Campus-wide networked services

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ABSTRACT

Brunel's network services philosophy is described. Some of the techniques used to implement the philosophy are explained, with particular reference to 'personal' computers.

Philosophy

At Brunel we aim to provide a wide range of computing services to the staff and students of the University. We try to arrange that all services are available to all users at all locations, and that the way each service is used is identical on all machines of a given type.

The whole service is operated as a single entity, even though it spans two main sites, tens of departments, over 1000 machines, and 7500 users. This means that each user has *one* username, *one* password, *one* home directory and filestore quota, and *one* mailbox. Users can switch between Unix, DOS, and (to a lesser extent) Mac, and find all their files and other resources 'already there'.

This 'single system image' philosophy extends to machines and software packages: all machines of a given type have identical configurations, and all software is set up to work on every machine that it is compatible with. Users are not aware of the actual location of the software, and can sit down and work at any machine on the Brunel network.

How it is done

1. Simplify the problem

The Computer Centre has comparatively few staff and must support an ever-growing population of users and machines. We have used many ideas from Project Athena at MIT[TREESE88] to design a system that can grow without consuming support effort in proportion to its size.

One important simplification is limiting the number of different machine-types that we support. The current list is:

Current: SPARC running SunOs 4.1.x
Trigem 386/486 PCs running MSDOS 5 and Windows 3.1

Obsolescent:
Sun-3
Early PCs
early DOS

Developing:
SPARC running Solaris 2.x

We do permit other types of machine on the network, but only on the understanding that the user must do the work to make them conform to campus standards. The biggest category is Apple Mac, where the Centre does provide some advice and puts users in touch with others who have already connected their machines. There are also small numbers of VAX/VMS, SGI, IBM, and Archimedes machines.

Another important simplification is to limit the number of network protocols in use. All critical services are based on the Internet Protocols, though one or two others are tolerated where necessary.

2. Central Configuration, Distributed Resources

There is no 'central computer' or 'central fileserver' - we prefer to spread the load between a number of machines, some in the Centre and some located in other buildings. There *is* a central point of configuration for each service. Each 'namespace' has a single master copy, and is automatically replicated if necessary.

We use NIS (Yellow Pages) as the access and distribution mechanism for most configuration data. Name-to-address translation is handled by DNS, though many machines access this information through NIS servers.

The filestore is provided by Unix NFS servers, and is managed by Amd, the public-domain automounter. This allows us to refer to files and directories by the same names on all machines. PCs have a program called 'mount' which uses data from NIS to provide a similar facility for DOS.

3. An identical setup for all users

Before using *any* Brunel computer, a user must login with a valid username and password. All logins are recorded. At login time a standard environment is constructed, which the user can then tailor if they wish.

On Unix machines, all users are given *csh* as their default shell, so the environment is built by the `'.login'` and `'.cshrc'` files. These normally have only one line, to 'source' a file from a centrally-maintained directory. If the user wishes to modify the environment they add lines to their dot-files *after* the 'source' line. This ensures that PATH and other important variables can be changed centrally to allow for changes in the operating environment.

On DOS machines a series of 'batch' files are run, starting with a centrally-maintained one and ending with one under the user's home directory. The early files are responsible for things like locating the user's home-directory and mounting it on drive 'H', setting a default PATH and reporting on filestore quota. Later files affect groups or individual users.

The DOS 'login' 'mount' and 'quota' programs were written at Brunel and are available by anonymous FTP from the `pub` directory of `src.brunel.ac.uk`

4. Group machines into classes

It would be very convenient if every machine could be identical, as then a single configuration could be used everywhere. This is not possible in practice, but machines can be classified by their major function and then managed as classes rather then individual units. The important classes are:

General-purpose server
: This is the class that most 'fileservers' are built from. Each machine supports an NIS server, a DNS server, PCNFSD, POPD, RARPD, and exports an NFS spool area for PC printing. Servers also act as IP routers to make PCNFS configuration easier.

Unix client
: These are normally workstations or 'interactive services'.

DOS
: A DOS machine running PCNFS. Some of these are in public areas and have protected hard-disks. Others are in staff offices.

