Internet Telephony and Multimedia: Status and Directions

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Overview

- new Internet services: “telephone”, “radio”, “television”
- why Internet telephony?
- why not already?
- Internet telephony modalities
- components needed:
  - data transport
  - resource reservation
  - signaling
  - service location

New Internet services

- tougher: replacing dedicated electronic media
- distribution media: hard to beat one antenna tower for millions of $30 receivers
- typewriter model of development
- radio, TV, telephone: a (protocol) convergence?

The phone works — why bother with VoIP?

user perspective

- variable compression: tin can to broadcast quality
- security through encryption
- caller, talker identification
- better user interface
- internat. calls: TAT transatlantic cable = $0.03/hr
- no local access fees (but ↓ 1c/min.)
- easy: video, whiteboard, . . .

carrier perspective

- silence suppression ➠ traffic ↓
- shared facilities ➠ management, redundancy
- advanced services (simpler than AIN and CTI)
- operational advantages
- cheaper switching
- fax as data

The radio/TV works - why bother with Internet media?

- time-offset: listen real-time or download-and-play
- content marking, meta information
- “sparse” distribution

The new phone companies

- separation bit carriage $\leftrightarrow$ services
- anybody with Internet connection can provide services (ACD, 800, 900, directory, . . .)
- distinction “in” vs. “out” of network not useful
- incremental start-up investment not large
- new players:
  - cable companies ➠ no new infrastructure, but mostly one-way
  - electric utilities ➠ need line management anyway
  - Qwest, IXC (resell to ISPs), . . .

Internet telephony as PBX replacement

global Internet not quite ready ➠ try as PBX

- have mission-critical LAN, PCs anyway
- usually ample (if switched) bandwidth, low latency
- packet switching is cheaper
- network PCs $\stackrel{\$}{=}$ ISDN phones
- no need for billing

Internet telephony services

- voice mail $\longrightarrow$ email
- calendar integration
- user-programmable call processing logic
- call first available sales person (ACD)
- call whole department
- web IVR
- return web page with favorite “on hold” music

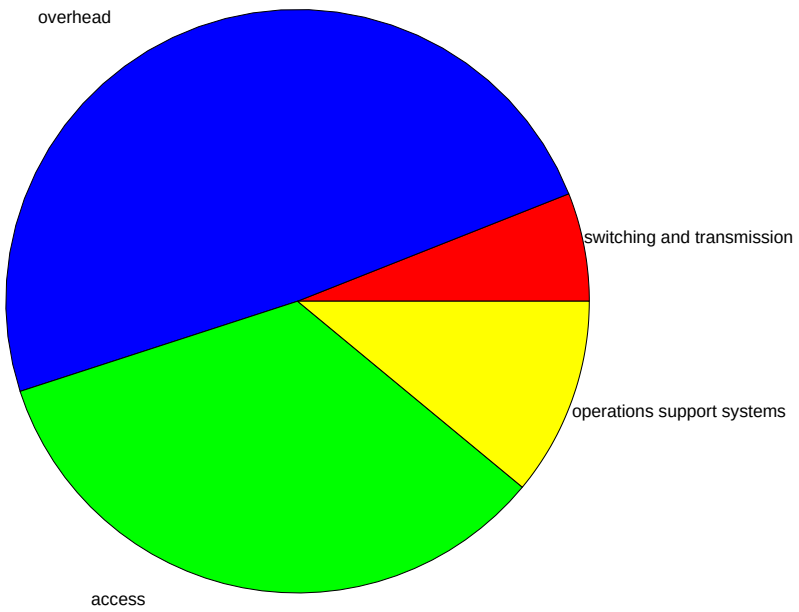
Internet telephony services

- camp-on without holding a line
- short message service (“instant messaging”)
- schedule call into the future
- call with expiration date
- add/remove parties to/from call ➠ mesh
- “buddy lists”

