The Future of the Net

Wireless 2002

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Talk Concept

- project the future of the Internet by seeing what is going on in the standards organizations
- an indicator not a predictor

  remember ATM service?

Syllabus

- Internet background and history
- developments in Internet-related technology
- current directions in Internet services, management and applications
- Q&A
- fear, threats, myths and other factors
- focusing on the future

History

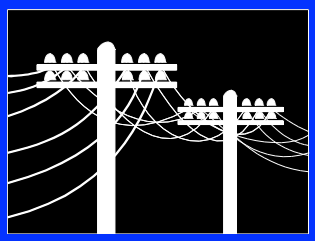
- start with history
- because we have been here before
- because too many lessons not yet learned

Background and History

- historical competition between circuit- and packet-based network designs
  - circuit: phone net, SNA, ATM, frame relay, MPLS, switched optical . . .
  - packet: XNS, IPX, AppleTalk, CLNP, IP
- historical competition between smart and stupid networks
  - smart: phone net
  - stupid: Internet
- layers get confusing
  - layers 1, 2, 3 & 8 interact

Circuits

- path through network to destination
- set up before data can be sent
- removed after transfer completed
- all data follows same path through the network
- service requirements can be used in path setup process
  - e.g., bandwidth, reliability, latency ...
- looks like a wire

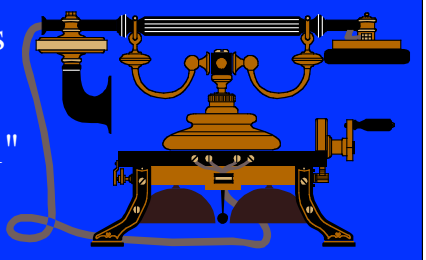


Packets (a.k.a., datagrams)

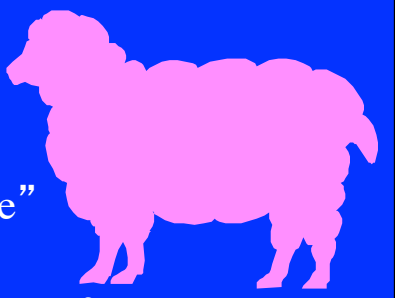
- self contained chunk of data
- "self contained" in that:
  - it includes delivery & sender addresses
  - may be part of a sequence of chunks
    - but forwarding devices in network needs no knowledge of sequence for proper delivery
  - it can include handling hints
- packets sent to closest forwarder (router)
  - which sends packet to next router in the direction of dest.
  - which sends packet to next router in the direction of dest.
- only state in router is direction to send for each dest.

Traditional Phone Network

- circuits
- connection-oriented
- hard state in network devices
- central resource control
- socialist? "for the good of all"
- applications in network
  - e.g., phone switch
  - end-to-end touch-tone signaling was a mistake
- predictable development path
  - extended development cycle



Internet



- datagrams
- soft state in network devices
- competitive resource control
- capitalist? "individual initiative"
  - but too much selfishness hurts all
  - must play by the same rules - but no enforcement
    - **the tragedy of the commons**
- applications in hosts at edges (end-to-end)
- hard to predict developments
  - chaos at "Internet time"

Implications of Packet-Based Networks

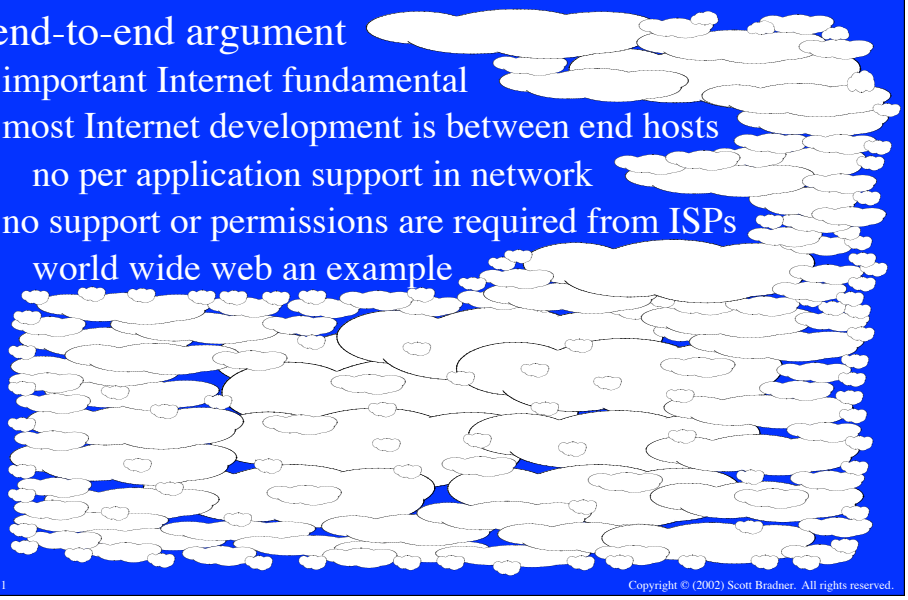
- "shortest", rather than "best" path used
- paths through network are not stable
  - they change based on
    - link failure, traffic engineering, routing instability
- impacts QoS
  - can not reserve resources
  - unpredictable QoS

!QoS

- access control harder
  - e.g. tracking down DoS attacks
- little central control

Internet Architecture

- end-to-end argument
  - important Internet fundamental
  - most Internet development is between end hosts
    - no per application support in network
  - no support or permissions are required from ISPs
    - world wide web an example

