, that the HEP community would be better served.

SATINE 2

EXPERIMENTS ON ECS2

M.Hine, CERN, Geneva

22 May 1986

1. Background.
2. Aims and Design of Present Experiments.
3. The 1986 Experimental Programme
4. Experiments in 1987 and Implications for Future Services.

Laboratories and Persons Involved.

1) Rutherford Appleton Laboratory, Didcot, UK
   C.Adams, J.Burren.
   In collaboration with Manchester and Loughborough Universities, GEC and British Telecom.
2) CNUCE, Pisa, Italy
   A.Bonito, N.Celandroni, E.Ferro, L.Lenzini.
   In collaboration with Telespazio.
3) Technical University, Graz, Austria
   O.Koudelka, W.Riedler
   In collaboration with Austrian PTT
4) Experiments have been made possible by a grant from the CEC Cost 11-ter programme, coordinated by M.Hine, CERN, Geneva, Switzerland, and by permission from EUTELSAT to use an ECS-2 satellite channel for experiments at no cost.

1. Background

1.1 Needs for wide area high speed data services.

- Large File Transfer with short delay
- Quasi-interactive access to supercomputers
- Mixed media traffic with sound and video
- Flexible access to many sites within user groups
- Traffic between LANs, not individual users
- Single user speeds in range around 1 Mb/s
- Error rates zero for File Transfer to 10^{-5} for e.g. audio or facsimile

1.2 Present Public Facilities:

Leased PCM ground links
- Coaxial Cables or Fibre Optics
- Microwave Links

Satellite Links
- Télécom 1 circuits
- ECS2 circuits

Essentially Point-Point Links, reserved ahead with in most cases long notice and reservation periods.

Error rates adequate except for microwave links in bad conditions.

Tariffs based on fixed costs plus duration, not on volumes of data sent.

Public Switched Services starting in some countries, based on ISDN technologies, essentially 64 kb/s.

1.3 What is missing at both PTT and user level?

- Sharing of channels among many users
- Multidestination connection to LANs
- Variable speed and error performance
- Priority for special traffic, e.g. voice
- Tariffs based on individual usage

1.4 Previous work, aimed at missing facilities.

HELIOS: Getting the best of present PTT offerings.

- Saclay, INRIA, CISI are setting up experimental Mb/s services using standard Télécom 1 circuits to develop high speed interfaces and protocols, and get user experience with Saclay-Cern users.

STELLA-2 and UNIVERSE Experiments:

Exploit natural switching capability of satellites:

- OTS satellite, 11/14 GHz, 3 m. diam antennae
- satellite link speed 2 Mb/s, half rate coded
- data speed 1 Mb/s, error rate < 10-9
- Earth station driven by minicomputer attached to LAN, via simple

controller generating 20-40 ms HDLC data frames sent to earth station.

- in UNIVERSE, the system could support several earth stations sharing the 1 Mb/s rate with variable length sub-bursts for different calls inside each station's transmit burst, in a superframe.

2. Aims and Design of Satine-2 Experiments

2.1 - The name Satine-2 is a recognition of a grant from Cost 11-ter which follows that from Cost 11-bis forSatine (SATellite INternetwork Experiments), the name then given to the second phase of Stella.
- The aim is to try out techniques based on UNIVERSE internationally, with industrially engineered equipment and more advanced software.
- Main participating laboratories, all active in Stella:
  Rutherford-Appleton Laboratory, Didcot, UK
  (hardware and system design, with GEC,
  Manchester and Loughborough Universities)
  CNUCE, Pisa, Italy
  (Software and protocol expertise)
  Technical University, Graz, Austria.
  (Satellite transmission expertise).
- Austrian PTT, British Telecom, Telespazio all showed positive interest, and helped obtain EUTELSAT agreement for use of ECS-2 transponder free of charge.

2.2 Upgrade of Stella/Universe Service Parameters.

- Up to 64 stations active at one time, each able to handle many calls in parallel.
- System to handle at the same time packet voice, Facsimile or slow scan TV, Bulk file transfer and interactive traffic with appropriate speeds and error rates, on a burst by burst basis.
- Separation of Stream and Datagram traffic.
- Variable satellite link bit rate: 1, 2, 4, 8 Mb/s, switchable from burst to burst, with different types of modulation to allow operation within a 5 MHz bandwidth.

  - Variable rates of coding: 1/2, 5/8, 3/4, 7/8, uncoded also switchable from burst to burst; aim to offer guaranteed error rates better than 10^{-4}, 10^{-6}, 10^{-9} for different services, by adapting code rate to signal/noise conditions with corresp[onding changes in data rate.
- Interfaces to allow data to come from a Local Area Network or individual circuits.
- Demand allocation of channel capacity, with priority, on a one second time scale.

2.3 Satine-2 System and Equipment

The present experiments will run between three users, RAL, CNUCE and TU Graz, each with an earth station.(Fig.1)

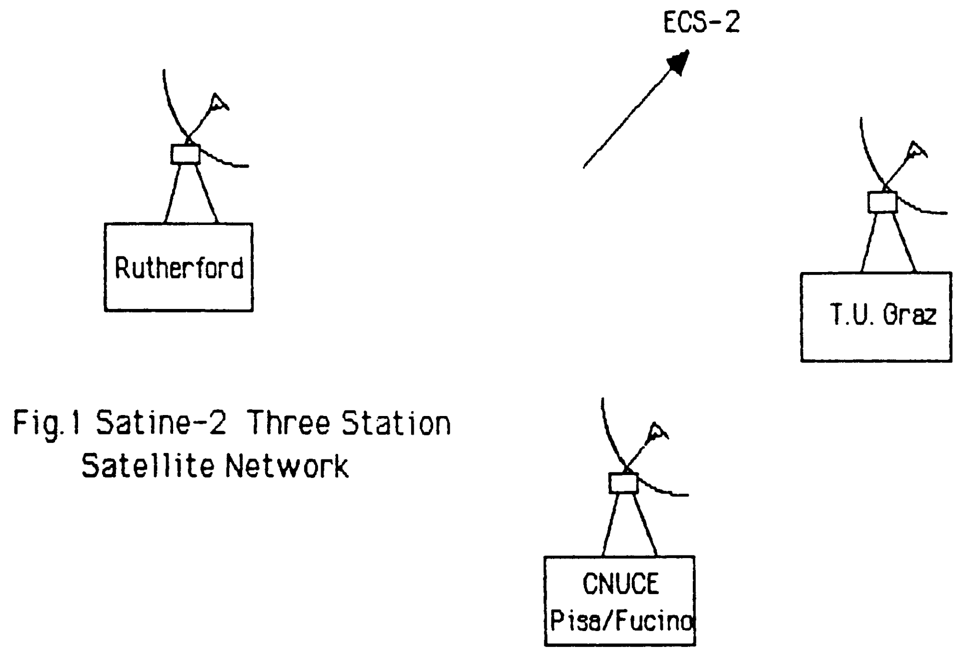


Fig.1 Satine-2 Three Station Satellite Network

These are fed with data from host computers or other sources on Cambridge Ring LANs, carried over from Stella/Universe. Up to 64 stations can be handled at one time in the system design. (Fig.2)

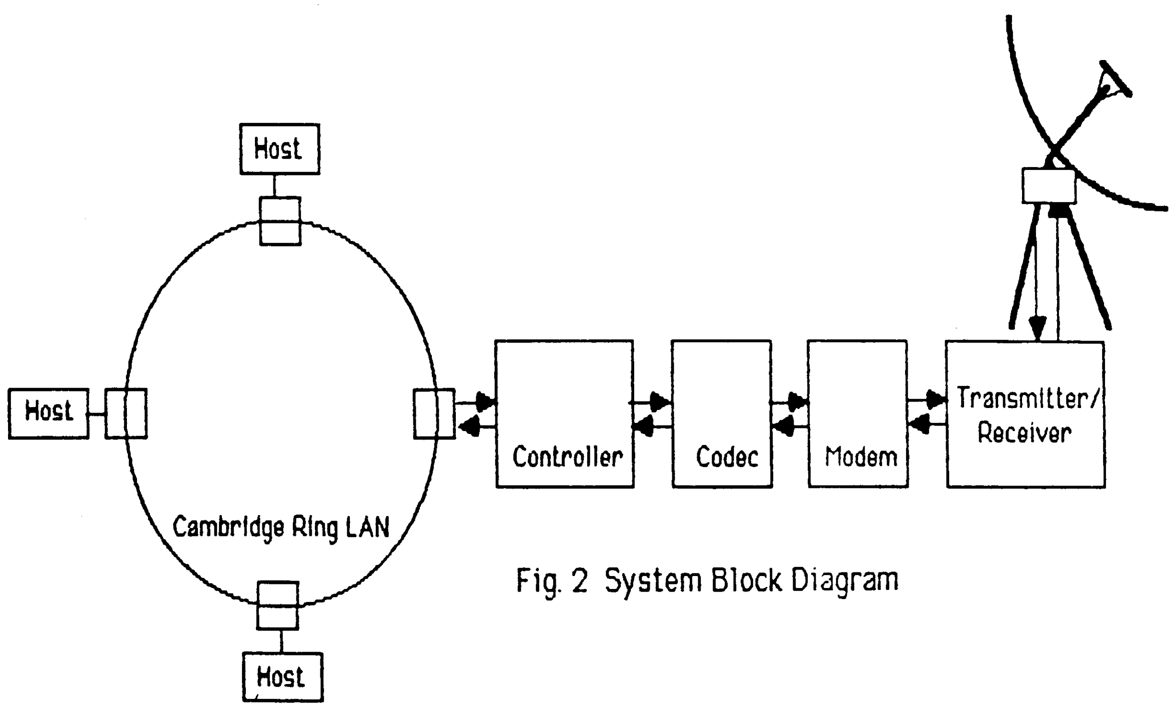


Fig. 2 System Block Diagram

The difference between Stella/Universe and the Satine-2 systems is in three components: Satellite Controller, Codec and Modem, and the accompanying Access scheme and transmission software.

Satellite Controller.

This has functions of collecting data from the LAN, requesting satellite channel capacity for its total needs at any time, sending and receiving data blocks at allocated times in the Frame, sending out data to users on the LAN.

If the Master station, in addition it receives requests for channel capacity, and allocates slots for other stations.

The new FIFO Order-based Demand Assignment (FODA) access scheme uses the controller to buffer and order its traffic by priority internally, and demand capacity for its total needs, not as in Priority Oriented Demand Assignment (PODA) bringing priority of each packet into the channel assignment scheme, with accompanying heavy overhead. The FODA controller uses priorities in its use of its assigned total channel capacity in sucessive Frames.

Two types of data traffic are separately scheduled, Stream traffic for voice, facsimile and similar traffic where regularity of packet arrival is important, but error rates can be higher than for computer data, and Datagram traffic, where error-free transmission is essential, but delays not so significant.

The length of the transmission Frame (Fig. 3, times not to scale) is chosen to fit voice stream traffic, where a 64 kb/s voice channel needs 32 packets/s for a convenient 256 byte packet size. With 2Mb/s and uncoded packets (errors not critical) a dozen streams will take less than half the channel capacity, the other half being free for datagrams.

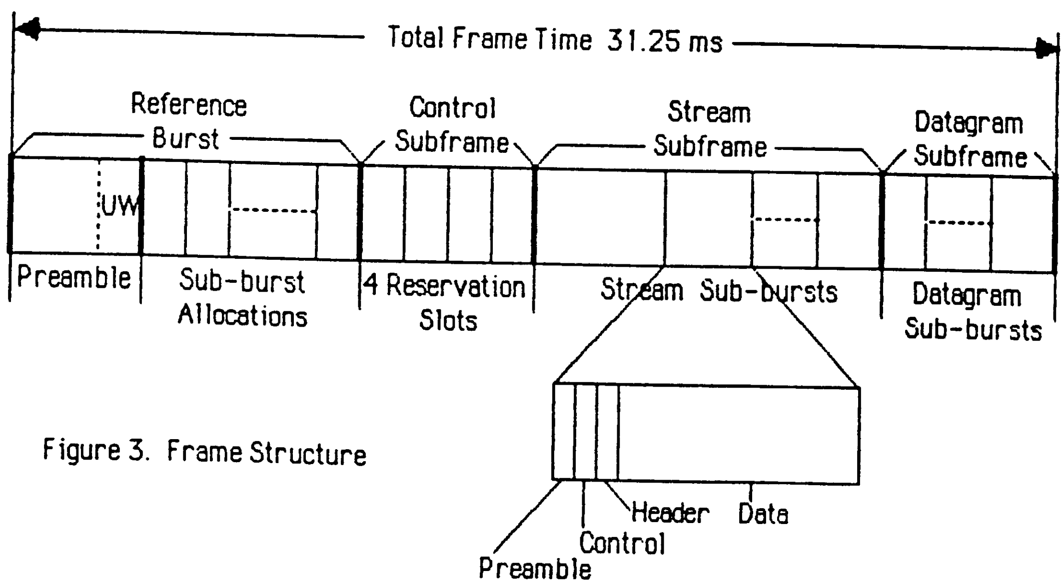


Figure 3. Frame Structure

To allow access of every station to reservation slots, 64 frames are grouped in a 2 sec Superframe, a station having access to its reservation slot at least once per half second. Stream channel allocations are sent out by the Master in the Reference burst at the start of each Superframe only, while datagram allocations are sent every frame, since they may change more frequently than voice calls.

The amount of real data per burst depends on the coding level used, which is set by the sender, and can change from burst to burst.

<u>Coding and Codec</u>

Stella/Universe used a fixed half rate convolutional encoder and Viterbi decoder, which was available and appropriate for the typical long data blocks sent and the poor link budget assumed in the design. Satine-2 handles many shorter, blocks with little space for overhead.

In general, since with coding less energy per signal bit is needed, the most economical system uses high data and coding rates at the same time to achieve a given error rate. The Satine-2 system offers therefore adaptive combinations of bit and coding rates on a block by block basis to match the needed error rates for different calls under varying transmission quality.

The coding used in Stella does not fit these needs, and Satine-2 will try out block codes, with blocks of only around 100 bits, possibly with interleaving to help correct burst errors. Cyclic and Reed-Solomon codes have been considered, and the choice of code depends on the error rates and burst error frequencies, and on the computing load put on the controller. A first implementation showed a poor choice in this respect, and a simple, less performant, code will be used at the start while the design is being revised. This is another example of a lesson drawn in Stella, that the controller-codec-modem chain must be designed as a whole, not built of pieces each of which is optimal by itself.

Modem

One object of the experiments is to compare different modulation and detection techniques over the speed range 1-8 Mb/s, always maintaining the frequency spectrum safely within the 5 MHz channel spacing. This implies 4 or 8 signal levels i.e. 2-3 bits per symbol. Three types of modulation are provided: Offset QPSK, Bandlimited QPSK, Rounded waveform PSK.

An important factor is the effect of non-linearity in the transmitter amplifier, which increases spectrum width, particularly for modulation schemes which do not maintain constant r.f. amplitude. To minimise these problems sophisticated filtering on transmit and receive are needed, and non-linear predistortion to cancel the HPA non-linearity. Taken with the need to switch data rates instantaneously, this implies digital techniques all through the modem, apart from the final A-D converters to/from the Intermediate Frequency amplifiers in the station. Digital techniques ensure stable performance and ease of change of filter parameters compared with analogue systems.

Several different detection schemes were analysed and simulated, and both threshold and near maximum likelihood detection will be used for different data rates, the latter with error correction coded signals to get the maximum gain from coding.

3. The 1986 Experimental Programme

3.1 Present State of Equipment

Earth Stations

The two earth stations used for Stella at Rutherford and Graz until the end of 1984 were refurbished and tested this Spring. The performance on satellite loop with classical continuous random data was found to be excellent. Similar performance was found in tests between Rutherford and Graz.

Telespazio did not wish to continue to operate the station at Pisa, but offered use of their own station at Fucino.

Controller

The first GEC model has been running at RAL, and CNUCE has installed and checked out the software as far as can be done without satellite time, which is asked for in the beginning of June. Other models for CNUCE and Graz will be delivered shortly. The software design had previously been studied extensively by simulation.

Codec

In view of the redesign of the codec, the first tests during the summer will be made using the old Stella codec, which will not allow flexible bit and coding rates. Models of a simplified block code codec will be available in the autumn, so that tests of the full range of facilities will only be possible in 1987.

Modem

Industrially made models of the modem will also be available in the Autumn, but with the maximum speed limited to 4 Mb/s. Loughborough University is continuing development of hardware to reach the 8 Mb/s speed reliably.

