Unit 1: Overview of Operating Systems

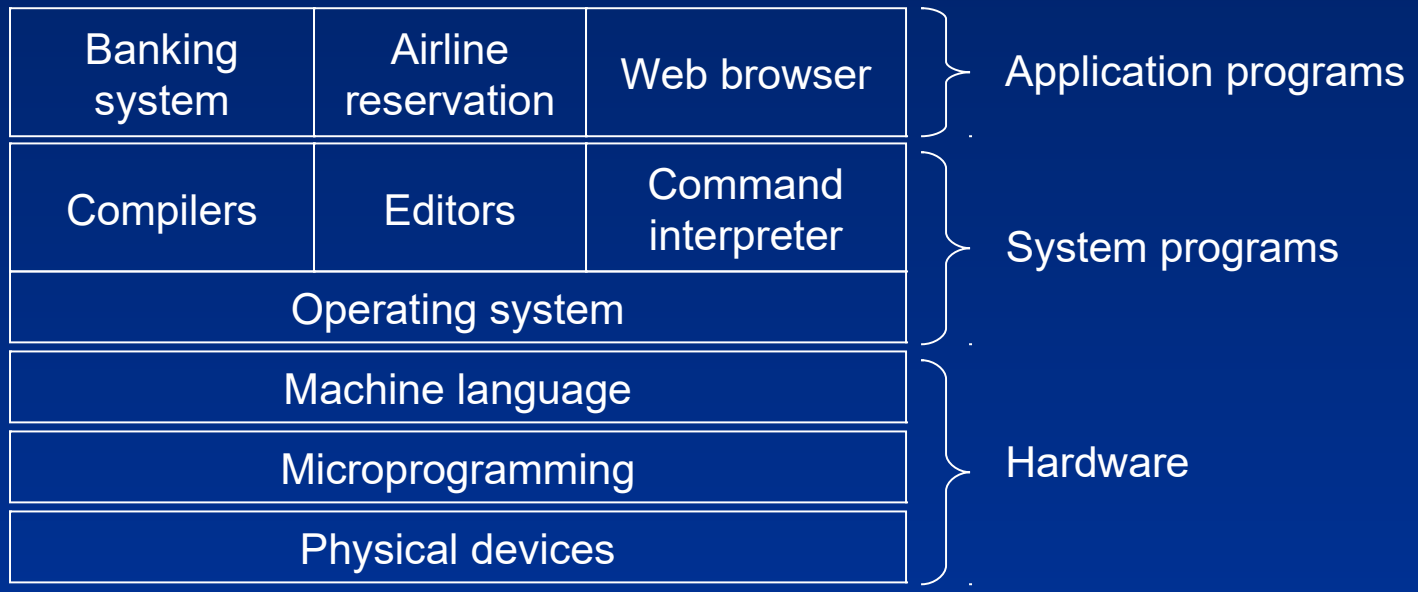
1.2. The Evolution of Operating Systems

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

Operating Systems Concepts

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



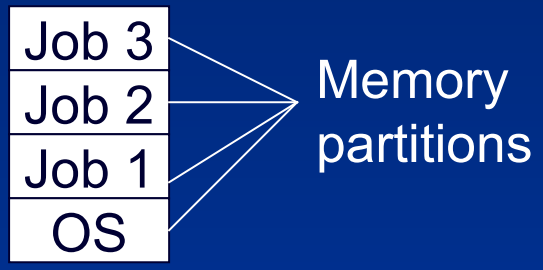
History of operating systems

- 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



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
- Mobile Systems
  - New UI paradigm , efficient energy management, etc.

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

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 managment
  - Multiprocessor management, diagnosis, test
  - Parts of file system and of the networking interface