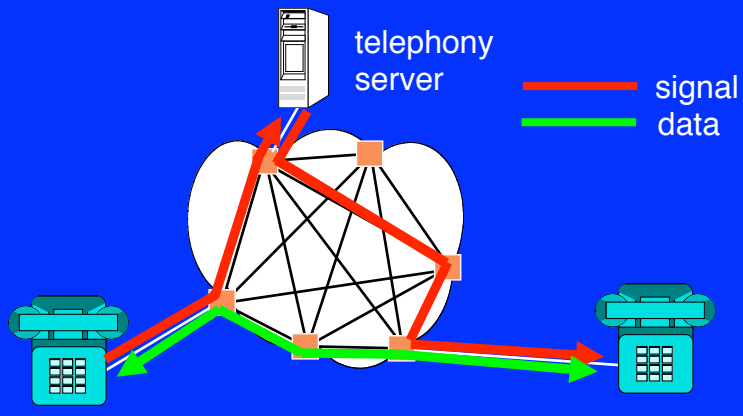


The Power of Experimentation

- what is the effect of the difference between the core-based and edge-based application architectures in providing what the user wants
  - nothing - if you know exactly what the market wants
  - otherwise - core-based makes it hard to experiment with new applications
- innovation
  - not the word that comes to mind for telephone services

Internet Architecture, contd.

- signaling and data paths in Internet may not coincide
  and paths vary

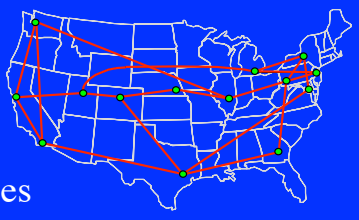


Internet Architecture, contd.

- service provided by 3rd parties - not only by ISPs
- different from phone world
- a quote from an IETF mailing list

```
Hi Roy,
 I still don't understand why it is a "users"
 choice where the "services" are executed - I
 would have thought that this would be
 networks choice
```

Circuits in the Internet

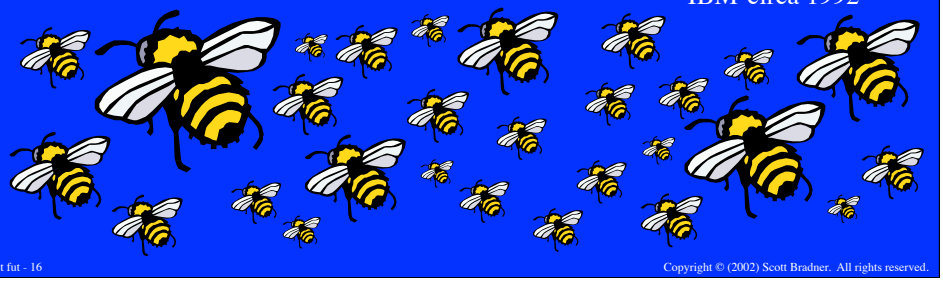


- do not seem to go away
- used for traffic engineering
  - city-pair pipes
  - maybe class of service city-pair pipes
- finer grain (instance of application) use still pushed
- remember the fate of ATM
  - circuit - used for trunks not flows
  - QoS - ignored (ATM not end-to-end)
  - link sharing - may make sense
  - as **the** bearer service - did not make it

Conceptualization Problem

- fundamental disconnect between "Internet" and "phone" people "bell-heads vs. net-heads"
- by their definition the Internet can not work
  - and must be fixed - they will rescue us

"You can not build corporate network out of TCP/IP."
IBM circa 1992



Tweaking Circuits

- Internet is getting dynamic underlying circuits
  - ATM SVPC, MPLS, switched optical, ...
- how should routing interact?
  - which side should be in control
- what is impact of lower layer healing?
  - in Internet healing is now at level 3 - but seen as slow
  - speed up level-3 healing or use level-2?
- IETF working on a common control plane
  - ccamp working group

IP as a Common Bearer Service

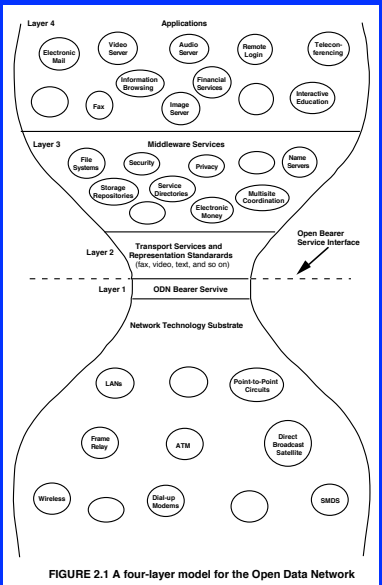


FIGURE 2.1 A four-layer model for the Open Data Network

From: Realizing the Information Future

IP As Common Bearer Service, contd.

- but what should it bear?
- just because you **can** get everything to run over IP, **should** you?
- a LAN is a reasonable concept
- a level 2 access network can make sense
- broadcast HDTV over IP may not
- phone calls?
- videoconferences?

everything / IP ?

Simplicity?

- "simplicity" was once a mantra
  IP is very simple
- now seems to be unattainable
  seems undesirable by some
- second system syndrome (if it were only that!)
  non-TE MPLS an example?
- operations threat
- reliability threat
  "increasing the brittleness of the networks"

!Simplicity

- 10,258 lines in index for Cisco basic router manual
- 158 lines in index of new features in latest release
  "no new release without 100 new commands"
- many ISP network failures due to misconfigurations
- simple standards are very hard to do
  comes down to leaving out "neat" features

Technology, Regulation & VCs

- potentially deadly embrace:
  technology, regulation & VCs

- technology can not be developed without investment
- VCs often do not understand technology
- regulators feel technology is second to policy
- regulations scare VCs and inhibit market forces
- scared VCs do not invest in technology