Local Area Networks

Rutherford and CNUCE both have Cambridge Rings from Stella, and an ex-Universe network will be loaned to Graz.

Operating Schedule

Eutelsat has allocated 240 hours of ECS-2 capacity in a normal 11-14 GHz transponder (not the SMS transponder), for tests this year. Part has already been used for the Rutherford-Graz random bit error tests, and data exchange tests are scheduled to start early June. The Fucino station can be used only after some equipment has been moved from Pisa, and the new boxes are delivered.

Range of Tests.

The tests in 1986 will be done essentially with the old codec and modem, to check on error rates at different power levels etc. and on the operation of the satellite controller in starting up another station, allocating stream and datagram channels separately and in parallel with varying simulated traffic and observing saturation behaviour, simulating master failure and recovery.

4. Experiments in 1987 and Implications for Future Services.

The work in 1986 includes many visits between sites for installation and testing, which have been made possible by the grant of 40,000 ECU from Cost 11-ter. This was half of the amount needed and requested for the two year programme foreseen, Cost 11-ter finding that the work did not match easily with the aims of its programme, which is about higher level protocol problems.

The work for 1987 will be to repeat the technical tests with the new codec and modem over the wide range of parameters offered, and to explore the way the whole system works with a variety of real and simulated data. The traffic can be a mixture of packet voice, facsimile, bulk file transfer and distributed computing. Equipment used in Universe for generating this traffic will be available.

This work will require a continuation of support for travel and other forms of international collaboration, which so far is not guaranteed.

This situation shows up again a curious gap in international support programmes for technology, the absence of help for overall user-oriented development and demonstrations.

In general, it is often possible to get support for work on particular parts of a technology, e.g. higher level protocols or for fibre optics components, or for purely national projects covering systems: Universe could only be set up as a UK project, there was refusal to allow participation by other Stella laboratories.

Satellite networks are obvious candidates for international experiments, both for their natural future application and to get the PTT and other authorities to think internationally early on.

Networks are also a technology where user involvement has been demonstrably effective in the past, Arpanet and Janet are shining examples.

The groups which have worked on Stella, Universe and in ESA have the quality of covering the whole technology, from Megabit transmission to application level protocols to management problems and experience with real user services, which the more specialized but better supported firms and agencies do not have.

It is disappointing, therefore, that experiments such as Satine-2 apparently fall outside ESPRIT, RACE, COST, EUREKA or national programmes in one way or another. Each of the driving forces in these programmes, computer firms, PTTs, Industry ministries, seems to see either unwanted competition or other people's interests in such experiments, because they do try to cover a whole field.

What could be the future of a service based on the ideas in Satine-2? It could meet all the needs listed in 1.1 above for defined groups of users, if easy access to satellite channels was made available.

On-site stations looked attractive some years ago, to avoid long high speed ground links; this limitation is rapidly disappearing, with e.g. the BT Megastream 2 Mb/s links at only a few time classical rented telephone line costs.

The Satine-2 satellite channel acts like a star network with switching of streams of Mb/s data in a fraction of a second. When ISDN-like switched services for Mb/s rates become widespread, they are still in the test laboratory today, they could duplicate many of the satellite facilities.

Rutherford is running in parallel with Satine-2 in such a land-line experiment, UNISON, which will allow comparison of the techniques. It uses 80 Mb/s fast Cambridge Rings as a local network/exchanges in several laboratories, connected by Megastream links to an ISDN switch in London. Individual users' traffic is all in packets, and ISDN circuits are set up dynamically with appropriate capacities for the total traffic between each pair of sites, not on a per user basis.

The Satine-2 system can thus be seen as a complement to Unison, for use where ISDN-like facilities are not available. A large scale test of a mixed system is needed.

STATUS OF NATIONAL RESEARCH NETWORKS

European Networkshop 1986

BELGIUM STATUS REPORT

Paul Van Binst

Inter-university Institute for High Energies (IIHE/ULB-VUB)
Brussels Universities, Belgium

There is, as of today, no nationally organized academic and research network in Belgium. Various networking activities have developped over the past years, some based on point-to-point lines and "closed" communication protocols implemented in large networks like EUNET or EARN, others based on the use of the public packet-switched network, DCS, and aimed at a more "open" approach. This is the case of three universities (ULB and VUB in Brussels, UIA in Antwerp) which collaborate in the field of high energy physics and have implemented the British "Coloured Books" protocols allowing file transfer and mail in a large international community of users.

Many universities and other organisations are now seriously considering the move towards the newly defined standards like MHS and FTAM. It is expected that, following the RARE and COSINE initiatives, a synergy will develop in Belgium between all interested parties for the support and realization of open systems interworking.

STATUS FOR NETWORKING ACTIVITIES IN DENMARK

Peter Villemoes
Danish Computer Centre for Research and Education (UNI-C)
Vermundsgade 5, DK-2100 Copenhagen

Several institutions within research and higher education in Denmark are connected to EARN or EUNET.

The computing centre for research and education (UNI-C) operates a number of point to point networks plus a private X.25 based network (Centernet) for terminal access, and UNI-C is also connected to EARN.

The public X.25 service is used to access both national and international hosts.

Denmark participates in the NORDUNET programme, together with Finland, Iceland, Norway, and Sweden. NORDUNET will establish a common X.400 mail service, initially based on EAN software, and a common file transfer service, initially based on the JANET Blue Book, with FTAM as the final goal.

There are presently only few detailed plans for networking in Denmark, but over the next 3-5 years there may be substantial funding available for communications infrastructure.

FUNET

MEMORANDUM

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University Support Department
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FINLAND

22.5.1986

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Telex 125833 VTKKSFattn: FUNET/2088
EARN and Bitnet pietikai @ FINFUN

FINNISH UNIVERSITY NETWORK - CURRENT STATUS

During the last few years discussions and investigations had been undertaken related to the computer network of Finnish Universities. It was recognized that both the national and international communication services for researchers using computers was necessary. At the beginning of 1984 a project named FUNET - Finnish University Network - was launched by the Ministry of Education. The project is sponsored by the Ministry and the Finnish PTT.

Architecture and protocols

The Finnish University Network - FUNET - is based on the use of the public X.25-based network service Datapak offered by the Finnish PTT. Open triple X PAD service (X.3, X.29, X.28) is available on all the hosts. Besides this there are more services between compatible computers due to the use of computer dependant network solutions by the manufacturers. These homogenous parts of FUNET are called closed subnetworks. By now there are three types of subnets: DNA/Decnet (DEC), HP/AdvanceNet (HP) and DCA/Telcon (Sperry).

It's of course favoured to get open solutions for the high level protocols. FUNET participates in NORDUNET X.400- and FTAM-rpojects that are also coordinated by RARE, objective of these projects is to get working networks that are based on international standards.

A research project on the FTAM-protocol has been launched at the University of Helsinki. It's expected to carry out prototype implementations as a part of the project programme.

It has also started a research project on the MHS X.400 protocol at the University of Helsinki. The MHS implementation EAN from the University of British Columbia is intended to get installed on VAX /VMS- and VAX/Unix -systems as soon as possible.

The connection with EARN is also operational. At the moment there are 7 nodes in Finland.

EARN

FUNET was connected to EARN in the autumn 1985. The national node representing Finland is a IBM-4341 running VM/CMS at the Helsinki University of Technology. It is connected with a leased line to QZ, Stockholm.

The Finnish University community uses this node to communicate with EARN-nodes outside Finland. The Decnet subnet in FUNET is also connected with EARN by the JNET software product from Joiner Associates Incorporated running in 3 VAX'es. This sofware gives more services to the Decnet-users than just login.

The connection to the EARN can be considered as a gateway, especially because of the use of the JNET facilities. A complete FUNET-EARN gateway can't be inplemented as long as we have no open mail-system as a network service. At least at the beginning it is not possible to have just one Finnish node from the EARNs point of view as it was desired.

Addressing formats

No special addressing formats have been considered so far due to the status of the network. When the EAN- and EARN-traffic is established, the recommendations of the User Communities of these network in Europe will be obeyed.

Administrative rules

The right to use the network is up to the Universities. In actual practice this means that the University Computing Centers supervise access to the networking facilities of the host computers.

As a rule there are no major restrictions.

Current status

Funet has been developed gradually. Currently there are about 45 accessible hosts within Universities. Remote login service was operational nearly at every University, on one or more nodes. Also more facilities are available on computers depending on the computer type.

For the international mail traffic the EARN- and EAN-networks will be used. The internal mail is handled mainly by COM- and PortaCOM-systems, but also the VMS/MAIL and a self-made NEWS service (implemented at the Tampere University of Technology on the base of VMS/MAIL, a kind of a bulletin board) are used in Decnet.

The future work will be concentrated on open file-transfer and MAIL. FUNET participates in cooperation with the Nordic countries (NORDUNET) and also to other international efforts (RARE, COSINE, EARN, etc.).

Personal contacts

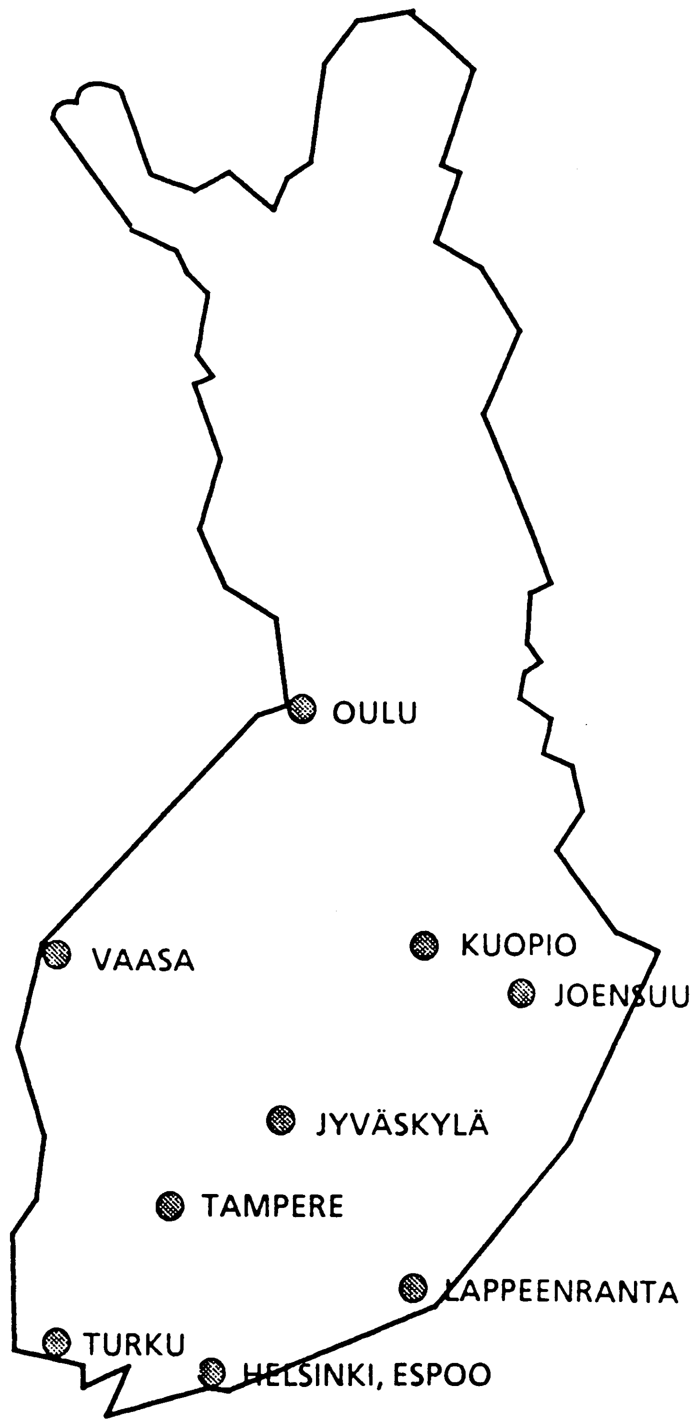
FUNET steering committee

Matti Ihamuotila Finnish State Computer Centre University Support Division	Chairman EARN Bod
Lars Backström University of Helsinki, Computing Centre	Nordic Cooperation (NORDUNET)
Juha Heinänen Tampere University of Technology	
Jukka Oranen Finnish PTT	
Risto Raitio Ministry of Education	
Panu Pietikäinen Finnish State Computer Centre University Support Division	Secretary Technical Coordinator

Other contacts

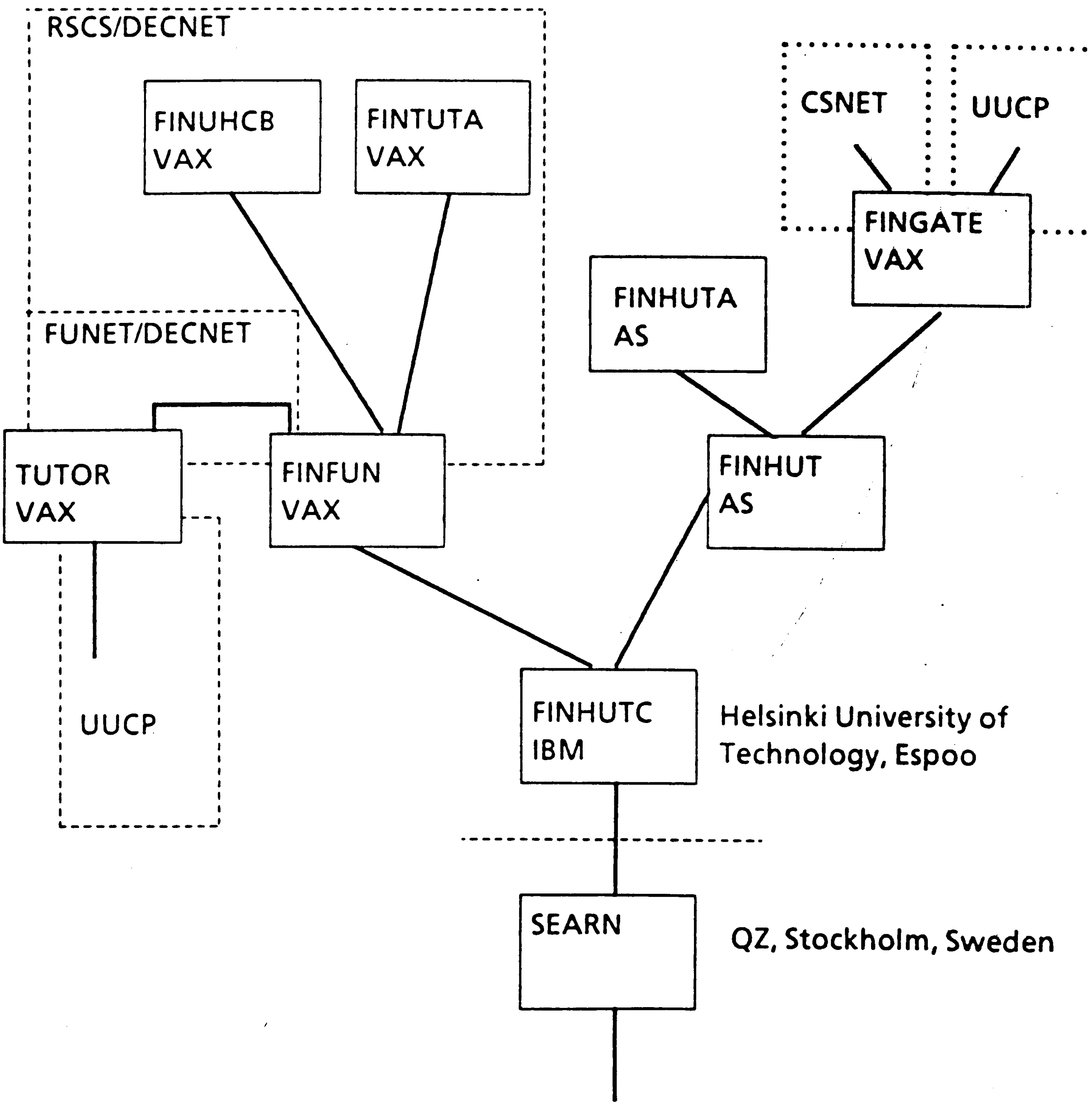
Martti Tienari University of Helsinki, Department of Computer Science	FTAM Nordic Cooperation
Kimmo Laaksonen Helsinki University of Technology	DEC/Decnet
Liisa Marttinen University of Helsinki. Department of Computer Science	MHS
Teppo Savinen Helsinki School of Economics and Business Administration	HP3000
Jouni Vuorela Tampere University of Technology	VAX/Decnet

FINNISH UNIVERSITY NETWORK
FUNET DECNET -SUBNET
GEOGRAPHICAL SPREAD OVER THE COUNTRY



TOTAL NUMBER OF NODES IN THE SUBNET IS ABOUT 35 (VAX, DEC, PDP)

EARN IN FINLAND



FRENCH ACADEMIC AND RESEARCH NETWORK

R E U N I R

COPENHAGEN, MAY 26th 1986

R E U N I R

REUNIR is the current french academic and research network. Its objective is to establish a communication infrastructure for the french academic research community, by connecting and unifying the networks already existing in universities and research centers.

