COMMUNITY NETWORKS AND INTERORGANIZATION LINKS

- Internal Organization Boundaries
- Protocol Proliferation
- When does Protocol Translation work?
- Crossing External Boundaries
LAN is only one component!

The Community Adds:

1. Several LAN's per organization
2. Links to other sites (via P.T.T.)
3. Links to other organizations

4. Printer Services
5. Cheap storage services [RELIABLE] [ARCHIVE]
6. Super Array Processor

7. Enterprise data
8. Mail queuing and delivery
9. Multi-author-decision concurrency
INTERNAL: { PROTOCOL DISASTER SCENE }

EXTERNAL: { POLICY PROBLEMS TOO }
Typical Communication Examples

- Engineers want to use WP Laser Printer
- Mail and Message Exchange
- Output of Admin DBMS
  \[\rightarrow\]  Engineering Writes Report
  \[\rightarrow\]  Produced by WP Center
- Administration uses data service via B.T.T.
- Engineering "..."
  etc.
THE EMERGING PICTURE

ADMINISTRATIVE
DP CENTER

ENGINEERING
COMPUTING AREA

INTERNET

TO
P.T.T.

IBM

DEC

APOLLO

XEROX

PRINTER

IBM

DEC

APOLLO

APOLLO

WORD PROCESSING
DEPARTMENT
<table>
<thead>
<tr>
<th>Protocol Family</th>
<th>Number of M.I.T. Hosts</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHAOS P</td>
<td>80</td>
</tr>
<tr>
<td>IP/TCP</td>
<td>48</td>
</tr>
<tr>
<td>PUP</td>
<td>20</td>
</tr>
<tr>
<td>DECNET</td>
<td>12</td>
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<td>XEROX NS</td>
<td>4</td>
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<td>RSCS</td>
<td>3</td>
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<td>DOMAIN</td>
<td>2</td>
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<td>X.25</td>
<td>2</td>
</tr>
<tr>
<td>UUCP</td>
<td>1</td>
</tr>
</tbody>
</table>

Total: 172 Implementations

140 Hosts
32 Multi-Protocol Hosts
WHY ARE THE NETS DIFFERENT?

1. PURCHASER DECISIONS:
   - First priority is computing application (admin/wp/eng'g)
   - Interconnection requirement is less clear
   - Hard to measure value
   - Secondary concern

2. MANUFACTURER DECISIONS:
   - Technology choice not clear
   - Non-interconnect → captive market

AT LEAST A DECADE OF CONFUSION!
INCOMPATIBILITIES
AT THREE LEVELS -

1. DIFFERENT MANUFACTURERS HAVE
   CHOSEN DIFFERENT LOCAL NET TECHNOLOGY
      - ETHERNET
      - RING
      - BROADBAND
      - PABX

2. EACH MANUFACTURER PROVIDES A
   COMPLETE END-TO-END TRANSPORT-
   SERVICE (EACH DIFFERENT FROM NEXT)

3. INTERPRETATION OF THE DATA IS
   DIFFERENT ON EACH MACHINE -
      - CHARACTER CODES
      - 32/36 BITS
      - BYTE ORGAN, BIT ORDER
      - PRINTER FORMAT CONTROL
3-LAYER MODEL

APPLICATION

END-TO-END TRANSPORT

NETWORK DRIVER

APPLICATION

END-TO-END TRANSPORT

NETWORK DRIVER

Physical wire
3-Layer Model

ISO/OSI Correspondence

Application

End-to-End Transport

Network Driver

-1, 2-

-3, 4, 5-

-6, 7-

Physical wire
Physical wire:
- Tell owner and what name to use for this file
- Read disk
- Make up packets
- Write disk
- Check integrity of received file
- Commit transaction
LEVEL 1 (LOCAL NET TECHNOLOGY)

INCOMPATIBILITY IS EASY TO BRIDGE, INVISIBLY...

(EVERYTHING ELSE IS HARD)
Q. Why different end-to-end transport protocols?

