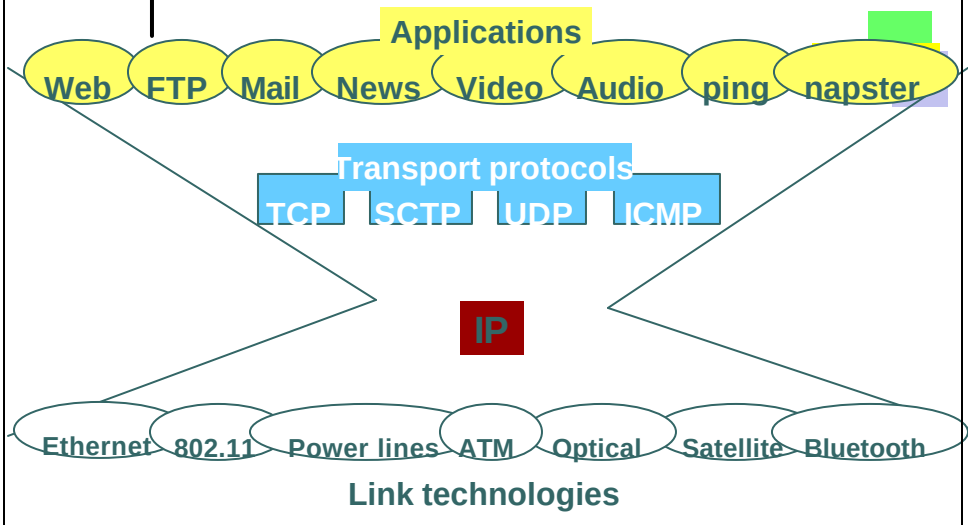
CS514: Intermediate Course in Computer Systems

Lecture 22: March 10, 2003

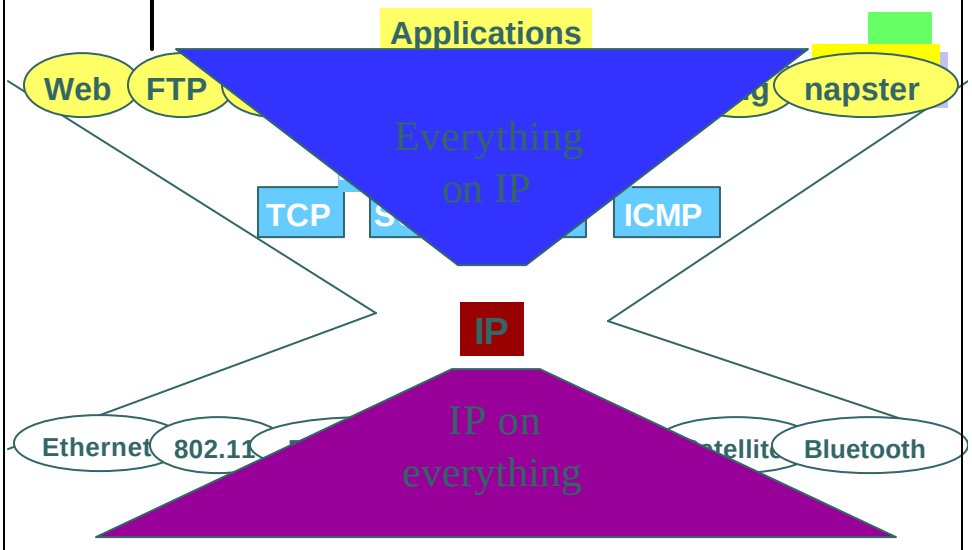
"The Next Generation Internet: IPv6 (not) and SIP"

The Internet hourglass



From Hari Balakrishnan

The Internet hourglass



From Hari Balakrishnan

What does IP provide?

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- Packetization
  - Fragmentation and reassembly
- The name of an interface
  - The IP address
- The ability to route to that interface
  - Routing protocols, including ICMP redirect
- *Nothing else!*
  - Well, a little QoS in the form of diffserv

IP: RFC 791

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- Published in 1981
- 45 pages
  - Half of which no longer apply
- The whole internet is built on these 45 pages!

