

The Implications of the Unmet Last Goal for the Internet Protocols

Scott Bradner
Harvard University
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IP Design Goals - Goal 0

- ◆ multiplexed utilization of **existing** networks

- different administrative boundaries

- multiplexing via packet switching

Dest Addr	Src Addr	payload
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- meant that there had to be a bearer layer

- networks interconnected with packet switches called
gateways

- now called routers

- ◆ did not want to build a new global network

- too expensive

- too limiting

- reasons not understood by ATM fans**

- no migration to new technologies

- "Design Goals for the DARPA Internet Protocols" - Dave Clark, SIGCOM 1998

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IP Design Goals - Goals 1-3

- ◆ ordered set of 2nd-level goals
- ◆ most impact on design
 - 1/ **survivability** in the face of failure
e.g., stateless infrastructure
 - 2/ support **multiple types** of communications service
e.g., not limited to reliable service
 - 3/ accommodate a **variety** of network types
variety of speeds, minimum assumption of network functionality

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IP Design Goals - Goals 4-7

- ◆ other goals
 - 4/ permit **distributed management** of resources
each network section under its own management
e.g., routing management
 - 5/ **cost effective** utilization of resources
range of efficiencies - packet size vs. payload
 - 6/ **low effort** to attach a host
host needs to be complicated to hold up its end of the process
 - 7/ **account** for use of resources
mentioned in Cerf & Khan's 1st paper as an important function but few tools in Internet architecture for accounting

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Cerf & Kahn

“To allow networks under different ownership to interconnect, some accounting will undoubtedly be needed for traffic that passes across the interface. In its simplest terms, this involves an accounting of packets handled by each net for which charges are passed from net to net until the buck finally stops at the user of his representative.”

“A Protocol for Packet Network Interconnection” Cerf & Kahn - 1974

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Given That, Why No Accounting?

- ◆ easy to answer at first
 - government funded research net
 - government paying all the bills
- ◆ answer not always “no” for users as net became commercial
 - some ISPs used simple traffic level based billing
 - e.g., e.g., based on 95th percentile traffic load in a month
 - but no per-session accounting
- ◆ but many stayed at flat rate for users
 - bill based on size of pipe

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Some Reasons

- ◆ cost too much to bill
 - phone company billing process big % of overall cost
- ◆ what are you going to bill for?
 - no consistent definition of “Internet service”
 - e.g., what about over subscription of access networks?
- ◆ what about settlements?
 - in Cerf & Kahn, usage-based user bill came from a perceived need for usage-based inter-ISP settlements
 - that need has not developed

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Background: ISPs

- ◆ types of ISPs
 - default-free - carry “all” Internet routes
 - others - carry subset of Internet routes with “default” route to default-free ISP
- ◆ ISPs have “customer” &/or “peer” interconnections
 - customer: an entity that pays for connectivity
 - expects to get to “the Internet” (all destinations)
 - peer: cost sharing interconnection
 - generally, no fees paid
 - but only get the to peer’s customers

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ISP Peering

- ◆ nearby ISPs of similar size peer
 - not limited to the “big” ISPs
 - not limited to default-free ISPs
- ◆ ISP can peer with other ISPs while being a customer of another ISP (or more than one)
 - peering offloads traffic that otherwise would go through paid link with ISP provider(s)
- ◆ peering is a business decision
 - only done if both sides see it as being in their own interest
 - occasional efforts to regulate to mandate peering

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Current Internet Payments Model

- ◆ customer pays their ISP(s) for connectivity
 - flat rate or usage-based
- ◆ if ISP is runs default-free it peers with other default-free ISPs
 - generally no money changes hands
- ◆ non-default-free ISP buys connectivity from another ISP (or ISPs)
 - pay for service - flat rate or usage-based
 - but no specific money flow based on traffic from or to a specific customer - or on traffic content
 - only aggregate traffic loads

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ISP Billing Assumption

- ◆ ISP charges their customers enough to cover the ISP's costs and to create a profit
 - same theory for airlines
- ◆ ISPs oversubscribe infrastructure
 - cable: number of customers on a single net
 - DSL: number of customers on a DSLAM uplink
- ◆ oversubscription produces congestion
- ◆ congestion degrades user quality
 - may make some applications unusable

