

Unit OS1: Overview of Operating Systems

1.2. The Evolution of Operating Systems

Windows Operating System Internals - by David A. Solomon and Mark E. Russinovich with Andreas Polze

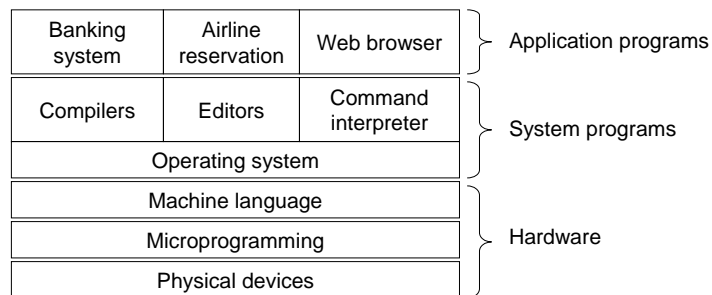
Roadmap for Section 1.2.

- History of Operating Systems
- Tasks of an Operating System
- OS as extension of the hardware
- Main concepts: processes, files, system calls
- Operating system structuring

3

Operating Systems Concepts

- System software manages resources
- OS hides complexity of underlying hardware
- Layered architectures



4

History of operating systems

- Batch processing

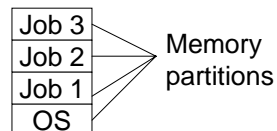
The elements of the basic IBM 1401 system are the 1401 Processing Unit, 1402 Card Read-Punch, and 1403 Printer.



- Punching cards programming



Multiprocessing



5

The Evolution of Operating System Functionality

- Batch Job Processing
 - Linkage of library routines to programs
 - Management of files, I/O devices, secondary storage
- Multiprogramming
 - Resource management and sharing for multiple programs
 - Quasi-simultaneous program execution
 - Single user
- Multiuser/Timesharing Systems
 - Management of multiple simultaneous users interconnected via terminals
 - Fair resource management: CPU scheduling, spooling, mutual exclusion
- Real-Time Systems (process control systems)
 - Management of time-critical processes
 - High requirements with respect to reliability and availability

6

Tasks of an Operating System

- Processor management - Scheduling
 - Fairness
 - Non-blocking behavior
 - Priorities
- Memory management
 - Virtual versus physical memory, memory hierarchy
 - Protection of competing/concurrent programs
- Storage management – File system
 - Access to external storage media
- Device management
 - Hiding of hardware dependencies
 - Management of concurrent accesses
- Batch processing
 - Definition of an execution order; throughput maximization

7

Kernel- and User Mode Programs

Typical functionality implemented in either mode:

Kernel:

- Privileged mode
- Strict assumptions about reliability/security of code
- Memory resident
 - CPU-, memory-, Input/Output management
 - Multiprocessor management, diagnosis, test
 - Parts of file system and of the networking interface

User Space:

- More flexible
- Simpler maintenance and debugging
 - Compiler, assembler, interpreter, linker/loader
 - File system management, telecommunication, network management
 - Editors, spreadsheets, user applications

8

Layered Model of Operating System Concepts

nr	name	typical objects	typical operations
1	Integrated circuits	register, gate, bus	Nand, Nor, Exor
2	Machine language	instruction counter, ALU	Add, Move, Load, Store
3	Subroutine linkage	procedure block	Stack Call, JSR, RTS
4	Interrupts	interrupt handlers	Bus error, Reset
5	Simple processes	process, semaphore	wait, ready, execute
6	Local memory	data block, I/O channel	read, write, open, close
7	Virtual model	page, frame	read, write, swap
8	Process communication	channel (pipe), message	read, write, open
9	File management	files	read, write, open, copy
10	Device management	ext.memory, terminals	read, write
11	I/O data streams	data streams	open, close, read, write
12	User processes	user processes	login, logout, fork
13	Directory management	internal tables	create, delete, modify
14	Graphical user interface	window, menu, icon	OS system calls