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- The whole internet is built on these 45 pages!
  - In one sense, this is stunning
  - In another sense, maybe to be expected

IPv4 Header

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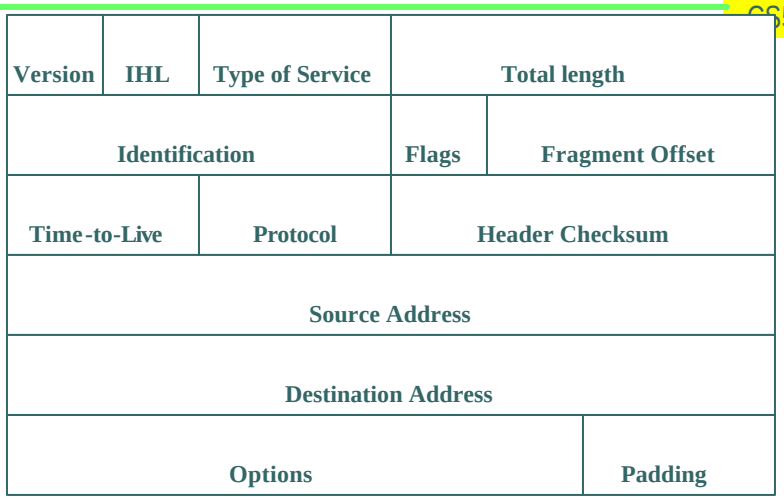

IPv4 Header: Packetization

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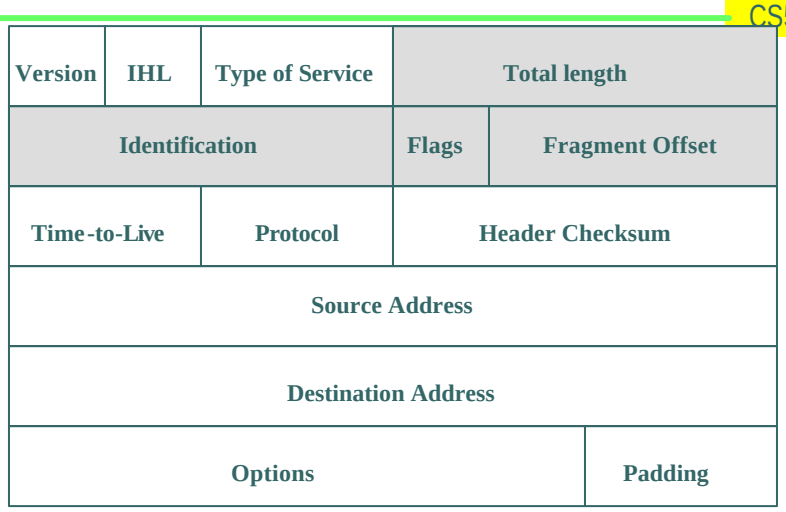

IPv4 Header: Interface Name and Routing

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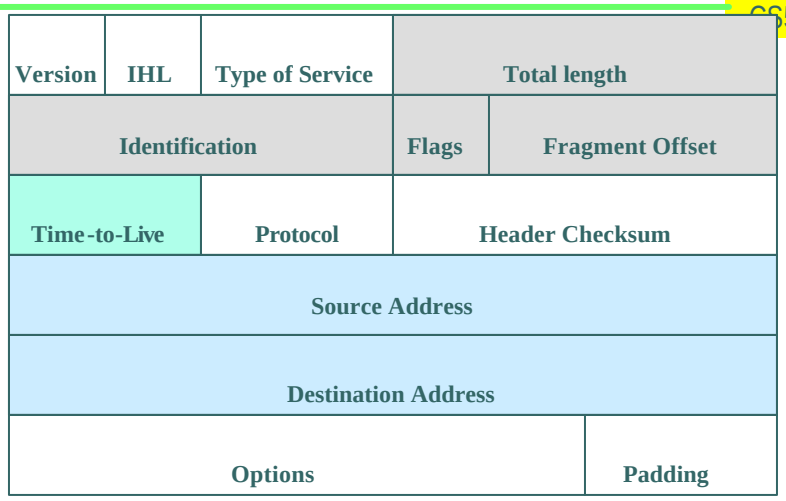