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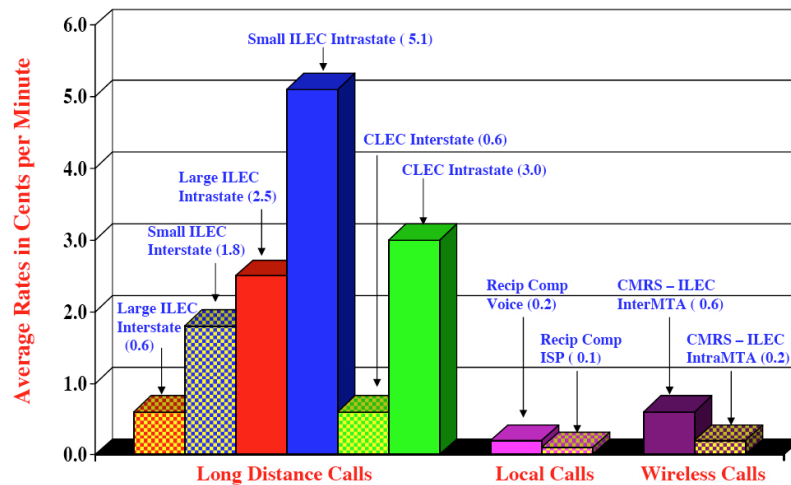
Traditional Telephone Model

- ◆ caller's phone company charges caller for a call
- ◆ if callee is connected to another phone company's network, caller's phone company pays callee's phone company to deliver call to callee (a.k.a. "call termination")
 - charges can balance out if equal traffic
 - cell phones different - callee also pays
- ◆ "long distance" a bit more complicated
 - caller pays long distance company which pays the caller's and callee's phone companies

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Inter-Carrier Telco Compensation



High (¢/min):	1.5	8.9	9.9	34.9	6.8	35.9	0.3	0.1	8.9	0.3
Low (¢/min):	0.5	0.3	0.4	0.7	0.2	0.4	0.0	0.0	0.2	0.0

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from: The Missoula Plan

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Telephone Competition

- ◆ effectively no competition for residential and small business wireline service
- ◆ strong competition in long distance
- ◆ strong competition in wireless (cell phones)
- ◆ good competition in enterprise wireline service

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Broadband Competition

- ◆ for residential
 - phone company (DSL), DSL resellers, & cable companies - duopoly
- ◆ for small businesses (< T1 upstream)
 - phone company (DSL) & DSL resellers, some cable
- ◆ for larger businesses (\geq T1 upstream)
 - tail circuit: regulated phone company, many ISPs
- ◆ for large businesses ($> 10\text{Mbps}$)
 - tail circuit: regulated phone company, 3rd party fiber
 - many ISPs

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It's a Best Effort Internet

- ◆ all Internet traffic is currently “best effort”
 - packet processing not different on a per customer, per application or per user basis
- ◆ all customer traffic (packets) treated equally
 - remember, the network core only deals with packets
 - some funniness for VPNs but we will ignore that
- ◆ intra-ISP prioritization of routing protocol and network management packets
 - packets filtered at borders to prevent incoming traffic being marked for special priority

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The Internet as a Business

- ◆ organizations that use the Internet can make money on a per transaction basis
 - the more business, the more money
 - e.g., Amazon,
- ◆ but an ISP gets revenue from customers for service
 - service: transport packets toward destination
 - agnostic to “value” of packet contents

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What is an ISP Selling?

- ◆ “the Internet”
- ◆ but what is “the Internet”?
- ◆ BGP routing sees the Internet as a collection of interconnected ASs
- ◆ but pattern of interconnection is seen as a business secret
 - no regulations define interconnection requirements or specifications
 - subject to bi-lateral agreements
- ◆ there is no empirical definition of “the Internet”

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Knowing What is There

- ◆ telephone companies must report all sorts of information to regulators - but not ISPs
- ◆ no useful measurements of the current Internet infrastructure
 - had some understanding of the old NSFnet traffic patterns but none of today's commercial net

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Practically, What is the Internet?

- ◆ a communications system that will deliver, to the best of its ability, packets from one place to another
- ◆ user generally has no way of knowing the path the packets will take
 - thus, has no way to develop an expectation of usefulness
 - e.g., will Skype work well enough when I call Joe?