Switching costs

Device	port speed	port cost	cost/64 kb/s
8-port Ethernet hub	10/100 Mb/s	8	0.008
24-port Ethernet switch	10 Mb/s	55	0.35
8-port Ethernet switch	100 Mb/s fiber	474	0.30
8-port Ethernet switch	1 Gb/s	1187	0.08
24×100BaseT + GigE	10/100 Mb/s	141	0.09
100 T1 circuit switch	1.5 Mb/s	25,000	1041
5ESS local (no AIN), 5000 lines	64 kb/s	300	300
5ESS local (AIN), 20,000 lines	64 kb/s	175	175
Small PBX (few hundred lines)	64 kb/s	1,000	1,000
Large PBX (> 5000 lines)	64 kb/s	500	500

Telephone costs



infrastructure	10-23%
switching and transmission	6%
overhead	49%
access	34%
operations support systems	11%

Transport costs

network	$/min	$/MB
wholesale telephone	0.01–0.02	
U.S. domestic interstate consumer rates	0.05–0.15	
U.S. domestic intrastate consumer rates	0.05–0.25	
modem		0.25 – 0.50
private line		0.50 – 1.00
frame relay		0.30
MCI frame SVC		0.05
Internet		0.04 – 0.15
Internet modem		0.33
Internet backbone		0.01

1’ voice = 480 kB w/silence suppr., 1 MB without

Phone usage

“Free” phone calls does not mean unbounded increase:

year	lines (millions)	local calls min/day/line	local calls min/day/person
1980	102.2	39	17.5
1988	127.1	39	20.2
1996	166.3	40	25.1

Why aren’t we using it now?

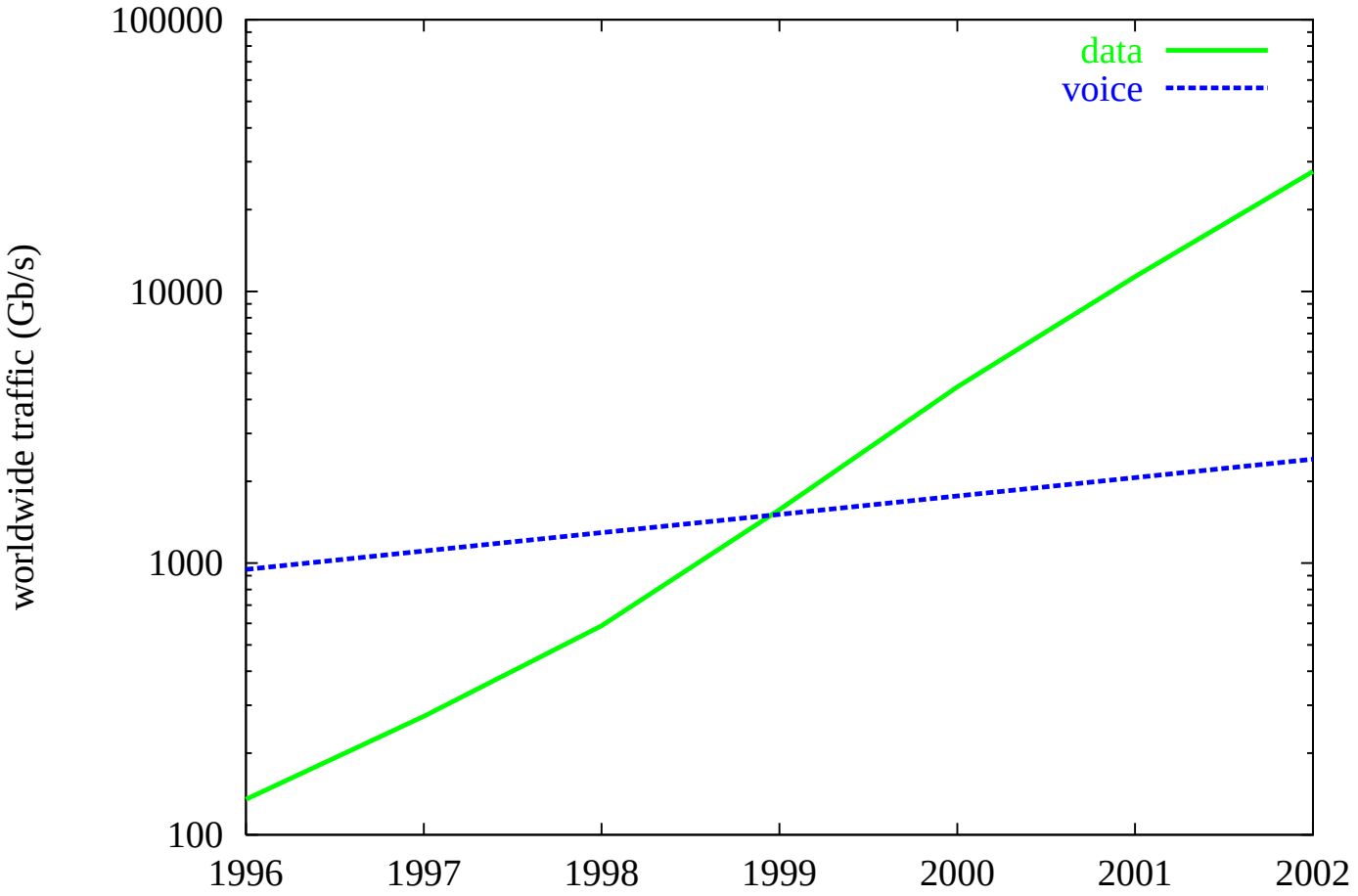
world phone traffic	600	Gb/s	U.S. total	368	Gb/s
international traffic	13	Gb/s	U.S. interstate	55	Gb/s
			AT&T long distance	61	Gb/s
public Internet (late 1999)	300	Gb/s			