A. Substantive unresolved differences!
- Address plan, structure, size
- Packet size, fragmentation, reassembly
- Flow control, source quenching, windows
- Class of service, delay, reliability, privacy
- Route control
- Error recovery procedures
**Protocol Translation Fails!**

Example: Two file transfer protocols...

**ORDERLY FTP**
- send inquiry
- wait for ack
- send full packet
- wait for ack
- EOF = first non-full packet

**BLAST FTP**
- send inquiry with file size
- wait for ack with data rate
- send bursts of packets at that rate
- receiver sends ack (and any retransmit requests) at end

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[Diagram of protocol flow and data transmission]
Protocol Translation Fails!

Example: Two file transfer protocols...

**ORDERLY FTP**
- send inquiry
- wait for ack
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- EOF = first non-full packet

**BLAST FTP**
- send inquiry with file size
- wait for ack with data rate
- send bursts of packets at that rate
- retransmits any requests at end

Problems

1) **ORDERLY FTP**: ACK of last packet means transfer committed.

2) **BLAST FTP**: Can't send first packet till last ORDERLY packet is received.

3) **ORDTP** sender may give up in disgust waiting for last ack!

4) Translator must have storage for largest possible file!
OTHER HARD-TO-TRANSLATE SUBLTETIES IN FTP

"SEND FILE XYZ TO DIRECTORY JONES ON HOST W"

CONVENTION #1:  Incoming files → receiving room
                 message → recipient
                 explicit pickup by recipient

CONVENTION #2:  Incoming files → recipient's directory
                 If file name already in use,
                 refuse the file

CONVENTION #3:  Incoming file → recipient's directory
                 Overwrite any old file of same name
GENERAL TRANSLATOR FOR ANY LEVEL FOUNDERS ON SUBTLE SEMANTIC DIFFERENCES
Specialized Translator with knowledge of higher-level application can succeed.

Need different level-n translator for each level-(n+1) protocol.

e.g. File Transfer
Remote Login
Remote Procedure Call
INTER-ENTERPRISE GATEWAYS

WHY?

- COMPANY-TO-COMPANY PURCHASE ORDERS
- WIRE TRANSFERS
- PURCHASE OF DATA BASE INFO
- GENERAL MESSAGE SERVICE

EXTRA REQUIREMENTS:

- PRIVACY OF ENTERPRISE DATA
- IMPROPER TRANSIT
- CORPORATE IMAGE
- LIABILITY FOR ACTING ON MSG
- AUTHENTICITY OF ARRIVING MSG
M.I.T. Network Links

- ARPANET — Xerox, DEC, Honeywell, Ford, Carat, etc.
  — CSNET — IBM, HP, etc.

- USENET (UNIX User Group)

- BITNET (IBM University User Group)

- TELNET (P.T.T.-like)

- TTYNET (P.T.T.-like)

- SYMBOLICS (Corporation)

- IBM (Corporation)

* late summer 1983
POLICY EXAMPLES

- END POINTS PROVIDE POLICY
  GATEWAY DOES NOT INTERFERE

- NO TRANSIT

- LOG ADDRESSES

- LOG DATA

- ONLY SOME HOSTS MAY PARTICIPATE

- ONLY SOME USERS MAY PARTICIPATE

- MAIL ONLY (No remote login or job entry)

- OUTGOING MAIL HELD FOR HUMAN REVIEW

\[ \text{LINK FROM A TO B} \]
\[ \Downarrow \]
\[ \text{TWO POLICIES INVOLVED} \]
1. **Gateways Have Filters**

![Diagram of network with gateways and filters]

- Filters traffic to A's satisfaction
- Filters traffic to B's satisfaction

**Examples**
- Hold for human review
- Copy into a log
- Accept or refuse based on source/destination
- Forward to different location for inspection
Policy Enforcement Example

M.I.T.

Serial Line G/W

Interconnect network

IBM VM/320

Serial Line G/W

Policy VM

M.I.T. Network

1BM Network
Provides
- authentication
- introduction
- billing for services rendered by $B \to A$
or $A \to B$