Internet MBONE and Applications

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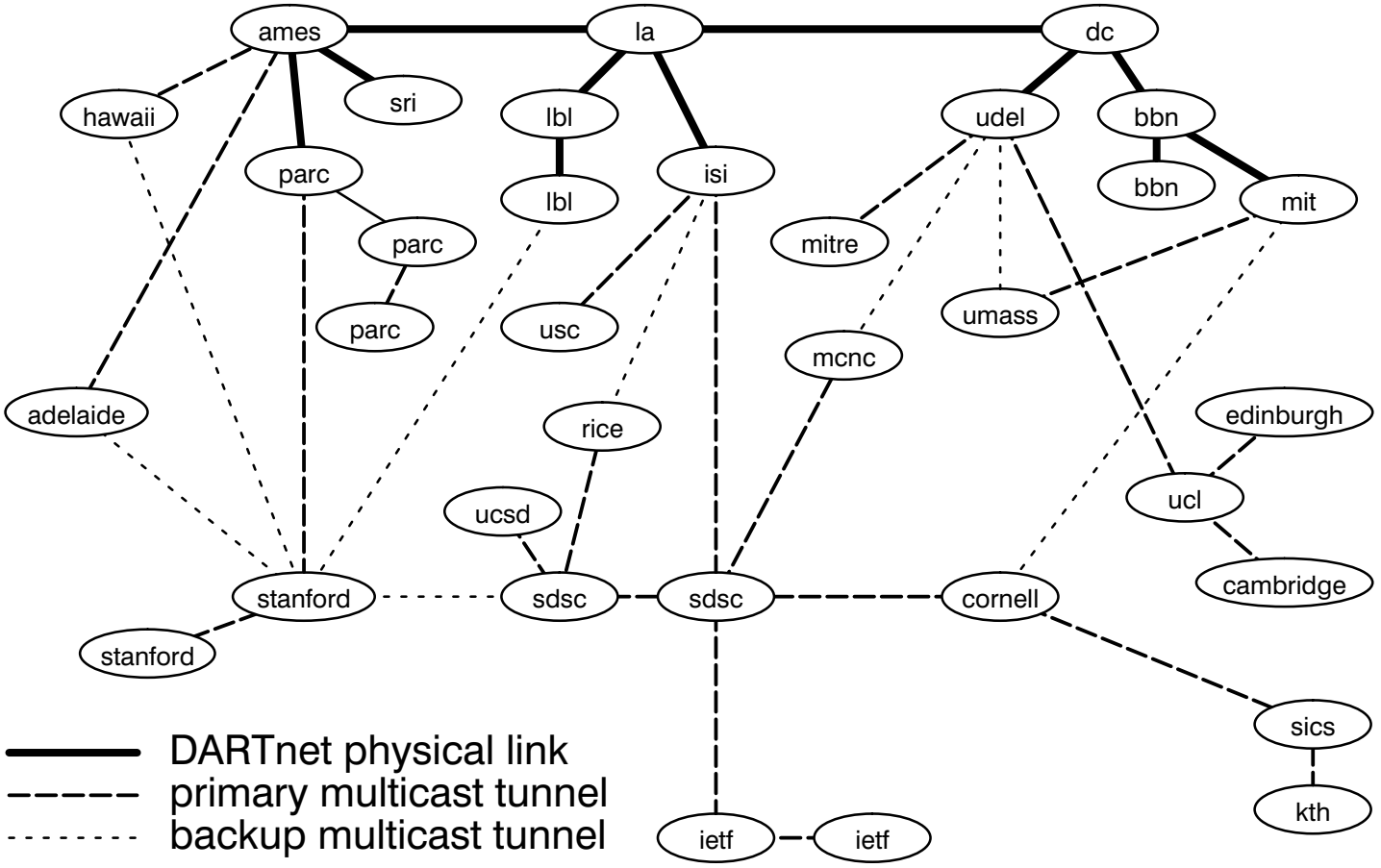
Giving multicast a kick-start!