- unpredictable sound quality, reliability
- doesn’t work well for dial-up users
- no cheap Internet devices
- 1 billion phone lines, 122 M in U.S. ➠ gateways
- no billing infrastructure

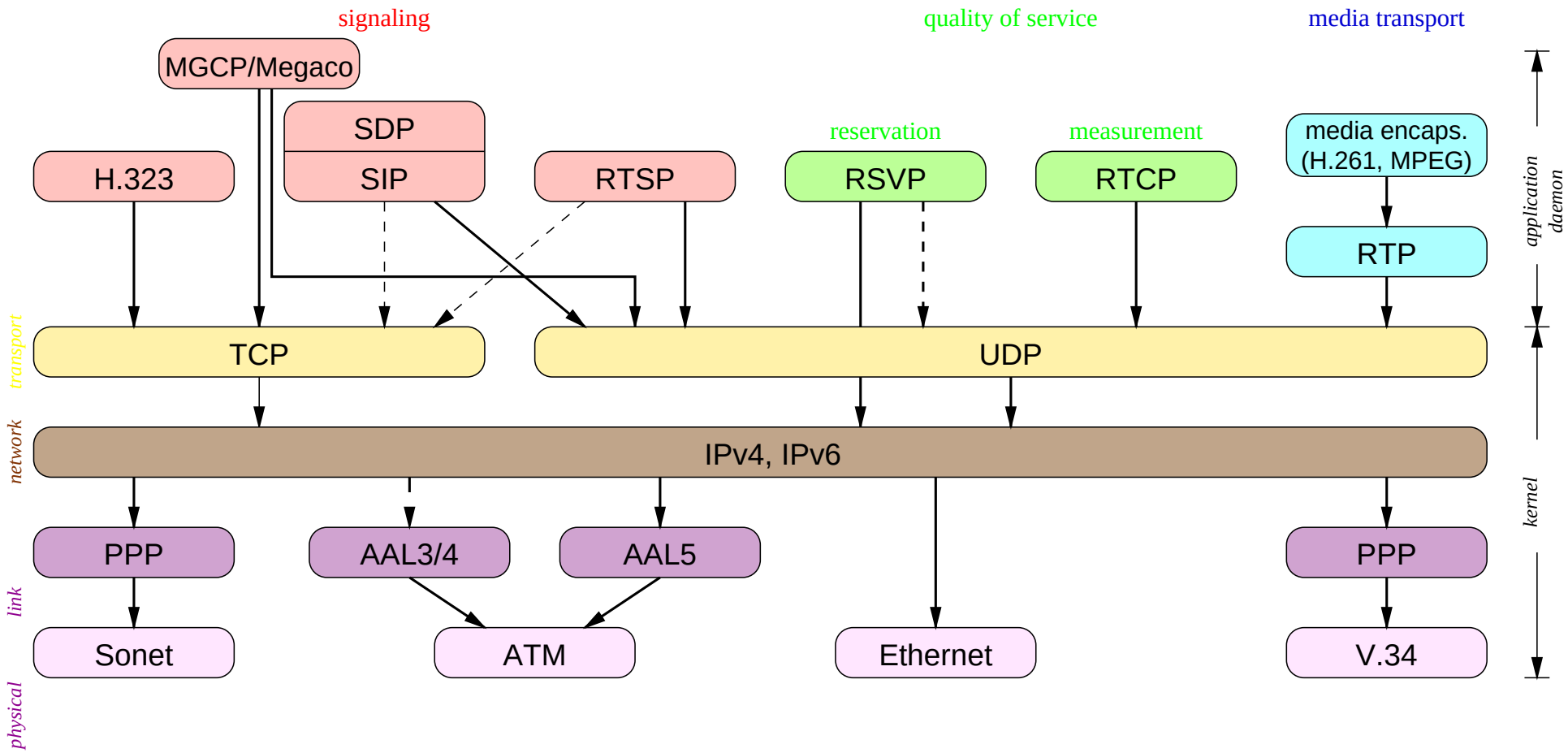
Projections

- MCI: “80% data, 20% voice”
- “AT&T could lose $350 million in international calls by 2001”
- “By 2002, the Internet could account for 11% of U.S. and international long-distance voice traffic”
- “Up to 10% of the world’s fax market, which generates $45 billion in telecom revenue a year, will move to Internet in 2 or 3 years”