Subclasses can be established where necessary, inheriting most behaviour from the main class but with some variations. For example, a 'classroom workstation' might run a screensaver and reboot itself every night. Subclasses are particularly important for DOS machines, as only two or three printers can be made available at once and it is necessary to mount the 'nearest' public printer by default.

5. Group the software

Some software is needed by everyone on all machines. Some is commonly needed but only licensed for a few machines. Most is used occasionally by only a few users.

It is not possible to make all commands of all packages available all the time, because too many of the command names clash. A solution to this problem under Unix was developed at Brunel[FINDLAY90] and has now been extended to the DOS environment. It is based on a command called 'use', which 'attaches' a package to the user's session. This mechanism handles the 100+ 'occasional-use' packages known to the Brunel network, while the more frequently-used packages are mounted in 'standard places' available at all times. The frequently-used software is replicated on several servers, and client machines use the closest available copy.

6. Specific services

6.1. Printing

All print queues are handled by Unix machines, and all have unique names that are known to all other machines on the network.

Each Unix machine updates its ‘printcap’ configuration every night, using data from a master config area. This ensures that new printers will be known everywhere within a day or two of being connected. DOS machines (and Macs with NFS/Share) can then mount any printer from any general-purpose server. PCNFSD has been modified to refuse print requests from anonymous users, and the Unix lpr/lpd programs have been modified for extended access control and printer accounting.

6.2. Mail

We run several (currently two) mailhubs with identical configurations. A pseudo-host called `ft-mailhost.brunel.ac.uk` * is registered in the DNS, listing all addresses of all mailhubs. Workstations, PCs, Macs, etc submit mail to this pseudo-host by SMTP. Mailboxes are kept in user home-directories,[FINDLAY88] so they can be read directly by user interfaces on any Unix machine, and accessed through POP or IMAP protocols from any other machine.

6.3. X.29 and Telnet

Two Unix machines have X.25 connections and run SPAD daemons. PAD calls from all Unix machines are tunnelled through TCP/IP to one or other of these servers. There is no X.29 support on DOS machines: most requirements are satisfied by telnet, or by logging into a Unix machine and making the call from there.

All parts of the network except halls of residence have full Internet routing, so telnet ‘just works’.

6.4. Information Services

Brunel currently has a small Gopher service, which is developing into the ‘CWIS’ role. We have clients for Unix/terminal, Unix/X, DOS, and (probably) Mac. The World-Wide-Web system[BERNERS-LEE ET AL92] is richer than Gopher, and may take over now that the Mosaic user interface is available. †
Links to other services such as the NISS Times database are added to the Gopher and Web setups where possible rather than pointing users at the NISS Gateway.

Where remote logins are needed (e.g. for BIDS) we use a command called ‘infoservice’ running on Unix. This checks that the user is permitted to use the service they have requested, and it then handles the connection and login phases. Users never have access to the passwords, which allows us to control use of the services in line with the license agreements. This command cannot easily be made available on DOS because there is no mechanism for using data that is not accessible directly by the user.

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* No comment...

† By anonymous FTP from `ftp.ncsa.uiuc.edu` in directory `Mosaic`

The Usenet News is held on one machine at Brunel and is made available over NFS and also by NNTP. We have clients for Unix/terminal, Unix/X, DOS, and (probably) Mac.

For the X.500 Directory, we have one master and one slave server. Clients are provided for Unix/terminal, Unix/X, DOS/Windows, and access is also available via Gopher.

All PCs with adequate hardware can run Vista eXceed, so graphical interfaces using X on Unix can be run from PCs.

Apple Macintosh

Macs are not supported by Computer Centre, but they do integrate reasonably well with the rest of the system. Many have NFS/Share installed: this is quite expensive but it does give full access to the campus filestore. MacTCP in conjunction with various public-domain programs provides E-Mail, News, Gopher, etc.

Some departments support small Mac clusters and connect them to the main network using Kinetics boxes or gateway processes running on Unix machines.

Summary of design principles

- Human effort must not increase in proportion to the number of machines, users, or services (!)
- Every service must have a single point of control.
- Services should continue to *run* even if the control point is down.
- Everything you can measure (except money) doubles about every 12 months.

References

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