REUNIR is an acronym for : REseau des UNIversités et de la Recherche (in english : network of universities and research).

REUNIR is concerned with the promotion and effective realisation of computerized communication aimed at academic and research activities.

P A R T N E R S H I P

REUNIR is constituted primarily by the two main academic and research bodies in France :

- Education Nationale (National Education),
- CNRS = Centre National de la Recherche Scientifique (National Center for Scientific Research)

together with several specialized research centers :

- INRA = National Agronomical Research Institute
- ORSTOM = Organisation for Scientific Research in over sea countries
- INSERM = Health and Medical Research Institute
- CIRAD = International Cooperation Center in Agronomical Research for Development

O B J E C T I V E S

REUNIR has the following objectives :

- manage the basic communication network between the computer centers and the laboratories administrated by its partners,

- extend this basic network to other interested research organisations,

- establish connection with others, national and international, academic research networks.

A C T I V I T I E S

The current activities of REUNIR are of two kinds :

- immediate action to improve the communication between the users of the REUNIR community, with an ever growing opening towards international networking.
This is achieved through specific projects coordinated by the REUNIR Technical Team.

- middle and long term planning for effective application of communication standards.
This requires to follow closely the evolution of the OSI standards and to control their implementation by the manufacturers. To be effective, this control has to be done at an international level, and REUNIR intends to participate fully in the activities of the european organisations and projects such as RARE and COSINE.

The current scope of activities extends to :

- message handling systems,
- file transfer,
- interconnection of main computing centers,
- direct acces to calculus and documentation services.

O R G A N I Z A T I O N

Janine CONNES and Jean-Claude IPPOLITO assume the direction of the network. They are assisted by :

- the Nodes Managers Comitee,
- the End-User Group,
- the Reunir Technical Team.

C O N T A C T

To obtain more elaborate information about REUNIR, please contact :

- Mme CONNES
  C.N.R.S.
  15, quai Anatole France
  F. 75008 PARIS

or - Mr IPPOLITO
  C.N.U.S.C.
  950, route de Saint-Priest
  BP 7229
  34084 MONTPELLIER Cédex

R E U N I R : STATE OF THE NETWORK INFRASTRUCTURE

Users of the REUNIR Network access heterogeneous computers : IBM, BULL, DEC, CRAY, UNIVAC...

Currently, the network structure includes several components :

- a hierarchical topology providing universities with access to local regional and national computing facilities,

- a private X25 network connected to Transpac,

- a large SNA network between mainframes and users workstations,

- local area networks inside laboratories or campus,

- hyperchannel connexions for high speed file transfer services.

To establish these connexions, REUNIR is using

- public X 25 network (Transpac)

- leased lines : medium speed for users connexions to computers services,
high speed links up to 2 megabits/s to provide connectivity between computers.

International communications are available through

- specialized international networks (Eurasnet, Space, Nascom, Cernet...).

- general purpose networks (Earn, Arpanet...).

R E U N I R C U R R E N T W O R K I T E M S

Six main work items are currently under work.

They are organized as projects associating network analysts from REUNIR nodes under management and coordination of the REUNIR Technical Team.

Project 1 : Message Handling Services and File Transfer

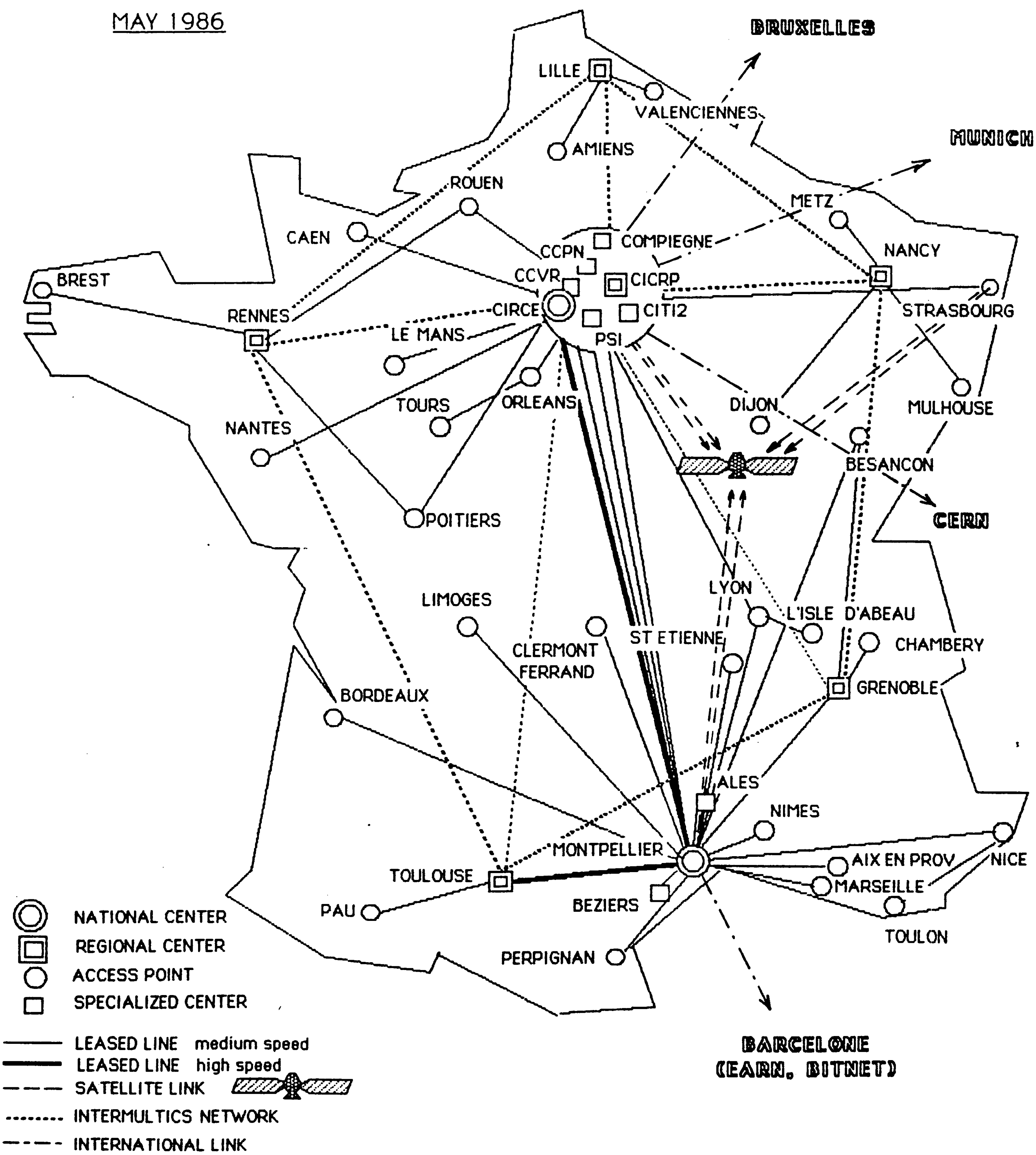
1.1 Interconnexion of current mail services on X400 basis using Cosac implementations

1.2 High Speed Data Transfer Services between nodes :

- Netex services,
- SNA services.

1.3 FTAM Migration

REUNIR network



Projects 2 and 3 : Hierarchical Network Development for Universities.

Project 2 : Local Nodes Services

Project 3 : Regional Nodes Services

Project 4 : Local Area Networks

- development of LANs in laboratories or campus
- connexion of LANs to REUNIR Nodes

Project 5 : International Communication and Gateways

Project 6 : Graphics and Imagery Distribution.

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Date: 23 April 1986

R E P O R T

OSI Developments in Greece: The Ariadne Programme.

ABSTRACT

This report contains a summary of the current networking activities in Greece which are included in the Ariadne programme. The material is organized as follows: Introduction, Network Structure, Planned Services, Conclusions. Finally, a list of the organizations participating in the project is given in the Appendix at the end of the report.

397/13.2.86/5.000

1. Introduction

The Ariadne programme has as its main objective the development of an experimental computer network for the interconnection of the central computer systems of the universities and research institutes in Greece. The network is being developed with respect to current ISO/CCITT recommendations and practices and it will eventually provide the necessary infrastructure on which selected services will operate.

The programme is administered by the General Secretariat of Research and Technology in Greece and it is now in its second year of development. The first year (1985) was mainly devoted to planning and acquisition of network equipment (which was based on a feasibility study concluded in the previous year), while the second year (1986) is more a period of applying experimental connections. The above two-year period constitutes the first phase of the programme, and a second (expansion) phase will follow during 1987 and 1988.

In mid-1987 the national packet-switching network Hellaspac will come into operation, and the resulting academic network will be connected to it via a gateway. At present there is a gateway available to NTI in Paris which will also remain operational in the future.

2. Network Structure

The network will be developed according to the two-phase plan outlined above.

2.2.1 First Phase

Initially there is a one node (star) configuration with a 12-port Telepac module which is a Unix-based communications processor with expansion possibilities. Two of the ports are reserved for two LSI.X25 PADs each of which can accommodate a total of 16 channels. The rest of the ports will be linked to various central computer systems (types: Cyber, Prime, Perkin-Elmer, VAX) as well as to some smaller machines. One of the ports is reserved for a link with NTI in Paris which will be effected via a local concentrator.

There are also available two more machines which are meant to be used mainly as X.25 carriers: one BULL SPS7 and one TELMAT SM90 which are both Unix-based machines. In fact it is envisaged that all this will eventually lead to a total Unix environment.

At present only a few of the total number of links are operational, but it is expected that before the end of this phase most of the ports available will be linked to various computer systems.

2.2.2 Second Phase

Two more Telepac nodes are planned to be installed, in addition to the Athens central node, one in Thessaloniki (north) and one in Patras (south-west), thus making up a communications triangle which will sufficiently cover Greece.

Each node will have ports connected to local or regional computer systems, i.e. each node will act as a star network within a certain geographical region. Network management and control will initially be exercised from Athens, but as the whole networking system allows decentralization of operations, some of the tasks will eventually be operated from the other two nodes.

Line speeds available at the moment are at the 4800 bps level but they are expected to increase to 9600 bps or higher during this phase.

3. <u>Planned Services</u>

User responses to a questionnaire about preferred services throughout the network have indicated remote computer access as a first priority, followed by file transfer and access to other networks. Additional services such as electronic mail, videotex and other specialized services are also desirable.

As regards applications for which standards or draft standards are (or will become) available, e.g. teletex, message handling systems, all these will be considered as potential network applications.

Also, European initiatives which aim at the establishment of international services for large user communities (such as the high energy physics community - CERN initiative) will be followed with great interest, as they practically lead to interworking among national academic networks in Europe and probably elsewhere.

4. Conclusions

As a conclusion, it may be said that the Ariadne programme has so far been successful in that it has been accepted as a worhtwhile initiative by a large number of researchers in Greece (who are the future users), and also in that it has generated a rather high degree of interest both inside and outside the academic community.

Its main objective, however, which is the provision of services for the academic and research community, will be realized after the elapse of a rather long period of time.

In the mean time, the network being develop will remain experimental, and it is expected that the experience which will finally be accumulated over this period of time will eventually lead to certain concrete actions, which will follow the conclusion of the second phase.

Appendix: List of Participating Organizations

General Secretariat of Research and Technology
(Ministry of Industry, Energy and Technology)

National Research Centre Demokritos

National Documentation Centre

University of Athens

Technical University of Athens

University of Patras Institute of Computer Technology

University of Thessaloniki

National Telecommunications Organization (OTE)

STATUS FOR THE NORWEGIAN UNIVERSITY NETWORK (UNINETT)

1. STATUS OF UNINETT

Type of Network: UNINETT is a joint effort between the universities, research institutes, vendors and PTT. The UNINETT services are offered to universities, schools, research institutes and research departments in industry.

We are using the public X.25 service Datapak between the participating institutions, and have local X.25 switches at each university, see annex 1.

Facilities to the users: So far, all services are experimental (except terminal access). During 1986, this will change. The following experimental services are operational:

- Message Service, EAN implementation of X.400, coordinated with the RARE Message Service. In connection with the message service, the users are offered a directory service. The message service is heavily used.

- UNINETT File Transfer Service, so far implemented only on NORD 100 (SINTRAN) and VAX (VMS). The file transfer service is offered on few machines, and is therefore not frequently used.

- Terminal access, based on tripple X (PAD). Users can connect from their local terminal to any computer connected to the international X.25 network following the tripple X recommendations. Through the terminal service it is possible to connect to EARN (the Norwegian node is at RUNIT) and QZ COM.

Use of protocols. The protocols used are:

- For the Message Service: X.400.

- For the File Transfer Service: UNINETT File Transfer Protocol (UFTP), a simple file transfer protocol specified by the UNINETT project which are running on top of an ISO cl. 0 Transport service.

- For the Terminal Access Service: X.28/X.29/X.3.

Gateway interconnection. For the File Transfer and Terminal Access Service there is no gateways. The Message Service has the following "official" gateways:

- To the "Gray book" service in UK: A gateway is available at UCL, London.

- To the Australian QZ-service: A gateway is available at Melbourne University, Australia.

- To ARPA: A gateway is available for the UNINETT community at the Norwegian Telecommunication Administration, Research Establishment, Kjeller, Norway.

- To CSNET: Using the ARPA gateway to reach CSNET-RELAY in ARPA.

Technically it is also possible to reach other message systems (ex. EARN, UUCP) from EAN, but the missing international infrastructure do not permit us to publish these "unofficial" possibilities.

2. FUNDING

The future of UNINETT (the Norwegian University Network) seems to be secured by funding from the Ministry of culture and Scientific Affairs. For future projects, UNINETT will be able to focus on getting services operational, rather than doing experiments with services.

We have just started to reorganize our organization and defining new project activities which will lead us towards an operational network.

