IP Multicasting and the MBONE

IT-3 Advances in Internetworking:
Supporting Multicasting
NETWORLD+INTEROP
Frankfurt, Germany
31 May 1995

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Overview

❏ IP Multicasting

- Service Model

- Routing protocols: RPF, DVMRP, MOSPF, PIM

- Tunnels

❏ MBONE

- Overview, History (Growth), Problems, Future

❏ References

- (some of the) available implementations
- useful URLs

Service Model (1)

❏ **Unicasting**: Transmitting a Packet to a single destination.

❏ **Broadcasting**: Transmitting a Packet to all destinations.

❏ **Multicasting**: Transmitting a Packet to a **Group** (of receivers).

> ⇨ **Ethernet multicasting**:
>
> - Group is encoded in the destination address of packets, it is an ethernet multicast-address.
>
> - Packet is received by all hosts on ethernet who want to receive the group. Efficient delivery through packet filtering on address in ethernet controller hardware possible.
>
> ⇨ **Disadvantages**:
>
> - Works only in a local ethernet, not in the global Internet.
>
> - Bridges do not know receivers, multicast packet has to be broadcasted to every segment

Service Model (2)

❏ **IP Multicasting:**

Sending IP packets to group of receiving hosts in an IP internetwork.

- Efficient delivery to several hosts simultaneously, only one copy of the packet on every subnet that leads to a group member.
- Dynamic group membership, hosts may join and leave at any time.

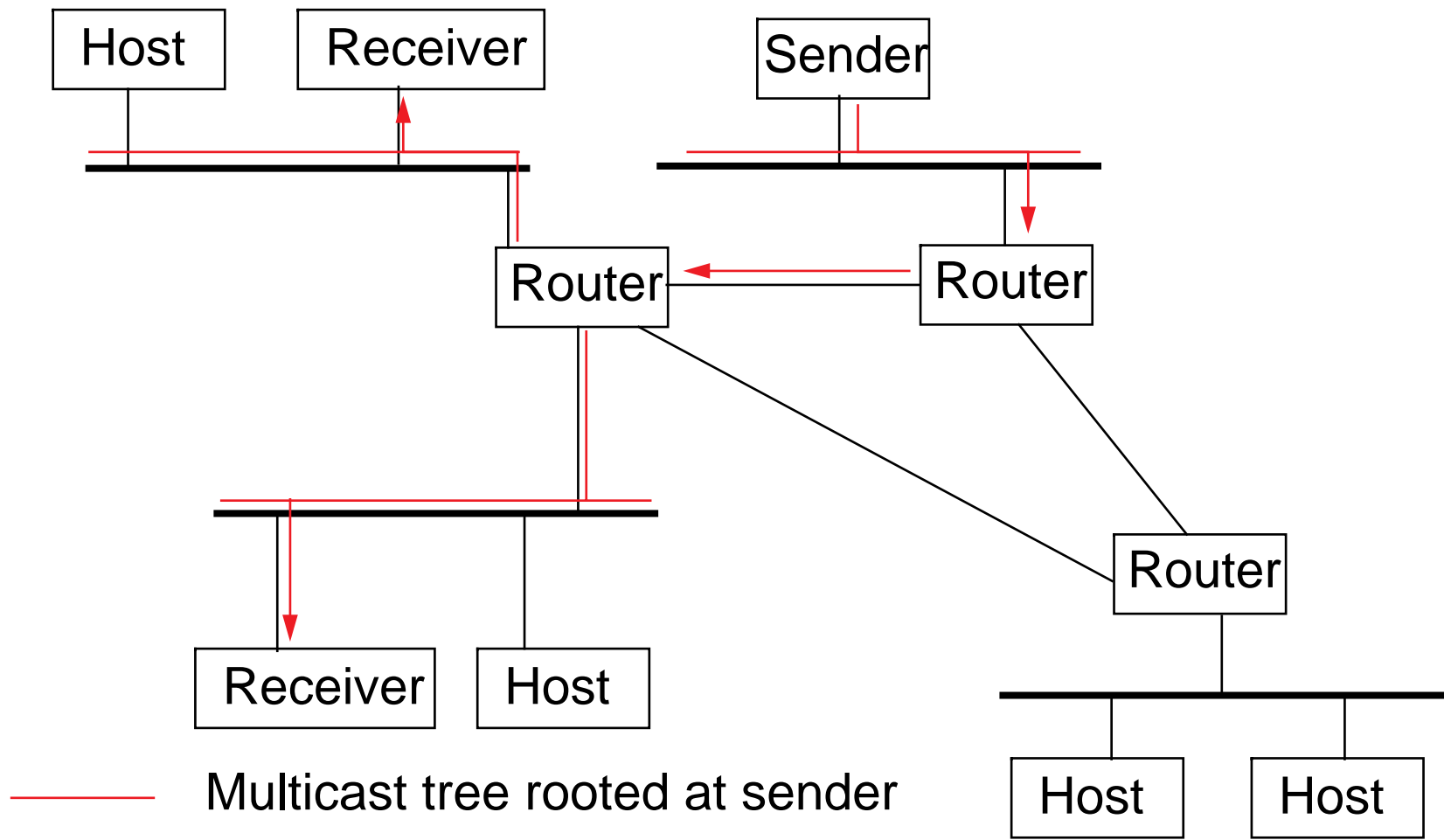❏ **Group Adresses (IP multicast addresses)**:

