Collaborative Work on the Internet

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As of today, more than 10,000 people on 1500 networks in 30 countries are routinely using the Internet for collaborative work (audio, video and shared whiteboard).

Most of these people are computer scientists or engineers involved in network research.

You shouldn’t let them have all the fun.

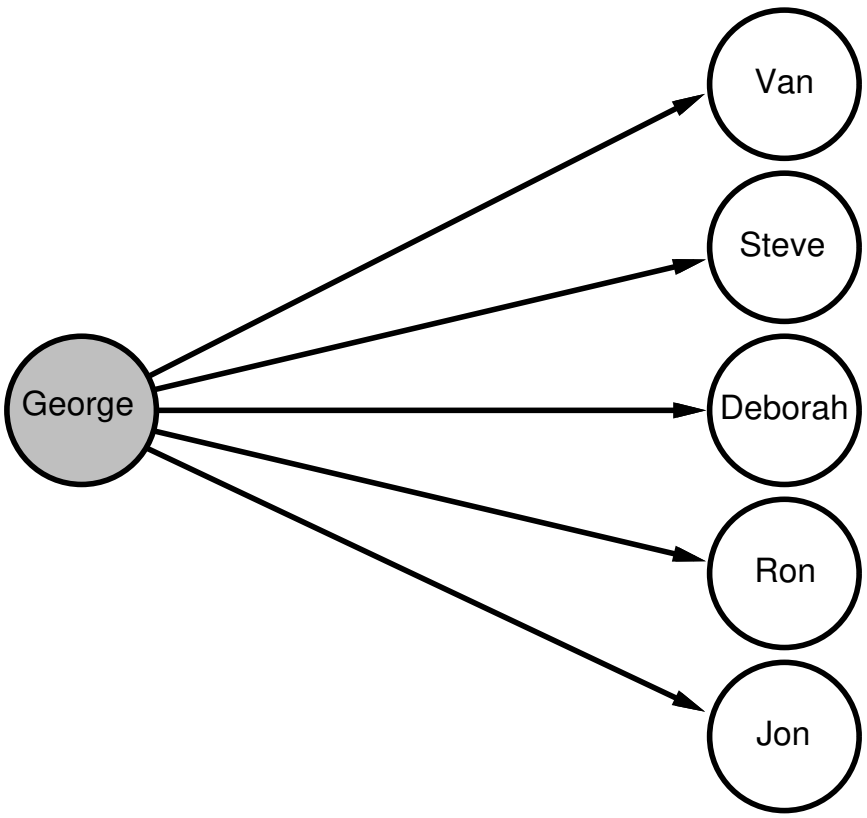
There has been research in packet audio and video for almost 20 years.

A lot of valuable lessons were learned but conferencing systems were hard to use and not very successful.