- May 1999: BT builds IP phone network in Spain
- only about 2.5m cable and DSL users in U.S. at end of 2000

Data vs. Voice Traffic



Internet multimedia protocol stack



Components for Internet Multimedia

multicast: routing, address allocation

data transport: RTP

resource reservation: RSVP, YESSIR, diff-serv

“TV” – announcing multicast sessions: SAP

“phone” – session setup for conferences/telephony: SIP

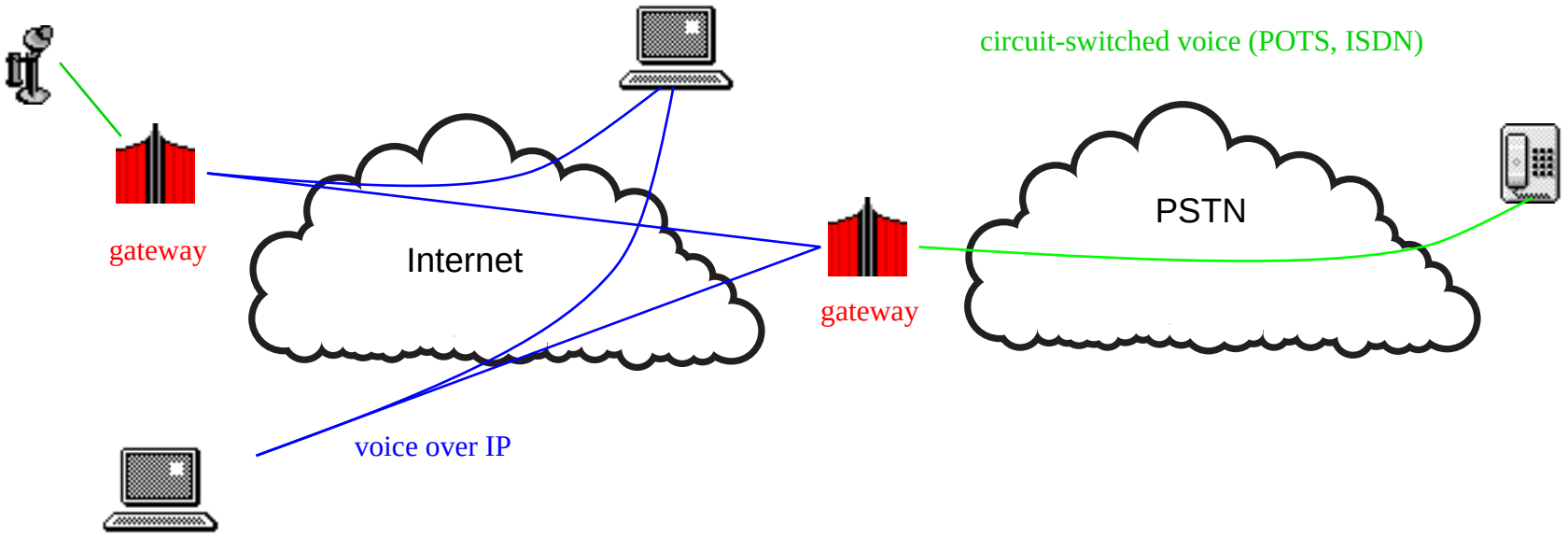
“VCR” – control of streaming media: RTSP