3. INTERNATIONAL COOPERATION.

UNINETT is participating in the following international organizations:

- Cost 11 ter
  (Amigo, distributed management)

- Nordunet
  (To establish harmonized network services between Nordic universities and research organizations)

- RARE
  Technical coordination of a MHS-service between European research institutions

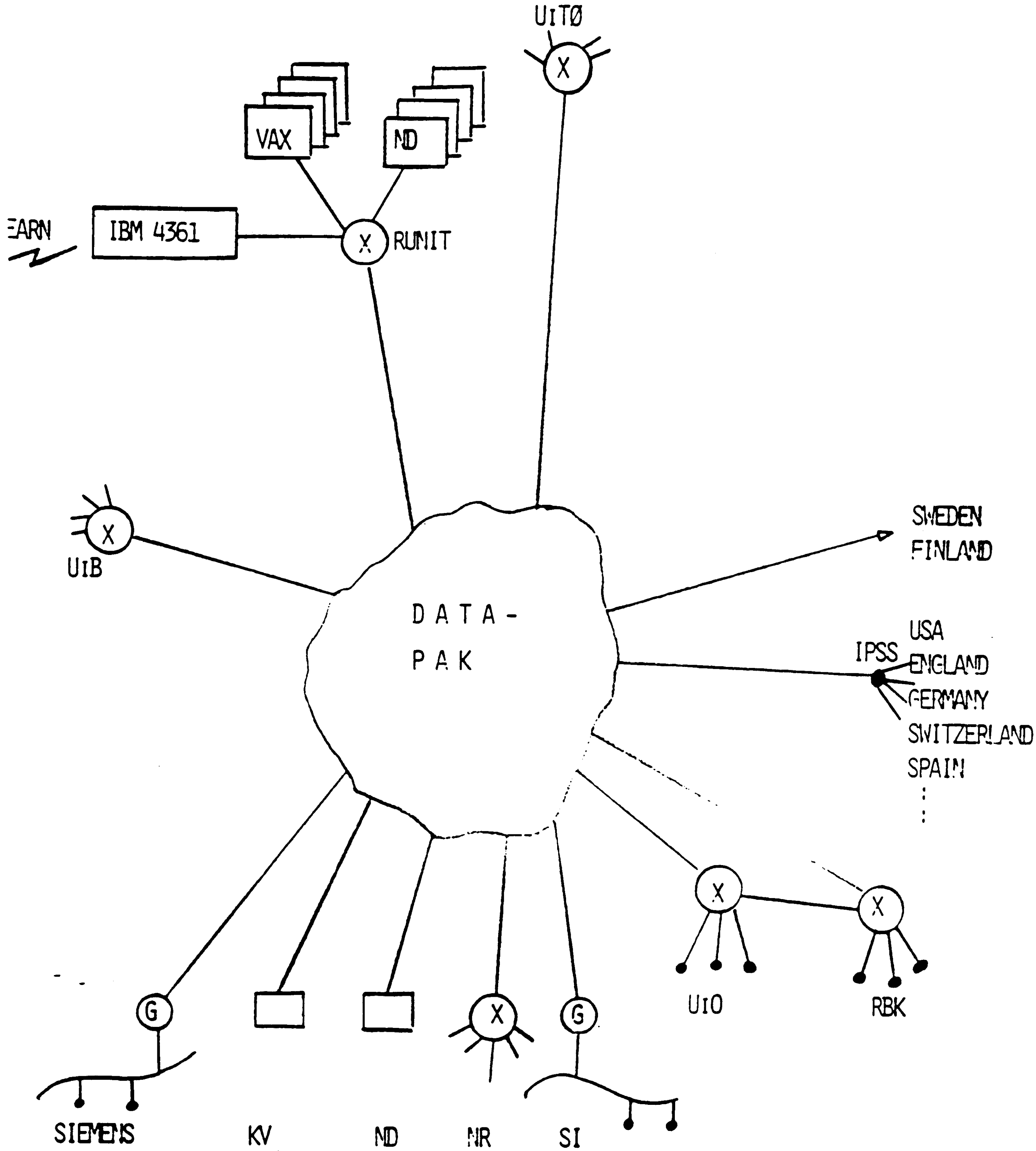
4. CONTACTS

The following candidates are at the moment responsible for the different activities:

Overall service: Roald Torbergsen, RUNIT - The Computing Centre at the University of Trondheim - <torbergsen@vax.runit.unit.uninett>

MHS service: Alf Hansen, RUNIT - The Computing Centre at the University of Trondheim - <alf-hansen@vax.runit.unit.uninett>

File Transfer service:
Einar Løvdal, UiO - The University of Oslo <x.loevdal-e@use.uio.uninett>



UiTØ	=	University of Tromsø
UiB	=	University of Bergen
KV	=	A/S Kongsberg Våpenfabrikk
ND	=	A/S Norsk Data
NR	=	Norwegian Computing Centre
SI	=	Centre ... Industrial Research

RBK	=	Blindern-Kjeller Computer Facility
RUNIT	=	Computing Centre at the University of Trondheim
X	=	Local X.25 switch

NORDUNET

Birgitta Carlson
Stockholms University Computing Center, QZ
Chairman of the NORDUNET programme comittée

NORDUNET PROGRAMME

Since 1980 yearly conferences have been organized to foster cooperation and exchange of information among the Nordic national university network projects. Based on these experiences a task force was formed to prepare a programme for computer network cooperation within the Nordic countries the result of which is the NORDUNET programme.

The programme was presented to the council of the Nordic ministers in 1984 and was judged to be of great value for advancing cooperation research and education in the Nordic countries. A Nordic network would provide an infrastructure that could strengthen the level of competence in least favored regions independant of geographical factors. The Nordic ministers thus allowed a sum of 10 MNOK (norwegian crowns) to a four year project to the NORDUNET project starting summer 1985.

This paper describes the intentions, objectives and current status of the NORDUNET project. This project will aligne the Nordic network activities and work towards harmonization and a common Nordic infrastructure.

Nordic National Network projects

In the Nordic countries national university networks were initiated and implemented since the end of 1970's. A brief decription of these is given below.

- Denmark: The Centernet project was started 1978 and is based on the OSI model. In the first phase the network should give terminal access to the three regional university computing centres NEUCC in Lyngby. RECAU in Aarhus and RECKU in Copenhagen. The Centernet project has cooperated with the telephone companies JTAS/KTAS what regards the transport network PAXNET and is based on X.25. The computers which are connected are CDC, IBM, UNIVAC/SPERRY and RC (Regnecentralen). The network offers terminal traffic and it supports lineoriented terminals.

- Finland: After several years of discussions and studies the Finnish university network, FUNET, project started 1984. The project is supported by the ministery of education and the PTT is providing free X.25 (DATAPAK) services.

  The objective is to establish PAD connection to most of the host computers at the universities. Closed subnetworks between computers of the same type are also included in the plans. Development of other services within the OSI framework based on higher level protocols are planned to start during 1985. FUNET then plans to use the same protocols and solutions as in other nordic countries so that no gateway functions will be necessary between Finland and the networks in Sweden and Norway.

- Iceland: Network plans have been initialized in Iceland and the PTT is planning to open a X.25 based service during 1985. Cooperation with the other Nordic Countries is regarded as highly interesting.

- Norway: In Norway the Uninett project was started in 1975. Uninett is based on the OSI model and has mainly been financed by NTNF (the Norwegian science research council) and the participating institutions. The project was started early and hence there was no protocol standard for interactive traffic and file transfer. The PAD standard was soon adopted but the other Uninett protocols will be exchanged to standard protocols as soon as these exist.

  Uninett has been in operation since 1978 and offers to-day interactive terminal traffic, simple file transfer and computer conferencing (COM). MHS will be implemented.

  The main efforts within the Uninett project have been placed on research on for instance multimedia messageing, connection of different networks and experiments on broadband networking.

- Sweden: The SUNET project started 1980 within the framework of the programme for information technology of the Board of Technical Development. SUNET is based on the OSI model and it uses the X.25 services Datapak from the PTT.

  The SUNET protocols are mainly based on the Uninett protocols which has had the advantage that development and implementation of the higher level protocols have been done in cooperation between two projects.

  The use of the network has been widened to institutions outside the information technology area and the operation of the network is carried out by the university computing centers in Sweden.

NORDUNET OBJECTIVES

The NORDUNET project shall establish a stable reliable network that will connect the Nordic research and development environments. The services of the network should be easily available to the users.

The programme shall open for electronic exchange of messages, documents and data and permit usage of computer resources, programs and databases within the Nordic countries. The user shall easily connect to the nordic and other international networks and information services.

It is important to point out that NORDUNET shall be based on existing telecommunication services and aim for the use of international standards. NORDUNET shall be based on the national network projects within the Nordic countries and these will be responsible for the daily operation.

In this way a common Nordic infrastructure for research and development will be provided. At the same time there will be established new services and the joint competence will be available to the local regions.

It is hoped that by this joint effort the conditions for exchange of information and cooperation will be brought up to an international standard.

Planned activities in the NORDUNET programme

Tasks

In order to establish the services that are necessary to obtain an infrastructure and open the communications to international networks a set of tasks are defined which are common to the Nordic community. These include the following.

- to define, initiate and coordinate developments projects that are necessary to realize the services. Moreover to coordinate the operation of the network in order to supervise the stability and availability in the network.

- to support the implementation of the common infrastructure through establishment of resources and competens locally where necessary.

- to develop information and documentation material as well as inform and advise the users of the services and how to use them. This will be developed with the initialization and setting up of an information service.

- to administer public relations, information and marketing of NORDUNET.

- to function as a catalyst for new development and research projects as well as evaluate applications for funding of such projects.

Projects

The project plan for NORDUNET contains activities within the following areas.

- Establishment of transport service
  Based on ISO transport station

- File transfer
  Standard FTAM (file transfer and management) when available.
  Temporary solution and transition is a problem.

- Message handling
  Based on CCITT X.400 series of protocols.

- Information services

- Internetworking
  Connection of local area and long distance networks asumes a common strategy for internet protocols.

- Network administration and control
  Operation and network control need good working tools which to-day are just in a starting phase of standardization.

- Formal methods for development and verification tools
  There is a considerable amount of research going within this area.

- Participation in standardization work.

- Support for pilot projects.

- Research projects.

It should be noted that around 3 MNOK are set aside for the two last activities which are regarded to be of special interest for the use and development of the Nordic network.

Relations to European networking projects, RARE and COSINE

In May 1985 a conference, European Network shop, was held in Luxenburg with representation from the academic networking projects in Europe. In many of the European countries communication services have been introduced for the academic community. Depending on when the services were planned they include different level of services and protocol definitions. The purpose of the network shop was to bring together representatives from these projects who are actively involved in the operation and development of the services.

The workshop was sponsored by CEC (Commission of European Committees), ECFA (Committee for Future Accelerators), ESF (European science foundation) and COST (Cooperation Européenne dans la domaine de la recherche Scientifique et Technique).

The result of this initiative was to form an association, RARE (Réseaux associés pour la Recherche Européenne) with the objective to establish a communication infrastructure for the European research community. This will be achieved by standardization and harmonization of the services and protocols as well as organizing information necessary to use the services in a productive way.

The association will base its work on the national projects and work closely together with standardization bodies, for instance CEN/CENELEC as well as the European Telecom suppliers.

By acting as a unified pressure group it is expected that the use of international standards will advance and the number and quality of vendor supplied implementations of these standards will increase.

A number of working groups have been defined and started within RARE of which following examples can be noticed:

File transfer
Message handling
X.25 standardization
Information services.

In late automn 1985 West Germany took an initiative to start a project within the Eureka framework named European research network. The proposed project contained activities which were in line with those of RARE. A meeting in Bonn,february 1985, hosted by der Bundesminister fur Forschung und Technologie, this initiative was discussed. The meeting resulted in a statement where it was made clear that RARE was intended to execute the initial specification phase for this Eureka project, now named COSINE (Cooperation for Open Systems Interconnection in Europe).

This expression of political support for the European networking activities is of coruse of fundamental importance for the possibilities to meet the goals of the projects and get proper funding of necessary resources.

NORDUNET already in 1984 had defined its goals and objectives in a way which is congruent to the RARE and COSINE projects and contains the same threads of activities and projects. The way of operation and the relations to the national projects have as well a similar structure. From the Nordic perspective we see interesting possibilities for cooperation with the European activities. NORDUNET has in fact started some projects, for instance within the message handling and file transfer areas where direct links exist with RARE. NORDUNET is the host of the European networkshop 1986 in Copenhagen.

Status of the NORDUNET project

The project started spring 1985. Since then the organization of the project has been defined, a steering committee nominated and principles of operation for this committee established. Activities carried out so far have been the following:

- A survey of the status of the national projects has been carried out to set a basis for the project.

- A survey of the international scene has been made to identify the role of Nordunet in an overall framework.

- Project plans are being prepared for the following areas

  * File transfer
  * Message handling
  * Information services

- Marketing information and public relations activities are being planned.

- A survey of user needs will be carried out.

Results of these surveys are made available to those interested.

A short presentation of the file transfer, message handling and information services projects will be given below.

File transfer

The aim of the file transfer project of NORDUNET is to build a harmonized, common file transfer service covering the academic community of all the Nordic countries. This service will be an important part of a common networking infrastructure serviig our community in the years to come. The project leade of the file transfer project is Einar Lövdal, Oslo University.

As a first phase an evaluation of the most relevant alternatives for the NORDUNET file transfer service has been carried out. The report does not envisage file transfer service and protocols based on manufactures standards like DECNET, EARN and COSMOS. This does not imply that these concepts are considered uninportant but NORDUNET should not see it as their task to promote vendor specific solutions. The primary concern of NORDUNET is to promote an open system of interconnection between the universities of the Nordic countries regardless of host type as well as to base the solutions as far as possible on international standards.

There exists currently no international standard for file transfer but the standardization work on ISO FTAM has reached a point where it has been decided to launch FTAM, CASE (Comman Application Service elements) and Presentation together as Draft International Standards (DIS) spring -86.

NORDUNET has decided to use the ISO FTAM as file transfer protocol as the final solution. However after having studied the status of the standardization work, in spite of recent fall though within for instance the MAP (Manufacturer Automotion protocol) programme, it is clear that it will be necessary to provide an interim solution for at least two years. A study has been performed by the project leader on currently available protocols regarding their protocol and implementation features (table 1 and 2) as well as their availability on computers and systems types of interest for the Nordic academic community (table 3). The protocols that have been studied are Blue book (JANET), RDA (DFN) and UFTP (Uninett).

One criterium is that NORDUNET should not take on any development work for the interim situation but use the resources available on more general long term projects.

These tables show that implementations of the Blue book protocol exist for all systems of interest for NORDUNET except Burroughs. Thus Blue book gives a coverage which is far more complete than the other protocols. The Blue book protocol also contains the most comprehensible set of features. The support of the Blue book implementations can also be contracted.

Cost scenarios for the three alternatives have been developed to give a cost comparison between the alternatives. This shows that under the condition that NORDUNET becomes a member of DFN the RDA alternatives are available fore of charge. This clearly favors the RDA from the economic point of view. However development costs for products not available from DFN have to be added wich makes the RDA and the Blue book alternatives more comparable costwise. The UFTP solution is by far the most expensive taking into account development and maintenance costs.

Thus NORDUNET has taken the decision to propose the use of Blue book as a limited interim solution. This means that NORDUNET will identify user groups with special needs of file transfer, supply these with necessary Blue book implementations, assist and install the software and help the user groups in the transition to the final FTAM solution. Contacts have been taken with JANET to ensure support for NORDUNET and cooperation is planned regarding the transition to FTAM. NORDUNET will as well take part in standardization and transition work. This will give the Nordic user groups a good interim solution and garanted a transition as smoth as possible to the long term FTAM solution.

Message handling

The NORDUNET message handling service shall be based upon the CCITT X.400 series recommendations of MHS.

The project plan is under development but a set of decisions has been taken to forward the project as fast as possible. A working group with representatives from the Nordic countries headed by Alf Hansen RUNIT, Trondheim, is in charge of this work.

At present the EAN Software from University of British Columbia, Vancouver, is a MHS implementation which has been in use in Norway and Sweden since 1984. EAN is installed on 5 computers at 3 institutes in Norway and on 5 computers in Sweden. A multitude of installations exist in Europe and in the rest of the world. RARE has decided to set up a first mail service based on EAN. EAN will be developped into a fully X.400 compatible shape and global distributed directory service will be established according to the plans.

NORDUNET has negotiated a common Nordic license agreement with UBC and plans are currently developed to set up distribution centers within the Nordic countries to distribute the software.

The operation of the services are basically national responsabilities but in the initial phase it is important to work out coordinated plans for organizing the service.

There is a need for information services containing a catalog of users of the NORDUNET MHS service. In the first phase it has been prioritized to provide written information about EAN users and nodes as well as information on how to reach other networks, for instance JANET and ARPA. This project must work in close cooperation with the informationservices project (see below).

KOM/COM on the DEC 10 in Stockholm and Oslo has so far provided most of the message handling services in the Nordic countries. A project plan is being worked out to develop X.400 for PortaCOM. This project will also include a directory service.

The NORDUNET MHS project will also study the CEN/CENELEC activities and take part in and follow up on on-going harmonization projects, within the field.

Information service

The project on information services is felt to be of crucial importance to spread knowledge about the NORDUNET services to the users. Mats Brunell, Stockholm University Computing Center, QZ is responsible for this working group.

The project is carried out in cooperation with SUNET where a similar project was defined. The two projects could thus share resorces and substantial time and cost sharing could be made by not inventing the wheel twice.

An information leaflet as well as technical documentation is being worked out as soon as possible to market the NORDUNET services as well as services that can be reached through NORDUNET. One contact person per country is in charge of collecting and disseminating information.

The MHS project has taken an interim decision to set up one name server per country.

A complete project plan is being worked out which will include proposal for newsletter, on-line information services, contacts with other net-works and so on.

Feature	Blue Book	RDA	UFTP
Service from other layers	Yellow Book	ISO Transport Service	ISO Transport Service
Mechanisms for negotiation	Yes	No	No
Error Recovery mechanisms	Yes. Not in minimum subset.	No	No
Supported File Structures	Flat or Unstructured	Flat	Flat or Unstructured
Access Modes	Ample. Adequate for min subset	Adequate	Adequate, but unprecise
Access Control	Good	Sufficient	Too poor
Model of File Contents	Comprehensible. Too small for min subset?	Rudimentary	Rudimentary, OK for binary files
General Impression of Protocol	Heavy. Mature FTP.	Simple	Simple, needs revision

Table 1. Summary of RDA, UFTP and Blue Book Protocol Features.