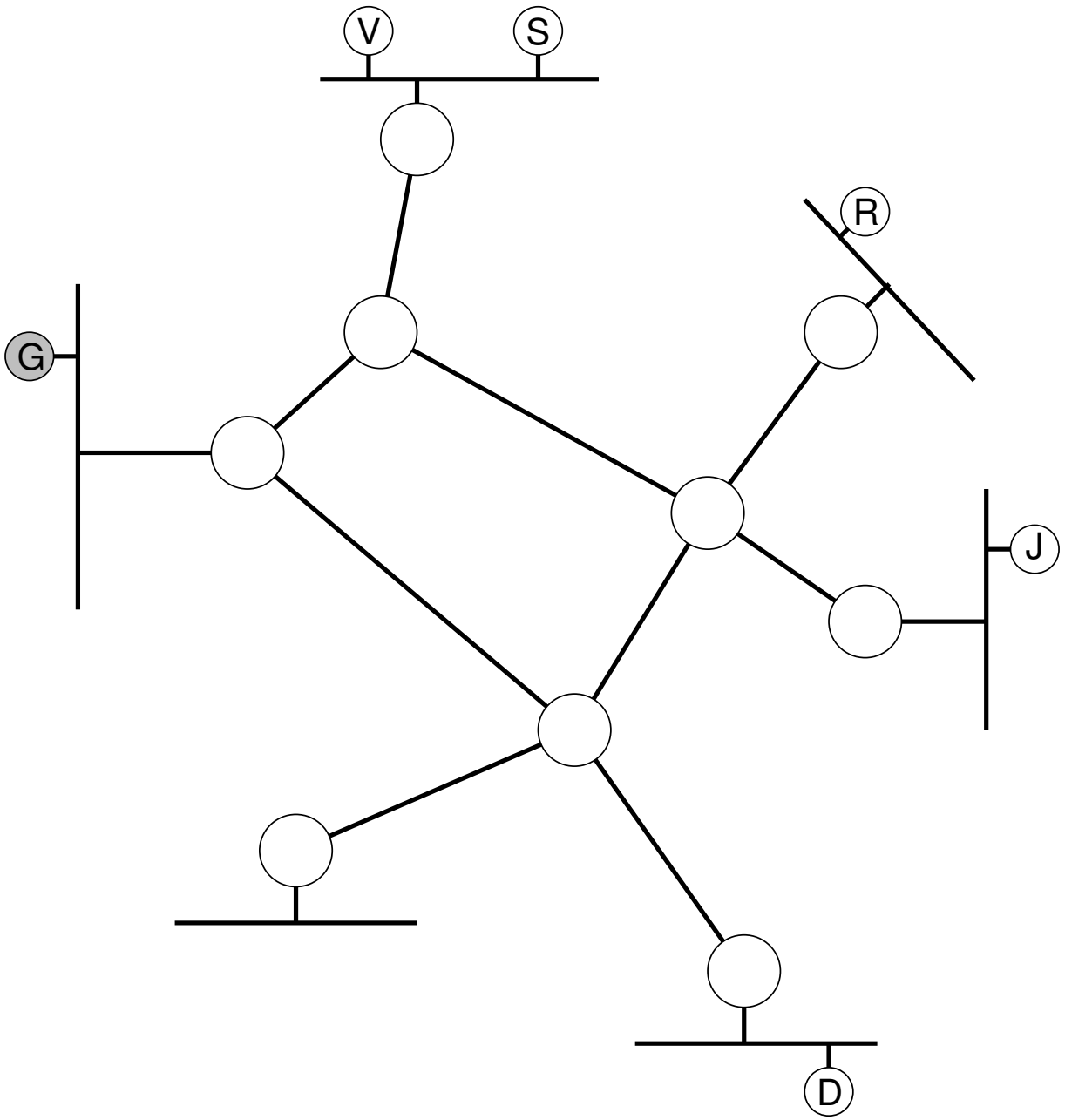
In hindsight, a core problem was that they were modeled on phone calls (the worst possible model for collaborative work).

Multi-party conversations are hard to set up.

I.e., sender thinks the world looks like this:



When in fact the topology is:



This results in multiple copies of data being sent across one link and demand on net will increase proportional to number of receivers. I.e., we won't be able to have large conferences.

Core problem: How to do efficient multipoint distribution (i.e., at most one copy of a packet crossing any particular link) without exposing topology to end-nodes.

Solution: Deering's IP Multicast

Dynamically constructs efficient, shortest-path, distribution trees from sender(s) to receiver(s).

Very simple service model:

- Receivers announce interest in some multicast address
- Senders just send to that address
- Routers conspire to deliver sender's data to all interested receivers.

IP Multicast developed by Steve Deering (Stanford, Xerox PARC) in 1988.

Had horrible chicken–egg problem getting it deployed.

In March ’92, Steve Deering and Steve Casner (USC/ISI) created a small, multicast ‘overlay’ of the Internet called the MBone (Multicast Backbone) then used it plus the vat audio tool (McCanne & Jacobson, LBL) to distribute an IETF meeting to 32 people in 4 countries.

Over next 9 months, they distributed audio and video from every IETF meeting which eventually suckered most major network providers into hooking up to MBone so they could participate in meetings.

By Dec. 92, the MBone reached 20 countries and IETF had over 300 remote participants. The network research community suddenly realized the MBone existed and every major conference and meeting since has been broadcast.

These days there are several events a day ranging from seminars and conferences to Space Shuttle flights to Jazz and Rock bands.

There are also dozens of small, private meetings of distributed research collaborations.

The MBone is growing exponentially, like the Internet, but almost twice as fast (a doubling time of around 8 months).

But, since the MBone is still an ‘overlay’ on the Internet (multicast routers are distinct from normal, unicast routers), it’s not trivial to get hooked up and requires cooperation from local and regional network people.