Regulation

- Internet has been mostly regulation-free
  - in the U.S. & Canada- some US exceptions:
    - Communications Decency Act
    - tax moratorium
- much regulation in the rest of the world
  - generally to control content or protect telcos
  - IP-telephony is illegal in many countries
- 'regulate to ensure quality and reliability'
  - side effect - disrupt technical innovation
- but regulators are innovative (non-technical)
  - especially when revenue is threatened

Regulations

- regulators are in trouble
- current regulations are based on service
  - if you offer telephone service you get telephone regulations
  - if you offer video service then you get cable TV regulations
- what do they do with a converged network?
- regulations push social and revenue goals
  - universal service fee, content controls
- they will figure out a way
  - they have motivations (tax revenue, content control)

Technology

- no apparent slowdown in ideas for new technology
  - though simplicity does not seem to part of picture
- but too frequently "idea" is to apply technology from one environment to another one
  - e.g., IP call detail records, MPLS-as-ATM
- some rather silly ideas were funded a few years ago
  - but better too many silly ideas if that means more good ones
- IPR a big issue

Intellectual Property Rights

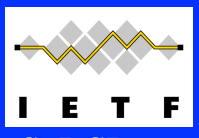
- IPR is a fact of life
  - some companies get > 1,000 patents a year
  - protection and barter
- IPR makes standards process much harder
  - what is a fair license?
- can not just standardize IPR-free technology
  - IPR can show up later
  - non-involved companies or submarine patents
- idealistic people in standards organizations are a problem
  - patents vs. good of the community

Venture Capital

- easy pickin's are gone
  - have to think now - but may not have expertise
- ~ $200 B lost in telcom over last few years
  - total tecom debt - $700 B ?
- advantage of days gone past
  - things that would fail could get funded
    - good for innovation
  - no longer as easy
- VCs have over corrected to experience
  - too hard to get money for **new** ideas
  - but may be still too easy to get money for recycled ideas

Standards Organization Landscape

- international organizations (by age)
  - ITU, ISO/IEC JTC1, IETF, IEEE, ETSI, W3C
  - plus a cast of thousands of wannabes
- national organizations
  - ANSI, T1
- forums etc
  - Frame Relay, ATM, QoS, DSL ...


What's Going On - Standards-Wise?

- standard organizations are rarely idle
  - but not all activity is useful
- varying degrees of relevance in work
  - size of standard is not a reliable indicator
    - sometimes a counter-indicator
- many topics
  - layers: "wires", mechanisms, applications, protocols
  - areas: L2, L2 transport, e-business, telephony, languages
- look at a few

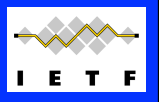
Wires

- L2 & L2 transport
  - Etherneten
  - wireless wires
  - MPLS
  - optical net control
  - common control plane
  - VPN
  - pseudo wires

Ethernet

- IEEE 802.3ae - 10 Gbps
  - constant discussion over max frame size
    - some push to support jumbo frames (> 1500 byte)
    - backwards compatibility issues
    - standard in development but product already available
  - 40 Gbps effort has started
- Ethernet in 1st Mile (EFM)
  - at least 10 Mb - copper & fiber
  - work item approved in IEEE 802 16 July 2001

Wireless: PAN



- IEEE 802.15, a.k.a. Bluetooth
- **W**ireless **P**ersonal **A**rea **N**etwork
  - 10 m radius wireless
  - low power
- IETF IP over Bluetooth BOF
- standard in development
- some products
- uncertain future (802.11 encroaching)

Wireless: LANs

- IEEE 802.11
  - 802.11a - in development
  - 802.11b - 11 Mbps WLAN - widespread use
  - 802.11g - extend 802.11b to >20Mbps WLAN - in dev.
- IEEE 802.16
  - wireless MAN - >2 Mb - licensed bands
  - WirelessHUMAN™
    - Wireless High-speed Unlicensed Metropolitan Area Networks
- IEEE wireless coexistence group
  - how do all these things fit together?

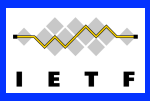
Wireless: 3G

- 3G - third generation cell phones
  - 2Mbps data ("Internet") a major push
- multiple groups: 3GPP, 3GPP2
  - 3GPP: ETSI, T1P1, ARIB/TTC, TTA, CWTS
    - aim is "all-IP" based mobile networks
  - 3GPP2: ANSI-driven (3GPP restricted to GSM)
- collaboration between 3GPP and IETF
  - 3GPP brings requirements to IETF
  - uses IETF protocols
- 3G standards released, IP work underway
  - what will be impact of 802.11*?

$$$$$$$
$$$$$$$
$$$$$$$

Multiprotocol Label Switching (MPLS)

- add tags to IP packets at ingress routers
  - tags used by **MPLS** switches in forwarding decision
  - direct traffic along a path that routing would not take
  - tags stripped at egress
- started as a traffic engineering (TE) tool
  - direct inter-POP traffic along a path with capacity
  - was performance enhancement idea at one point
- now being seen as a QoS technology and more
- another net-head vs. Bell-head difference
  - net-head: TE using **RSVP**-based signaling
  - Bell-head: MPLS as ATM with variable length cells
    - using LDP & CR-LDP



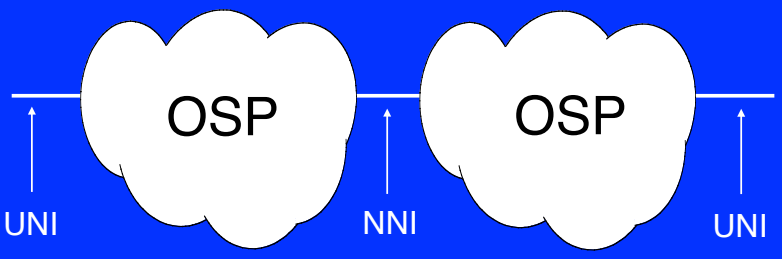
MPLS, contd.