IPv4 Header: And a little QoS

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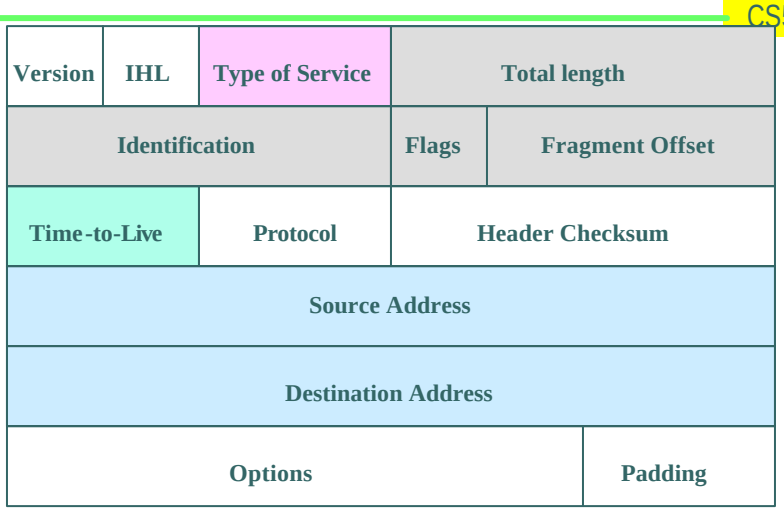

What are the problems with IPv4?

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- Critical problem
  - Not enough addresses
- Also critical (though most folks unaware of it)
  - Routing table blowing up
- Other problems
  - Non-optimal routes with mobility
  - Address spoofing
  - Little or no QoS / resource reservation
  - E2E IP-level security hasn't really worked out

IPv6

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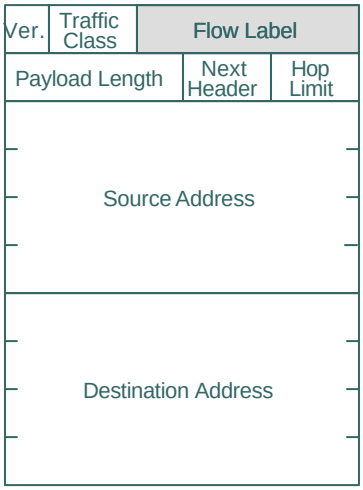

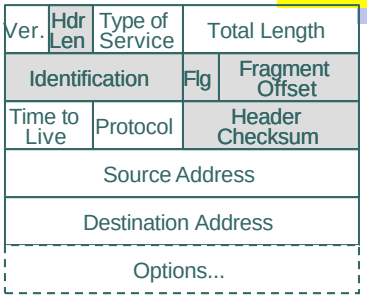

shaded fields have no equivalent in the other version

IPv6 header is twice as long (40 bytes) as IPv4 header without options (20 bytes)

Courtesy Steve Deering

Which problems does IPv6 fix?

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More addresses		
Routing table		
Optimal mobility		
Address spoofing		
E2E security		
QoS		

Which problems does IPv6 fix?

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More addresses	✓	128 bit addresses
Routing table	??	Same addressing architecture, so only with better assignment
Optimal mobility	✓*	A bit awkward, but seems to work
Address spoofing	X	Same addressing architecture
E2E security	X	Same security (IPsec), though eventually no NAT
QoS	X	Same QoS (diffserv)…but what about the Flow Label???

