Plan 9

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Synchronization

- Survey
  - How many have installed *nix on a box?
    - Windows?
  - How many have done an upgrade?
  - How many have a personally owned box with multiple users?
    - Done an upgrade?
  - What does “PC” stand for?
- Today: Plan 9 from Bell Labs

Synchronization

- Friday
  - “Review session”
  - Your chance to “review” me

Overview

- What style of computing?
  - The death of timesharing
  - The “Unix workstation problem”
- Design principles
- Runtime environment
- File servers (TCP file system)
- Name spaces

Timesharing

- One computer per ...
  - City: Multics
  - Campus: IBM mainframe
  - Department: minicomputer
- Sharing, protection easy inside “the community”
- Administration amortized across user base
  - Printers, too...

The *Personal Computing* Revolution

- Consequence of the microprocessor
- Get *your own* machine!
- No more “disk quota”
- *You* decide which software is on the box
  - Upgrade whenever *you* want
- Great!

The Rallying Cry

- One of the Alto's most attractive features is that it does not run faster at night.
  - Butler Lampson?

The Personal Computing Disaster

- ***You*** do your own backups
  - Probably not!
- ***You*** do emergency security upgrades
  - Day or night!
- Sharing files is hard, risky
  - machine:/usr/... (until it retires)
- Every machine you use has different software

Hybrid Approach

- Centralize “the right” resources
  - Backed-up, easily-shared file systems
  - Complex (licensed) software packages
  - Version management / bug patches
- Access those resources from a fast local machine
- Which OS on the servers?
  - Don't care – black boxes
- Which OS on the workstation?

Workstation Operating Systems

- Unix?
  - Good: It's the system you're used to using
  - Bad: Administer it yourself
    - /etc/passwd, /etc/group, anti-relay your sendmail...
- Windows
  - Your very own copy of VMS!
  - Support for organization-wide user directory
  - Firm central control over machine
    - “install software” is a privilege

Workstation Operating Systems

- Mac OS 9
  - Your own ... whatever it was
- Mac OS X
  - Your own Unix system! (see above)
- VM/CMS or MVS!!!
  - IBM PC XT/370
  - Your own ***mainframe***!
    - You and your ***whole family*** can (must) administer it

The “Network Computer”

- Your own display, keyboard, mouse
- Log in to a real computer for your real computing
- Every keystroke, every mouse click over the net
  - Every font glyph...
- Also known as
  - Thin client, X terminal, Windows Terminal Services
- Once “The Next Big Thing”
- Thud

The Core Issues

- Who defines and administers resources?
- What goes across the network?
  - X terminal: keystrokes, bitmaps
  - AFS: files
- Are legacy OSs right for this job?