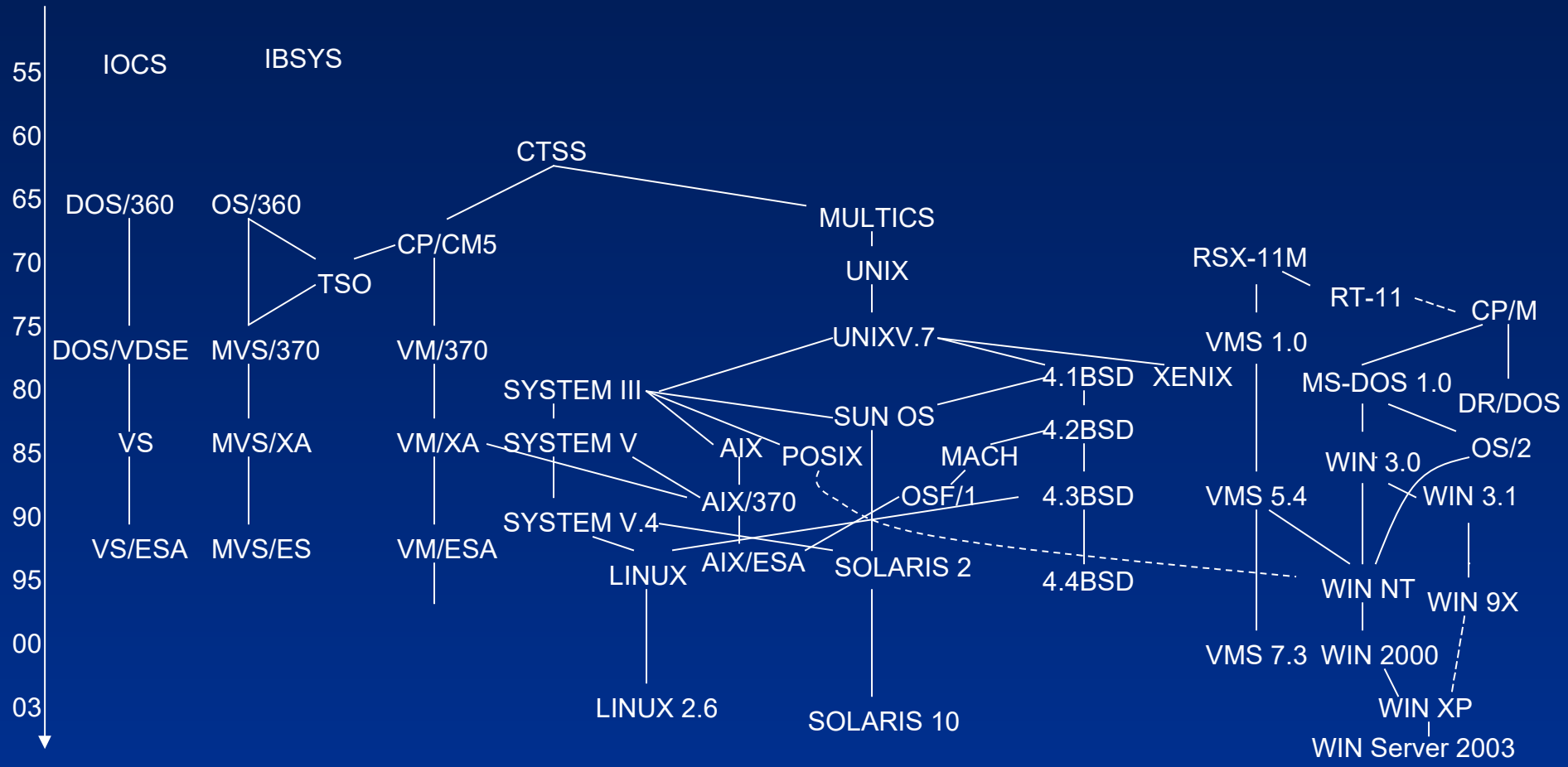
User Space:

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

OS acts as Extension of Hardware

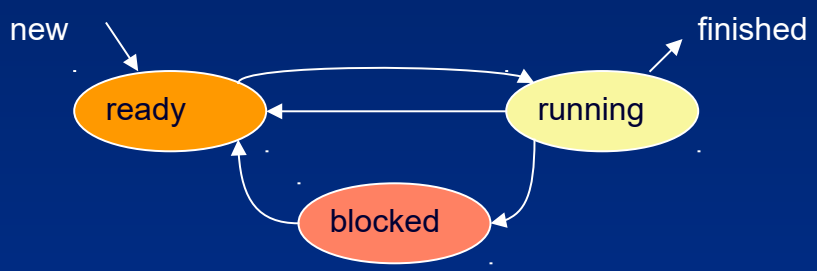
- System view: layered model of OS
  - Implementation details on one layer are hidden from higher layers
- Same machine, different operating systems:
  - IBM PC: DOS, Linux, NeXTSTEP, Windows, SCO Unix
  - DEC VAX: VMS, Ultrix-32, 4.3 BSD UNIX
- Same OS, different machines: UNIX
  - PC (XENIX 286, APPLE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