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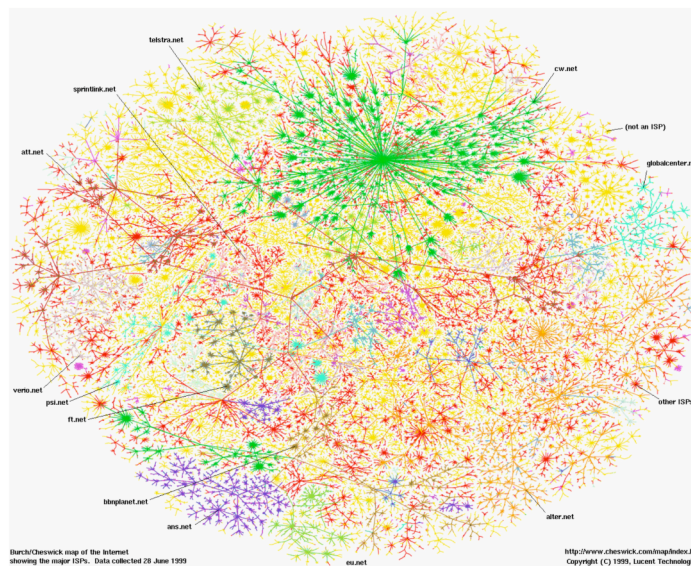
Today's Internet

- ◆ built by many companies
- ◆ built to interoperability standards
e.g., IP, BGP etc
- ◆ not to operations standards
e.g., how much oversubscription is too much
- ◆ no quality predictability, no service guarantees
- ◆ infrastructure does not help end system security

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Today's Internet



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Because it was There?

- ◆ the primary pre-web applications of the Internet were email and remote login
- ◆ then came the web
- ◆ that got widespread deployment
- ◆ because it was there people began using the Internet (and IP protocols) to support other things
e.g., voice

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Voice

- ◆ voice is the big-money network application
\$280B/year in US (or more)
- ◆ most voice services can be supported over IP
if it's on IP, why not the Internet?
- ◆ pundits & investors began assuming IP was the answer (and the future)
“voice will be come a niche business”
- ◆ FCC 12/29/2006:
“enhanced national security, disaster recovery and government services through the creation of a unified, end-to-end IP-based network”

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Just Because You Can?

- ◆ “anything” can run over IP (and the Internet)
but is it the best thing for every thing?
- ◆ voice, data, TV, TDM circuits ...
- ◆ assumption is that a common infrastructure is more cost effective

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Is ‘Good Enough’ Good Enough?

- ◆ all sorts of applications are being delivered over the Internet
because they work *most* of the time
“It fails to fail often enough so it looks like it works.”
Mike O’Dell
- ◆ but no guarantees bothers some people
regulators for example
and traditional telephone people

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Critical Infrastructure

- ◆ the Internet is now seen as a “critical infrastructure”
 - the Internet *is* the core infrastructure for much of US communications and commerce
- ◆ but the Internet was not designed
 - and specifically not designed to be relied upon as a critical infrastructure
 - IP was designed to allow communications to survive in the face of network failures - but only the packet transport part
 - not the coordination between providers part

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A Changing World

- ◆ once upon a time ISPs were “just” Internet service providers
 - they provided IP transport over lines leased from telephone companies
- ◆ telephone companies basically ignored the Internet
- ◆ now many big ISPs are parts of telephone companies

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A Different Mindset

- ◆ 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"*

- ◆ the Internet does not have a binding between
connectivity and service providers

a user can get email service from Yahoo instead of
Verizon (their DSL provider)

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Today's Internet



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A Confluence of Changes

- ◆ the Internet is now seen as a critical infrastructure
 - and must be well managed for to protect it
- ◆ ISPs are now more often telephone companies
 - and have a different understanding of network economics
- ◆ everything is moving to the Internet
 - phone companies see their traditional business threatened
 - regulators see their control threatened

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Add No Accounting

- ◆ back to the lack of accounting
- ◆ phone companies like accounting
 - feel naked without it
- ◆ they assume that the only way to provide an infrastructure is pay “by the use”
 - rather than “by the pipe”
- ◆ use needs to be accounted and charged for
 - or at least use where the user wants things to work
 - and “we can fix” the problem of the user being willing to go with “good enough”