* With difficulty

IPv6 Flow Label

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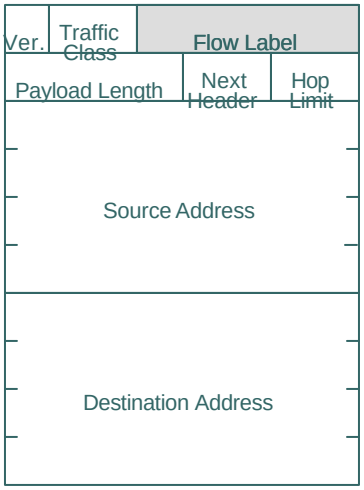

- Put there because there were 22 unused bits!
  - Really, that's the reason!
- Nobody has come up with a compelling QoS-related use for them

Will these motivate migration to IPv6?

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More addresses	✓	128 bit addresses
Routing table	?	Same addressing architecture, so only with better assignment
Optimal mobility	? ✓*	A bit awkward, but seems to work

Lets look at each…

"Triangle routing" for Mobile IPv4

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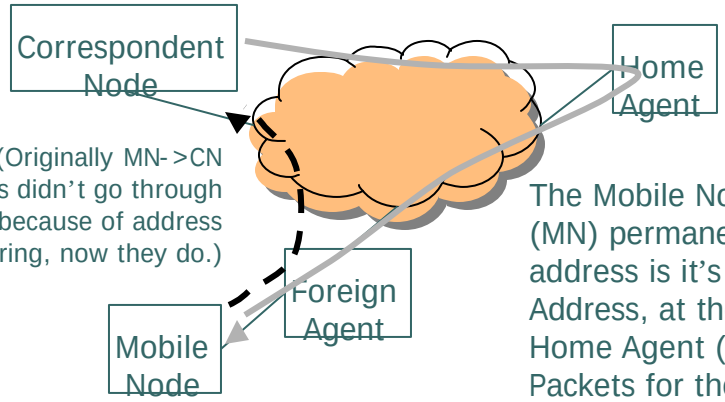

(Originally MN->CN packets didn't go through HA, but because of address filtering, now they do.)

The Mobile Node's (MN) permanent address is it's Home Address, at the Home Agent (HA). Packets for the MN route through the HA

Optimal routing in Mobile IP

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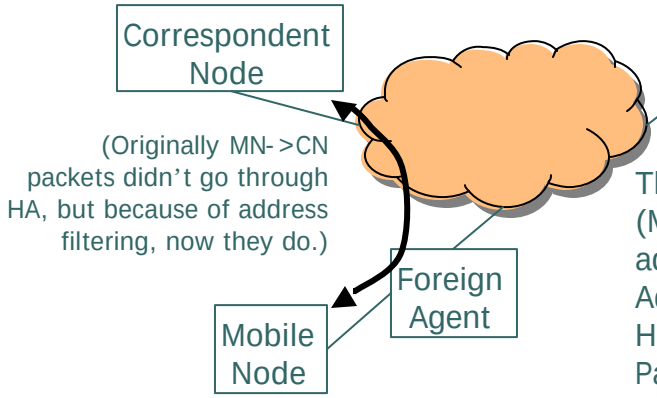

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Why optimal routing is not sufficient motivation

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- Mobile IP not used much
  - Motivation for Mobile IP was to allow hosts to have permanent addresses
  - But internet applications know how to deal with temporary addresses
- When used, it is possible to dynamically assign a Home Agent near the Mobile Node
  - cdma2000, which uses Mobile IP for its wireless 3G mobility

Dealing with temporary addresses

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- Client-server fine with temporary (client) addresses
  - Including email, chat, etc.
  - Nobody expects a server to be mobile
- Network Access Identifier (NAI) works as a permanent network-level identifier
  - Used for roaming dial-up
  - Has the form user@domain (like email)
  - Even works with Mobile IP

Why smaller routing tables is not sufficient motivation

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- First of all, many backbone operators don't really believe IPv6 will scale better
- Scalable routing is not the end network's problem
  - But IPv6 won't take off if the end networks don't use it

More addresses: the only compelling motivation

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- *But is it compelling enough?*
- Most internet applications already work with NAT
- The internet community is learning how to make peer-to-peer work with NAT (STUN)
  - Will be applied to VoIP initially
  - Furthermore, lots of folks like NAT (addr isolation)
- Even IPv6 will require NAT for a long time, to interoperate with IPv4
  - Given that applications have to deal with NAT either way, why bother with IPv6???