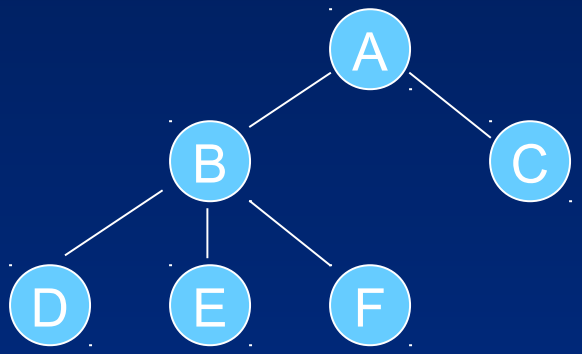
Operating Systems Evolution



Main Concepts: processes

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



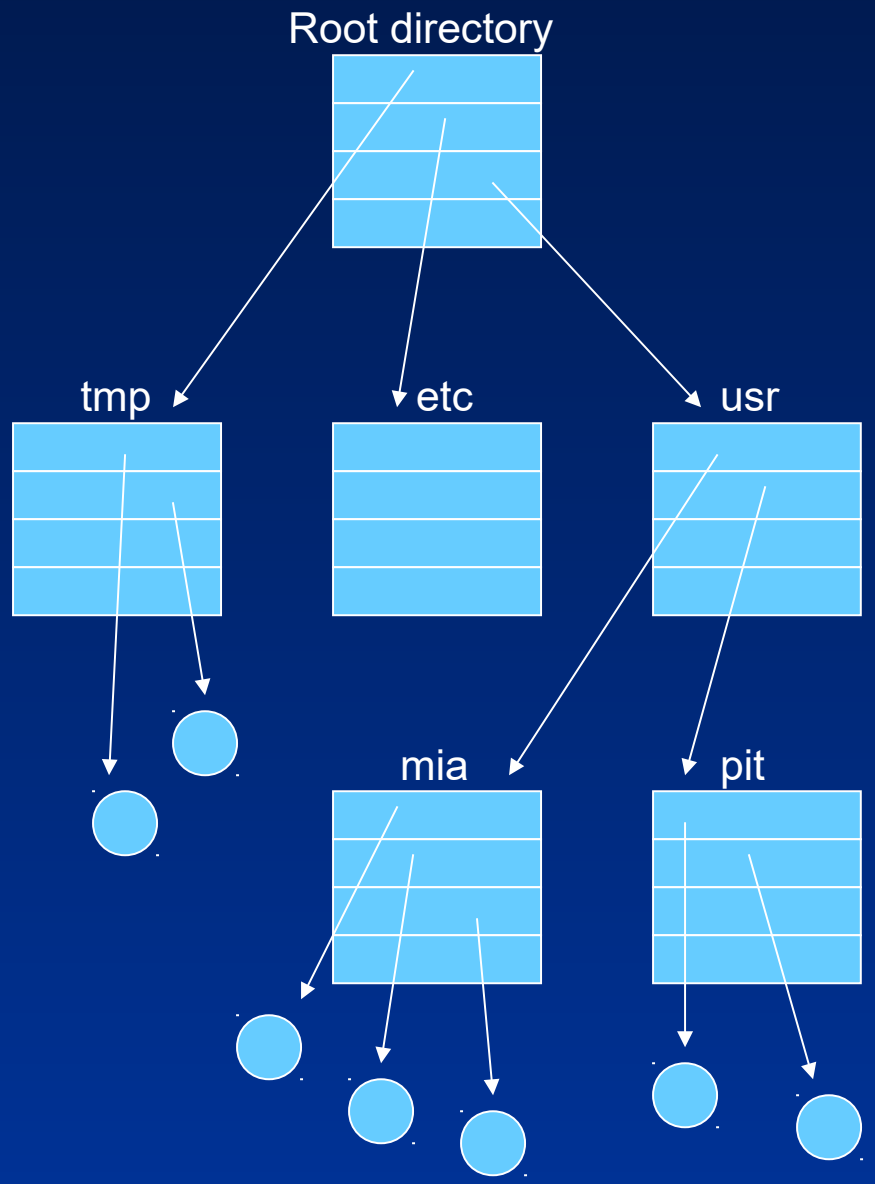


Process tree

- Scheduling, signals
- User identification, group identification

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



