Next Generation Internet

Where will it stop?

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Topics

- what got us here
- limitations within current Internet design
- addressing quality of service, security, reliability and network convergence
- standards organizations and the Internet

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In the Beginning

- in the beginning (and now)
- there was (is) philosophy
- smart network vs. smart edges
- centralized vs. distributed
- circuits vs. datagrams
- redundancy vs. reliability for reliability

- Internet: smart edges, distributed, datagrams
- phone co: smart net, centralized, circuits

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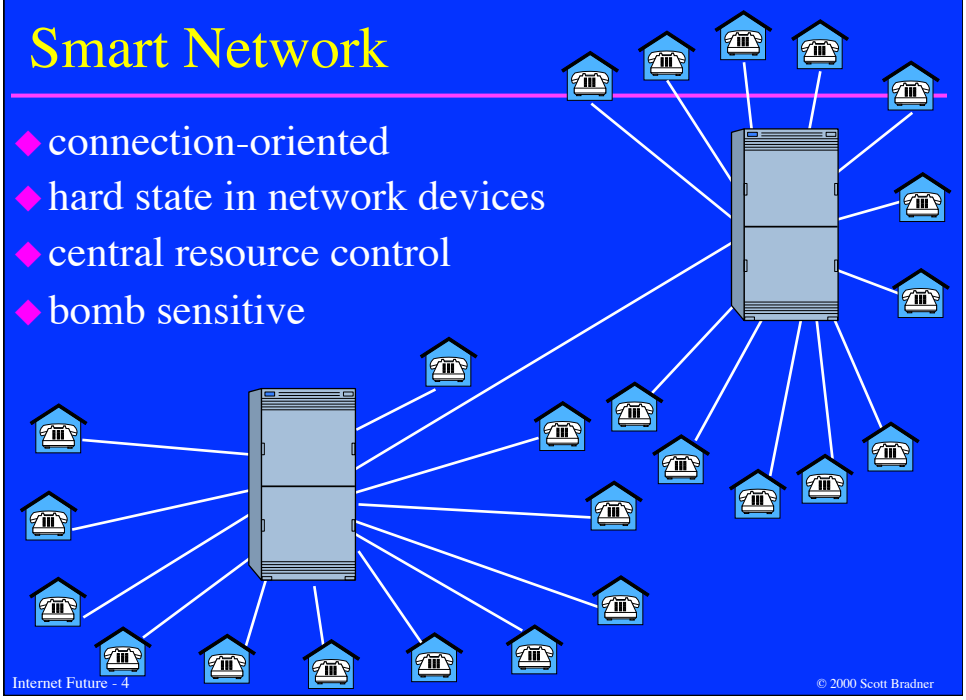
Smart Network

- connection-oriented
- hard state in network devices
- central resource control
- bomb sensitive



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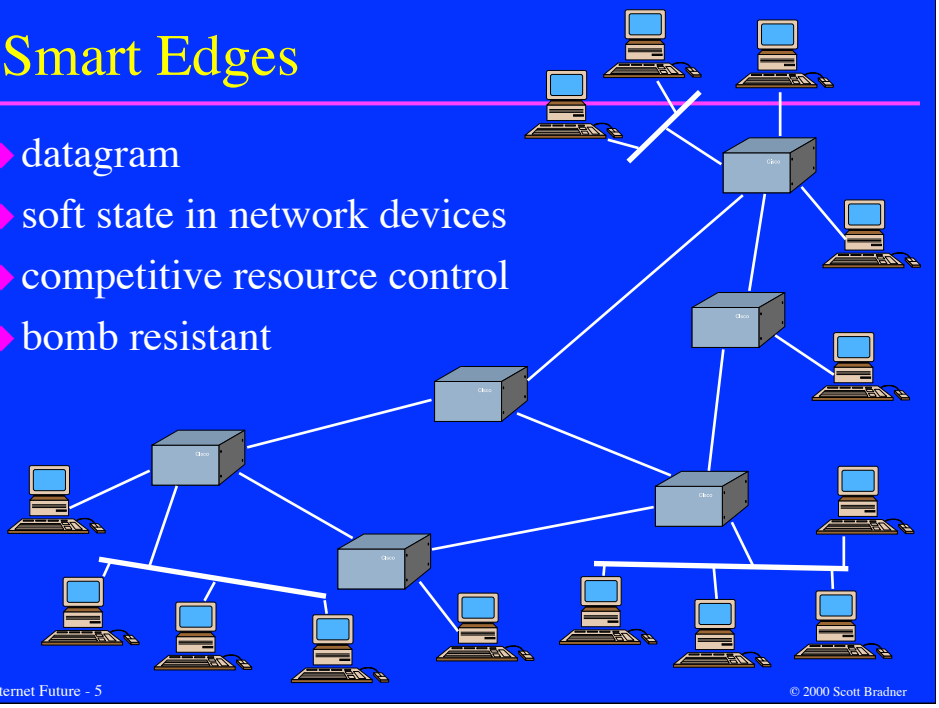
Smart Edges