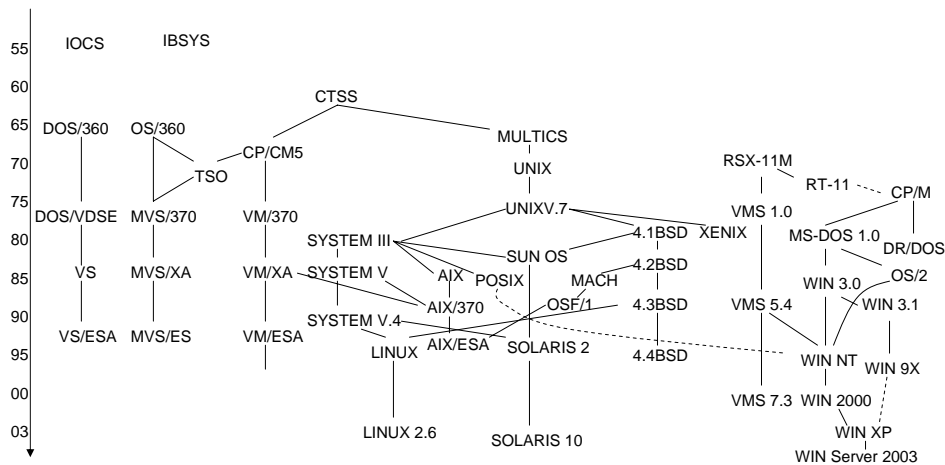
9

OS acts as Extension of Hardware

- System view: layered model of OS
 - Implementation details on one layer are hidden from higher layers
- Same machine, different operating systems:
 - IBM PC: DOS, Linux, NeXTSTEP, Windows, SCO Unix
 - DEC VAX: VMS, Ultrix-32, 4.3 BSD UNIX
- Same OS, different machines: UNIX
 - PC (XENIX 286, APPLE A/UX)
 - CRAY-Y/MP (UNICOS - AT&T Sys V)
 - IBM 360/370 (Amdahl UNIX UTS/580, IBM UNIX AIX/ESA)
- Windows NT, XP, 2000, 2003
 - Intel i386 (i486 an NT 4.0), Alpha, PowerPC, MIPS, Itanium

10

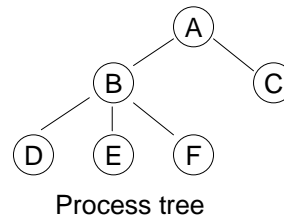
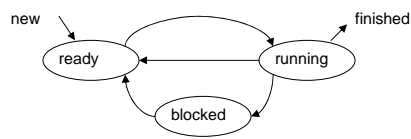
Operating Systems Evolution



11

Main Concepts: processes

- Processes, process table, core image
- Command interpreter, shell
- Child processes

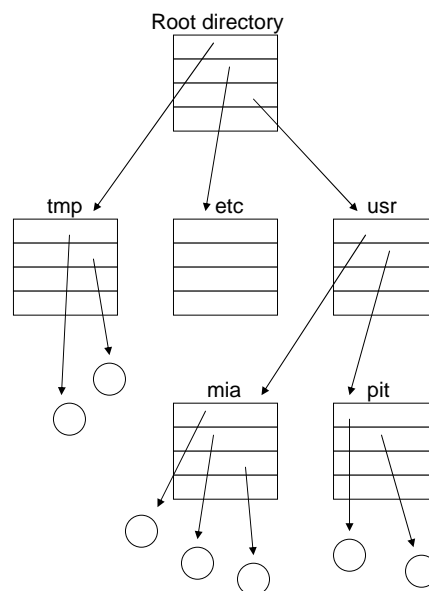


- Scheduling, signals
- User identification, group identification

12

Main Concepts: Files

- Files, directories, root
- Path, working directory
- Protection, rwx bits
- File descriptor, handle
- Special files, I/O devices
- Block I/O, character I/O
- Standard input/output/error
- pipes



13

Main concepts: system calls

- User programs access operating system services via system calls
- Parameter transmission via trap, register, stack
 - count=read(file, buffer, nbytes);*
- 5 general classes of system calls:
 - Process control
 - File manipulation
 - Device manipulation
 - Information maintenance
 - communications

14

Main concepts: shell

- Command interpreter
- Displays prompt, implements input/output redirection
- Background processes, job control, pseudo terminals