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

Main concepts: shell

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

$ date

$ date >file

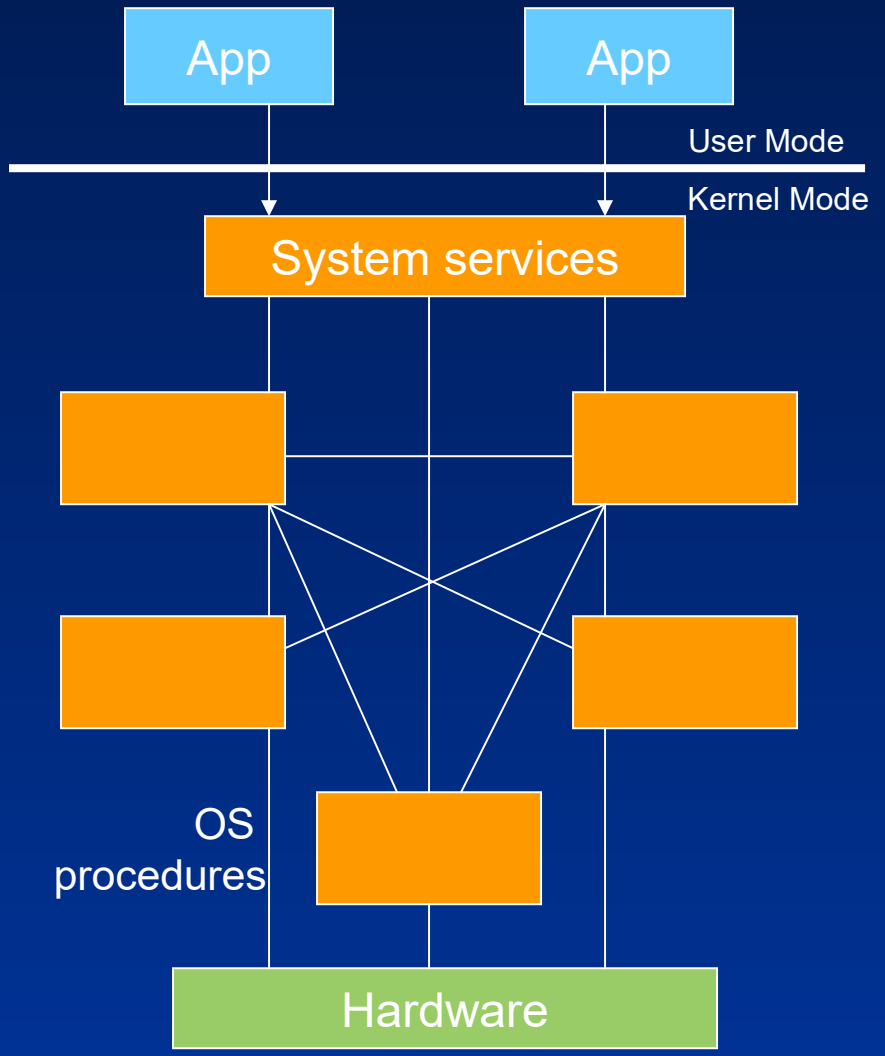
$ sort <file1 >file2

$ cat file1 file2 file3 > /dev/lp1

$ make all >log 2>&1 &

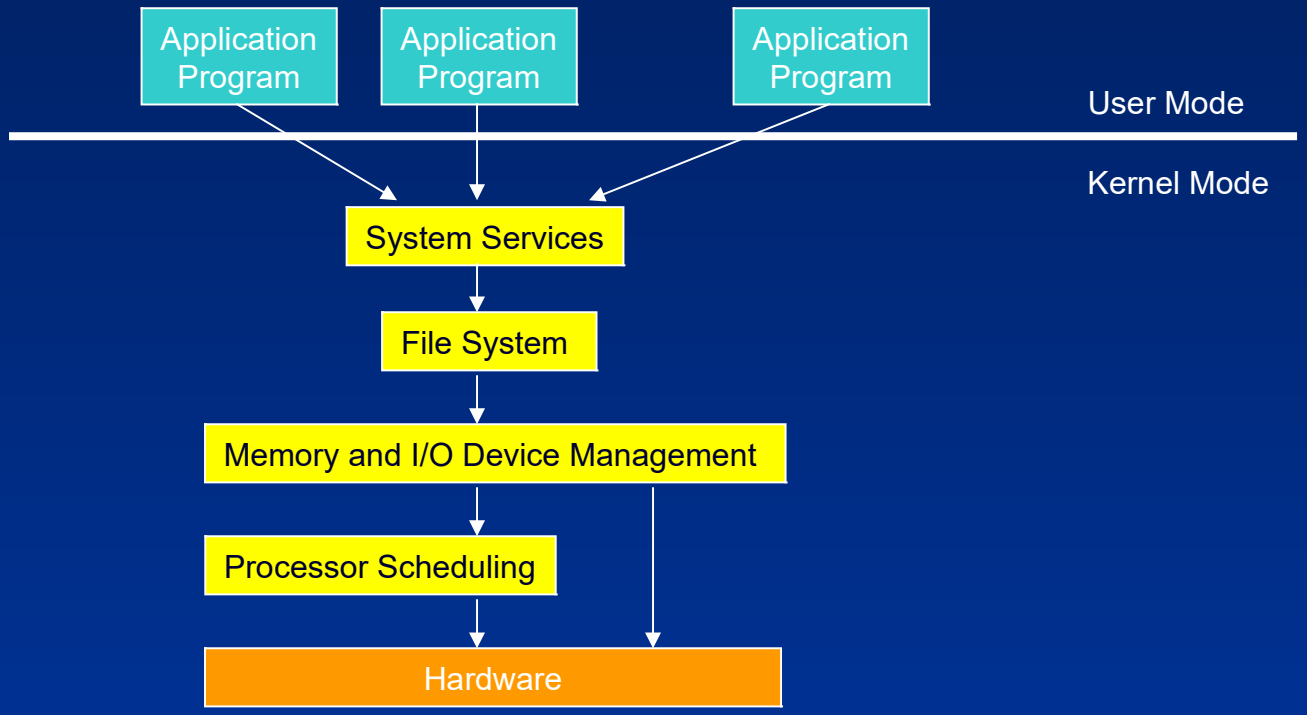