- much confusion over **MPLS** applicability
  - a long way from TE
  - **MPLS** on the LAN?
- seen as a way of converting Internet to circuit base
  - to fix QoS, security, charging, management, . . .
  - "a local gravity well"
  - an IP version of ATM?
- ATM lesson not learned
- remember that datagrams do work

MPLS != ATM

Optical Network Control

- three areas:
  - customer interface to optical cloud: a.k.a. **UNI**
  - connections between optical clouds: a.k.a. **NNI**
  - control within an optical cloud
- work in OIF, ITU-T & IETF



Optical Network Control: UNI

- **U**ser-**N**etwork **I**nterface
  - ATM terminology
- let customer request optical connection through optical service provider (OSP) cloud
  - e.g. "give me an OC48 to San Francisco"
- multiple approaches
  - new protocol
  - **RSVP**-based signaling
  - **LDP**-based signaling
- is there a business case?

Optical Network Control: NNI

- **N**etwork-**N**etwork **I**nterface
  - ATM terminology
  - between carriers
- no specific standards activity yet
- some "interesting" business issues to deal with first
  - how does the money flow?

Optical Network Control: In Cloud

- how to tell network components to setup or modify an optical path
- IP Optical (ipo) WG
  - optical control plane should be IP-centric, utilizing IP-based protocols for dynamic provisioning and perhaps restoration of lightpaths within and across optical sub-networks
- a number of proposals
  - RSVP, MPLS, OSPF, IS-IS
  - may use common control plane
- under development

Common Control Plane

- develop a common approach to controlling lower layer functionality in IP networks
  - where the lower layer is controllable
    - e.g. ATM, Frame relay, MPLS, switched optical
  - gmpls - 21 implementations reported so far
- deal with interaction with routing system?
- GMPLS standards just finished

Virtual Private Networks (VPNs)

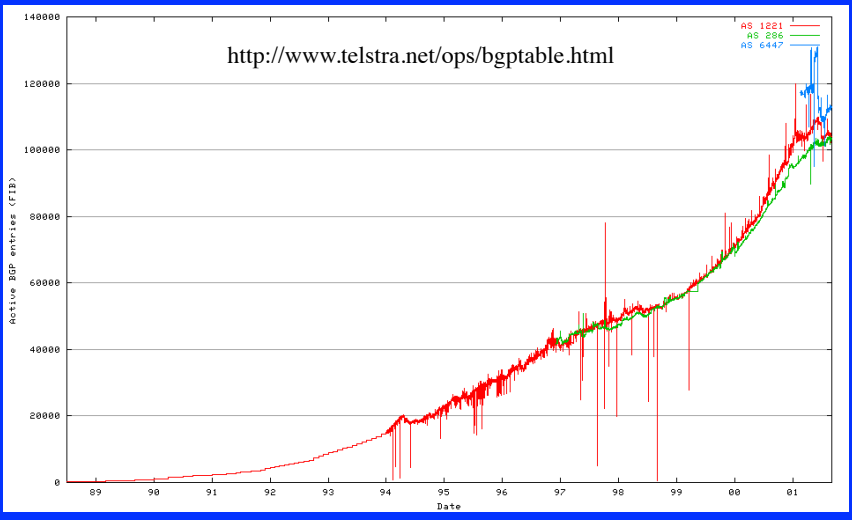
- many meanings for the term
  - end-to-firewall, end-to-end **IPSec**
  - firewall-to-firewall, CPE-to-CPE, POP-to-POP **IPSec MPLS**
- IETF: **N**etwork-**B**ased **VPN**s (nbvpn)
  - standardize a framework and one or more sets of mechanisms for supporting network-based IP virtual private networks
- ITU: **IP** **V**irtual **P**rivate **N**etworks Y.ipvpn
- under development

Pseudo Wires

- Pseudo Wire Emulation Edge to Edge (pwe3) WG
- emulate L2 “wires” over IP & MPLS
  - frame relay, ATM, TDM, SONET, Ethernet, MPLS
- food fight over emulation quality
  - “Turing test”?
    - or
  - define what user will get
- IP networks can have low jitter
  - see Scott Shanker’s NANOG presentation
  - < 1ms between Washington DC and San Francisco

Internet Routing

- some new work in the routing area

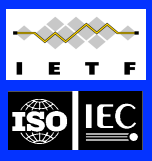


Internet Routing Basics

- Kleinrock & Kamoun - 1977
- hierarchical routing is the only way to deal with large networks else routing table gets too large
- can extend path length
  - the larger the network the less the increase in path length from added hierarchy
- hierarchy is network topology
  - hierarchy not related to topology does not help table size
  - hierarchy must be reflected in addressing
- therefore addressing must follow network topology

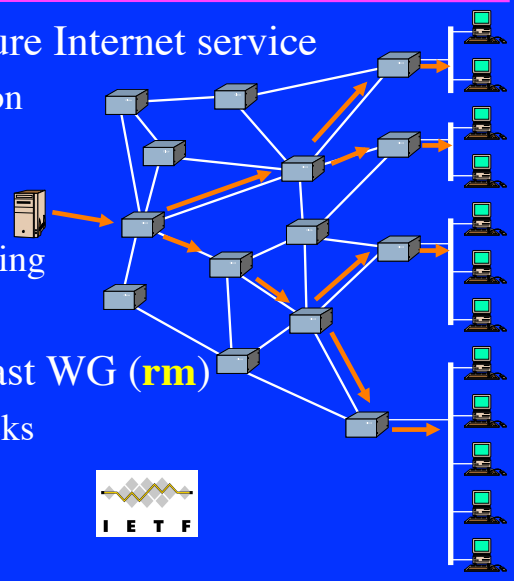
Internet Routing, contd.