\$ date

\$ date >file

\$ sort <file1 >file2

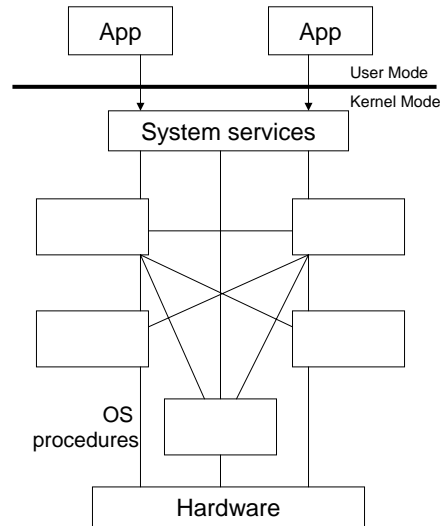
\$ cat file1 file2 file3 > /dev/lp1

\$ make all >log 2>&1 &

15

Structuring of Operating Systems

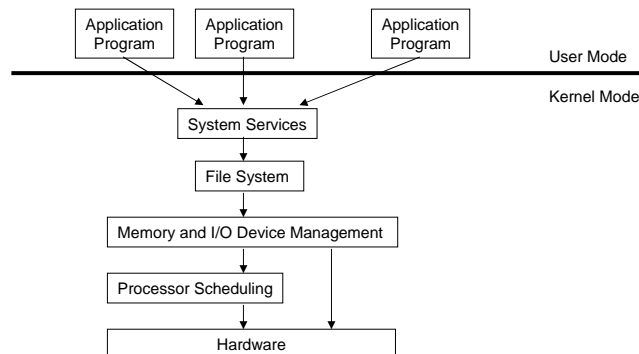
- **Monolithical systems**
- Unstructured
- Supervisor call changes from user mode into kernel mode



16

Layered OS

- Each layer is given access only to lower-level interfaces



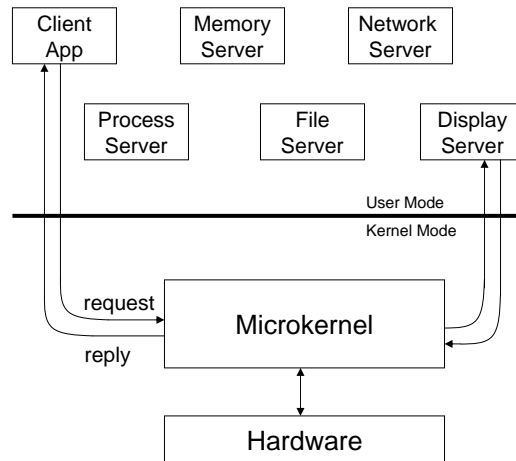
17

Microkernel OS (Client/server OS)

Kernel implements:

- Scheduling
- Memory Management
- Interprocess communication (IPC)