Structuring of Operating Systems

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



Layered OS

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

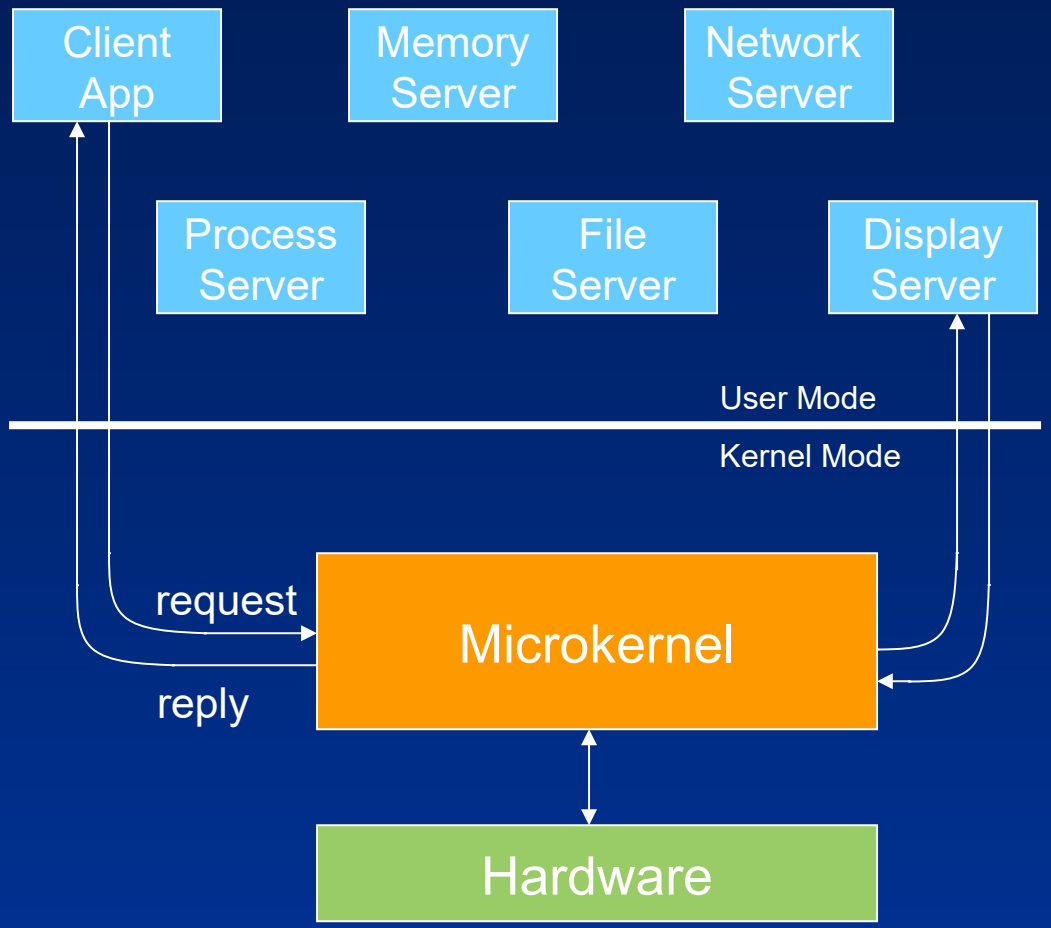


Microkernel OS (Client/server OS)

Kernel implements:

- Scheduling
- Memory Management
- Interprocess communication (IPC)