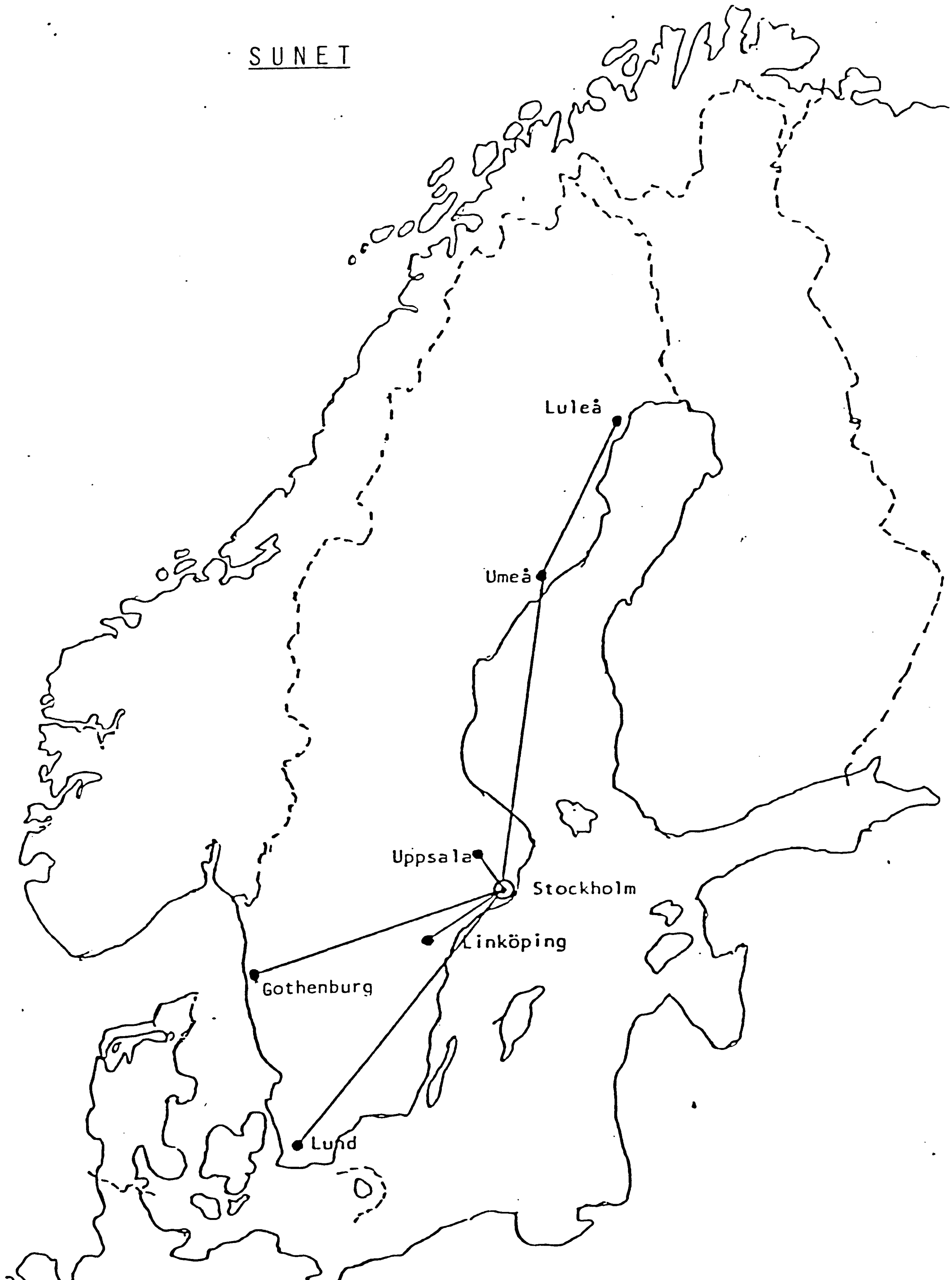
Feature	Blue Book	RDA	UFTP
Support	Good	Good	Poor
Transfer Reliability	Reasonable, minimum as X.25	As for X.25 + class 0 TS	As for X.25 + class 0 TS
Available implementations	Many!	Few, but many imp. projects	Few.
User Interface	Unstandardized, often good	Unstandardized, simple	Standardized.
Complexity	3-4 years of developm. work	Simple	Simple (1 year)
Accounting	OK	OK	Not adequate

Table 2. Summary of RDA, UFTA and Blue Book Implementation Features.

Host/ OS	Blue Book		RDA		UFTP	
	Status	Support	Status	Support	Status	Support
VAX/VMS	Operative DEC prod.	Full DEC support	Pilotv. running	Operative I/86	Operative	RUNIT ad. lib.
VAX/ UNIX 4.2	Operative from JNT	Supported by JNT	Developm. project	Finished I/86	-	-
DEC20/ TOPS20	Pilotv. from JNT	On field test	-	-	-	-
DEC10/ TOPS10	Operative from JNT	Supported by JNT	Developm. project	Finished I/86 (?)	-	-
SPERRY 1100	Pilotv. June 86	Sperry support	Operative from DFN		Developm. project	Finished II/86(?)
CYBER/ NOS	Pilotv. from CD	On field test	Developm. project	Finished I/87	Developm. project	
NORD 100 and 500	Operative from ND	Full ND support	-	-	Operative	RUNIT ad lib(?)
IBM/MVS	Operative	ad lib	Developm. project	Finished III/86	-	-
IBM/ VM 370	Operative from IBM	Full IBM support	Developm. project	Finished IV/86	-	-
B7800	-	-	-	-	Pilotv.	Univ. in Helsinki
PRIME/ PRIMEOS	Operative	PRIME support	-	-	-	-

Table 3. Available of Planned Implementations.

SUNET

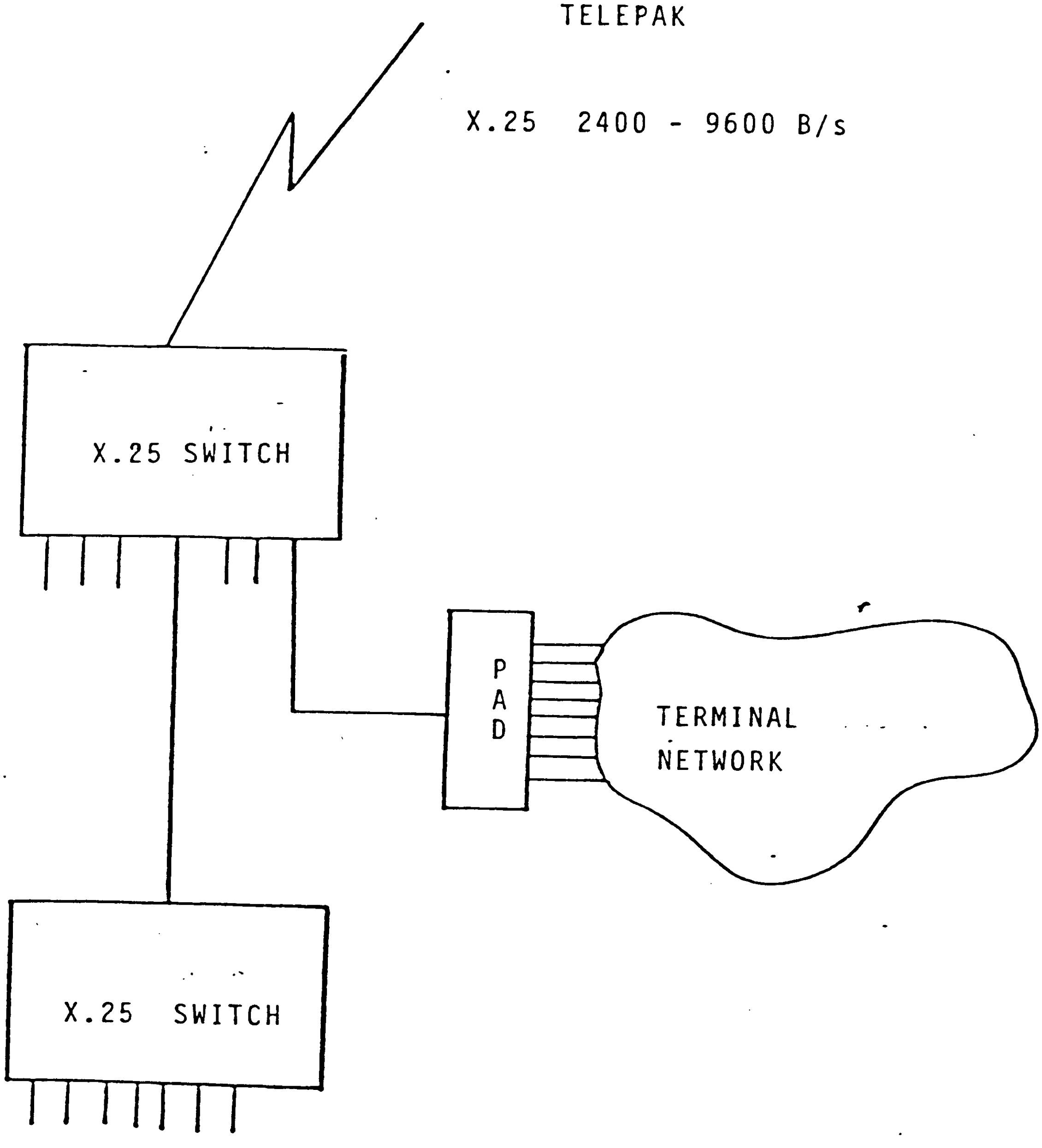


SUNET FIRST PHASE

PROJECT PLAN

- o PROJECT START 1980 2 - 3 YEARS
- o OBJECTIVES:
  - TO PROVIDE GOOD COMMUNICATION FOR RESEARCH LABORATORIES WITHIN THE FIELD OF INFORMATICS (6 UNIVERSITY REGIONS)
  - TO PROVIDE A TEST VEHICLE FOR RESEARCH IN HIGH LEVEL PROTOCOLS
- o SERVICES
  - INTERACTIVE ACCESS TO HOST COMPUTERS FOR ASYNCHRONOUS TERMINALS
  - FILE TRANSFER SERVICE BETWEEN CONNECTED HOST COMPUTERS
  - "ELECTRONIC MAIL" BY INTERCONNECTION OF THE LOCAL COMPUTER BASED MAIL AND COMPUTER CONFERENCING SYSTEMS BASED ON SWEDISH PTT X.25 SERVICE, TELEPAK (DATAPAK)
- o BUDGET
  - EQUIPMENT 1.5 MSEK (≈ 430 KSFR)
  - SALARIES, TRAVEL... 1.8 MSEK (≈ 510 KSFR)

S U N E T CONFIGURATION



COMPUTER CONNECTIONS

CONNECTED SYSTEMS

(SPRING 1984)

	PAD	TS	FTP	MAIL
NORD 100/500/Sintran	(in/out)	0,1	U	TELEMAIL
VAX/VMS	-	0	D,U	
VAX/UNIX	IN/OUT	0	U	TELEMAIL
DECNET, GATEWAY (LiTH)	IN/OUT	0	U	TELEMAIL
CD/NOS 2,1	-	0	U	
CD/NOS 2,2	IN/OUT	-		
UNIVAC/DCP40 f.e.	IN/OUT	0..4	B,U	(TELEMAIL)
PRIME	IN/OUT	-	B	
IBM	-	-	-	
DATA GENERAL	-	-	-	
DEC 20	-	-	B,U	

EXPLANATIONS:

( )	UNDER DEVELOPMENT
U	UNINETT FILE TRANSFER PROTOCOL
B	"BRITISH" (RAINBOW)
D	DECNET

P R O T O C O L S

ISO LAYER	PROTOCOLS USED IN SUNET
TRANSPORT LAYER	ISO CLASS 0 AND 1 TRANSPORT PROTOCOL
SESSION LAYER	CCITT S.62 SESSION PROTOCOL
PRESENTATION LAYER	----
APPLICATION LAYER	UNINETT FILE TRANSFER PROTOCOL

PAD	CCITT X.3, X.28, X.29

SUNET bis

A project financed by the science research council. The project is financed for three years , 1984/85 - 1986/87 within an amount of 12.5 MSEK.

Ojectives

- Build a reliable, open, easily usable computer network
- Permit national and international traffic
- Terminal connections
- Filetransfer
- Messagehandling
- Follow existing standards
- Be based on available products

Activities

- Information about the project
- Stabilisation of Sunet 1 network
- Information services
- Decnet procurement
- MHS - X.400
- ISO - FTA M
- Terminal connections ISO/VTP
- Protocoltesting and validation
- Net - to - net communication
- Co-operation with the Swedish Telecomm
- Permanent Sunet organisation

Protocols

- Network	X.25, DATAPAK
- Terminalconnection	triple X
- Messagehandling	X.400 series
- Filetransfer	ISO - FTAM

OSI - Support for DECNET

Before 31st of dec 1986
- OSI - communication over X.25 , IEEE 802.3
- ISO Transport station including inteernet
-X.400 message router

Before 30th of June 1988
- X.400 message handling
- FTAM
- MAP

ACTIVITIES FOR THE CREATION OF " S W I T C H ",

A SWISS NATIONAL NETWORK FOR RESEARCH AND EDUCATION

Goal

Creation of an infrastructure providing telecommunication services on the base of the principles corresponding to those stated by RARE.

Organisational base

Responsible institution : the "Conférence Universitaire Suisse" ("CUS" or "SHK"), an organisation coordinating the policy of all cantonal and federal universities in Switzerland, respectively its Informatics Commission ("CICUS") - something like a swiss university computer board. Networking activities are run by a network working party, with sub-groups for technical studies and for operational concerns (also responsible for running EARN and CHUNET), with plans for a user interface sub-group. Ultimately, an independant organisation under the name of "SWITCH" will succeed the CUS in its responsibility for networking.

Present activities

Two principal activities :

- Provision of networking services on the base of EARN (10 sites with 20 nodes), and - to some degree - of CHUNET, an experimental MHS network with 4 active sites.
- Preparation of the future national network.

The past period has served to establish a sound base for the actual creation of the planned network. Some key activities :

- Acquiring the necessary know-how and the basis for the decisions to be made, technically and administratively.
- Gaining operational experiences with MHS by participating with the "CHUNET" experimental network in the pilot operation decided in Luxemburg.
- Coordination of networking activities in the different universities, particularly important due to the extremely rapid introduction of large local area networks in most universities.
- Participation in the preparation of a federal law on the promotion of informatics, granting 15 million FS for the creation of the planned network.
- Establishing international contacts (RARE, COSINE, convention with DFN). The CUS will be a founding member of RARE (to be succeeded by the SWITCH organisation as soon as it exists).
- Participation in three domains of RARE activities : CEPT liaison, MHS, FTAM; it is a strategy to limit active participation to few domains, corresponding to major areas of interest at the national level.
- Promotion of the idea of telecommunication services in the swiss academic community (for instance, editing the "SWITCH" journal).
- Preparation of the "SWITCH" organisation.

Next steps, preoccupations

Rapid creation of the "SWITCH" organisation; preparation of formal specifications for the planned services; preparation of an interim solution for high throughput communications with super-computer facilities (e.g. high-speed bridges between university LANs ?); establishing funding for running expenses for the operational phase of SWITCH (not included in the initial funding); establishing good and economically sound working relations with the swiss PTT; recruitment of competent staff.

Status of Academic Networking in the United Kingdom

P.F. Linington - 86 May 24th

The private UK academic network called JANET now links all the Universities and many of the Polytechnics and Research Council laboratories in the country. 1985-86 has been a period of consolidation and growth following the creation of the unified network from a number of separate components. The network consists of ten packet switches sited at

London
Manchester
Rutherford
Daresbury
Edinburgh
Bath
Cambridge
Belfast
Swindon
and Bidston.

The links between the major switches operate at 48kbps and those to the more minor ones at 9.6kbps. Individual sites are connected at either 9.6kbps or 48kbps, depending on the level of traffic. This network is now carrying more than 700 Megabytes a day, and traffic levels continue to rise. The usage is for a mixture of terminal access, mail, file transfer and remote job entry.