The Plan 9 Approach

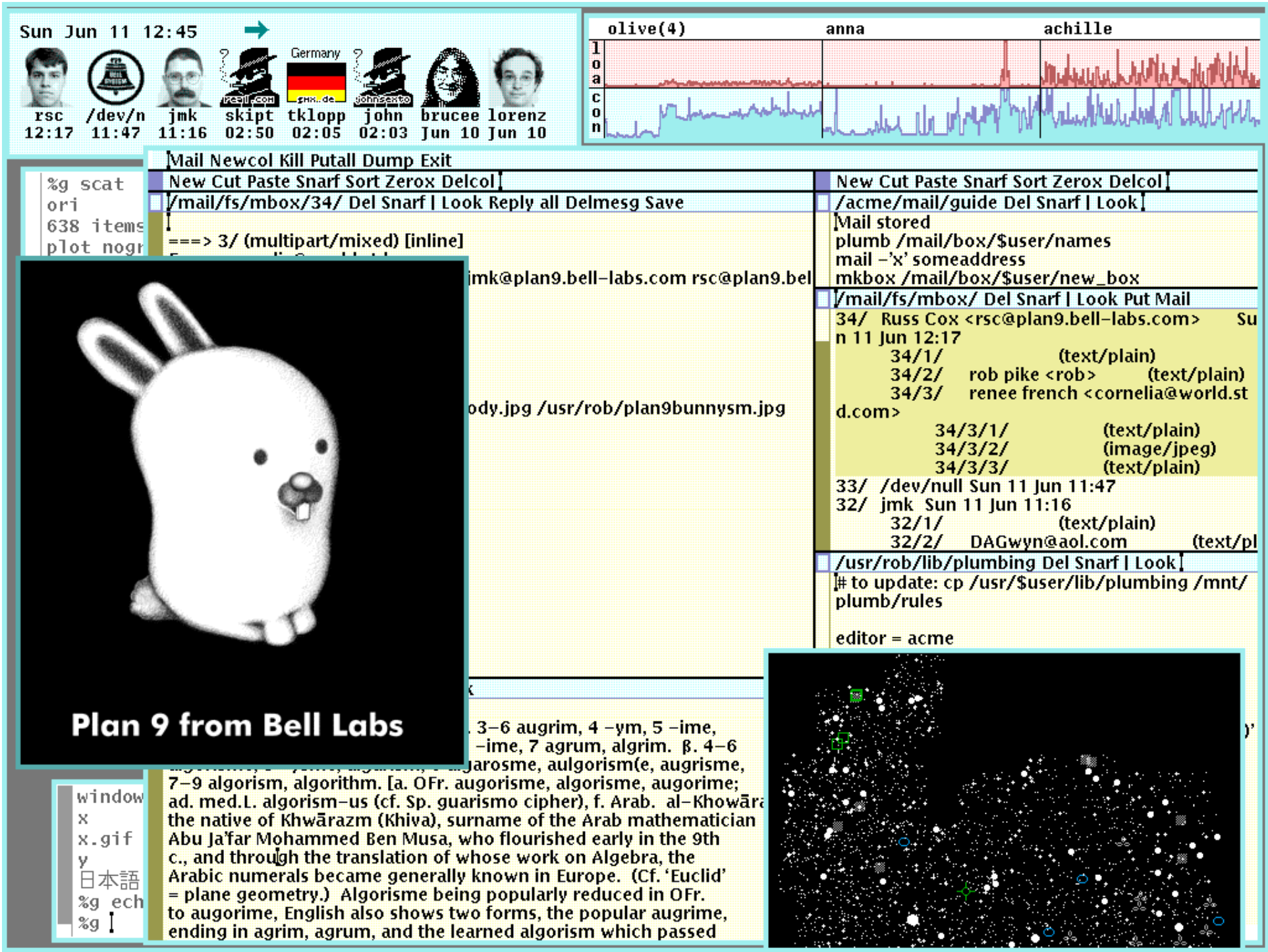
- “Build a UNIX out of little systems”
  - ...not “a system out of little Unices”
- Compatibility of essence
  - Not real portability
- Take the good things
  - Tree-structured file system
  - “Everything is a file”
- Toss the rest (ttys, ***signals***!!!)

Design principles

- Everything is a file
  - Standard naming system for all resources
- “Remote access” is the common case
  - Standard resource access protocol, 9P
- Personal namespaces
  - Naming ***conventions*** keep it sane
- A practical issue: Open Source
  - Unix source not available at the birthplace!

System Architecture

- Shared-memory multiprocessor ***cycle servers***
- Reliable machine-room ***file servers***
  - Plan 9's eternal versioned file system
- Remote-access workstation ***terminals***
  - Access your ***view*** of the environment
  - Don't ***contain*** your environment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jmk 11:16
skipt 02:50
tkloppe 02:05
john 02:03
brucee Jun 10
lorenz Jun 10
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olive(4)
anna
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Mail Newcol Kill Putall Dump Exit
New Cut Paste Snarf Sort Zerox Delcol
/mail/fs/mbox/34/ Del Snarf | Look Reply all Delmesg Save
===> 3/ (multipart/mixed) [inline]
/acme/mail/guide Del Snarf | Look
Mail stored
plumb /mail/box/$user/names
mail -'x' someaddress
mkbox /mail/box/$user/new_box
/mail/fs/mbox/ Del Snarf | Look Put Mail
34/ Russ Cox <rsc@plan9.bell-labs.com> Sun 11 Jun 12:17
34/1/ (text/plain)
34/2/ rob pike <rob> (text/plain)
34/3/ renee french <cornelia@world.std.com>
34/3/1/ (text/plain)
34/3/2/ (image/jpeg)
34/3/3/ (text/plain)
33/ /dev/null Sun 11 Jun 11:47
32/ jmk Sun 11 Jun 11:16
32/1/ (text/plain)
32/2/ DAGwyn@aol.com (text/pl
/usr/rob/lib/plumbing Del Snarf | Look
# to update: cp /usr/$user/lib/plumbing /mnt/plumb/rules
editor = acme
Plan 9 from Bell Labs
7–9 algorism, algorithm. [a. OFr. augorisme, algorisme, augorime;
ad. med.L. algorism-us (cf. Sp. guarismo cipher), f. Arab. al-Khowārā
the native of Khwārazm (Khiva), surname of the Arab mathematician
Abu Ja'far Mohammed Ben Musa, who flourished early in the 9th
c., and through the translation of whose work on Algebra, the
Arabic numerals became generally known in Europe. (Cf. 'Euclid'
= plane geometry.) Algorisme being popularly reduced in OFr.
to augorime, English also shows two forms, the popular augrime,
ending in agrim, agrum, and the learned algorism which passed

