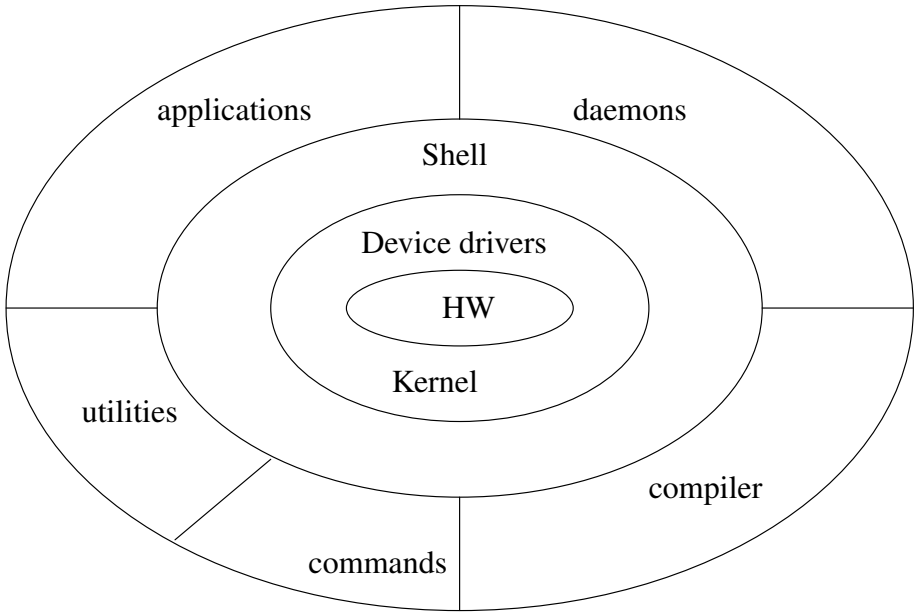
Operating system components



- compiler
  - `gcc`, `g++`, `gm2`, `gjc` and `gpc`.

Operating system components

- utilities
  - `emacs`, `vi`, and `fsck`.
- commands
  - `cp`, `mv`, and `tar`.
- applications
  - gnome, X windows, kde.
- shells
  - `bash`, `sh`, `csh`, `ksh` and `tsch`.

Further reading

- Mike Gancarz, “Linux and the UNIX Philosophy”, ISBN 1-55558-273-7, 2003
- Karl Fogel, “How to Run a Successful Free Software Project”, ISBN 0-596-10759-0, 2005

Modern Operating system requirements

- must exploit parallelism
- needs to be extremely portable

Very Brief Implications UNIX History

- Ken Thompson of AT&T invented UNIX in 1969 and it ran on a PDP-7
  - UNIX was based on Multics
  - one motivation for writing UNIX was to run a program called "space travel"
- Thompson borrowed ideas from Multics
- *Good programmers write great software; great programmers "steal"*
- notice how Thompson avoided the "not invented here" syndrome

Very Brief Implications GNU/Linux History

- split into two sections
  - the Linux kernel (which bridges the hardware/software interface)
  - and GNU utilities, compilers, shells, daemons, applications