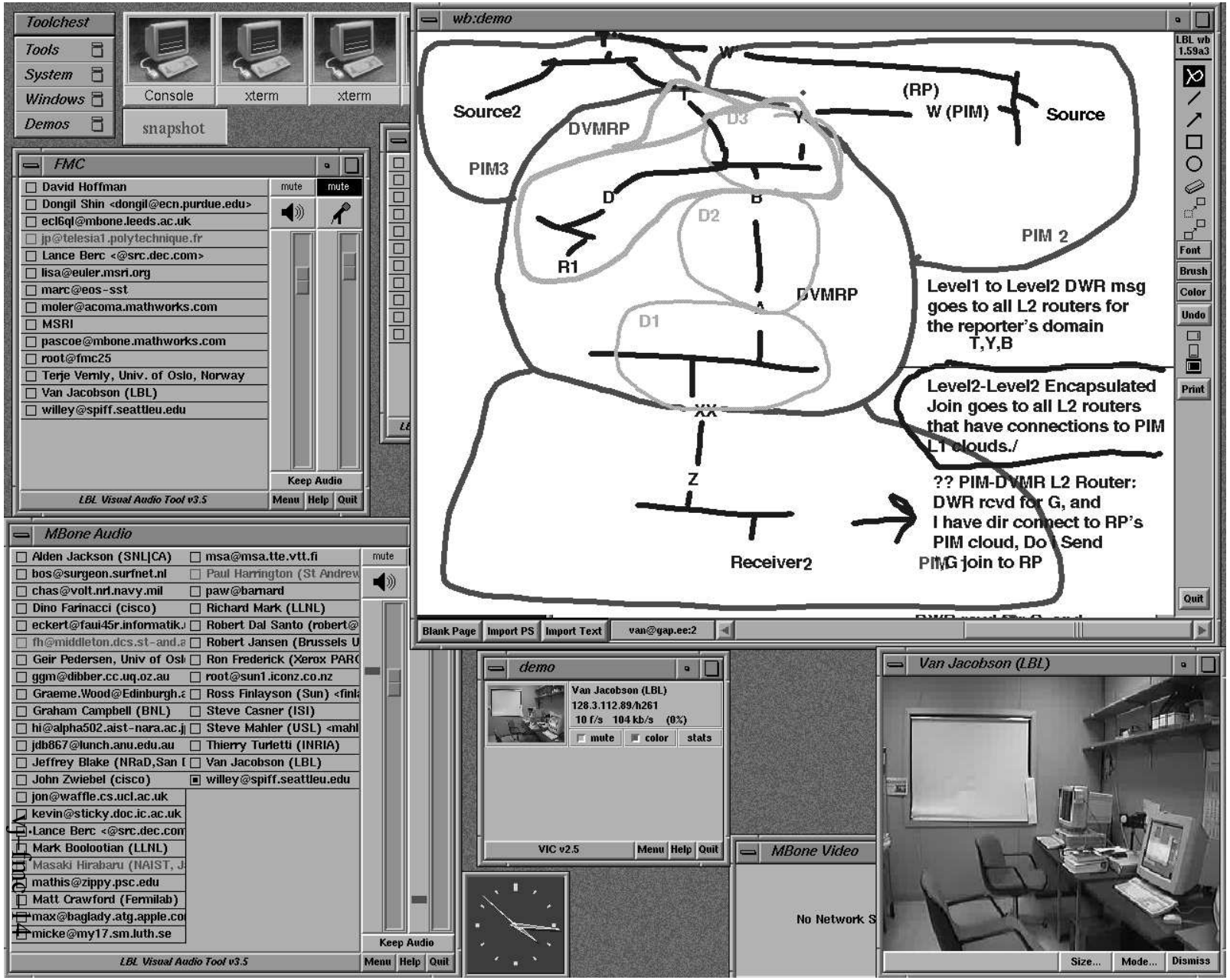
All that is about to change. Most major router vendors now support IP multicast (e.g., cisco just released it with v10.2).

In the next year we should see the MBone go away as a distinct entity as we evolve to ubiquitous multicast support throughout the Internet.

That will mean that anyone hooked to the Internet can participate on conferences with everyone else hooked to the Internet.

We (Steve McCanne, Sally Floyd and me) developed an architecture for conferencing using IP multicast and we developed four tools based on that architecture:

- vat (**V**isual **A**udio **T**ool)
- vic (**Vi**deo **C**onferencing)
- wb (distributed **W**hite**b**oard).
- sd (**S**ession **D**irectory) to tie everything together.