- IP Class D Adresses (224.0.0.0 to 239.255.255.255)

❏ **API (Unix):**

- Standard BSD socket interface using group addresses
- Service only supported for UDP (or similar datagram TPs)
- Some new socketoptions, eg:
  - IP_ADD_MEMBERSHIP, IP_DROP_MEMBERSHIP
  - IP_MULTICAST_TTL

Routing Example

Host   Receiver   Sender

Router   Router

Router

Receiver   Host

Host   Host

——— Multicast tree rooted at sender

Routing

❏ **Host support for IP Multicasting (RFC1112)**

- IP Multicast addresses are mapped to ethernet multicast addresses for delivery on local ethernet (01-00-5E-XX-XX-XX)

- **IGMP** - Internet Group Management Protocol, add-on protocol to IP (like ICMP) to announce interest in multicast groups, so routers know where group members are.

❏ **Router support for IP Multicasting**

- Host support (IGMP)

- Routing protocol for multicast traffic to calculate a loop-free multicast tree.

- Duplicate incoming multicast packets onto all appropriate outgoing interfaces for that sender and multicast group.

- Send out packet only if TTL of packet is larger than threshold configured for interface (to keep traffic geographically restricted)

Routing protocols (1)

❏ **RPF - Reverse Path Forwarding**

- Basic mechanism used in many multicast routing protocols: Duplicate and forward multicast packet to all interfaces except the one where the packet came from. Forward packet only if the incoming interface would be used to send unicast packets to the source of the multicast packet.

❏ **DVMRP - Distance Vector Multicast Routing Protocol**

- RIP adopted for multicasting. Based on refined RPF.

- Multicast packets are broadcasted onto every subnet, routers that find no group members on a leaf subnet send back *prune* messages that will cut back the multicast tree.

- New clients send *graft* messages to router to get multicast traffic.

- Without *prune* messages, packet hits all leaf routers.

Routing Protocols (2)

❏ **MOSPF: Multicast Open Shortest Path First**

- Adoption of OSPF for Multicasting.

- Causes less excess traffic than DVMRP.

❏ **PIM: Protocol Independent Multicast**

- Relies completely on unicast routing tables
 (DVMRP and MOSPF use own routing tables).

❏ **Dense Mode PIM**:

- Similar to DVMRP, traffic based pruning. Causes excess
  traffic after *prune* message times out (like DVMRP).

❏ **Sparse Mode PIM**:

- Different (complex) routing model. Traffic gets forwarded
  onto links only after explicit *graft* messages.

- Much better suited to large, sparsely populated networks.

