Cerf and Kahn: TCP/IP
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today design decisions

thursday architectural principles
Interconnection challenges

Heterogeneity

- Different addressing, supported packet lengths, reliability mechanism, latency, status information, routing

Must let each network operate independently

Solution:

“unacceptable alternative”
Gateways sit at interface between networks

![Diagram of three networks interconnected by two gateways](fig2)

Fig. 2. Three networks interconnected by two gateways.

...and speak an Internetworking protocol

![Internetwork packet format](fig3)

Fig. 3. Internetwork packet format (fields not shown to scale).
IP packet fragmentation

Allow maximum packet size to evolve

Protocol mechanisms to split packets in-transit
  • byte-level sequence numbers

Reassemble at end-hosts
  • Why not gateways?
Unreliable datagrams

No need for reliability in underlying network

Greatly simplifies design

• Exception handling always adds complexity
• But in IP: Any problem? Just drop the packet
  - examples?

What’s not a stated reason for datagrams?

• Statistical multiplexing
Routing unspecified—but constrained!

- Hierarchical (network, host) address
- Route computed within network, hop-by-hop
- 8 bits for network: “This size seems sufficient for the foreseeable future.”
- Later: 32 bits in three size classes (A,B,C), and then CIDR.

Many new routing/forwarding designs need to change this address format
Associated with a process on a host

Identify endpoints of a connection ("association")

Rejected design:

- connection at host level
- packet may include bytes for multiple processes

What’s the difference between a port and an address?
What we now call TCP

Window-based scheme

Provides reliability, ordering, flow control

- Even though you might want only some of these

What else does it do today?

- Congestion control
- Three-way handshake
It is our expectation that the host level retransmission mechanism ... will not be called upon very often in practice. Evidence already exists [ARPANET] that individual networks can be effectively constructed without this feature.

Why did they write this? Is it true now?

No congestion control in this early version!

• TCP congestion control introduces losses intentionally
Project suggestions

see separate document
Announcements

Read over syllabus

Review due Thursday:

• End-to-end arguments in system design
  (Saltzer et al, 1984)