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Invent a New Internet Model

◆ Ex ITU Secretary-General Yoshio Utsumi

“the Internet need not be one net controlled by one centre”

domestic networks are *“more efficient and economical”* (because much traffic is local)

“telephone networks are made up of regional, domestic networks united together in agreement with ITU framework. A similar situation may start with the Internet” - if so the ITU will be called upon to fix things (within 5 years)

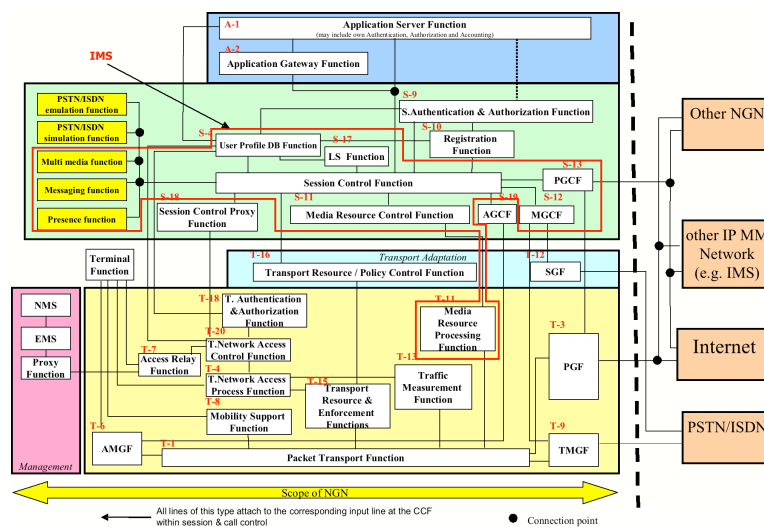
http://www.theregister.co.uk/2005/11/21/utsumi_rejection/

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Invent a New Internet?

◆ ITU-T NGN Effort



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Invent a New Internet, contd.

- ◆ it's my wire, I'll do what I want with it

Edward E. Whitacre - CEO AT&T

'Google, Vonage & Skype are using **my** network for **free**'

William L. Smith - CTO Bell South

'we should be able to charge Yahoo to let their web page load faster than Google'

- ◆ Walter McCormick, Jr. for US Telecom Industry Association to Congress

his companies would never *"block, impair, or degrade content, applications or services"*

(but do not make any rules to stop us)

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Network Neutrality

- ◆ Vint Cerf et al vs. TIA et al: US Senate

- ◆ Vint's reason

carriers could make it so carrier permission (or payment) is required for new applications

block new app development - destroy generative effect of the Internet

- ◆ TIA's reason

if Internet is a commodity then carrier is not assured a return on investment

<http://commerce.senate.gov/hearings/witnesslist.cfm?id=1705>

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The “New” AT&T

- ◆ FCC approved the AT&T - Bell South merger 12/29/06
- ◆ chairman Martin made it clear that the phone companies should be able to do whatever they want (relative to network neutrality)
- ◆ AT&T made “voluntary concessions” to not violate network neutrality - on **some** of their network

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What Would Have been Different?

- ◆ if accounting had been part of the original Internet
 - ISPs could have scaled based on traffic (because of getting traffic based revenue)
 - ISPs would have had an incentive to improve infrastructure
 - because other ISPs could have differentiated between paths through other ISPs based on quality
 - ISPs would have had direct incentives to interconnect
 - change peering business models

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But It's Not Different

- ◆ so now what?
- ◆ hard to see telco mindset being compatible with today's Internet model
 - would rather suppliers pay(extra)-to-play
 - pay more than just an Internet access fee
 - see some packets as being worth more than others
- ◆ maybe transport infrastructure should be a separate business
 - with guaranteed rate of return
 - but agnostic as to ISP running over it

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Competition

- ◆ basic problem is that there is no actual competition for Internet services
 - duopoly at best - and in most places a monopoly
- ◆ a separate, non-competitive, regulated infrastructure could enable real competition at the ISP level
 - could also enable specialty services (e.g., IPTV, VoIP) to offer services separate from being an ISP

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Future

- ◆ common sense is not common enough
and there are different definitions of “sense”