- requirement to preserve hierarchy means renumbering when changing ISPs
  - multi-homing an issue
- some tweaking around the edges
  - add multiprotocol (including IPv6) to **BGP**
  - enhancements to **IS-IS** (IETF as input to ISO)
- new thinking needed
  - e.g., IRTF Routing Research Group



Multicast

- seen as most basic future Internet service
  - audio & video distribution
  - news services
  - stock quotes
  - audio & video conferencing
  - general data distribution
- IETF **R**eliable **M**ulticast WG (**rm**)
  - developing building blocks
  - no one technology



Multicast, contd.

- traditional multicast is multi-to-multi
  - long been a future, but many deployment, business and operations issues
- IETF **S**ource-**S**pecific **M**ulticast (**SSM**)
  - one-to-many
  - change multicast group label to be 64-bit "**S,G**"
    - 32-bit sender IP address "**S**"
    - 32-bit multicast group relative to that sender "**G**"
    - reserve 232/8 for **SSM**

sender	group

SSM Advantages

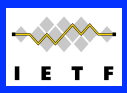
- address allocation **16,777,216 groups**
  - a /8 per sender, no synchronization required
- finding the sender
  - part of group "name" **mcast.cnn.com, h-news**
  - just send packets via unicast to sender
- manageability
  - router-enforced single sender model
  - protects network
  - understandable billing model (sender pays)
- i.e. might actually make sense

SSM, contd.

- uses modified version of **IGMPv3** on LAN
  - changes some processing rules - ignore some messages for addresses in **SSM** address range
- host uses (**S,G**) pair
  - how host knows is outside the scope of the protocol
- uses modified version of **PIM-SM** off LAN
  - change processing rules for addresses within 232/8

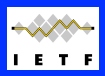
Quality of Service (QoS)

- QoS controls seen as critical (by some) for future converged Internet
  - a big net-head vs. Bell-head difference
  - over-provision vs. complex controls
  - should there be busy signals on the Internet?
- QoS requirements coming from many places
  - ITU-T, TIA, QoS Forum, ETSI, IEPS, . . .
- too much focus??



QoS Technology: per-flow

- IETF Integrated Services (intserv) WG
  - Resource Reservation Protocol (RSVP) signaling
  - intserv services: Guaranteed & Controlled Load Service
    - renamed by the ITU-T Y.iptc to:
      - "delay sensitive statistical bandwidth capability"
      - "delay insensitive statistical bandwidth capability"
  - intserv offers link-level per-flow QoS control
  - RSVP offers signaling for intserv
    - also used as a general signaling protocol - e.g. MPLS
    - new RSVP extensions WG
  - ITU Y.iptc (IP traffic control) effort uses intserv services and diffserv EF



QoS Technology: class-based

- IETF Differentiated Services (diffserv) WG
  - class-based QoS
  - packets marked at network "edge"
  - routers use markings to decide how to handle packets
  - four services
    - best effort - normal Internet traffic
    - 7 precedence levels - prioritized classes of traffic
    - Expedited Forwarding (EF) - leased line like service
    - Assured Forwarding (AF) - 4 queues with 3 drop classes
  - requires edge policing - technology not yet defined

QoS Technology: Other Ideas

- a number of similar ideas from traditional telcom
- map flow-based QoS into a circuit of some type
  - MPLS Label Switched Paths
  - ATM VCs
  - optical lambdas
- the old circuits vs. packets fight
- could make sense for trunks

SCTP

- **S**tream **C**ontrol **T**ransmission **P**rotocol
- originally designed to carry telephone signals over IP networks (IETF sigtran WG)
- converted to general transport protocol
  - runs directly over IP
  - TCP-friendly congestion control
  - can replace TCP in some applications
  - adds protection against SYN attacks, channel muxing, fragmentation, multi homing, & option for order-of-arrival delivery
  - adding optional application-driven retransmission

IPv6

- IETF ipngwg working group
- technology standards done - many implementations
- waiting on uncle Bill
- cell phones and China may show the way
  - but routing is not any better

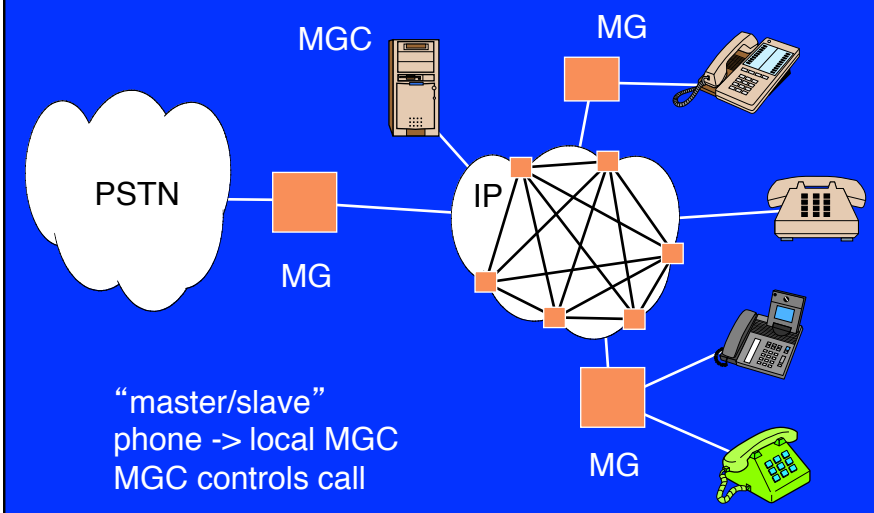
Telephony

- telephony cntrl: MGCP, megaco/H.248. H.323, SIP
- phone number resolution: enum
- wireless: WAP, SeaMoby, 3G, rohc
- settlements: ITU-T
- PSTN/IN control: pint, spirits
- finding PSTN gateways: trip
- lawful interception: raven, ETSI, T1