Toolchest
Tools
System
Windows
Demos
Console
xterm
xterm
snapshot
FMC
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jp@telesia1.polytechnique.fr
Lance Berc <@src.dec.com>
lisa@euler.msri.org
marc@eos-sst
moler@acoma.mathworks.com
MSRI
pascoe@mbone.mathworks.com
root@fmc25
Terje Vernly, Univ. of Oslo, Norway
Van Jacobson (LBL)
willey@spiff.seattleu.edu
mute
mute
Keep Audio
LBL Visual Audio Tool v3.5
Menu
Help
Quit
MBone Audio
Alden Jackson (SNL|CA)
bos@surgeon.surfnet.nl
chas@volt.nrl.navy.mil
Dino Farinacci (cisco)
eckert@faui45r.informatik.
fh@middleton.dcs.st-and.a
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Robert Jansen (Brussels U
Ron Frederick (Xerox PARC
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Ross Finlayson (Sun) <finl
Steve Casner (ISI)
Steve Mahler (USL) <mahl
Thierry Turletti (INRIA)
Van Jacobson (LBL)
willey@spiff.seattleu.edu
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Keep Audio
LBL Visual Audio Tool v3.5
Menu
Help
Quit
wb:demo
LBL wb 1.59a3
Font
Brush
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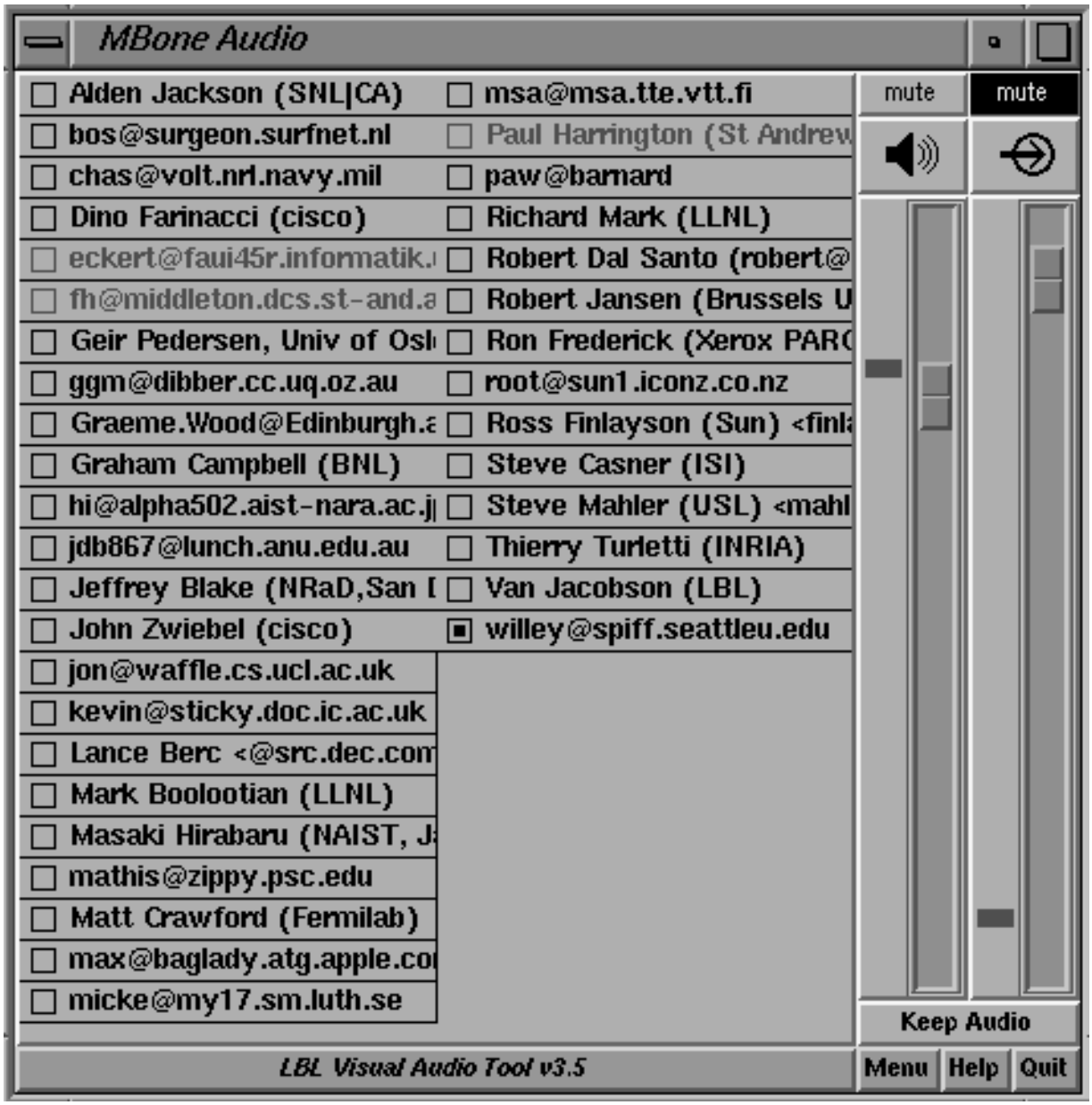
Quit
Source2
DVMRP
PIM3
W
T
D3
Y
(RP)
W (PIM)
Source
D
B
D2
PIM 2
R1
DVMRP
D1
XX
Z
Receiver2
Level1 to Level2 DWR msg goes to all L2 routers for the reporter's domain T,Y,B
Level2-Level2 Encapsulated Join goes to all L2 routers that have connections to PIM L1 clouds./
?? PIM-DVMR L2 Router: DWR rcvd for G, and I have dir connect to RP's PIM cloud, Do I Send PIM G join to RP
Blank Page
Import PS
Import Text
van@gap.ee:2
demo
Van Jacobson (LBL)
128.3.112.89/h261
10 f/s 104 kb/s (0%)
mute
color
stats
VIC v2.5
Menu
Help
Quit
MBone Video
No Network S
Van Jacobson (LBL)
Size...
Mode...
Dismiss