What about when we run out of IPv4 addresses?

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- Think of NAT as extending the IP address space to 48 bits
  - 32 bits IP address, 16 bits port number
  - Each addr-port pair defines an “address”
- This address space realistically* allows about 25 “addresses” per person globally
  - * After taking into consideration address assignment inefficiencies (see RFC 3194, “The H-Density Ratio for Address Assignment Efficiency”)
- In other words, we won’t run out of IPv4 addresses…

Who will deploy IPv6 first?

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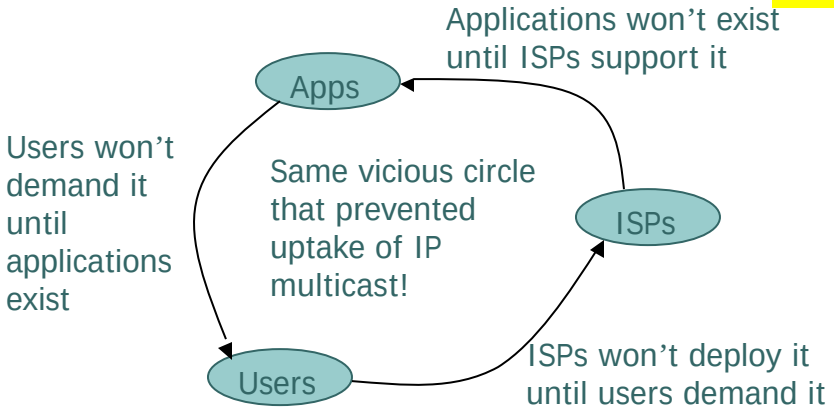

Teredo: IPv6's best hope

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- Teredo: Tunneling IPv6 over UDP through NATs
- draft-ietf-ngtrans-shipworm-08.
- Allows IPv6 hosts to run through NATs without any ISP support
  - Similar to STUN
- IPv6 address contains NAT address and port

You should be worried when…

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- Governments recommend your protocol
  - European Union recommendations for IPv6 early 2002
  - Japanese prime minister mentioned IPv6 in a speech!
  - Reminiscent of US and UK government mandate of OSI stack
- Contests with prizes are offered for applications using your protocol
  - IPv6 Promotion Council of Japan: ¥1,000,000 grand prize, ¥3,500,500 total prizes

Status of IPv6

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- Lots and lots of testbeds
- A few ISPs offer it commercially
  - Mainly Japan
- Shipped with Windows XP
  - But installed/configured via command window only!
  - Many other vendor OSs
- In most router vendors
  - Runs about 1/5th the speed of IPv4
  - But catching up…

My history with IPv6

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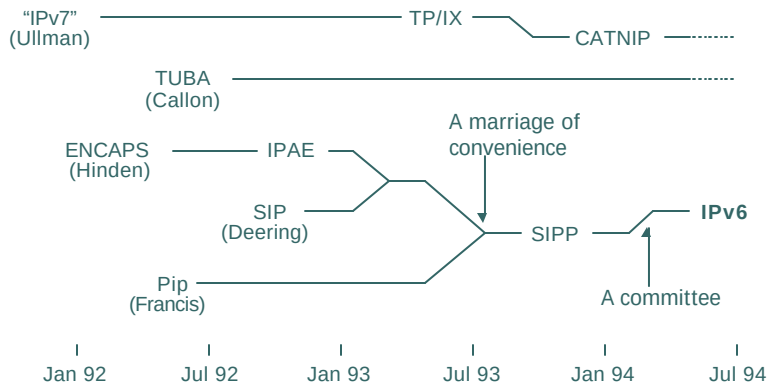