- datagram
- soft state in network devices
- competitive resource control
- bomb resistant



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Survivability

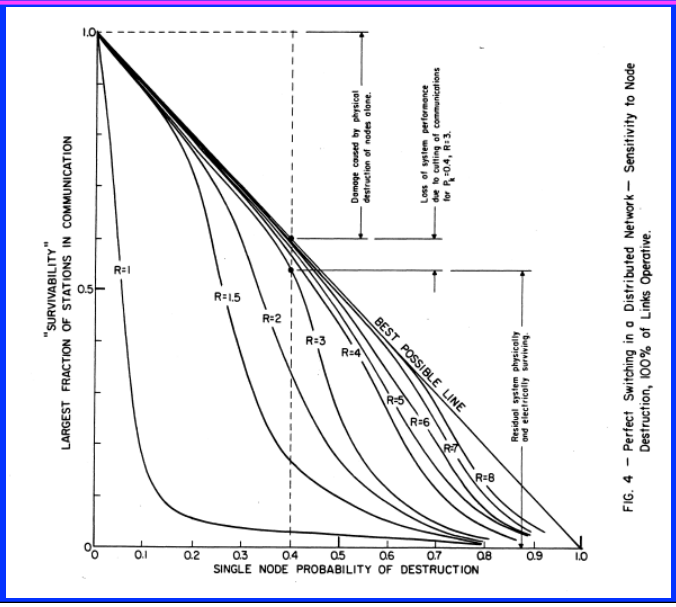

FIG. 4 — Perfect Switching in a Distributed Network — Sensitivity to Node Destruction, 100% of Links Operative.

From Baron

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Implications of Circuit vs Packet

- paths through network are not stable
  - change based on
    - link failure
    - traffic engineering
    - routing instability
    - link utilization (someday)
- impacts QoS
  - hard to reserve resources
  - unpredictable QoS
  - IBM: *"can not build corporate network out of TCP/IP"*

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Phone Net vs. Internet

- phone net
  - applications & services in network
  - applications built & installed by phone switch company
  - services provided by phone company
  - hard to do 3rd-party applications & services
- Internet
  - applications & services in computers at edges
  - applications & services can be built by users
  - applications & services can be installed by users
  - no permission required from network operator

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What Is the Internet

- general connectivity service for data
  - "network of networks"
  - only thing that needs to be in common is TCP/IP protocol
- no one runs it
- over 8,000 Internet service providers
- much data flows over phone company wires
  - but few phone companies are involved in Internet service
  - *"voice will be a niche market"*
- self (random) organized

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Internet Architecture

- randomly interconnected ISPs
- no defined "backbone"
- no regulatory backbone
- supports all sorts of applications
  - service providers do not control what applications are run

Internet architecture is not changed to support specific applications

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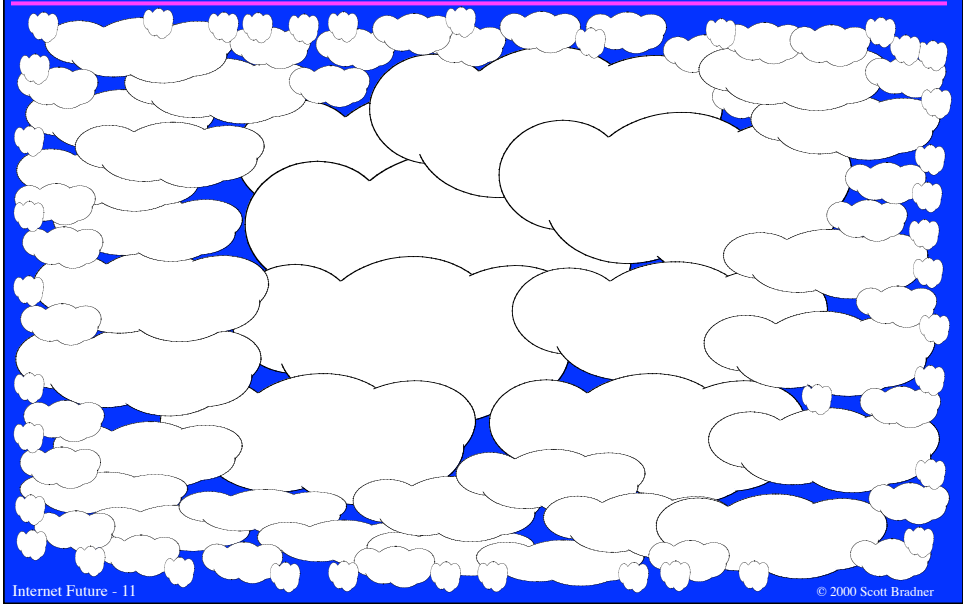
Internet Physical "Architecture"