Telephony Control: Phone Model

- two protocols
  - **MGCP** - Media Gateway Control Protocol - RFC 2705
    - informational RFC: **not an IETF standard**
    - well supported in industry - including cable modems
  - **megaco/H.248** - joint IETF/ITU-T effort
    - MGCP was an input to the effort
- break up phone switch into controller and gateways
  - "looks" like phone switch
  - a.k.a. softswitch (but softswitches can often do much more)
  - MGC is in control

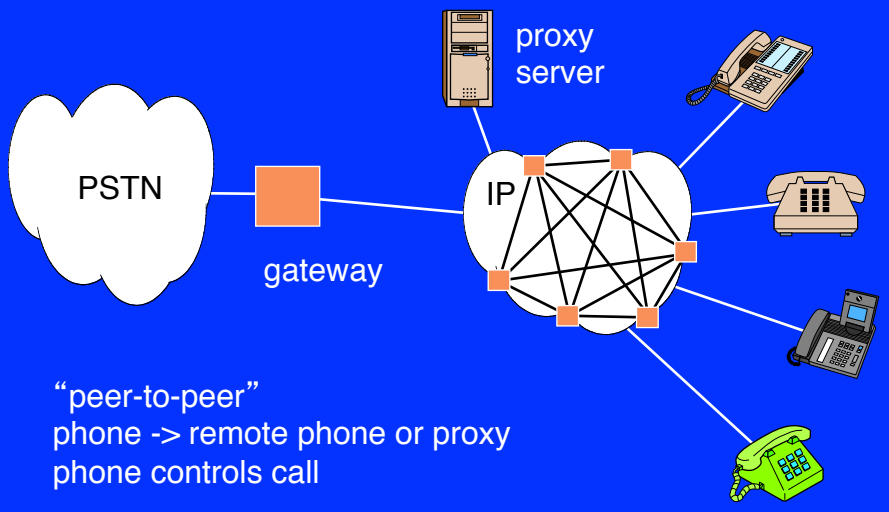
Telephony Cntrl: Phone Model, contd.



Telephony Cntrl: Internet Model

- two protocols
  - **H.323** - ITU standard
    - e.g. net meeting
  - **SIP** - **S**ession **I**nitiation **P**rotocol - IETF Proposed Standard
    - RFC 2543
- interworking effort underway
- Internet model of smart edges
  - light-weight servers in network (proxy, forwarding)
  - do not have to be run by connectivity provider

Telephony Cntrl: 'Net Model, contd.



"peer-to-peer"
phone -> remote phone or proxy
phone controls call

The Importance of Phones

- big issue in IETF development of telephony technology for IP networks
- phone people assumed that phone traffic would have precedence over all other use

  IETF did not agree I'm more important!
- particular issue in responding to congestion

  everyone thinks the other guy should back off

I'm more important! I'm more important!

I'm more important!

Finding Things Using Phone Numbers

- **Te**lephone **Num**ber Mapping (enum) - IETF WG
- IETF working group - RFC 2916
  - input: an e.164 style phone number
  - output: one or more URIs
- uses domain name (DNS) system
  - for phone number of **+ 46 8 9761234**
  - look up **4.3.2.1.6.7.9.8.6.4.e164.arpa**
- significant political issues
  - who controls per-country mappings?
  - who controls or runs the mappings for a user
- is privacy a problem?

Wireless: Mobile Phone

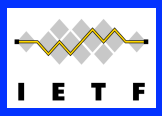
- **W**ireless **A**pplication **P**rotocol (WAP)
  - "walled garden" wireless support
  - own version of **HTTP** etc
  - requires gateway to Internet
  - mixed view of future
- 3G - third generation wireless
  - conflicting views - **WAP** vs. direct Internet
- Q- "why IP to mobile phone?"
  - A - to enable application development

PSTN / IN Control - IETF WGs

- **P**STN and **I**nternet **I**n**t**ernetworking (pint)
  - Internet control of PSTN services
  - e.g. click-to-call

Call Scott

- **S**ervice in the **P**STN / **I**N **R**equesting **I**n**t**ernet **S**ervice (spirits)
  - notification of PSTN events to Internet servers
  - e.g. Internet call-waiting

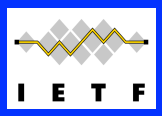


- call processing language: CPL
  - tell phone switch what to do
- interesting security and accounting issues

Scott is calling
- hang up on him
- take message
- voice mail
- forward to joe
- accept call

Finding PSTN Gateways

- **T**elephony **R**outing over **IP** (TRIP) - IETF WG
- Internet routing protocol to find PSTN gateways
  - combination of **BGP**, **IS-IS** and **OSPF**
- **TRIP** is used by location servers (LSs) to exchange phone reachability information
  - LS advertises phone numbers it can reach
  - e.g. country, local area, or organization



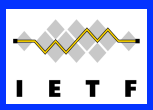
- telephony signaling protocol independent
  - i.e. supports **SIP** & **H.323**

Lawful Interception

- IETF www.ietf.org/mailman/listinfo/raven
  - "raven" discussion in IETF resulted in a decision to not mandate intercept features
  - technical and logical reasons
  - e.g. no consistent international definition
- ETSI www.etsi.org/technicalactiv/li.htm
  - define requirements, security, handover, etc
- TIA www.tiaonline.org/standards/newdocs.cfm proj # 4846
  - define interfaces
  - "safe harbor"