Tunnels

Virtual links between remote routers to bypass intermediate routers not capable of multicasting

Internet
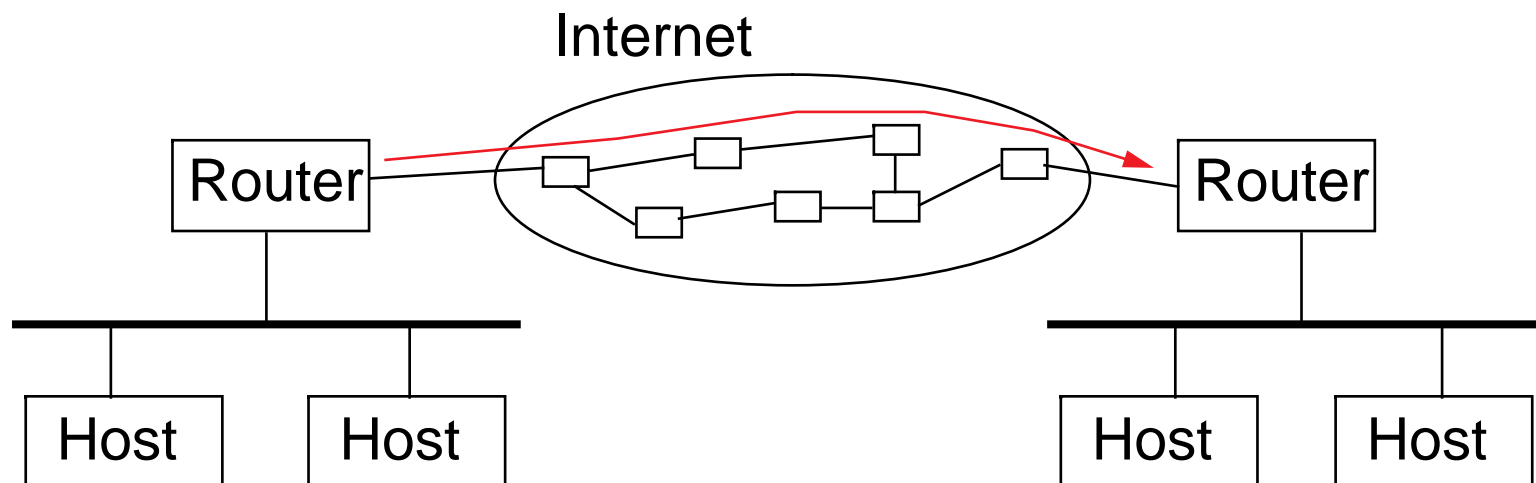
- Common scheme not only used for multicasting traffic.

- Initial tunnels used IP loose source route option (for tunnel destination)

  ⇨Intermediate routers could not switch these packets fast.

- Current DVMRP tunnels encapsulate multicast packets (IP proto 0x4)

# Overview

MBONE - The Multicast BackBONE on the Internet

❏ Experimental virtual overlay network for multicasting consisting of:

  • Multicast-capable islands interconnected by tunnels.

❏ MBONE routing protocol DVMRP in most parts,
DVMRP, MOSPF or PIM at the edges.

❏ Geographic regions separated by link thresholds:

  • Site: 16, Germany: 32, Europe: 48,
    World(video): 64, World(audio): 128, World(gsm): 192

❏ MBONE in most parts of Europe uses pruning, but not in USA.

❏ Management of multicast routers (workstations) often not by IP
service provider but by end users.