User-mode servers

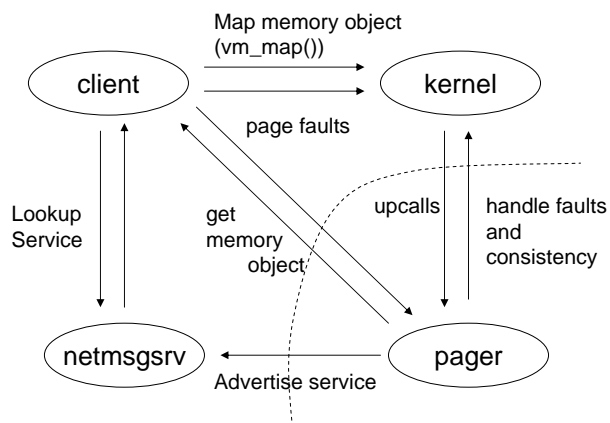


18

Mach Microkernel OS Extended Memory Management

Paging handled by user-space server

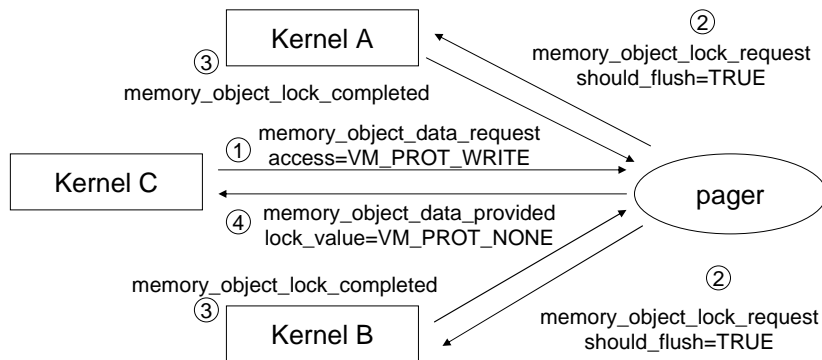
Port: comm. endpoint, network-wide



19

Mach Microkernel OS Distributed Shared Memory System

- Access remote memories,
port access rights - ACL



20

Windows NT Origins

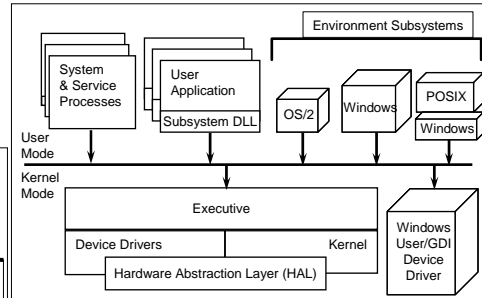
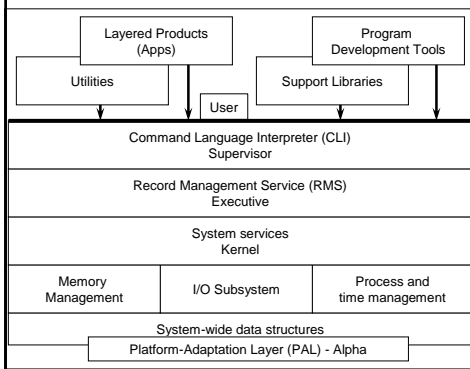
- **Design began in late 1988/early 1989 after Dave Cutler and a handful of Digital employees started at Microsoft**
 - Dave Cutler—legend in the operating system world
 - Project leader for Digital's VMS (Virtual Memory System)
 - Internally, Windows NT has many similarities to Digital's VMS (scheduling, memory management, I/O and driver model)
 - VMS+1=WNT just a coincidence
 - **Original goal was replacement for OS/2**
 - **Later goal changed to be the replacement for Windows 3.0**
 - The name "Windows NT" was chosen because
 - NT stands for New Technology
 - But at a high level, the architecture and user interface are not really that "new" (as compared to most 32-bit OS's)
 - Also, the i860 Risc CPU NT was originally targeted at was code named N-Ten
 - **Interesting book on the early years of NT:**
 - Show-stopper!: The Breakneck Race to Create Windows NT and the Next Generation at Microsoft
 - By G. Pascal Zachary, ISBN: 0029356717
- NOTE: In the CRK, "Windows" refers to Windows 2000, Windows XP, and Windows Server 2003**
- Where there are specific differences, these are noted

21

VMS and Windows

- a bird's-eye view on architectures

Layered design for VAX/VMS operating system



Windows high-level architecture

22

Release History

- Although product name has varied, internally, each version identified by a "build number"
 - Internal identification - increments each time NT is built from source (5-6 times a week)
 - Interesting timeline: <http://windows2000.about.com/library/weekly/aa010218a.htm>

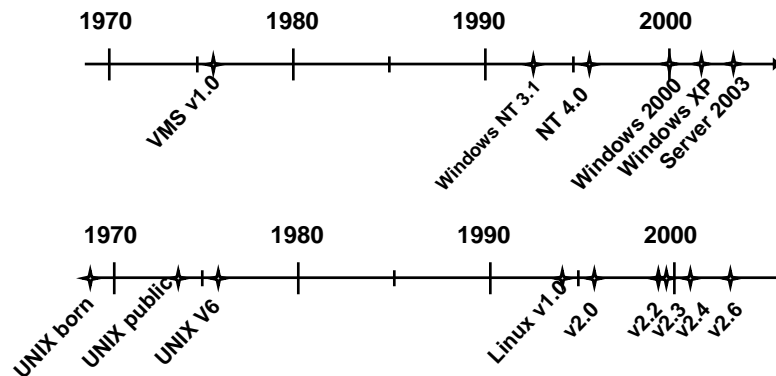
Build#	Version	Date
297	PDC developer release	Jul 1992
511	NT 3.1	Jul 1993
807	NT 3.5	Sep 1994
1057	NT 3.51	May 1995
1381	NT 4.0	Jul 1996
2195	Windows 2000 (NT 5.0)	Dec 1999
2600	Windows XP (NT 5.1)	Aug 2001
3790	Windows Server 2003 (NT 5.2)	Mar 2003
4051	Longhorn PDC Developer Preview	Oct 2003

Within the CRK, the term Windows refers to Windows 2000, XP, Server 2003

23

Windows And Linux Evolution

- Windows and Linux kernels are based on foundations developed in the mid-1970s



(see <http://www.levenez.com> for diagrams showing history of Windows & Unix)

24

Further Reading

- Dennis M. Ritchie, The Evolution of the Unix Time-sharing System,
 - in Proc. of Lang. Design and Programming Meth. Conf., Sydney, Australia, Sept 1979, Lecture Notes in Computer Science #79, Springer-Verlag, 1980.
- David Donald Miller, OpenVMS Operating System Concepts,
 - 2nd Ed., Digital Press, 1997.
 - History of Digital Operating Systems (from pp. 447)
- Mark E. Russinovich and David A. Solomon, Microsoft Windows Internals,
 - 4th Edition, Microsoft Press, 2004.
 - Historical Perspective (from pp. xix)
- G. Pascal Zachary, Show Stopper! The Breakneck Race to Create Windows NT and the Next Generation at Microsoft,
 - ISBN: 0029356717, Free Press, 1994.

25