Practically all the attached sites operate some form of local area network, and it is generally to this that the wide area connection is made; mixed wide and local area operation is therefore the norm. The local area networks are a mixture of X.25, slotted ring and CSMA/CD technologies, as necessitated by the varying geographies and activities of the sites involved.

Because each site administers its own local connections, the total number of systems is difficult to estimate accurately, but there are probably about 700 connected systems and some 25000 terminals, about half connected directly to network PADs.

The network supports a directory of systems, called the name registration service, which currently has records of almost 600 systems in one or more of the available protocol contexts. Registration is expanding by about ten percent each month.

In the autumn of 1985, the government awarded additional funding for the expansion of this complex of wide and local area networks, to a total of 8M ecu over three years. In this time, the trunk speeds in the wide area will be increased to 0.25Mbps, providing a redundant mesh of links multiplexed onto 2Mbps circuits. The typical site access speed will be increased to 48kbps, with more capacity being provided where traffic merits it. The local area networks will be upgrades to provide higher performance and increase the proportion of equipment connected.

The protocols used in the UK academic community are currently an interim set defined before the OSI standardization was well advanced. These

Coloured Books cover:

Terminal access
File Transfer
Electronic Mail
Job Transfer
and Screen mode access.

Protocols from the set are implemented on some 25 different machine and operating system types, and are in regular service use.

For the future, the UK academic community is committed to a transition to the ISO defined OSI protocol standards. A detailed planning exercise is in progress, aimed at a phased transition from the old to the new protocols without interruption of service. This will involve a complex management project to ensure that the necessary protocol conversion facilities are provided and that the directory facilities support the distributed transition.

A draft report of the transition study group has recently been issued for comment, and copies of this report can be obtained from the UK Joint Network Team.

As a first step in this transition, a joint project has been established by the Alvey Directorate and the JNT to provide a gateway service between the EAN proto-X.400 community and the UK Grey Book mail community. This gateway is being developed and is currently being operated on a pilot basis by University College London.

ECFA SUBGROUP 5 STATUS REPORT AND RECOMMENDATIONS

February 1986

Contents.

use the X.25 standard network interface, whether in private or public networks, or on point-to-point leased lines. Universities or laboratories with HEP groups should arrange for X.25 connection to their public networks when these become available, and conversions of non-X.25 private networks used by HEP laboratories to offer X.25 service is strongly encouraged".

A large number of laboratories, including CERN, have followed this recommendation to use the X.25 standard - or were already actively doing so; with it came the associated "triple X" standard for remote terminal access (CCITT recommendations X.3, X.28 and X.29), with the effect that physicists have seen, within a small number of years, some first elements of HEPNET functionality become a reality.

In the same report [1], Subgroup 5 identified four file transfer protocols (FTP) which were those predominantly used by the European HEP community: CERNET at CERN, DECNET mostly then in Italy, UNINETT in Scandinavian countries, NIFTP or "Blue Book" mostly then in the UK. It was recommended that "a consistent strategy of FTP converters" be adopted and that "a European collaboration to coordinate FTP conversion activities" be launched. Furthermore, the report stressed that "institutes and organizations not supporting one of the FTPs which will form the chain of protocols are encouraged by SG5, as an interim solution, to adopt and install one of them", in order to minimize the amount of heterogeneity in the short to medium term future.

With the permanent aim of fostering European HEP networking activities, ECFA SG5 launched a number of surveys, studies and other actions. These have been reported upon in September 1983 [2], while this status report covers the period since that date.

The group has met regularly in 1984 and 1985, at about four-month intervals, in various locations within Europe including CERN at least once per year. One meeting was held in conjunction with the UK Networkshop (1984), another one with the INFN Networkshop (1985). This corresponds to some of the main aims of the group, as described in [2] (section 1). Subgroup 5 is chaired since 1985 by J. Hutton (RAL), the secretary being E. Valente (INFN). A list of the group members appears in Appendix 1. The present report has been prepared by P. Van Binst.

All documents referred to in the present report, as well as a full index of Subgroup 5 papers, are available from Ms. M-T. Monnet, DD Division, CERN.

2. Users Guide and Directory.

These two documents were considered to be among the leading requirements of the average physicist user. They have now been produced and are available as two separate items: the fixed part or Users Guide was published in February 1985 [3] while the directory is regularly updated and is presently available both on paper [4] and as a file on the CERN Wylbur system (HELP X.25). This list contains, as of today, close to 100 hosts of interest to HEP users and accessible over the public and other X.25 compatible packet switched networks, and it is still growing. Subgroup 5 is now considering more automatic means of keeping and updating this information.

3. File transfer.

As was described above, the Subgroup identified early in its activities a restricted list of file transfer protocols and recommended that a consistent strategy of converters be set up. This gave rise to the setting up of the GIFT project [5] which produced operational software during the first half of 1985, that could be used by a large fraction of the European HEP users community; indeed, a file transfer protocol converter is running at CERN and allows the direct transfer of files between hosts using the CERNET, Blue Book (JANET) and DECNET protocols. Also, since then, a number of networks have been set up using recommended protocols (e.g. PHYNET in France).

Other protocols are presently being considered for inclusion in the GIFT project.

4. Practical use of the "Triple X" recommendations.

A small team conducted a survey of the implementation of the X.3, X.28 and X.29 recommendations in various environments, with a particular emphasis on the definition and common understanding of the PAD parameters in different public networks [8]. This is a delicate area where many discrepancies are to be found among PTT's and other network providers, as well as between different network hardware and software vendors. The group was invited to join in a harmonisation activity sponsored by the Commission of the European Communities. Their report is now being finalized for publication.

5. Electronic mail.

A survey of the various electronic mail systems available to HEP network users has been conducted by Subgroup 5

1. Historical background and recent activities of the group.

In 1979, the European Committee for Future Accelerators (ECFA) established a Working Group on Data Processing Standards in HEP. This Working Group spawned a number of subgroups to cover the many areas to be studied; Subgroup 5, named "Links and Networks", is devoted to data communications.

ECFA works in close collaboration with CERN as well as Saclay, RAL, DESY, INFN, IN2P3, etc. Indeed, it groups all the European HEP laboratories, large and small, stand-alone or hosted in universities or other institutions. This gives the organization potential access to a wealth of information and expertise, not only in high energy physics but, as in the case of this Working Group, also in data processing and data communications at large.

The first main task of Subgroup 5 was to define, out of the confused and heterogeneous situation which was the state of HEP networking in the early 80's, the concept of a networking architecture that was given the name HEPNET or "High Energy Physics Network". This was by no means an easy task, as is always the case when one has to deal with an existing situation which, however imperfect, brings some well-defined functionality to those who are currently using it. This kind of argument has to be borne in mind when considering for instance the US situation (see later in this report).

HEPNET is a general concept, which has to be translated into a set of application tools, or facilities, for HEP users. It must provide, for instance, electronic mail, file transfer and remote terminal access all over Europe and, if possible, all over the world. This has to be done by making use of physical communication channels and networks, accessed by layered high-level protocols, in line with the currently prevailing thinking in networking and data communications matters, based on the now well-known 7-layer OSI model [6].

Obviously, wherever possible, standard protocols and procedures should be used in order to simplify the design and implementation efforts and to facilitate the communications between users of dissimilar systems.

One such standard, which was getting worldwide recognition and has been implemented since in a great variety of environments, both public and private, is the CCITT X.25 recommendation for accessing public packet-switched networks [7]. For this reason, Subgroup 5 **recommended** in August 1982 [1] that, in the field of wide area communications, **"data transmission between laboratories, both nationally and internationally, should**

[9] which led to a similar activity inside CERN [10]. The reports coming from these studies have led Subgroup 5, like CERN, to the **RECOMMENDATION that HEP GROUPS SHOULD MOVE AS SOON AS POSSIBLE TOWARDS THE USE OF THE CCITT "MESSAGE HANDLING SYSTEM" (X.400 series of recommendations [11])**. Where appropriate, use could be made of the EAN package which constitutes a presently available approximation of the X.400 recommendations. A coordination of such activities at the European level has been set as one of the first items on the action list of the RARE association (see below).

6. High speed data transmission.

Some members of the group have been investigating the possibility of achieving, within the short to medium term future, high speed (2 Mbit/s) data transmission, by making use of satellite channels. A project known as HELIOS has been defined by the Saclay group to initially link CERN to the Paris region, using the TELECOM 1 satellite [12]; this project has now been extended to other partners in France as well as Belgium, while other countries (notably Germany, Italy and the Netherlands) are presently considering participation.

Another experiment, using the ECS satellite system, has been started by groups in UK, Austria and Italy.

7. Local Area Networks.

This fast moving and difficult subject has been addressed by some members of the Subgroup with varying degrees of success. Quite fruitful collaboration has taken place with ESONE and ECA, some seminars being jointly organized, but has not yet led to well defined projects or recommendations. Most of the work has been concentrated on the problems of the choice of a type of transport layer, as well as the internetworking between wide (X.25) and local area networks.

8. Contacts and coordination activities.

8.1. ECFA DPHG.

The ECFA Working Group on Data Processing Standards in HEP was later renamed ECFA Data Processing Harmonisation Group or DPHG. Quite a few of the subgroups have discontinued their work, having produced a final report on the subject they had considered. It is felt that there is still a need for a small steering group to keep the DPHG going, in order to promptly react to the needs for coordination and harmonisation arising for various bodies in the HEP community. As Subgroup 5 is still continuing its activities, a permanent link has been established between the DPHG steering committee and this subgroup.

8.2. LEP collaborations.

Subgroup 5 has been very careful in keeping links with the four LEP collaborations, where the network experts are often members themselves of the subgroup. A formal gathering of the subgroup and of representatives of the four LEP collaborations was organized at the subgroup's meeting at CERN in October 1984.

8.3. HEP-CCC.

Subgroup 5 strongly encouraged the creation of the High Energy Physics Computing Coordination Committee, or HEP-CCC. This is a body consisting of Directors and senior staff of the main European HEP laboratories, which is informed of relevant matters by one or more DPHG or subgroup's representatives. The HEP-CCC naturally has the power to allocate resources, or define policies or priorities in all matters related to computing and communications in HEP.

8.4. European Networkshop and the RARE association.

It is the belief of the members of Subgroup 5 that the use of international standards as well as the development of better coordination between the interested parties at an international level is an essential step towards a solution to the many problems which are to be tackled in the very diverse environment of HEP networking. In this spirit, a conference called "European Networkshop" was convened in May 1985 in Luxembourg, under the auspices of the Commission of the European Communities and with the sponsoring of ECFA and other organizations. **The major outcome of that meeting has been the creation of a Joint Association of European Research Networks, entitled** RARE (Réseaux Associés pour la Recherche Européenne), which is to foster even more European - and hopefully worldwide - collaboration in the field of open networking.

RARE will be formally set up in 1986 as an international organization; ECFA will be officially represented at its Council of Administration, while many of the national representatives will also be members of Subgroup 5.

8.5. EARN.

The availability of the EARN network has been taken into account by Subgroup 5 which prepared in October 1984 a position paper on that subject [13].

The advantages of EARN are that it is free, at least until 1987, since IBM pays for the leased lines which make up the backbone of that network, including the transatlantic line which integrates EARN into BITNET; it is also easily installed on IBM systems, at least those running under the VM operating system, while the X.25 based software cannot always easily be implemented; it is also available on VAX, CDC and other systems.

Some quotes from [13] will summarize the view of Subgroup 5 towards EARN: "The aim of the HEPNET strategy is to adopt solutions which are in line with international standards ... and facilitate the interconnection of different kinds of equipment. EARN does not meet these criteria well. It is not compatible with the public packet switching systems, but can only run over leased lines. RSCS [i.e. the communication protocol used by EARN] is not a layered protocol of the modern type ... and is not an option with a long-term future. Also EARN cannot carry terminal traffic ... It can offer a short-term solution to some problems with a minimum of investment of effort, so that development work can be concentrated on longer-term solutions. Institutes who wish to take advantage of EARN will also need to plan for the future, when IBM stops paying for the lines. In addition they will need to consider communication with centres not on EARN ..."

8.6. USA HEP networking.

Subgroup 5 has been kept well informed about the various developments in the field of HEP networking in the USA. At its last meeting in October 1985, it invited two promoters of the recently defined USA HEPNET to come and present this proposed new facility which is based on a backbone leased line network linking BNL, FNAL and SLAC, with extensions to LBL, ANL, other US universities and laboratories, and also to Europe and Japan. The proposed network will support DECNET, X.25 and the Coloured Books, as well as terminal traffic.

The subgroup welcomed the US initiative and stressed the importance of the Europe-USA link, which might physically be a CERN-Fermilab point-to-point connection, by undersea cable or satellite. The difficulty of harmonizing the European and US situations was recognized, both at the technical level (poor availability and high costs of X.25 services in the US) and at the administrative one (notably the problem of third-party switching in Europe).

Subgroup 5 **recommends that first priority be given, in the USA HEPNET, to the use of X.25 and ISO compatible protocols** in order to harmonize as much as possible the US situation with the European one and lead the way to open systems interworking.

9. Tariffs.

Particularly delicate are the financial and tariff questions, which have to be dealt with in each separate country, having their own administrations and regulations. An attempt at comparing the costs of using leased lines versus packet-switched virtual circuits, for instance, encounters very serious difficulties which are due as much to the different nature of the technologies as to the attitudes of the interested parties.

These tariff questions are even more difficult to disentangle when one wants to work on both sides of the Atlantic. The tariff structures in the US are grossly different from the European ones, as are the attitudes of the service providers and users.

It may be noticed that most organizational, managerial and financial issues are tougher than technical problems and far from being resolved, especially considering the international aspects inherent in all activities in HEP, particularly networking.

It is the hope of Subgroup 5 that a better coordination at the international level, as is attempted by the setting-up of the RARE association and the involvment of the Commission of the European Communities, will allow the HEP users to see tariff structures better adapted to their needs and constraints. The involvment of Subgroup 5 in these matters is examplified by [14] and [15].

10. Conclusions and future of the group.

This is the third status report produced by ECFA Subgroup 5, after six years of activity. About 100 working papers have been produced by members of the group, who are all actively involved, at the national or international level, in developping and providing networking facilities for HEP users. Papers on the Subgroup activities were recently presented at an international conference [16, 17].

The members of the Subgroup have repeatedly reviewed the validity of their work. It seems that the quality of the international forum which the group constitutes, its impact on networking practices in HEP and indeed in larger circles, the well-established relations between the Subgroup and international bodies and institutions like CERN, CCC, RARE and the Commission of the European Commmunities, should all warrant the time and effort to continue its activities.

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Appendix 1. Members of Subgroup 5.