IP Storage

- **IP S**torage (ips) Working Group
  - iSCSI - run SCSI over IP networks
  - FC over IP - run Fiber Channel over IP networks
- original idea was for storage area networks
  - connect servers and storage systems
  - restricted geography
- but once something runs over IP it is hard to restrict
  - WG required to address IPS in all environments
  - pushback on security requirements
- under development



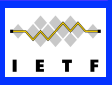
XML

- Extensible Markup Language
  - structured data in a text file
  - way to attach "metadata" to file
  - metadata lists attributes of file
    - e.g. product descriptions
- seen as a standard way to exchange any information between organizations
  - e.g. ISP SLAs
- XML Signature
  - joint W3C / IETF working group
  - how to carry PKI signatures in XML

XML - Powers and Issues

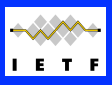
- can be used to describe just about anything
  - photos in a library collection
  - pair of shoes in a electronic catalogue
- but its just a language
  - need to have specific schema to say what fields and values are legit for each application
  - easy to get incompatible schemas

BXXP



- The **B**locks E**x**tensible E**x**change **P**rotocol
- application protocol framework for connection-oriented, asynchronous request/response interactions
- supports multiplexing of request/response streams
- peer-to-peer
- text-based - supports text or binary
- building block for network applications
- IETF Proposed Standards RFC 3080 & 3081

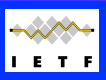
IOTP



- **I**nternet **O**pen **T**rading **P**rotocol
- interoperable framework for Internet commerce
- works with many payment systems
- replicates old paper-based trading, buying, & selling
- framework for developing commerce systems
- IETF Proposed Standard - RFC 2801

IDN

- Internationalized Domain Name (idn)



  specify the requirements for internationalized access to domain names and to specify a standards track protocol based on the requirements
- let people have a non-ASCII domain names
- significant compatibility issues with existing applications
- significant political issues

  who says what the mapping is for a language?
- under development

Management

- traditional in telco world

  soup to nuts system managemnt

  customer management, billing, provisioning, fault monitoring
- traditional in IP world

  element response system

  few network-as-a-whole tools

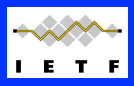
SNMPv3 & SNMPconf

- **SNMP Version 3** (snmpv3)
  - Simple Network Management Protocol with security and larger variables
  - management system for IP network elements
  - more monitoring than management so far
  - IETF Draft Standard
- **Conf**iguration Management with **SNMP** (snmpconf)
- COPS-PR (PIBs)
  - config-push model
  - under development - but uncertain future

TMN

- **T**elecommunications **M**anagement **N**etwork
  - work in ITU-T & ETSI
- telco management - not just networks
  - from provisioning, to monitoring, to billing
- very different than IETF understanding
- Joint NM ad-hoc group working on communication between organizations
  - ITU-T, ETSI, T1M1, TMF, IETF

Policy



- IETF Policy WG
- working on **network** management
  - not just element management
    - define a policy framework, information model, and schemata to store, retrieve, distribute and process policies relating to network operation

- derived from DMTF work
- test case QoS policy
- under development

Q&A

- questions I was asked to address by a startup
- sequence:
  - question
  - translation of question
  - my random thoughts

Q1:

- Current State of Telco Market?
  - how we got here?
  - how did the hype begin and end
  - where next?

Translation:

- is there anything that might be called a “telco market”?
- what **did** happen to that trillion $?
- how is this different than the railroads?

Thoughts

- projection via religion not knowledge
  - with a touch of conflict of interest as added spice
  - it's magic so it will do magic
- everything over IP can be done so it must be done
  - convergence as mantra
- lets replay the ATM projections
  - we still have the slides ...
- the telcos are too dumb to remember to breathe
  - oops - I forgot they have all the wire
- "voice will be a niche market"

More Thoughts

- physical infrastructure (at least for the backbone networks) is now paid for (sorry about that)
- even at 10% take-rate the edges have to get better
- even at **only** 2x/year the traffic is growing and over capacity will run out
- some "dream apps" may come true
  - TV-over-IP may make sense after all
  - VoIP has a future (but we will get to that in a bit)

Q2:

- Creation of Data services Market?
  - Leased-lines->Frame-Relay->ATM->????
  - What next??
  - Ethernet??

Translation:

- what is this fascination with wires anyway?
  - why not just use the Internet?

Thoughts

- multi-point to multi-point or Internet access
- the network must not exist if I can not "see" it
- gotta have QoS
  - what about CIR = 0?
- gotta have security
  - what is different in the threat model?
- but little money is made telling the customer he is wrong
  - make wires out of thin air if that's what he wants to buy
  - (can you spell VPN? -- I knew you could -- but if not, can you spell MPLS?)

More Thoughts

- ATM a billion dollar failure as a customer service
  - but primary inside-telco support - e.f. for frame relay
  - and big in ISP backbones, NR-VBR at best
- frame relay a multi billion dollar success
  - but much frame relay used to carry IP
    - not only frame relay
  - and much frame relay have poor or no CIR
- frame relay over IP is known to "work"
  - see MCI
- so why not do it again?

pwe3

- pseudo-wire emulation edge to edge
- foo over IP or MPLS (actually l2tpv3 or MPLS)
- foo = frame relay, SONET/SDH, ATM, TDM, Ethernet, MPLS
- e.g., an ATM network without the ATM network
- issues
  - expectations of QoS expectations
  - tell me what I got
  - misplacing security

Q3:

- How is IP influencing the Telco-heads?

Translation

- was lethargy the best policy?
- does Internet-IP make sense to a telco?