Courtesy Steve Deering

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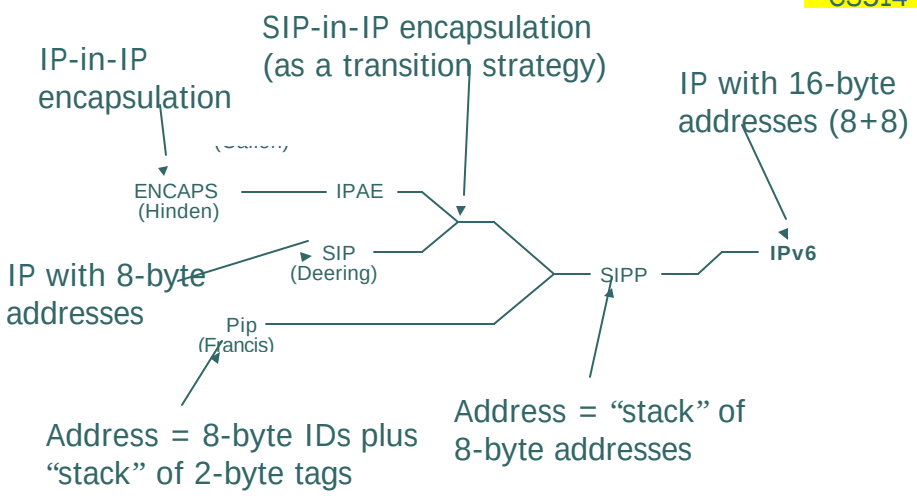

The Next Generation Internet: IPv6 (not) and SIP

Session Initiation Protocol

(RFC 3261, And many others)

What is SIP?

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- A (formerly) lightweight signaling protocol for IP networks
  - Allows two or more hosts to tell each other what they want to do
  - Way more powerful than simple “ports”, which require a pre-established understanding
- Required for audio/video over IP
  - Because there are many types of audio/video
  - Originaly a simple, multicast-aware alternative to H.323
- But has broad applicability
  - Messaging, presence, TCP, etc.

Capabilities of SIP

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- Addressing
  - Addresses users or machines
  - user@domain, or +1-234-567-8901
- User location discovery
  - Through registration
- Routing
  - SIP server discovery, redirection
- Signaling
  - Negotiate services, media type, IP type (unicast or multicast), etc.
- Presence and (instant) messaging
  - As SIP “event package” (I.e. application)

Capabilities of SIP

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- Secure signaling
  - Over TLS
  - Of course, can signal a secure media session, i.e. Secure RTP
- Mobility
  - Of machines across IP (re-INVITE)
  - Of users across machines (REGISTER)
- Service selection
  - Voice, email, fax, messaging, etc.
- “Call” (session) handling
  - Call forward, call transfer, 3rd party conferencing
- Interface with phone network
- NAT traversal (using STUN)

Basic SIP operation

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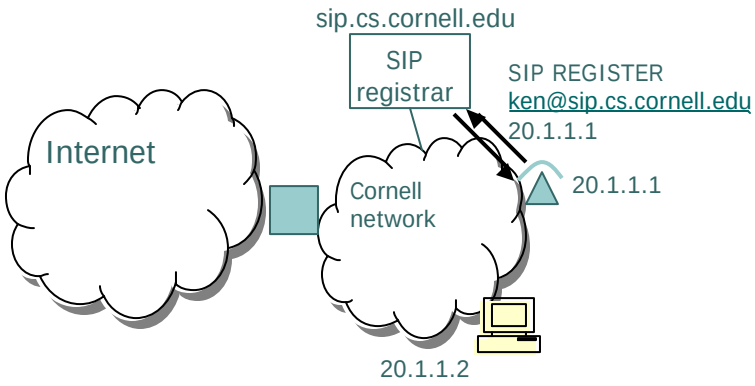