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IP as a Common Bearer Service

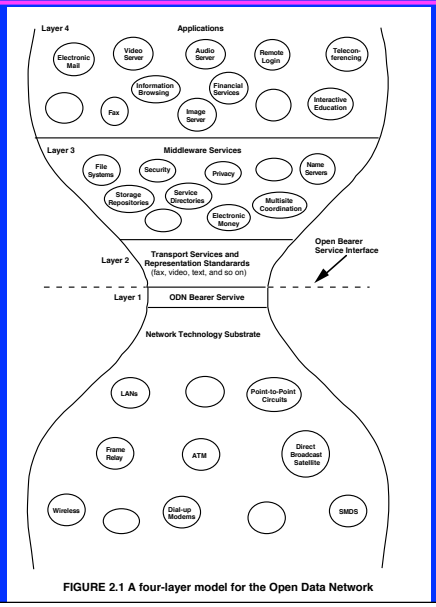

FIGURE 2.1 A four-layer model for the Open Data Network

From: Realizing the Information Future

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Internet Features

- you do it
- you don't need permission
- you don't have to wait for them
- that means the Net is unpredictable
  - a worry to government types
  - dynamism vs. stasis
  - the strength of the Internet is chaos

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What is Needed?

- some "standards" (note the quotes!)
  - IP, TCP, ICMP, SMTP, MIME, SNMP, ...
- all are bearer services at one level or another
  - build applications on top of them
- openly developed voluntary standards
  - use them if you want
  - restrict only the things that will hurt the net
- openness can cut two ways
  - allows companies to do what they want to do also

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Running out of Addresses

- 2 problems came to light in 1992
  - running out of Class B addresses
  - running out of space & time for routing table
    - table in network routers to indicate reachability
- 1st problem seen to mean running out of IP address space altogether
- routing tables were growing faster than memory technology
- two solutions: CIDR & IPv6

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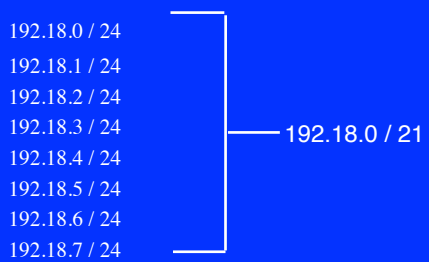
Classless Addresses (CIDR)

- classfull addresses (A, B, C) too coarse grain
- classless addresses assigned in power of 2 blocks
- specific length prefix is assigned based on need
  e.g., 128.103/16, 198.18.1/24
- aggregatible



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Hierarchical Routing and Addressing

- Internet network topology is a rough hierarchy
  - quite rough in places
- if addressing hierarchy not related to topology hierarchy does not help routing table size
- topology hierarchy must be reflected in addressing
- therefore addressing must follow network topology
  - but diminishing returns at higher-levels of network
- this will not change with IPv6
- not just a question of bigger processors in routers

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Internet Routing

- routing done per datagram
  - not per session
  - routers in network do not understand sessions
- routing table size impacts
  - memory requirements in routers
  - processing time - non-linear increase
  - dynamism - more entries mean more change
  - routing data exchange process - more information to move to more places more often

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Addressing the issues

- addressing quality of service, security, reliability & network convergence
- lots of work in IETF and elsewhere

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Differentiated Services

- is the Internet a one trick pony?
  - only ‘best-effort’ service
  - QoS to ISP means ‘ I will accept your packets”
- the Internet needs multiple “products”
  - better reliability for better money
- IETF working on QoS technology
  - coming to your network soon
  - RSVP & diffserv
- but real problems are business ones

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Network Security is an Oxymoron