Custom Namespaces

- /bin/date means ***your architecture***'s binary
- /dev/cons means ***your*** terminal
- Per-***window*** devices
- /mail/fs/mbox/25 is the 25th message in your box

The /bin File System

- Look, Ma, no $PATH!

```
% bind /sparc/bin /bin
% bind -a /rc/bin /bin
% bind -a /usr/davide/sparc/bin /bin
```

- /bin is a ***union*** directory
  - Each backing directory searched in order

/dev/tty vs. /dev/cons

```
% (process_foo <foo >bar ) >&errs
```

- What if process_foo wants to talk ***to the user?***
- Unix – magic device "/dev/tty"
  - When you open it, you actually open /dev/ttyXX
- Plan 9 – ***correct namespace*** contains /dev/cons
  - The right device is ***mounted as*** /dev/cons
  - By whoever runs you (window manager, login, ...)

Per-Window Devices

- X: a complex monolithic server somewhere
  - House of a thousand mysteries
  - ***Not*** on the 15-410 reading list: ICCCM
- Plan 9: Per-***window*** devices
  - /dev/screen, /dev/mouse, /dev/cons
  - /dev/label - window title
  - /dev/wdir – working directory

% echo top > /dev/wctl

The Serial-Port File System

- Look, Ma, no ioctl()!

```
% bind -a '#t' /dev
% echo b9600 > /dev/eia1ctl
% echo "foo" > /dev/eia1
```

The TCP File System

- Look, Ma, no finger command!

```
% cat /net/tcp/clone/ctl
44
% cd /net/tcp/44
% echo "connect 128.2.194.80!79" > ctl
% echo davide > data
% cat data
```

- Look, Ma, no NAT proxy setup!

```
% import gateway.srv /net/tcp
```

The /tmp Problem

- Unix /tmp: security hole generator
- Programs write /tmp/program.3802398
  - Or /tmp/program.$USER.3432432
- No name collision “in practice”
  - Unless ***an adversary*** is doing the practicing
  - ln -s /tmp/program.3802398 /.cshrc
  - Suggest a command line to a setuid root program...

Fixing /tmp

- No inter-user security problem if ***only one user***!
- Plan 9 /tmp is per-user
- Matches (sloppy) programmer mental model

Plan 9 3-Level File Store

- Exports one tree spanning many disks
  - Users bind parts of the tree into namespaces
- 3-level store
  - RAM caches disks, disks cache WORM jukebox
- Daily snapshots, available forever
  - /n/dump/1995/0315 is 1995-03-15 snapshot
  - Time travel without “restoring from tape”
  - Public files are ***eternally*** public – be careful!

Plan 9 Process Model

- New-process model
  - fork()/mount()/exec()
- System calls block
- Task/thread continuum via rfork()
  - Resources are shared/copied/new
    - Name space, environment strings
    - File descriptor table, memory segments, notes
  - rfork() w/o “new process” bit edits current process

Process Synchronization

- rendezvous(tag, value)
  - Sleeps until a 2nd process presents matching tag
  - Two processes swap values
  - “Tag space” sharing via rfork() like other resources
- Shared-memory spin-locks

Summary

- Files, files, files
  - “Plumber” paper
    - Programmable file server
    - Parses strings, extracts filenames
    - Sends filenames to programs
    - File, file, blah, blah, ho hum?
  - Isn't it cleaner than
    - Signals, sockets, RPC program numbers, CORBA?
- Not just another reimplementation of 1970

More Information

- http://www.cs.bell-labs.com/plan9dist/

Disclaimer

- A distributed system is a system in which I can't do my work because some computer has failed that I've never even heard of.
  - Leslie Lamport