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P. Bryant	RAL
B. Carlson	QZ
B. Carpenter	CERN
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R. Hughes-Jones	Manchester
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T. Kokott	Bonn
J-P. Laugier	DPhPE-Saclay
F. Liello	INFN-Trieste
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L. Robertson	CERN
A. Rouge	Paris
J. Rubio	Madrid
D.M. Sendall	CERN
D. Sultan	Paris
R. Tirler	DPhPE-Saclay
E. Valente	INFN
P. Van Binst	Brussels
P. Villemoes	Copenhagen
A. White	London

PRESENT STATUS OF THE RESEARCH NETWORKS IN ITALY

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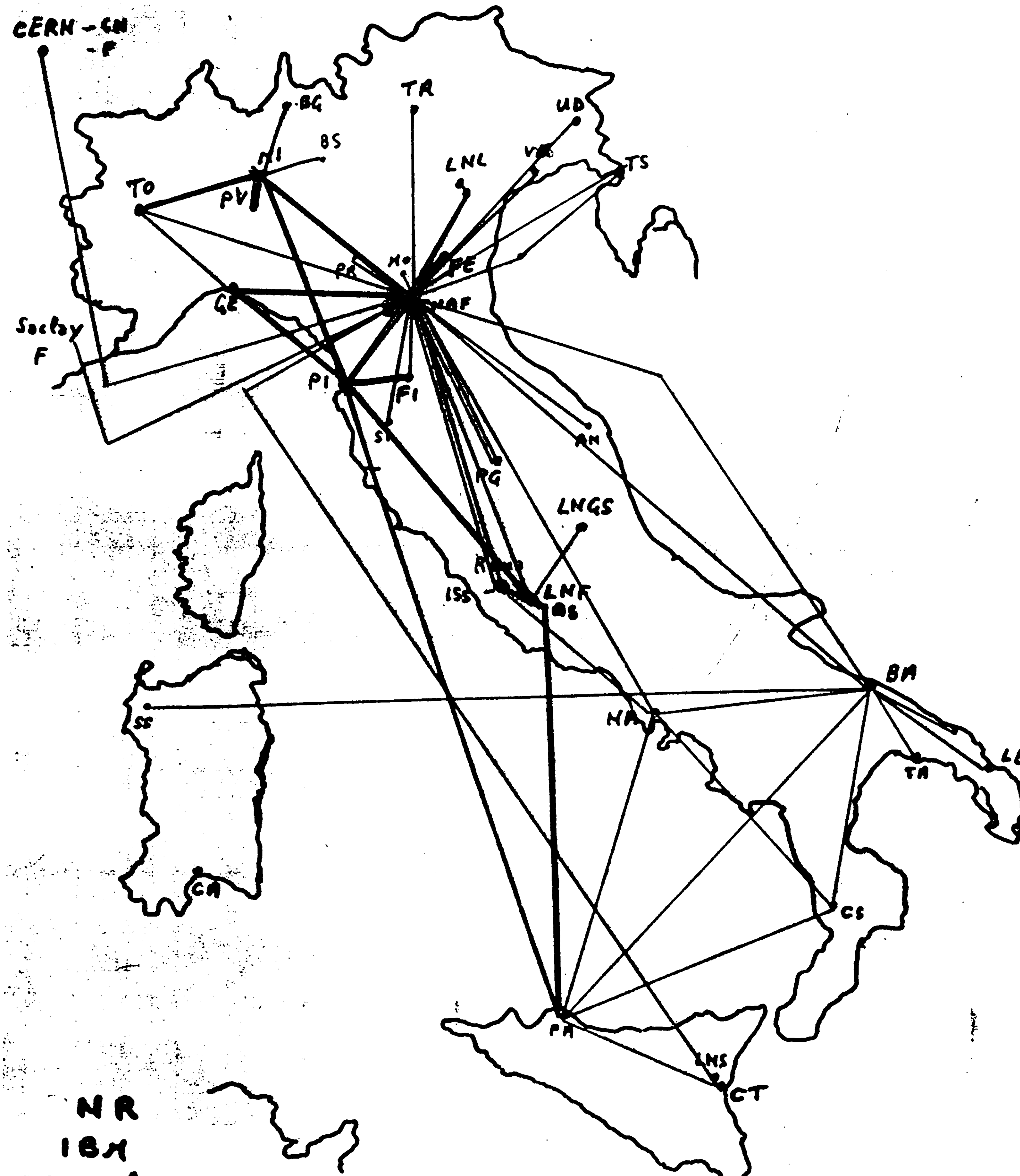
M. Sommani, CNUCE/CNR, Via S. Maria 36, Pisa, Italy.

Copenhagen 26-28 May 1986

INFN	CINECA	CILEA	IANET	ENEA
Digital	Digital	Digital	IBM	IBM
(DNA)	(DNA)	(DNA)	(SNA)	(SNA)
gateways	NETWAY	X25	X25	



NR
IBM
RSCS/NJE

Three major independent research organisations coexists at national level in Italy: CNR, ENEA and INFN. Each organisation has built its own network independently and only now these networks have started to interact with the consequence that some harmonization work is desirable. Furthermore there are three networks provided or planned by the big computer centers or consortia of computer centers used by the research community (CILEA, CINECA, IATINET). These networks were built for convenience of access to the facilities of the centers from remote users spread all over the national territory.

The following brief description of each network will help in understanding the status of research networking in Italy.

Networking in CNR.

Researchers of CNR have access to computational resources located either locally or in a few major computing centers of CNR, known as "service providers". Six service providers are using IBM or IBM-compatible machines and one has a CDC-machine. All IBM-like service providers are connected via RSCS/NJE and VM/PASSTHRU protocols. The CDC installation is going to be connected soon by means of the NJEF emulator of the IBM NJE. The other CNR installations are mainly using DEC, Honeywell or IBM equipment. The RSCS/NJE and VM/PASSTHRU networks are being extended in order to include all other IBM installations. The RSCS/NJE network of CNR is part of EARN. The VM/PASSTHRU network also includes another 10 nodes, mainly university computer centers, outside CNR itself. One connection between the CNR network and DARPA exists via SATNET. Some DEC installations are part of small DECNETs having a limited geographical extension; one of them is also an EARN node. The backbone of the IBM network will soon migrate to SNA and a DECNET including almost all DEC installations is being planned and should become operational in the first half of 1987. Gateways are being planned between IBM and DEC networks.

CNR institutes and laboratories are scattered all over the national territory, but network nodes are now mainly located in the north-western and central parts of Italy.

The CNR networking structure is also intended to be the instrument for experimenting and validation new OSI products, within the OSIRIDE project. OSI levels 4 and 5 and MHS implementations are already being tested. OSIRIDE is also currently defining FTAM options, functional units and document types, based on the latest DIS version of ISO 8571. An activity on the definition of test sequences and test scenarios for level 5 implementations has just been started.

Networking in ENEA

The network of the national body for nuclear and alternative energies (ENEA), ENET, is based on five IBM machines located in the centers around Rome and in Bologna. The protocol used is SNA over leased lines and the network is mainly used for job submission and administrative purposes. The ENEA network has connections to EARN, to the CINECA network and an international line to CISI at Saclay.

Networking in INFN

The INFN network, INFNET, has been built in order to provide a connection facility between the computers of the laboratories and centers of INFN all over the national territory. The majority of the machines being DEC with a few IBM's the resulting network has been based on lines leased from PTT and uses the protocols commercially known as DECNET.

The INFN investment in software has been mainly devoted increasing the performance and transparency of commercially available software to meet the required standards. Namely specific gateways has been developed to allow access to computers of different manufacturers (IBM, UNIVAC, CONTROL DATA) or to networks with different protocols (GIFT project).

Particular care has been taken to design the IBM gateway to provide the highest possible degree of transparency to the user in accessing these machines via DECNET for file transfer, job submission and interactive work.

Remote job submission and retrieval and file transfer gateways exist for the other machines.

INFNET is not only used by the HEP community, but is also accessed by the astrophysical and solid state physics communities.

As of May 1986 INFNET connects about 100 computers in Italy and, through two international lines to CERN, about 200 more computers used by Italian researchers or collaborators of Italian researchers.

The INFNET connects all the sections, laboratories and national centers of INFN and allows the access to the major Italian computer centers (CILEA, CINECA, CNUCE, CSATA, etc.) many computer centers of the Italian universities and the CERN computer center and international networks.

INFN has already announced its commitment to the OSI standards. However, the actual migration will be delayed until the OSI products commercially available will have reached a sufficient level of reliability and performance. The up-to-date estimate of the time of migration is now in 1988.

In the meantime INFN expects a growth in complexity and dimension of the network. It is expected to reach within the year 150 nodes connected in Italy, with a daily traffic of about half a gigabyte. A transition from some existing 9.6 kbps lines to 48 kbps ones has been already planned for the next months, while we expect the need for 1 mbps within the nineties.

Networking in CILEA

The CILEA consortium connects a large number of interactive terminals in the universities in the area around Milano to the central SPERRY computer. A DECNET network has been built connecting the departmental VAX computers in the universities, in order to allow a better access to its facilities. This network is also connected to INFNET and EARN.

The CILEA network was based on X.25 protocols over leased lines to allow for the widest possible interconnectivity between heterogeneous machines and terminals and an easy access to the public X.25 network. The choice of X.25 was also motivated by the previous experience of CILEA with the EURONET experiment.

Networking in CINECA

CINECA is the largest computer center of the research community in Italy. It owns two IBMs (3083 and 4381) a CRAY XM-P/1-2, a CDC 835 and a VAX 11/785. The main concern of CINECA is to allow an easy access for the users of the machines.

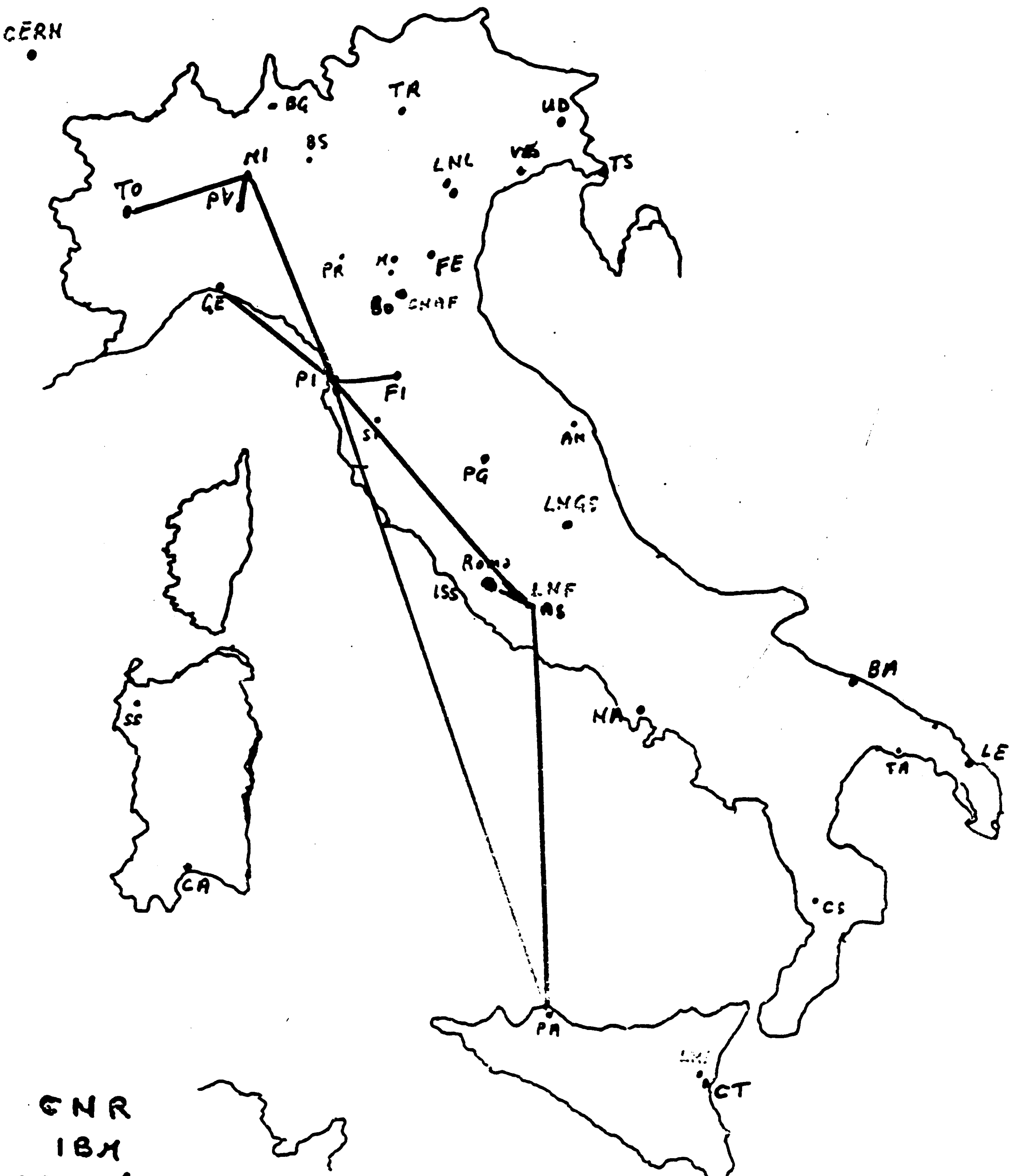
For this reason CINECA has built a large terminal access network covering a large part of Italy and a DECNET network connected to the VAX front-end to link many user machines through Italy. Connections to EARN/BITNET and to the public X.25 network (ITAPAC) are also provided.

IATINET

IATINET is a project for the interconnection of four major computer centers in the south of Italy (Bazi, Cosenza, Naples, Palermo) for job and resource interchange. It is based on IBM machines and the SNA protocol as an interim solution.

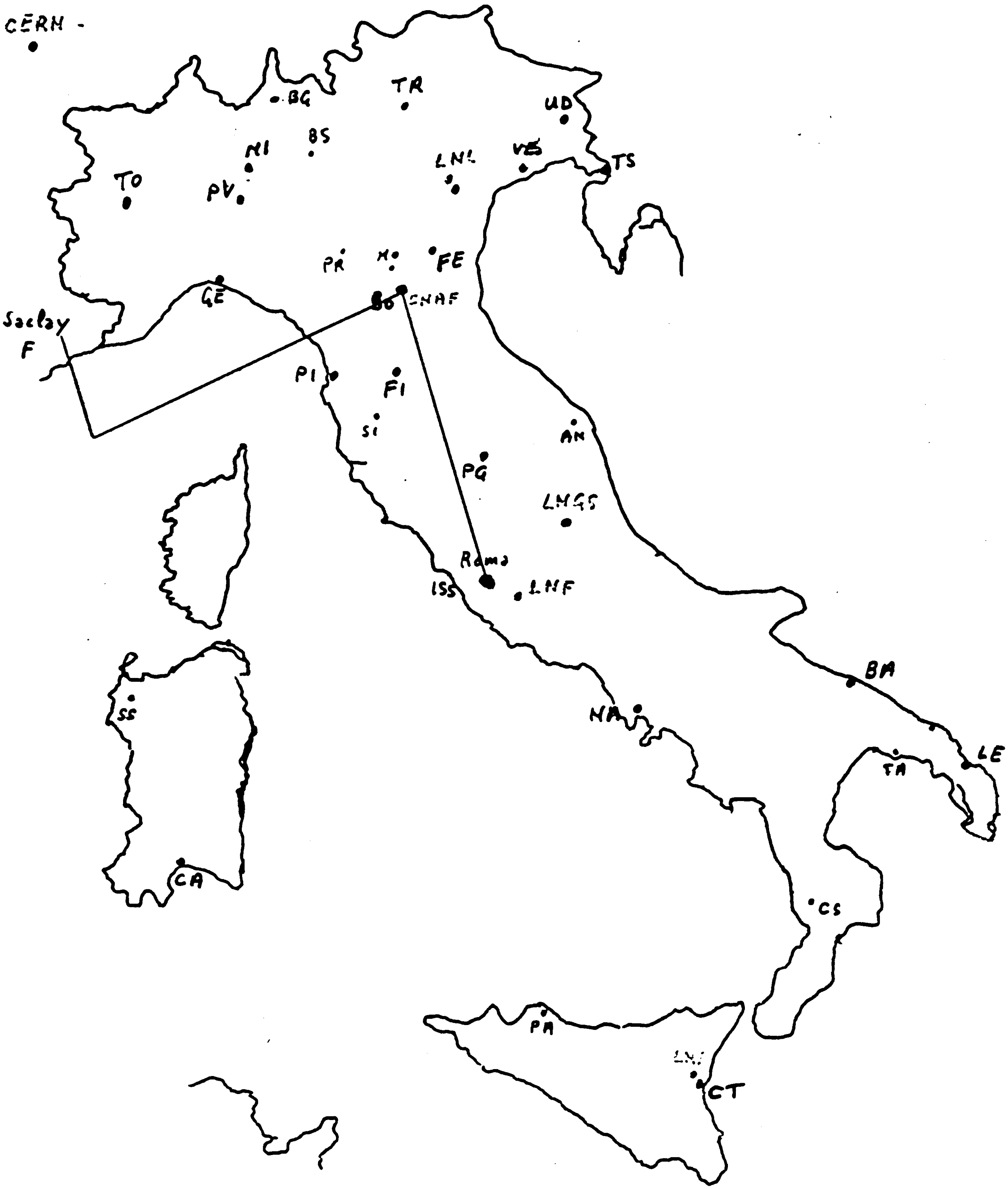
Other existing projects are not covered in the present brief review of course, but it is already easy to see that the existing networks have basically the same aim and are overlapped and interconnected in many points. An effort for the harmonization and transparent interconnection of these networks was started some time ago and we hope to have soon some results.

To achieve a true transparency of the interconnection of the different networks the OSI commitment is mandatory. The time-scale of the single transition from the interim protocols now used to the final OSI ones cannot be fixed here and now because it is related to the availability of the commercial OSI products and to the very special needs of the users of the individual networks.