❏ Growing exponentially, doubling every 8 month.
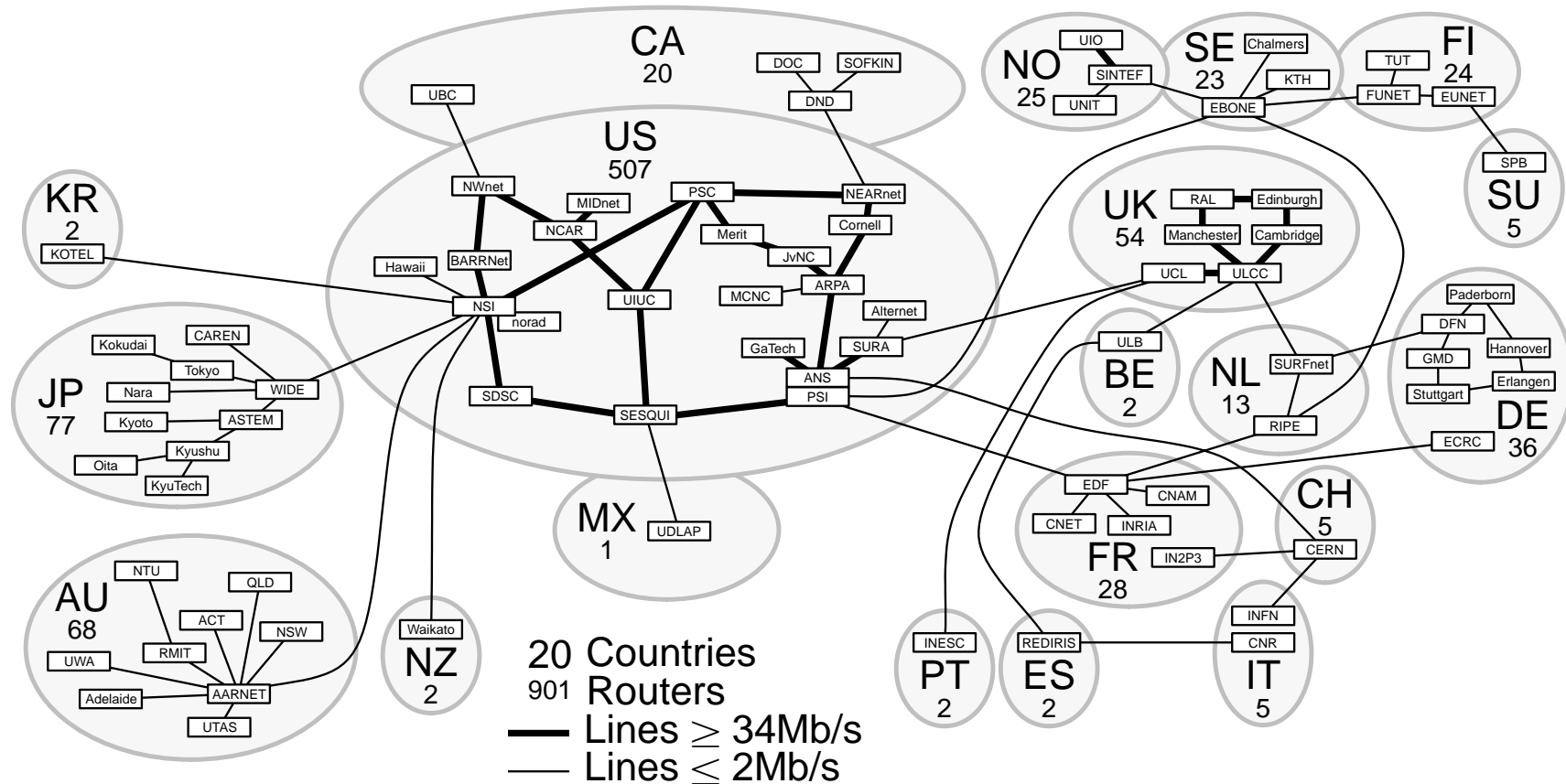
Growth (subnets)

❏ Current size of the MBONE (1'95):

About 1500 subnets in 30 countries with more than 20.000 users.