Vat Audio Tool

- Supports full, n-way communication (everyone can both talk and listen).

- Works with the audio hardware built into every modern workstation. There's nothing extra to buy.

- Supports conferences of arbitrary size and an arbitrary number of simultaneous conferences.


MBone Audio
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Dino Farinacci (cisco)
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willey@spiff.seattleu.edu
mute
mute
Keep Audio
LBL Visual Audio Tool v3.5
Menu
Help
Quit

Vic Video Tool

- Allows people to send video of themselves or other interesting objects.

- Decodes and displays video using software so receives on any machine and doesn't require special hardware.

- No limit on number of video streams or conferences.

- Supports almost any cheap video capture card for sending (video capture starting to be standard on new workstations).

demo
LBL Video Lab
128.3.112.89/h261
9.4 f/s 122 kb/s (0%)
mute
color
stats
Steven McCanne (LBL)
128.3.112.148/nv
2.0 f/s 2 kb/s (0%)
mute
color
stats
VIC v2.5
Menu
Help
Quit
MBone Video
eb@indiana
193.62.83.80/nv
0 f/s 0 bps (0%)
mute
color
stats
roger@sis.pub.mil.se
193.241.212.69/nv
0 f/s 0 bps (0%)
mute
color
stats
VIC v2.5
Menu
Help
Quit
Steven McCanne (LBL)
Size...
Mode...
Dismiss

Wb Whiteboard Tool

- Allows arbitrary number of people to write, type and draw on a shared drawing window that mimics a whiteboard.

