Internet Design Philosophy (Clark’ 88)

In order of importance:

0. Connect existing networks
   - initially ARPANET, ARPA packet radio, packet satellite network
1. Survivability
   - ensure communication service even with network and router failures
2. Support multiple types of services
3. Must accommodate variety of networks
4. Allow distributed management
5. Allow host attachment with a low level of effort
6. Be cost effective
7. Allow resource accountability

Different ordering of priorities would make a different architecture!
1. Survivability

- continue to operate in presence of network failures (e.g., link, router failures)
  - as long as network not partitioned, two endpoints should be able to communicate
  - any other failure (excepting network partition) should be transparent to endpoints

- decision: maintain e-e transport state only at end-points
  - eliminate problem of handling state inconsistency and performing state restoration when router fails

- Internet: stateless network-layer architecture
  - no notion of a session/call at network layer
2. Types of Services

- add UDP to TCP to better support other apps
  - e.g., “real-time” applications
- arguably main reason for separating TCP, IP
- datagram abstraction: lower common denominator on which other services can be built
  - service differentiation was considered (remember ToS?), but this has never happened on the large scale (Why?)
3. Variety of Networks

- very successful (why?)
  - because of minimalist service; requires underlying network only to deliver a packet with “reasonable” probability of success
- …does not require: reliability, in-order delivery
- mantra: IP over everything
  - then: ARPANET, X.25, DARPA satellite network..
  - now: Ethernet, SONET, WiFi, cellular, WDM…
Other Goals

- **allow distributed management**
  - administrative autonomy: IP interconnects networks
    - each network can be managed by a different organization
    - different organizations need interact only at boundaries
    - … complicates routing

- **cost effective**
  - sources of inefficiency
    - header overhead
    - retransmissions
    - routing
  - …but “optimal” performance never top priority
Other Goals (cont)

- **low cost of attaching new host**
  - not strong point → higher than other architecture because intelligence is in hosts (e.g., telephone vs. computer)
  - bad implementations or malicious users can produce considerably harm (remember fate-sharing?)
- **accountability**
What About the Future

- datagram not best abstraction for:
  - resource management, accountability, QoS
- new abstraction: flow (see IPv6)
  - but no one knows what flow is
- routers must maintain per-flow state
- state management: recovering lost state hard
- here (1988) is first proposal of “soft state”!
  - soft-state: end-hosts responsible to maintain the state
Summary: Internet Architecture

- packet-switched datagram network
- IP is the glue (network layer overlay)
- IP hourglass architecture
  - all hosts and routers run IP
- stateless architecture
  - no per flow state inside network