Ken's VoIP desk phone periodically registers ken@sip.cs.cornell.edu

Basic SIP operation

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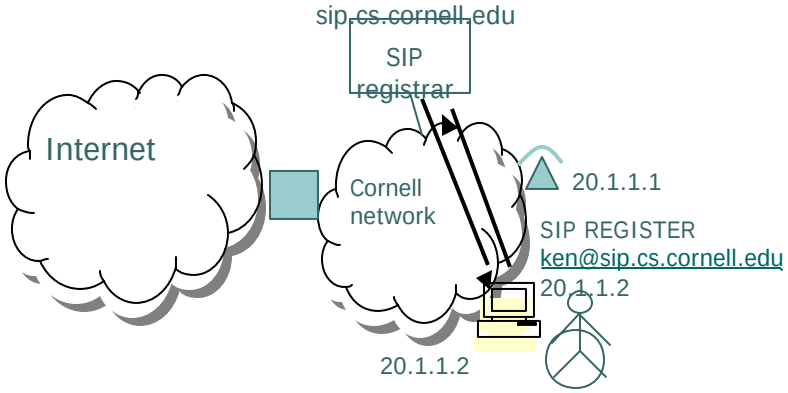

Ken moves to a computer down the hall, start VoIP app

Basic SIP operation

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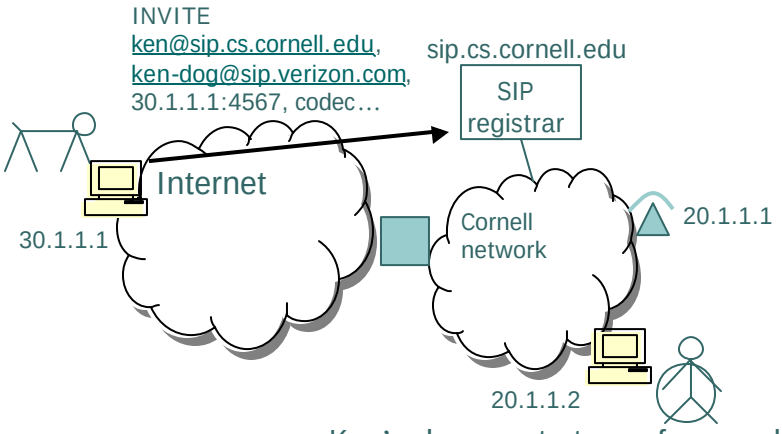

Ken's dog wants to go for a walk, activates its BoIP phone

Basic SIP operation

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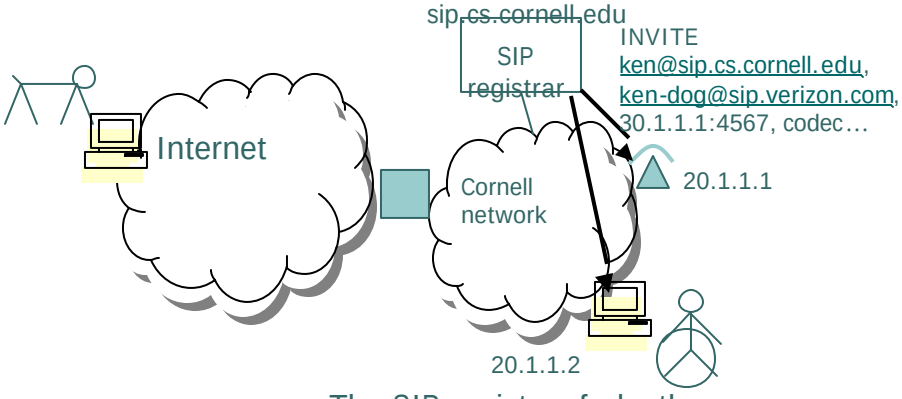

The SIP registrar forks the INVITE, sends it to both devices

Basic SIP operation

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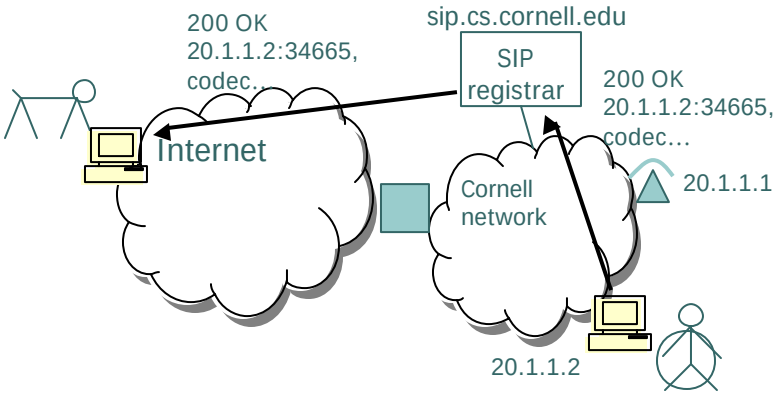