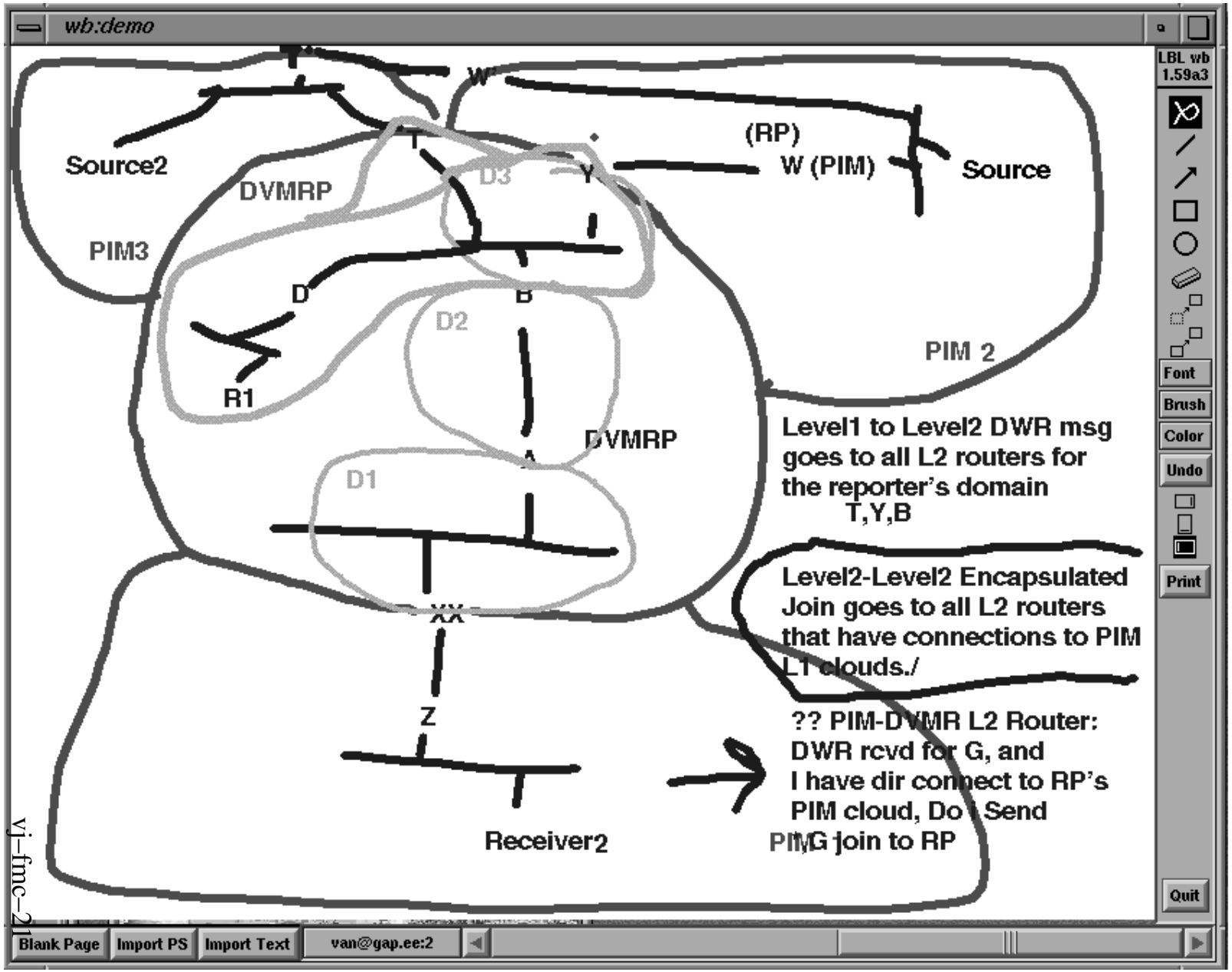
- Can import and distribute arbitrary postscript files (graphs, presentations, papers, whatever). The postscript can then be annotated by anyone and printed or saved.