local applications: conference bus

policy issues: billing, firewall access, clearing houses

Internet telephony modes

- tail-end hop off ➠ callee has phone
- front-end hop on ➠ caller uses phone
- Internet in the middle: per-call, multiplexed



Internet “signaling”

all non-data (“out-of-band”) functions:

routing: unicast; DVMRP, PIM, CBT for multicast $\surd$

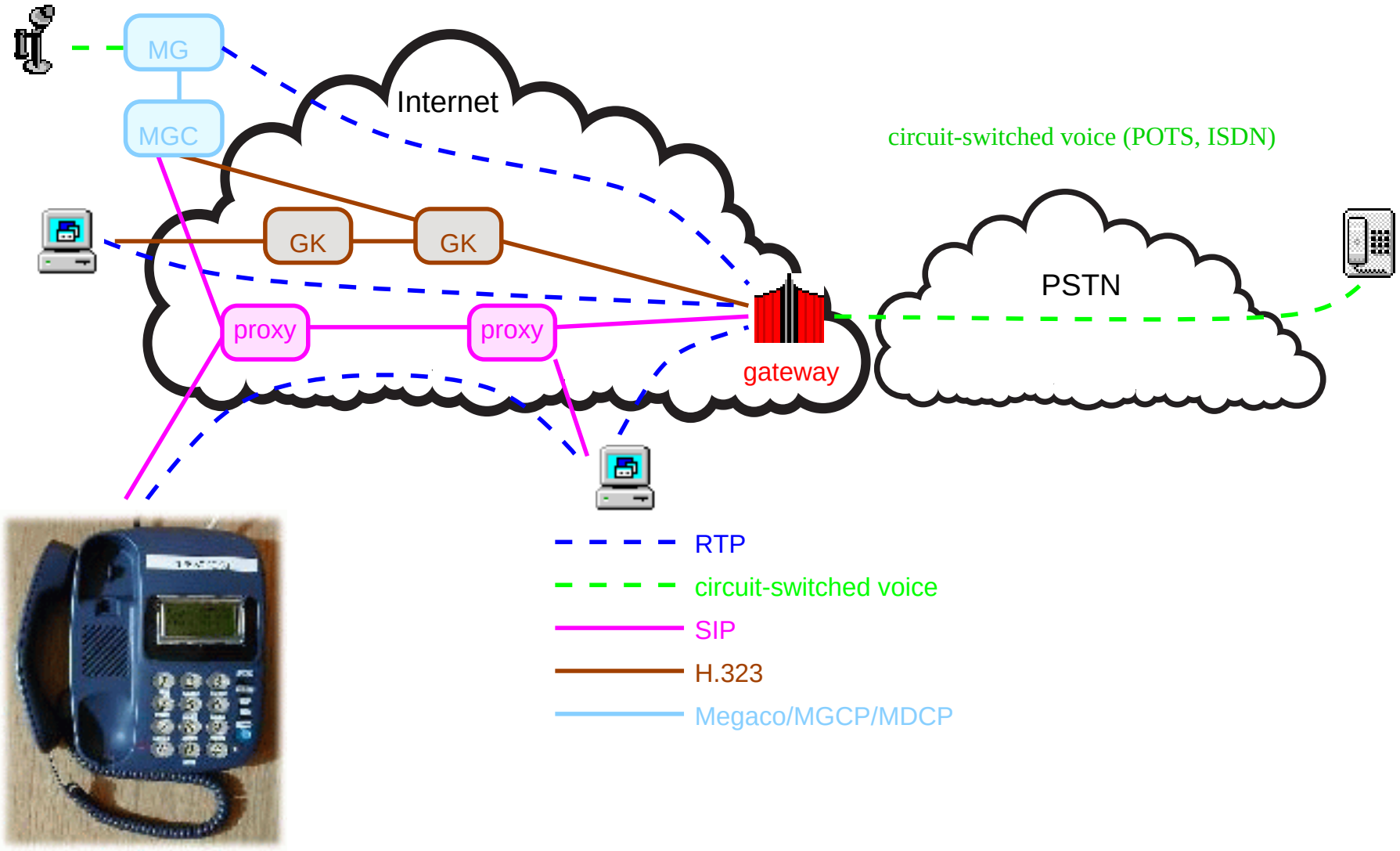
quality of service: RSVP, RTCP, diff-serv $\surd$