Several elements came together:

- Multicast developed in 1988 but not widely deployed
- Workstations have built-in audio, software video display
- DARTnet enabled testing multicast audio and video

Wild idea: Send live audio from March 1992 meeting of Internet Engineering Task Force (IETF)

San Diego IETF multicast router topology, March 1992



Looks like it was a good idea!

Remote participants in March 1992 IETF meeting:

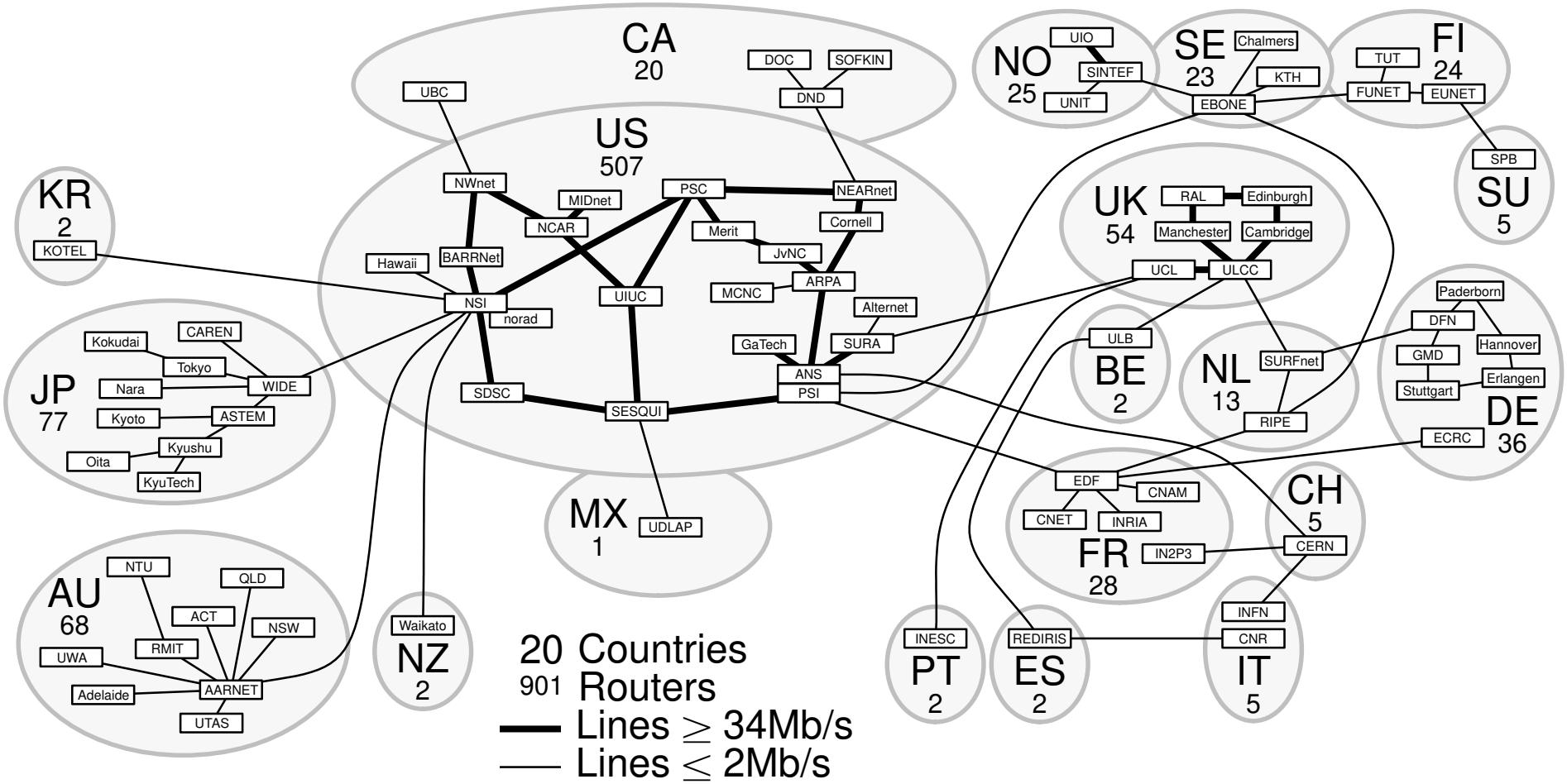
- 32 hosts
- 4 countries

Growth in six IETF meetings since then:

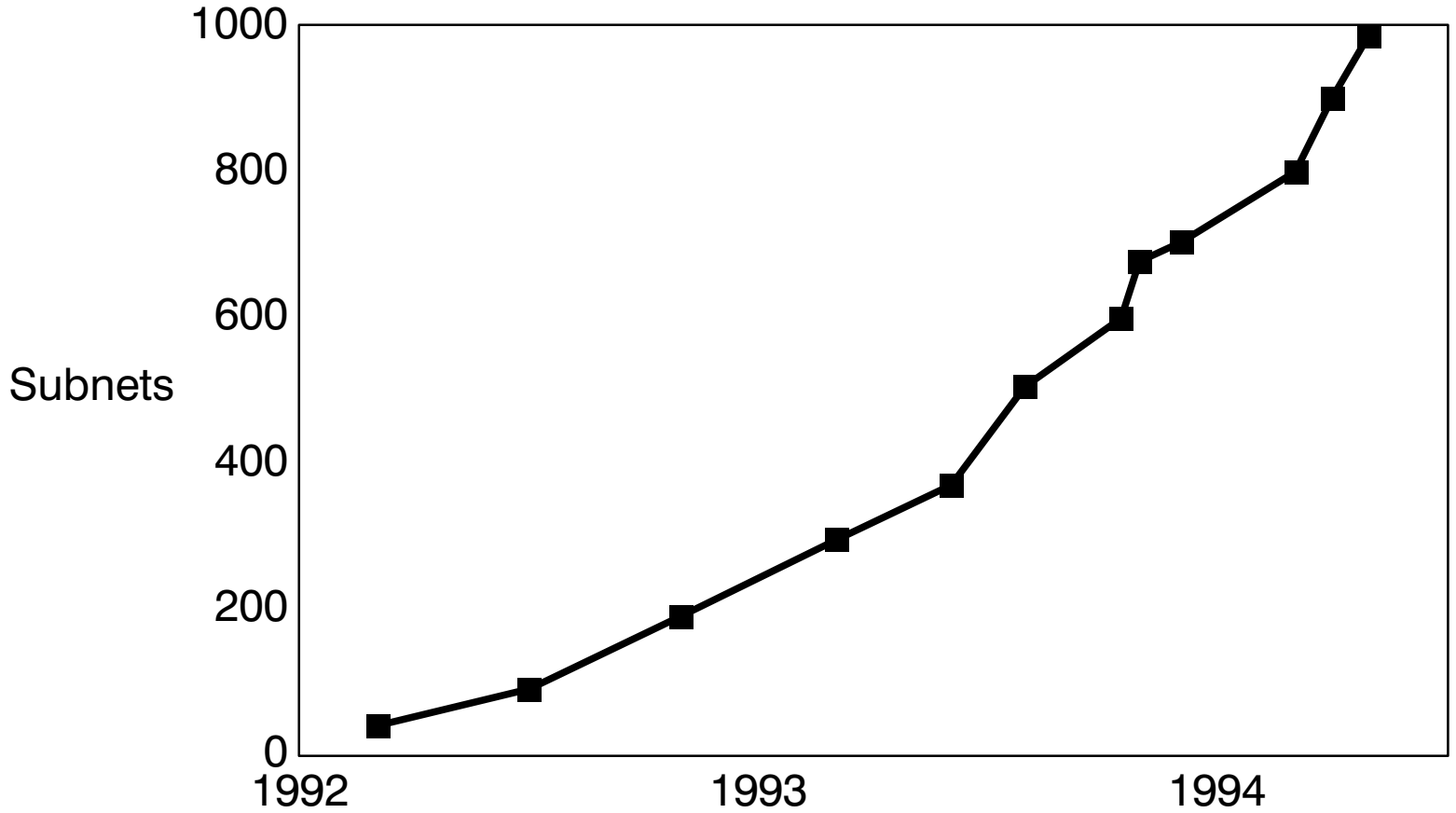
- 600 hosts cumulative
  (rivals number of local attendees since July 93)
- 16 countries
- video in addition to audio, two channels

After July 1992 meeting, decided to create MBONE...