Ken answers at the computer

Basic SIP operation

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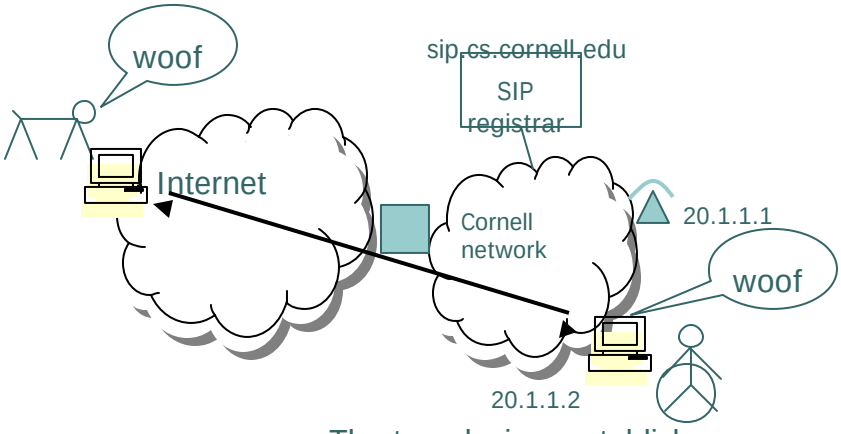

The two devices establish a media stream over RTP

Basic SIP operation

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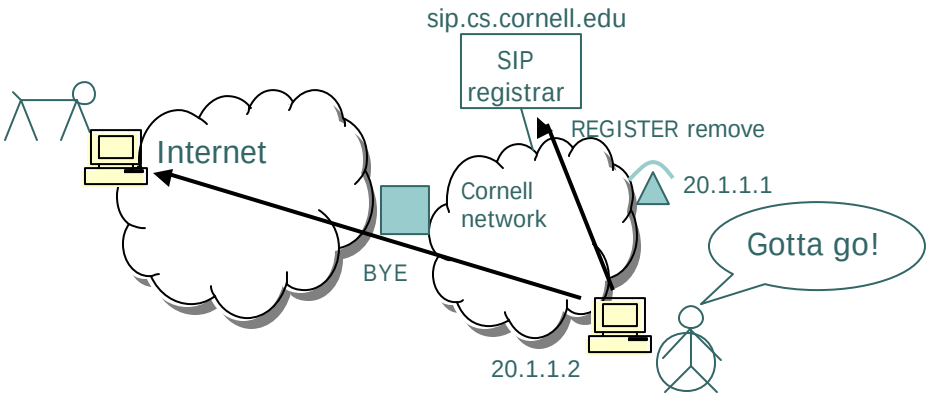

Ken hangs up, logs off the computer

SIP methods

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- SIP base methods
  - REGISTER, INVITE, ACK, CANCEL, BYE, OPTIONS
- SIMPLE presence methods
  - SUBSCRIBE, NOTIFY
- SIMPLE message method
  - MESSAGE

SIP status

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- Hasn't reached "critical mass" yet
  - Though used in growing number of enterprises for voice (PBX replacement)
- Microsoft moving to SIP
  - Messenger based on SIMPLE
  - VoIP based on SIP
- Unlike IPv6, SIP doesn't have the vicious circle
  - No ISP involvement needed
  - Microsoft can bootstrap SIP all by itself

SIP future

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- Once SIP takes off, every P2P application will be built over it
  - Games, voice, video, chat, voice chat, presence, messaging, file sharing, etc.
  - Because it scales, has security, and allows easier integration of multiple communications channels
  - Example: A web-based help desk will be able to determine what applications you have (through presence, once you approve), and send you web pages, videos, etc., as part of the help service