user Contact: map name to location (IP address)

call set-up/teardown: SIP, H.323

policy, billing: “vertical” protocols

Architecture



Differences: Internet Telephony $\leftrightarrow$ POTS

- separate control, transport (UDP) ➠ no triangle routing
- separate connectivity from resource availability
- separate services from bit transport
- datagram service ➠ less bootstrapping
- in-band signaling ➠ higher speed
- features "network" $\rightarrow$ end system: distinctive ringing, caller id, speed dialing, number translation, . . . ➠ scaling
- features: intra-PBX = inter-LATA and general
- protocols: user-network = network-network signaling

Two Views of Internet Telephony

Internet telephony:

- primarily voice
- look like phone system: ISDN signaling, separate “stack”
- interoperability with SS7
- or SS7 migration to Internet

Internet telephony:

- VoIP = yet another Internet service
- voice = small fraction of traffic in ten years
- SS7 = legacy, to be relegated to edges
- integration with email, web
- multimedia, including non-CM

Architecture

Centrally controlled (master-slave): media gateways controlled by call servers: "connect circuit 17 to IP address 128.59.19.1" $\longrightarrow$ Megaco, MGCP

- all services in server control
- no need to modify end systems
- "pay $4.59/month for call waiting, $7.50 for caller id"

Peer-to-peer: equal participants, end-to-end

- services in proxy servers and end systems
- need to modify software for new services
- "download new software for $19.95"

Connect MGCP islands using SS7 or peer-to-peer protocols

Open Operational Issues

- billing
- finding the nearest gateway to the Internet (➠ GLP)
- mapping E.164 (phone) numbers to IP addresses
- controlling phones through the Internet (PINT)
- 911 (emergency) services
- wire tapping (CALEA)
- anonymity and certified identity

Billing

- simplification: email/web delivery, credit card payment
- what to bill for?

  transport services: volume, time, reserved resources; "free upgrades"

  signaling services: filtering, forwarding, scripting, mobility, . . .

  storage services: voice mail

  gateway services: PSTN gateways

Emergency (911) services

- U.S.: dial “911” anywhere $\longrightarrow$ nearest Public Safety Answering Points
- look up street address from telephone company database
- but. . .
  - IP address dynamically assigned
  - may not be correlated to geography
  - dial-in from hotel, remote sites?
  - prevent services: hanging up, transfer, hold, . . .

Emergency services

- advantages:
  - multimedia (video, medical data, . . .)
  - medical database access, with authentication token
  - remote activation of medical devices
- solutions:
  - enclose (signed) location information with call
  - IP address $\rightarrow$ provider $\rightarrow$ lookup (RADIUS) ➠ needs authenticated protocol
  - GPS

Lawful intercepts (“wiretapping”)

- Internet already has remote packet tapping: RMON, telnet + rtpdump, . . .
- most intercepts done on local loop $\longrightarrow$ Internet doesn’t change that
- information services exempt from CALEA provisions
- difference between content and “pen register” (signaling) intercept
- see IETF `raven` mailing list

Summary

- transition of separate circuit-switched ➠ IP-based applications
- VoIP: transport + QoS + signaling + services
- packets from the inside out or the outside in?
- Internet telephony or Internet telephony
- stack: IP over ATM, Sonet, WDM?
- role of IPv6 or NATs?
- “the end of distance” or tiered IP service?