Thoughts

- why would a telco want to offer Internet connectivity? (as differentiated from IP connectivity)
  - it's just a bypass enabler
  - it's a customer emancipation offering
- because they think they can make a different Internet?
  - one where they own the customers
- the Internet does not bottle well

More Thoughts

- "the Internet does not work"
  "we" have to fix it
  something about the lack of wires (circuits)

Q4:

- State of VoIP?
  in Standards?
  in Telcos?

Translation

- whatever happened to that title wave?

Thoughts

- which VoIP?
  H.323, MGCP/megaco/H.248, SIP, ...
- just what is the customer advantage for megaco?
  i.e., a distributed 5E
- just what is the carrier advantage of SIP?
  i.e. a way that I can avoid carriers per-application charges

More Thoughts

- actually, what is the customer benefit from VoIP?
  today's VoIP that is
- major effort to reproduce the services that developed in spite of a constrained user interface
  gee whiz
- lots of potential, but ...
- btw - the ITU wants to define VoIP

Thoughts on Status

- SIP is terse at 276 pages
  for the base spec
- H.323 is N times that size
- opinion: standards maturity is not the problem
  SIP, H.323 & megaco/H.248 are stable enough
- but some push on SIP to enable a closed network

Q5:

- Last Mile Bottlenecks:

  What are the Telcos "really" doing about it?

Translation:

- why would the telcos fix something that is not broken in their view?

Thoughts

- the take-up rate on “high-speed” connection is 10% or so (FCC report)
  FCC “high-speed” is not
- and they loose money on each connection
  (hard to catch up in volume)
- btw - can you spell ILEC? (not clear you need to know how to spell CLEC or DLEC, may still need to be able to spell ISP for a while)
- pessimistic view: remember the iMode lesson
- optimistic view: remember the iMode lesson

Q6:

- Telco Spending Prediction:

Translation:

- is there any money out there?

Thoughts:

- ILECs: billionaires crying poverty
  reduced cap budgets are still real big money
- !ILECs: billions spent, now crying

Q7:

- Beyond 10Gig (Ethernet and OC-192)?

Translation:

- is there a “fast enough”?

  at least for a while?

Thoughts

- 40 Gbps work is underway (4x10)
  - chip sets on the way
- hard to see urgency today
  - backbone utilizations under 10%
  - fabrics are mostly 2.5Gbps
- on-card (d)wdm here
  - faster single lambda interfaces optimize physical fibers
  - need optical switching or lots of point-to-point need

Q8:

- Next 3 Years
  - market leaders
  - pundits

Translation:

- do we trust the pundits who have a perfect record of being wrong in the past?
- ABC?

Thoughts:

- telco pundits think the Internet does not work
  - do not understand concept of best-effort
- Internet pundits think that the telcos do not think
  - forget where the money is
- betting on the stupidity of telcos has not been a success path to date

Directions in Internet Services and Applications

- thoughts on a few topics
  - ISPs
  - users
  - content
  - applications

ISPs

- what is an ISP?
  - traditional ISPs have IP history
  - telco-based have circuit history
- what will it be?
  - telcos have the $ but generally not the clue
    - try to remake the Internet into telco model
    - but assume that content will rule

Who Owns the User?

- real ISPs (traditional Internet)
  - a service provider owns the customer for that specific service
- telco-based ISPs
  - the connectivity provider owns the customer for all services
  - e.g. WAP
  - inhibits innovation & restricts competition

Will Content ever Succeed?

- has not to date
  - all video-on-demand trial have failed
- long term carrier assumption of revenue future
- if you are asking "what is the application"
  - you have already lost
- many looking for "the killer app"
  - what was killer app for telephone
  - what was killer app for auto?
- if you must have one: connectivity
- content will be a service but not the only service

Social Pressures

- the Internet is aggressively non-national
  - the 1st amendment is a local ordinance
- threat to "order"
  - as information sometimes is
- governments feel they must "protect" citizens
  - e.g. China
- Internet routes around censorship
- what authority does the FCC have?

Applications

- too many applications are replicating function from some other medium
  - "keep it the same" so users are not confused
- not enough thinking
  - IP-ness is lost
- often not really Internet
  - IP-telephony or Internet-telephony?

Threats and Effectors

- phone companies have noticed the Internet
- they want to "help" the geeks
- they worry about QoS & predictability
  QoS predictability & investment predictability
- but their help would destroy what created the Net
- I'd rather do without the help
  but they are there & the regulators on their side
  (regulators don't like chaos)

Internet Myths

- is free
- is flat rate
- is government run/funded
- is just U.S. (or U.S. owns it)
- is regulation-free
- has a viable business model (will pay for itself)
- is inherently poor quality
- is the right answer to all telecommunications questions

Projections

- Internet model clouds the economic model
  other than selling shovels to the gold miners
  and the shovel business is getting hard

"but who is going to make money on that?"

John Mcquillan

URLs

3GPP: www.3gpp.org
3GPP2: www.3gpp2.org/
6bone: www.6bone.net/
ANSI: www.ansi.org
ATM Forum: www.atmforum.com
Bluetooth: www.bluetooth.com
CableLabs: www.cablelabs.com
DMTF: www.dmtf.org
ETSI: www.etsi.org
IEEE-SA: standards.ieee.org/
IETF: www.ietf.org
Internet 2: www.internet2.org
ITU: www.itu.int
JTC1: www.iso.ch/meme/JTC1.html
NGI: www.ngi.gov/
OIF: www.oiforum.com/
QoS Forum: www.qosforum.com
raven: www.ietf.org/mailman/listinfo/raven
T1: www.t1.org
TIA: www.tiaonline.org/
W3C: www.w3.org
WAP: www.wapforum.com/
tragedy of the commons: dieoff.org/page95.htm