- network reliability transports viruses
- real "network" security is actually at the edges
  - secure servers, etc
- can be helped by other tools
  - router filters
  - firewalls
  - good management
  - good policies
  - end-to-end encryption

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Network Reliability

- use redundancy to get reliability
- typical telco reliability requirement "5-9s"
  - 99.999% reliability
- can build "5-9s" systems with redundant low-reliability components and links
  - *"extremely survivable networks can be built using a moderately low redundancy of connectivity level"*
  - *"what would today be regarded as an unreliable link can be used in a distributed network almost as effectively as perfectly reliable links"*

Paul Baron

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Convergence Myths

- phone traffic is special
  - only in that you pay for it by the minute
- need to change IP to support phones
  - have not needed to change IP for an application before
- need to use phone #s as IP addresses
  - more and more phone #s are not addresses
    - they are names that get mapped into addresses
  - physics says this is *very* hard
    - phone # are not a good enough hierarchy

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What will the role of IPv6 be?

- IPv6 is the life raft that we will need to transfer to
- imagine an on-line China
- there is no way for v4 to last forever at the current rate of appliance growth
- the question is not if - its when
- my best guess - after uncle Bill ships
  - in Windows/NT 200x
- note - no real change to applications - v4 can do it all other than address size
  - NATs (and firewalls) change the timescale

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Internet of 2005

- it will be called IP
- it will be called the Internet
- it will always be "about to collapse"
- it will have differentiated services
- commerce will be normal
  - private data networks will not be
- many services (including voice) will be converged
  - but not all - may use ATM for muxing rather than IP in places

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Standards Organizations

- telephony-related work in the IETF
- IP-related work in ITU-T
- IP-related work in ETSI
- no organization to allocate issues
  - ICANN PSO not designed for this purpose
- architectural differences between approaches
  - megaco/H.248 vs. H.323 vs. SIP
  - may not be one answer

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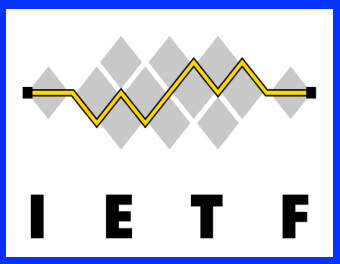
IETF Transport Area

Audio/Video Transport (avt)
Endpoint Congestion Management (ecm)
IP Performance Metrics (ippm)
Integrated Services (intserv)
Integrated Services over Specific Link Layers (issll)
IP Telephony (iptel)
Media Gateway Control (megaco)
Multiparty Multimedia Session Control (mmusic)
Multicast Address Allocation (malloc)
Network Address Translator (nat)
Network File System (nfs)
ONC Remote Procedure Call (oncrpc)
Performance Implications of Link Characteristics (pilc)
PSTN and Internet Internetworking (pint)
Resource Reservation Setup Protocol (rsvp)
Signaling Transport (sigtran)
Session Initiation Protocol (sip)
Service in the PSTN/IN Requesting InTernet Service (spirits)
TCP Implementation (tcpimpl)
TCP Over Satellite (tcpsat)
tElephone NUmber Mapping (enum)
Transport Area Working Group (tsvwg)
BOF - QoS signaling



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Standards Organizations, contd.

- existing organizations are not going away
  - new forums being formed every day
- organizations should work together where they can
  - sometimes hard due to process issues
    - e.g.: how & what time frame for approval process
    - document access
  - sometimes hard due to organizational bias
    - "we know better"

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Telephone Function in Internet

- if pure phone model
  - megaco-H.248 dumb phone/media gateway
  - signaling handled by media gateway controller
  - SoftSwitch-like servers provide phone features
- if pure Internet model
  - intelligent SIP or H.323 phone
  - signaling to another phone or to small proxy/gatekeeper
  - phone or proxy/gatekeeper provide features
- remember: data flows direct
- likely to be a mixture

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Architectural Bias

- my own biases
  - smart edges, no per flow state in network
  - lightweight servers in network - provided by 3rd party
    - middleware (DNS, gateways, proxies, caches, security)
    - user can subscribe to the ones he wants to
  - level-2 access networks - no level-3 routing on access net
  - use names to access services and end points not addresses
    - layer of indirection helps many things
- "who makes the money?" - a good question

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QoS

- aggregate QoS in WAN - not per flow
- different kinds of services
  - busy-signal-enabled service
  - degrades-on-load service
- note - if no special handling requested then no reliable way to know what application

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