CNR
IBM
RSCS/NJE
VM/PASSTHRU

ENEA
IBM
(SNA)



CERN
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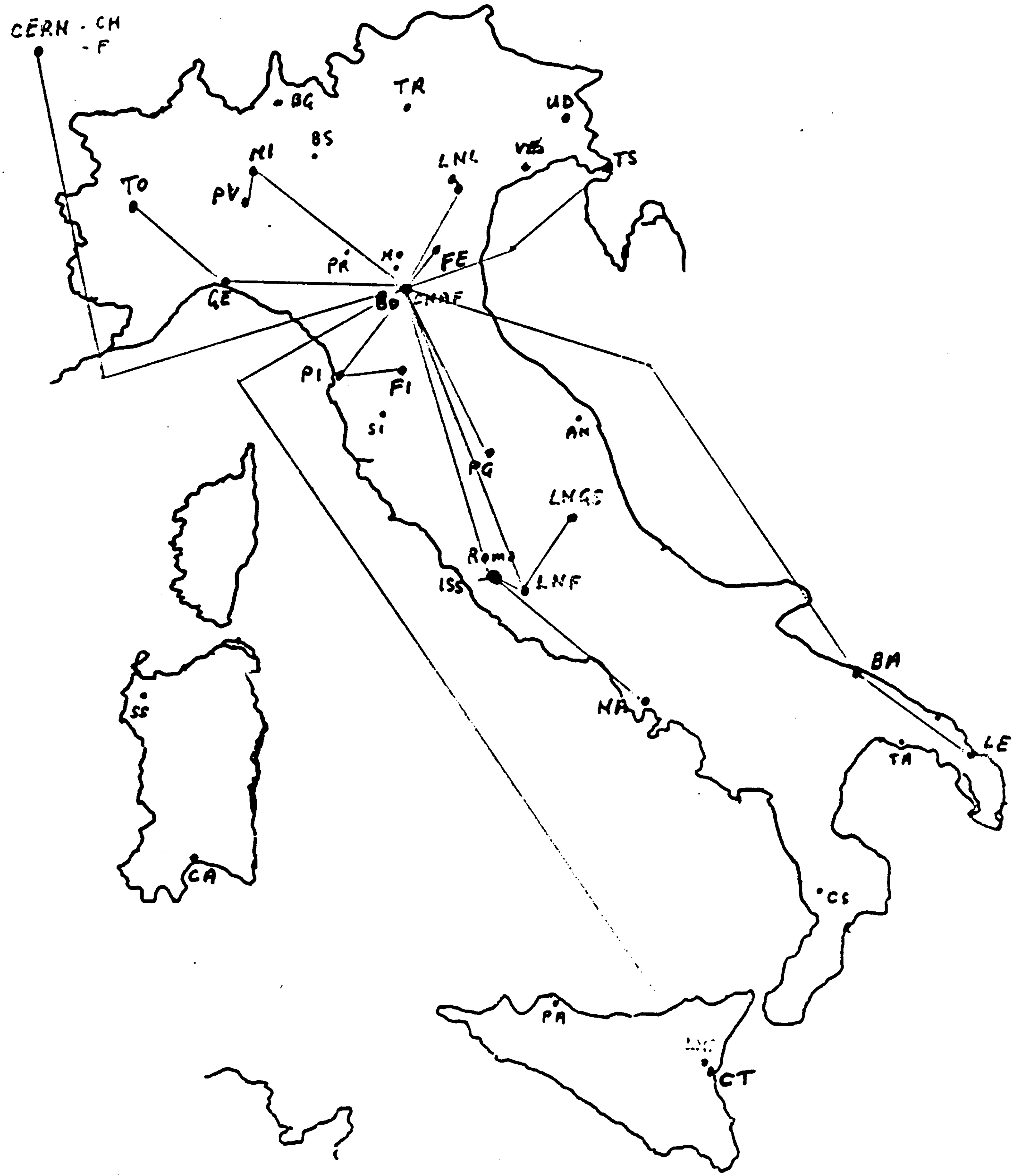
CT

INFN Digital (DNA) gateways



Digital

(DNA)

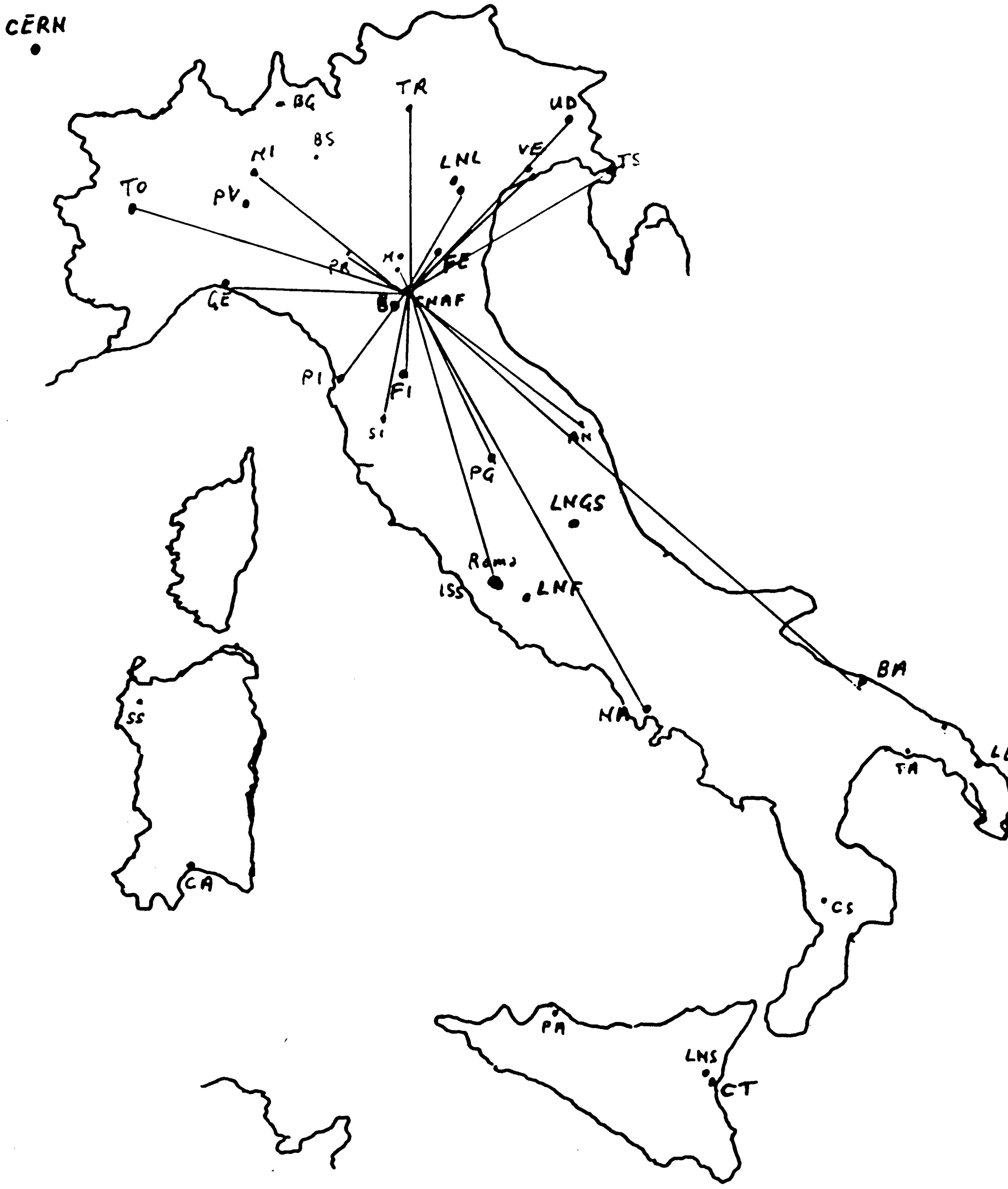
X25

CINECA

Digital

(DNA)

NETWAY

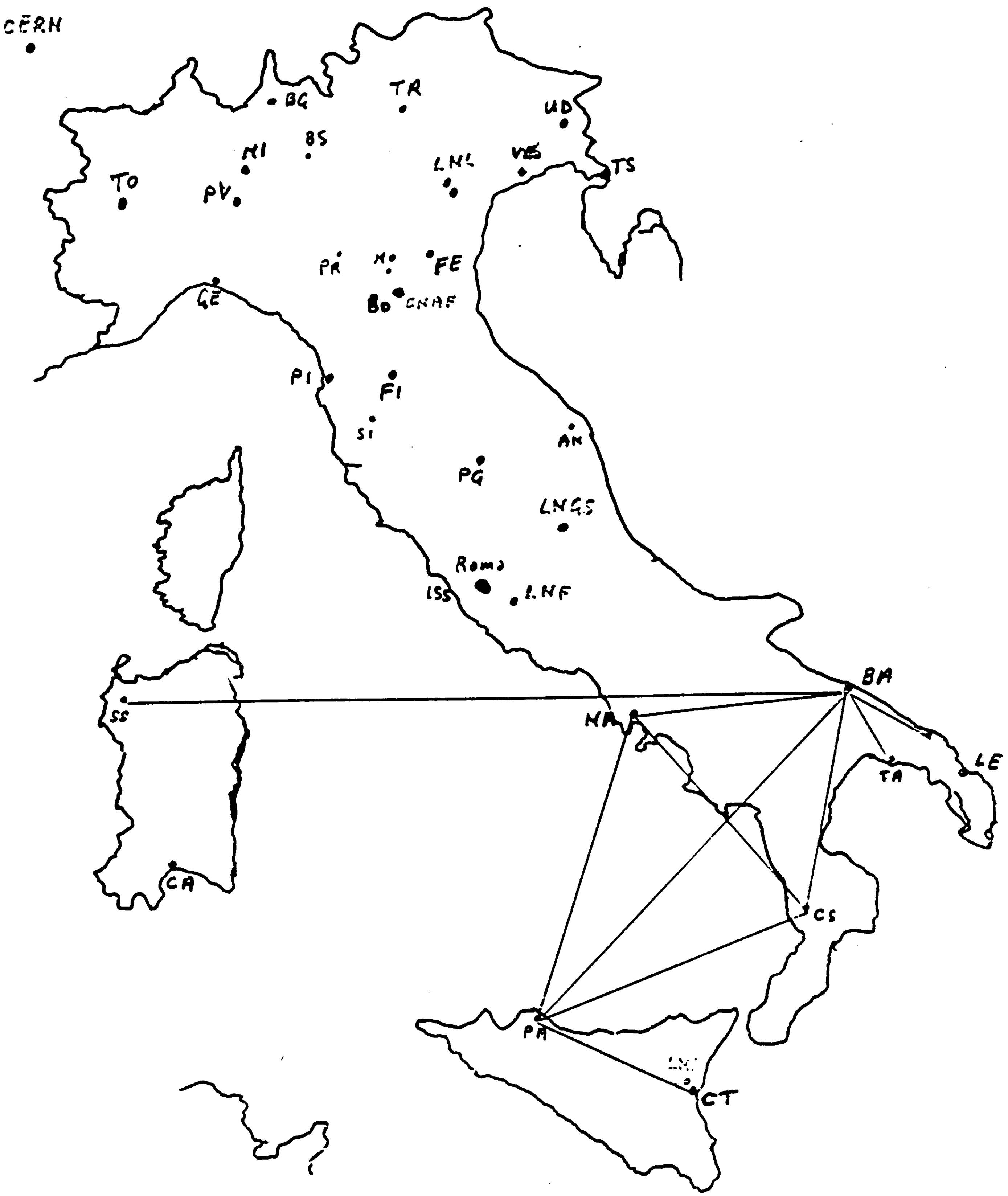


INNET

IBM

(SNA)

X25



EUREKA, RARE and the Deutsche Forschungsnetz (German Science Network)

Klaus-Eckart Maass
DFN-Verein, Geschaftsfuhrung, Berlin, F.R.G.

[Editorial note: DFN is a government-sponsored initiative funded by the German Ministry of Research and Technology for the purpose of designing and implementing a nationwide computer network to serve the communication needs of the German scientific community. Planning for DFN began in January 1982 and work on the first of 40 separate research projects began in July 1983. These plans called for basing the DFN network on the ISO Open Systems Interconnection-Reference Model and standardized protocols, as well as provision of both wide-area (WAN) network services (through the German PTT's X.25 service) and local area network services (LANs). An important phase of the project focuses on the technical aspects of providing gateways between WANs and new or existing LANs (such as Ethernet, Hyperchannel, PABX, etc.). Possibilities for broad-band satellite and ground-based communications will also be explored. In the application layer, the network will allow mailing, remote job entry, file transfer and access to time-sharing systems. Future goals also include a graphic network service based on the standardized Graphical Kernel System.

For additional information on DFN, contact the Central Project Management Group at: DFN, Zentrale Projektleitung, Glienicker Strasse 100, 1000 Berlin, F.R.G.

With reference to the RARE initiative, it is important that the distinction be made clear that this project does not concern itself with the establishment of an international network per se, but rather a network *infrastructure* whereby presumably existing national networks will be linked. This will be elaborated upon in a subsequent issue of COMPUTER COMPACTS.

For additional information on RARE, contact the RARE Secretariat, James Martin Associates, De Boelelaan 873, 1082 RW Amsterdam, The Netherlands.]

Once again, the jungle of abbreviations we live in has been extended by another word: RARE. RARE is taken from the French, 'RÉSEAUX ASSOCIÉS POUR LA RÉCHERCHE EUROPÉENNE', which in English means 'Joint European Research Network.'

A proposal for founding a European network association was made during a meeting of members of national science network projects in the middle of May 1985 in Luxembourg. At that time, it was decided that the essential goal of this European Association should be to foster a European data and communications network in order to improve the infrastructure around European scientific activities and to support the use of this network. The proposed network should be based on the principles of OSI (Open Systems Interconnection), in the hopes that the application of ISO standards would promote widespread use.

The DFN-Verein (German Research Network Association) has supported this initiative, which originally came from Prof. Dr. Karl Zander from the Hahn-Meitner-Institut in Berlin. As a national network organization of the Federal Republic of Germany, the DFN-Verein has become a founding member of RARE.

The European Scene

During the European Conference of Ministers on 5-6 November 1985 in Hannover, a German proposal for the Europe-wide extension of the German research network was accepted. The following countries agreed to participate in this EUREKA project: France, Finland, the Netherlands, Austria, Sweden and Switzerland. Interest in the project was also voiced by Denmark, Greece, the United Kingdom, Ireland, Italy, Luxembourg, Norway, Portugal, Spain and Turkey.

In the view of BMFT, the German Ministry for Research and Technology, which funds the DFN, within the context of EUREKA, the responsibility and management for individual projects should be with the developers and users rather than with a supranational organization. The developers and users themselves should be able to decide upon and realize the project in question.

In order to realize such a network project as quickly as possible, it was therefore considered a logical step to draw the RARE group, as an association of developers and users, into the framework of the EUREKA venture. The subsequent EUREKA conference was in May 1986 in Great Britain, at which time strategies for the creation of a powerful infrastructure for European science were discussed. The second European Networkshop was held in Copenhagen from 26-28 May. BMFT has apparently agreed that RARE should act as an umbrella organization for users and the Ministry intends to hand over the responsibility for the flow of information between national groups, the right for making development proposals, and the right to represent the project, to RARE.

Attitude of the DFN

The DFN management is positive in its attitudes regarding RARE and favors the extension of the German Research Network to the European scene within the EUREKA framework. Berlin has been suggested as a possible location for a European coordinating office, as it is felt that this would enable the optimal use of DFN-Verein's experience on the European scene.

According to DFN management, within the framework of EUREKA, priority should be given to the establishment of ISO and CCITT-based networks in those countries which currently lack a national network infrastructure and to ensuring the compatibility of the various national networks. The protocol profiles worked out by the SPAG (Standard Promotion and Application Group–Siemens, ICL, Bull, Nixdorf, and others) should be taken into account during the establishment of these networks, if possible. This should make the use of industrial products for electronic mail, data transfer, and dialogue possible. In a later phase, projects for rapid data communication in science, such as networking supercomputers, could be incorporated.

Taking all of these considerations into account, the DFN management's position stresses the fact that German development work should not be adversely affected and that the financial framework of DFN should be adapted to meet these new challenges in order to play a role in the creation of a European network infrastructure.

- definition of OSI protocols by international standards bodies (e.g., ISO, CCITT);
- OSI protocols should be implemented in their products by all manufacturers involved;
- these protocols should be technically and economically sound.

Experimental use of OSI X.25 (for communication) and X.400 (for message handling) protocols is being defined and will be initiated on EARN in April 1986. This experimentation will be extended to more sites and to other OSI protocols as these are defined. One of the objectives of the EARN Board is to complete the migration to X.25 by the end of 1987, an effort assisted by the IBM Networking Center in Heidelberg, FRG.