Very Brief Implications Linux History

- Linus Torvalds a Finnish student at the University of Helsinki wrote Linux
- famous posting to `comp.os.minix` on 25 August 1991 read:
- ```
  Hello everybody out there... I'm doing a (free) operating system
  ```
- sealed his fate..
- initially Linux was not designed for portability
  - but only to run on the 386 architecture
  ```

Very Brief Implications Linux History

- started out as “for fun” to run `bash` and `gcc` on his “toy” operating system
  - Linus started by utilising the file system code of Minix in Linux
- later on he found that good design principles led the way to portability for purity’s sake alone
  - other people helped porting Linux to other architectures
- Linux initially used components of Minix (which was later totally replaced)
  - it also heavily used the `gcc` compiler extensions (such as assembly language in macros and header files)

Very Brief Implications Linux History

- again avoided the NIH syndrome, certainly “stole” the ideas of `UNIX`
  - pipes, sockets, files, IO etc.

GNU History

- the GNU project started in 1984 to develop a complete UNIX like operating system which is free software
  - “free” as in speech and but not as in beer
- Richard Stallman started the GNU project and began work upon `gcc`, `emacs` and `gdb`.
- all GNU software is licenced through the GPL

GNU History

- in the early days the each software component had to be complete written from scratch
  - so that it could be completely owned by the GNU foundation

- more recently, almost nothing is written from scratch anymore
  - as each new software component borrows heavily from other GNU software components

GPL designed to uphold Free Software

- it provides
- the freedom to run the program, for any purpose (freedom 0).
- the freedom to study how the program works, and adapt it to your needs (freedom 1)
  - access to the source code is a precondition for this.
- the freedom to redistribute copies so you can help your neighbour (freedom 2)
- the freedom to improve the program, and release your improvements to the public, so that the whole community benefits (freedom 3)
  - access to the source code is a precondition for this.

Software engineering implications of GPL

- liberally encouraged to “borrow” code from other projects
  - encouraged to re-factor borrowed code if you extend a project (rather than to duplicate code with minor variants)
- libraries are constructed at both the source level and also at the object level
  - tremendous productivity gain compared to closed source development
  - todays new GPL project can become tomorrows library of source code
- software engineers advocate code reuse - but often miss the most important component
  - source code reuse

UNIX Philosophy in a nutshell

- small is beautiful
  - small software programs are generally fast
  - they are often combined with other software programs in useful ways (often unseen by original author)
  - any advance in computer speed will have a noticeable effect on a small program
- make each program do one thing well
  - removes extraneous code, removes complexity and improves flexibility
- build a prototype as soon as possible
- choose portability over efficiency

UNIX Philosophy in a nutshell

- store data in flat text files
  - all configuration files are plain text
- use software leverage to your advantage
  - source code reuse
- use shell scripts where possible
  - try to avoid writing an equivalent C program
- avoid captive interfaces
- make every program a filter

UNIX and GNU/Linux culture/goals

- allow the user to tailor the environment
- make operating system kernels small and lightweight
  - not always achieved but certainly a goal
  - see GNU Hurd
- use lowercase and keep it short
- save trees
- silence is golden
- think parallel

UNIX and GNU/Linux culture/goals

- sum of the parts is greater than the whole
  - large applications are built from smaller programs (eg shell scripts)
- look for 90% solution
  - doing 90% of the solution is much easier and will satisfy 90% of the user base
- worse is better
  - inclusive and least common denominator is likely to survive
  - worse is likely to be cheaper and thus more popular
- think hierarchically

Software projects

- Fredrick Brookes in his land mark book “Mythical Man-Month, The: Essays on Software Engineering”, Anniversary Edition, 2/E, ISBN: 0-201-83595-9, 1995
  - defines three systems of Man

- man builds the first system with his back to the wall
  - no time to do it right
  - built by a small number of people
  - fuelled by excitement
  - first system is a “lean, mean computing machine”

Software projects

- second system of Man
  - built by so called experts
  - built by much design and attention
  - might capture the hearts and minds of millions of users

- experts sometimes exact revenge on the basic idea and “improve” some of the basic algorithms of the first system
  - often fall into the NIH syndrome

- second system designed by a committee
  - overweight software which is slow
  - does not yield huge benefits from increases in compute power

Software projects

- second system is a success and failure
  - extra features which users *might* use
  - big, slow and bug ridden software

Third system of Man

- built by people who have been burned by the second system
  - it usually involves a name change from the second system
  - original concept intact and is regarded as obvious
- third system combines the best characteristics of the first and second system
- the designers of the third system are usually given time to do it right

GNU and Linux is both a third and second system

- GNU and Linux came along during 1984..1991 when UNIX went through a tumultuous second system period
- UNIX was of the 1980s was definitely a second system
  - slow (applications rarely ran faster than their 1970s counterparts..)
- bickering over UNIX standards
  - AT&T
  - Sun
  - Open Software Foundation (no relation to open source - or GNU ..)

GNU and Linux is both a third and second system

- people tired of bloat of UNIX are happy with GNU/Linux
- best ideas of UNIX are found in GNU/Linux
- much of the implementation is written correctly
  - developers have had the time to write code correctly
- it also uses a name change
  - UNIX to GNU/Linux

GNU/Linux as a second system

- arguably it is using a second system methodology
  - namely OpenSource or Free Software
- remember these generate much excitement in some areas..
- but it is now becoming formalised by many books
  - many conferences, symposiums, journals etc

Producing a successful free software project

- choose a good name
- have a clear mission statement
- state that licence terms unambiguously
- list the features and requirements
- clearly state the development status
- provide easy access to source code
  - download a tar.gz file using http or ftp
  - allow the git repository to be browsable

Release often/release early

- do not be afraid to release early
  - do not be afraid to release often

- Eric Raymond in his landmark essay The Cathedral and the Bazaar ⟨`http://en.wikipedia.org/wiki/The_Cathedral_and_the_Bazaar`⟩ cites Linus Torvalds as sometimes releasing two kernels a day

Use software version control

- popular choices are git, svn
  - concurrent version system
- allows you to keep a project of many source files
  - each modification can be `push`ed to the `git` repository
- co-developers can obtain copies of the project at any time in its life
- developers may `clone` a complete git repository
  - examine changes between software revisions