March 1993
San Diego IETF
32 sites in
4 countries
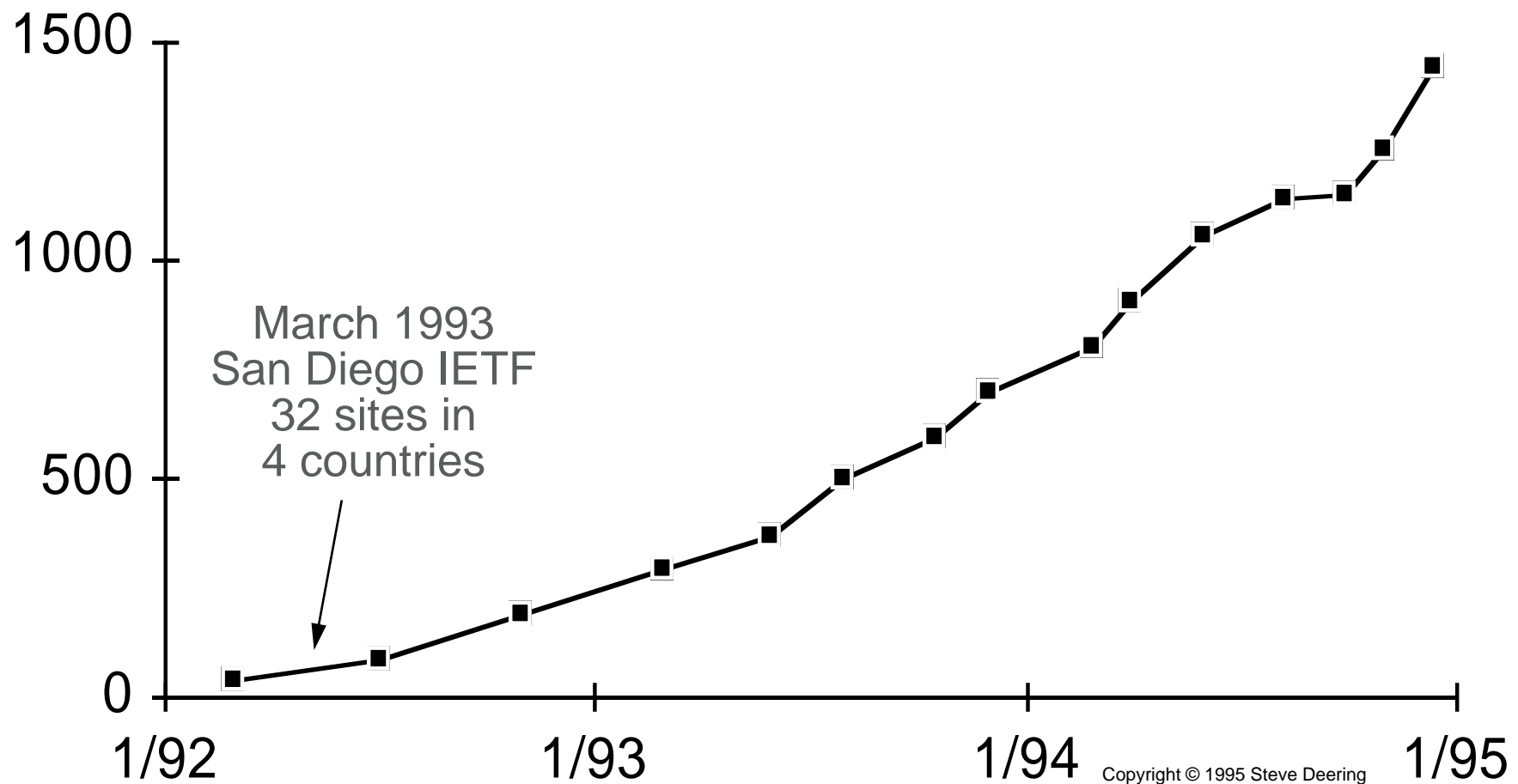
A historic map