Major MBONE Routers and Links, May 1994



MBONE Growth



What is the MBONE?

- Virtual network for multicast, overlaid on physical Internet
- Multicast-capable islands interconnected by tunnels
- Voluntary participation by IP service providers and end users who install multicast routers (mostly workstations)
- Experimental, not production *(but expectations growing, and commercial multicast routers in development)*
- Many people have contributed: BBN, INRIA, ISI, LBL, PARC, IETF hosts, network providers, end users

Wide Variety of Other Multicast Events

- Many events are seminars / conferences like IETF:

  Australia and UK Networkshops, RIPE in Prague, JENC in Trondheim, INET'93, Pancreatic Islet Symposium, Top Quark briefing, Interop

- Smaller, more interactive groups:

  IETF Working Group meetings, private 3-5 person collaborations

- Broadcasts hint at potential for very large scale services:

  Rebroadcasts of NPR and NASA Select, Radio Free Vat

- Also transmissions other than audio and video:

  JASON Project (oceanographic visualization), UH weather satellite images. multicast distribution of Netnews

Some Applications on MBONE

Audio tools:

Visual Audio Tool (vat) from LBL

Network Voice Terminal (NEVOT) from UMass

Video tools:

Network Video tool (nv) from PARC

INRIA Videoconferencing System (IVS)

Session Managers:

Session Directory (sd) from LBL

Multimedia Conference Control (mmcc) from ISI

Others: whiteboard (wb) from LBL, image (imm) from UH

Protocol Details

Internet:

Multicast IP

Transport:

Don't use TCP (don't want reliability, flow control)

Do use UDP plus RTP or vat protocol

Real-time Transport Protocol (RTP):

Provides sequencing, timestamping, reception reports

No explicit retransmission or flow control mechanisms

Standardization effort by IETF Audio/Video Transport WG

Encoding Details

Audio encodings

- Uncompressed stream is 8Khz 8-bit μ-law (64Kb/s)
- Compressed data rates of 32Kb/s, 13Kb/s, 4Kb/s

Video encodings

- Typical resolution is 320x240 pixels, 8 or 24 bits
- Frame rate varies with image, bandwidth, system load (typical BW limit of 128Kb/s $=>$ frame rate $2-10$ f/s)
- Frame differencing and transform coding
- Typical compression ratio about 20:1

How much bandwidth is it?

- One source fits easily:
  - 200 Kb/s audio+video < 1.5 Mb/s << 45 Mb/s
- Very large compared to a 1 megabyte file transfer:
  - File transfer typically takes tens of seconds.
  - 1 MB = 40 seconds @ 200 Kb/s, but teleconferences may last minutes to hours
- Not very many calls compared to telephone company:
  45 Mb/s / 200 Kb/s = 225 simultaneous calls

  => *Need more capacity: "Information Superhighway"*

How well does MBONE work?

- MBONE works well on lightly loaded links
- Requires careful engineering to avoid duplicate tunnels over same physical path
- TCP is very polite — when real-time traffic induces losses, TCP slows down, effectively giving real-time priority
- Real-time traffic exposed some systematic packet loss in routers that was tolerated by TCP
- Results are certainly useful, but not as good as desired

What's the Problem?

Problem 1: *Powerful tools in the hands of naive users... Excessive audio and video traffic may cause an Internet meltdown.*

Problem 2: *Internet was designed for "best effort" delivery; Real-time traffic requires low delay and low packet loss rate.*

Points to Take Home

- Internet MBONE video is already useful
- Real-time service is coming, then Internet will work well
- Break out of the rigid circuit model (ISDN, Switched 56...)
  - Internet already reaches workstations
  - Flexible bridging in end systems instead of hubs
- Not just for executives, but for designers, engineers, etc.
- Target is wide-scale use — seminars, collaboration, individuals becoming broadcasters

  => *One-way cable distribution is not sufficient*

For More Information on MBONE

Anonymous FTP from **ftp.isi.edu**

file **mbone/faq.txt**

or WorldWide Web

http://www.research.att.com/mbone-faq.html