COMMUNITY NETWORKS
AND
INTERORGANIZATION LINKS
COMMUNITY NETWORKS AND INTERORGANIZATION LINKS

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

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

NETWORK MACHINERY
LAN is only one component!

The Community Adds:

1. Several LAN's per organization
2. Links to other sites (via PTT)
3. Links to other organizations
4. Printer services
5. Cheap storage services (reliable?)
6. Super Array Processor

Network Machinery

Economy-of-scale services
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
Authority Boundaries

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
  ↓
  Engineer writes report
  ↓
  Produced by WP Center

- Administration uses Data Service via Q.T.T.

- Engineering
  " " " " " "

etc.
THE EMERGING PICTURE

ADMINISTRATIVE
DP CENTER

IBM

IBM

IBM
THE EMERGING PICTURE

ADMINISTRATIVE
DEPARTMENT
CENTER

ENGINEERING
COMPUTING
AREA

IBM

DEC

APOLLO

TRAVIS
THE EMERGING PICTURE

ADMINISTRATIVE
DP CENTER

IBM

WORD PROCESSING
DEPARTMENT

XEROX

PRINTER

ENGINEERING
COMPUTING
AREA

DEC

APPLE

APOLLO

TRACY
THE EMERGING PICTURE

ADMINISTRATIVE DP CENTER

IBM

IBM

ENGINEERING COMPUTING AREA

DEC

DEC

APOLLO

Apollo

APOLLO

Apollo

WORD PROCESSING DEPARTMENT

XEROX

XEROX

XEROX

XEROX

XEROX

XEROX

PRINTERS

INTERNET

TO
P.T.T.
<table>
<thead>
<tr>
<th>Protocol Family</th>
<th>Number of M.I.T. Hosts</th>
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<tr>
<td>CHAOS P</td>
<td>80</td>
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<tr>
<td>IP/TCP</td>
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<td>20</td>
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<td>X.25</td>
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<td>UCNP</td>
<td>1</td>
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<td>Total</td>
<td>172</td>
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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 $\rightarrow$ captive market

$\rightarrow$ AT LEAST A DECADE OF CONFUSION!
INCOMPATIBILITIES
AT THREE LEVELS -

1. Different manufacturers have chosen different local area net technology:
   - Ethernet
   - Broadband
   - Ring
   - 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 order, bit order
   - Printer format control
3-Layer Model

- Network Driver
  - Packet Address

- Network Driver
  - Packet Source

Physical wire

Embedded text: '84'
3-Layer Model

END-TO-END
TRANSPORT

NETWORK DRIVER

END-TO-END
TRANSPORT

NETWORK DRIVER

Physical wire↑
3-LAYER MODEL

APPLICATION

END-TO-END TRANSPORT

NETWORK DRIVER

APPLICATION

END-TO-END TRANSPORT

NETWORK DRIVER
3-LAYER MODEL

ISO/OSI Correspondence

APPLICATION

PACKETS, ADDRESSES

END-TO-END TRANSPORT

PACKETS, ADDRESSES

NETWORK DRIVER

APPLICATION

PACKETS, ADDRESSES

END-TO-END TRANSPORT

PACKETS, ADDRESSES

NETWORK DRIVER

PHYSICAL INTERFACE
3-Layer Model

- File Transfer application
  - End-to-End Transport
    - Network Driver
  - Packet address

- File Transfer application
  - End-to-End Transport
    - Network Driver
  - Packet source

Physical wire:
- Tell other end 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, VISIBLY...

(EVERYTHING ELSE IS HARD)
XEROX ALTO

FILE

ARPA
FILE TRANSFER

XEROX
FILE TRANSFER

ETHER
NET DRIVER

XEROX DOVER

FILE

XEROX
BITS

XEROX PROTOCOLS

BACKPACKED IN

ETHERNET

XEROX BITS

TRANSPORT

XEROX
FILE

NET DRIVER

XEROX
PRINTER

DRIVER
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
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
- revr sends ack (and any retransmit requests) at end
Protocol translation fails!

Example: Two file transfer protocols...

**ORDERLY FTP**

- send inquiry
- wait for ack
- send full packet
- wait for ack
- EOF is 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 acks (and any retransmit requests) at end

---

Problems

- **OP TP -> BFTP**

1. OP TP: ACK of last packet means transfer committed.

2. BFTP can't send first packet till last OP TP packet is received.

3. OP TP sender may give up in disgust waiting for last ack!

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

"SEND FILE XYZ TO DIRECTORY JONES ON HOST W"

CONVENTION #1: Incoming files ➔ receiving room message ➔ recipient explicitly 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
POUNDERS ON SUBTLE
SEMANTIC DIFFERENCES
A specialized translator with knowledge of higher-level application can succeed.

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

- File Transfer
- Remote Login
- Remote Procedure Call
INTER-ENTERPRISE GATEWAYS

WHY?

- COMPANY TO COMPANY PURCHASE ORDERS
- WIRE TRANSFERS
- PURCHASE OF DATABASE 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, CORSAIR, etc
  — CSNET — IBM, HP, etc.

- USENET (UNIX USER GROUP)

- BITNET (IBM UNIVERSITY USER GROUP)

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

- TN3270E (P.T.T. - like)

- SYMBIOSYS (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

\[ \text{LINK FROM A TO B} \]
\[ \Psi \]
\[ \underline{\text{TWO POLICIES INVOLVED}} \]
1. GATEWAYS HAVE FILTERS

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

Diagram:
```
ENTERPRISE A
Network

filters traffic
to A's satisfaction

ENTERPRISE B
Network

filters traffic
to B's satisfaction
```
Policy Enforcement
Example

M.I.T. Network

IBM
VM/320
Policy VM

Interconnect network
Provides:

- authentication
- introduction
- billing for services rendered by B → A or A → B