Major MBONE Routers and Links, May 1994

20 Countries
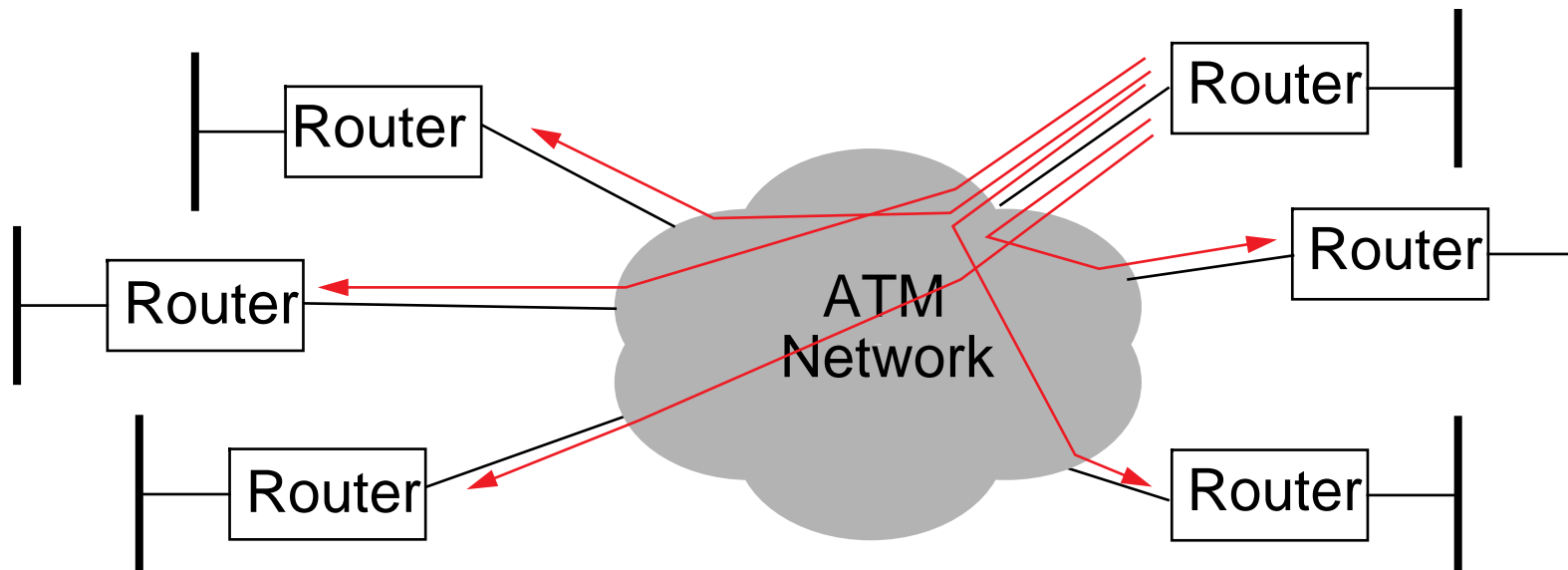901 Routers
Lines $\geq$ 34Mb/s
Lines $\leq$ 2Mb/s

Multicast on *cloud* subnets

❏ Backbone networks are often multi-access networks
  but without sufficient multicast capabilities:

  • ATM, Frame-Relay, SMDS, X.25

  • Multicast traffic must be transported through tunnels,
    but this does not scale.

⇨ **Solution**: Direct multicast support in the subnet technology (ATM).

Management

❏ **Management of multicast groups:** *First come first serve* (some registered under MCAST.NET domain though)

  ⇨ use random multicast group from SD (and pray).

❏ *Bandwidth management: common sense*

  ⇨ Restrict maximum bandwidth of multicast traffic on a link (512 kbps in the MBONE, not implemented everywhere).

  ⇨ Announce worldwide transmission on *rem-conf* mailinglist to reserve that timeslice.

❏ **Access management:** *If you flood the net we disconnect you*

  ⇨ Traffic limits in applications and access control in routers.

❏ **Quality of service management:** *It's still an experiment*

  ⇨ Better packet forwarding strategies needed

Future

❏ Increasing bandwith in backbone networks:

  ➭ More widespread use (especially in Europe).

❏ Deployment of pruning multicast delivery:

  ➭ Makes MBONE more interesting to 64 kbps (ISDN) users.

❏ Implementation of Multicast in commercial router software:

  ➭ Multicasting becomes an intrinsic service in backbone networks

  ➭ MBONE will go away

❏ Hierachical routing architecture needs to be deployed:

  ➭ Transition from DVMRP to (probably) sparse mode PIM in the backbone due to better scaling properties.

  ➭ Inter-domain and Intra-domain routing has to be deployed for multicasting

IP Multicast Availability

!! Not a complete list !!

❏ **IP Multicast host software**

   ⇨ Standard in Irix (SGI), Solaris 2.x (SUN), OSF/1 2.x (DEC)

   ⇨ Patches for SunOS 4.1.x, Ultrix, HP/UX 9.0.x, AIX

   ⇨ PC/TCP (FTP Software), patches for WATTCP, MacTCP ?

❏ **IP Multicast router software**

   ⇨ Mrouted 3.3 for SunOS 4.1.x (DVMRP with pruning)
       being ported to other platforms

   ⇨ Cisco (PIM sparse/dense mode + DVMRP glue)
       Catalyst Switch (IGMP)

   ⇨ Proteon (MOSPF + DVMRP glue)

   ⇨ Alantec Smart Hub bridge

Where to get further information

❏ **Mailinglists**:

➪ MBone: mailto://mbone@isi.edu>

➪ Germany: mailto://mbone-de@informatik.uni-erlangen.de>

➪ Conferencing: mailto://rem-conf@es.net> (traffic management)

❏ **Software**:

<ftp://parcftp.xerox.com/pub/net-research>

❏ **Docs**:

<ftp://gregorio.stanford.edu/vmtp-ip/sdthesis*> (*the* paper)
<ftp://venera.isi.edu/mbone/faq.txt> (also mbone mailing archive)

!!! Many more URLs for MBONE applications !!!