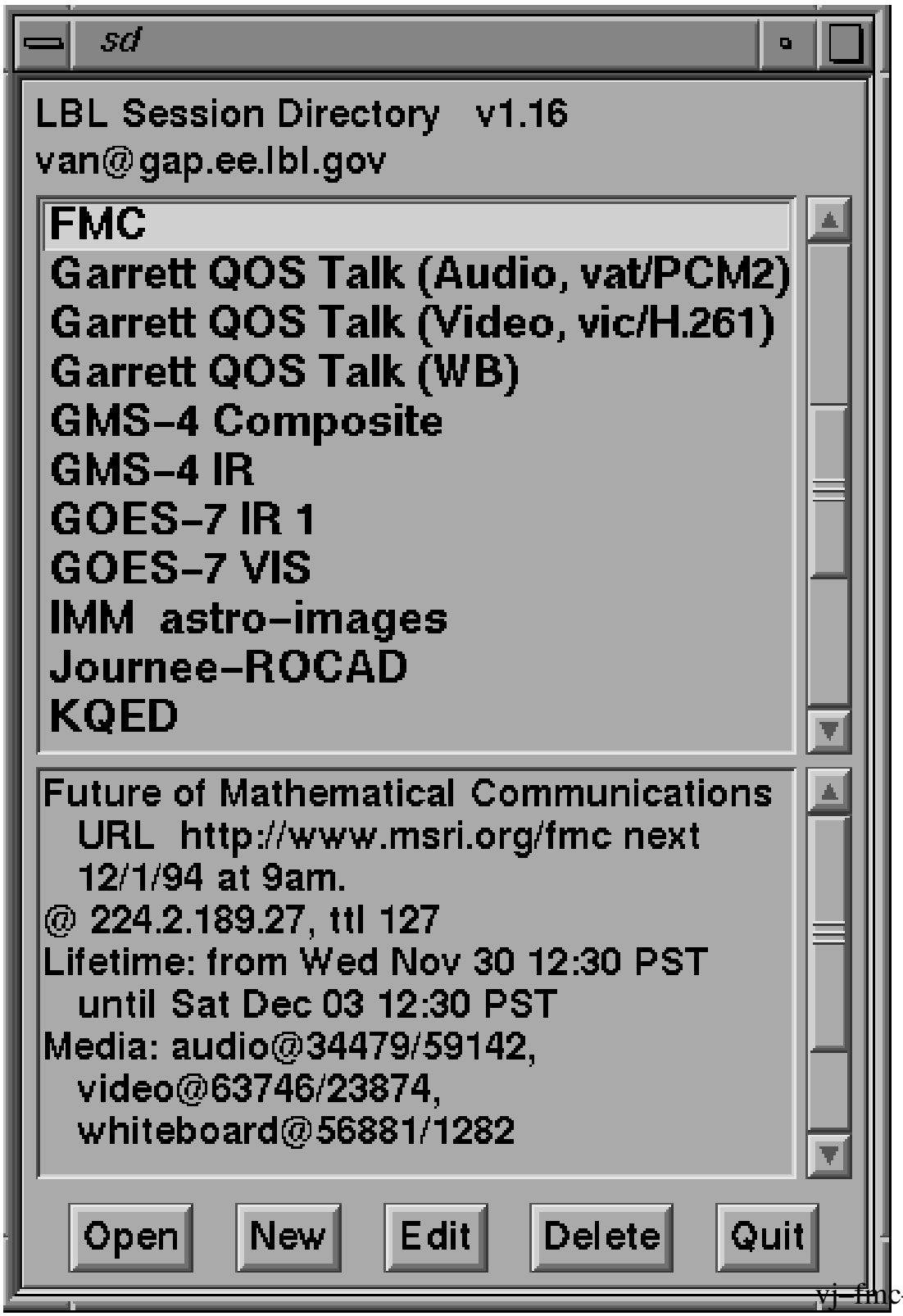
Whiteboard (cont.)

- Whiteboard can have arbitrary number of distinct pages and users can easily flip between pages.

- Everyone's drawing is persistent – you can scroll back in time for retrospection or to restart discussion from an earlier state.

- Can join or leave wb session at any time without losing any data.


wb:demo
LBL wb 1.59a3
Source2
DVMRP
PIM3
(RP)
W (PIM)
Source
D3
T
Y
D
B
D2
R1
PIM 2
DVMRP
D1
Level1 to Level2 DWR msg goes to all L2 routers for the reporter's domain T,Y,B
Level2-Level2 Encapsulated Join goes to all L2 routers that have connections to PIM LT clouds./
XX
Z
?? PIM-DVMR L2 Router: DWR rcvd for G, and I have dir connect to RP's PIM cloud, Do I Send PIM join to RP
Receiver2
Font
Brush
Color
Undo
Print
Quit
Blank Page
Import PS
Import Text
van@gap.ee:2


sd
LBL Session Directory v1.16
van@gap.ee.lbl.gov
FMC
Garrett QOS Talk (Audio, vat/PCM2)
Garrett QOS Talk (Video, vic/H.261)
Garrett QOS Talk (WB)
GMS-4 Composite
GMS-4 IR
GOES-7 IR 1
GOES-7 VIS
IMM astro-images
Journee-ROCAD
KQED
Future of Mathematical Communications
URL http://www.msri.org/fmc next
12/1/94 at 9am.
@ 224.2.189.27, ttl 127
Lifetime: from Wed Nov 30 12:30 PST
until Sat Dec 03 12:30 PST
Media: audio@34479/59142,
video@63746/23874,
whiteboard@56881/1282
Open
New
Edit
Delete
Quit

sd
Name:
Description:
Address:
224.2.208.208
Port
ID
Audio
59462
19400
Video
Whiteboard
Scope
Site (31)
Region (63)
World (127)
Lifetime
Starts:
today
at:
05:00
for:
2 hours
Create
Cancel

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Alden Jackson (SNL|CA)
msa@msa.tte.vtt.fi
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