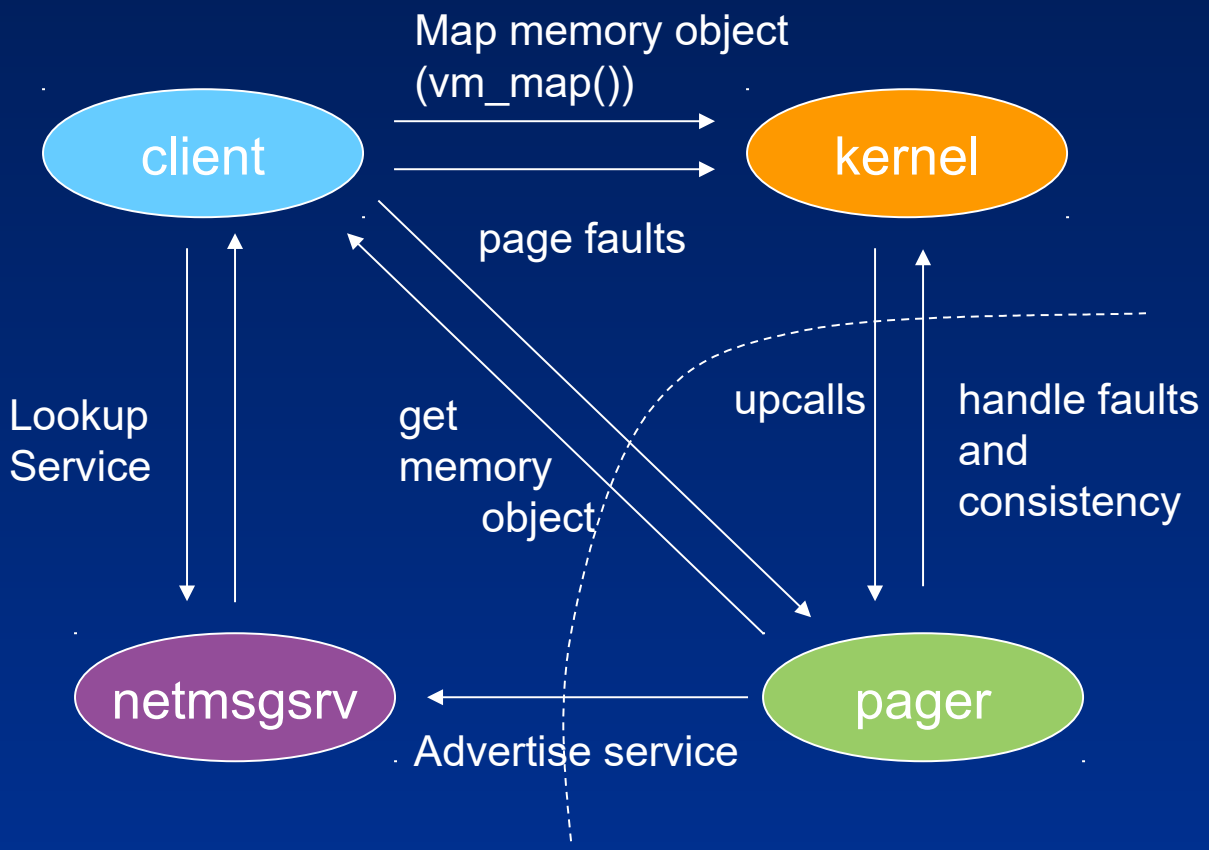
User-mode servers



Mach Microkernel OS Extended Memory Managment

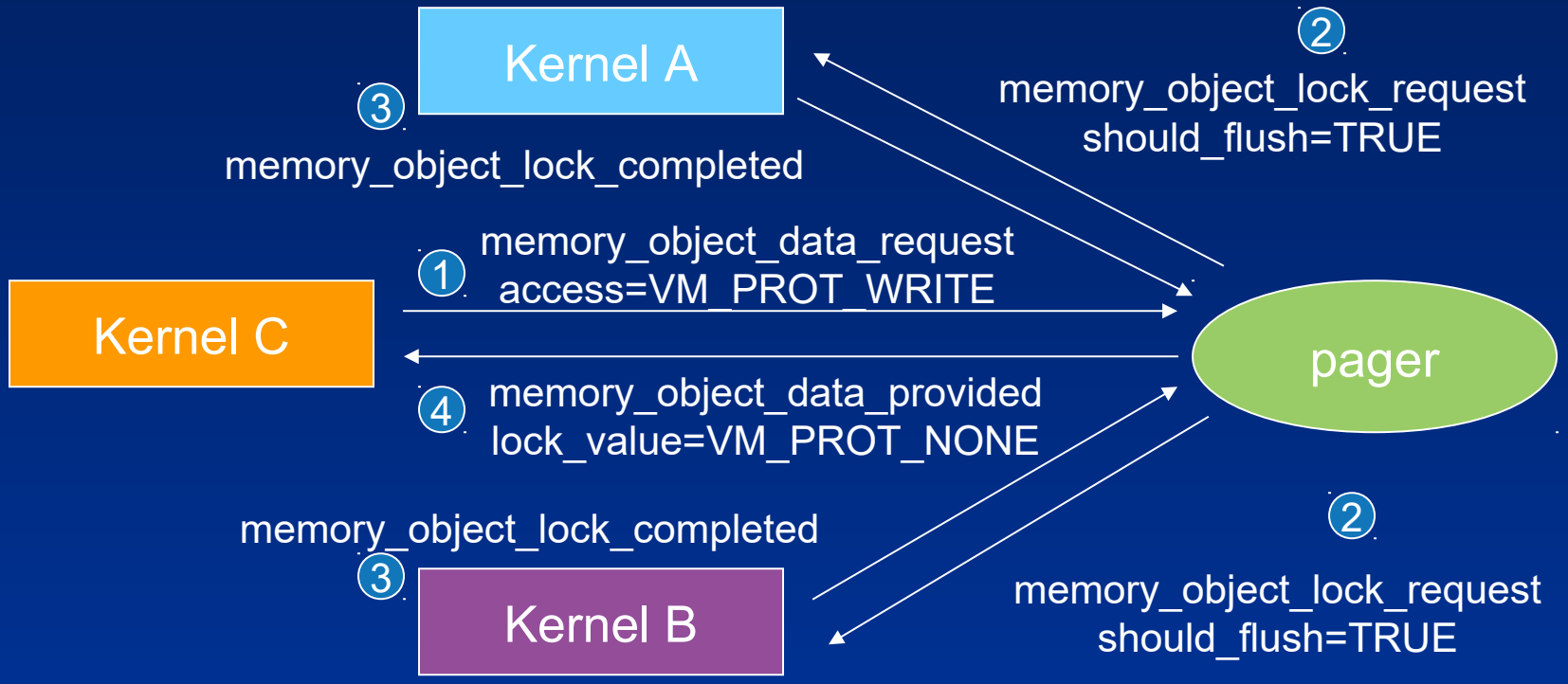
Paging handled by user-space server

Port: comm. endpoint, network-wide



Mach Microkernel OS Distributed Shared Memory System

- Access remote memories, port access rights - ACL



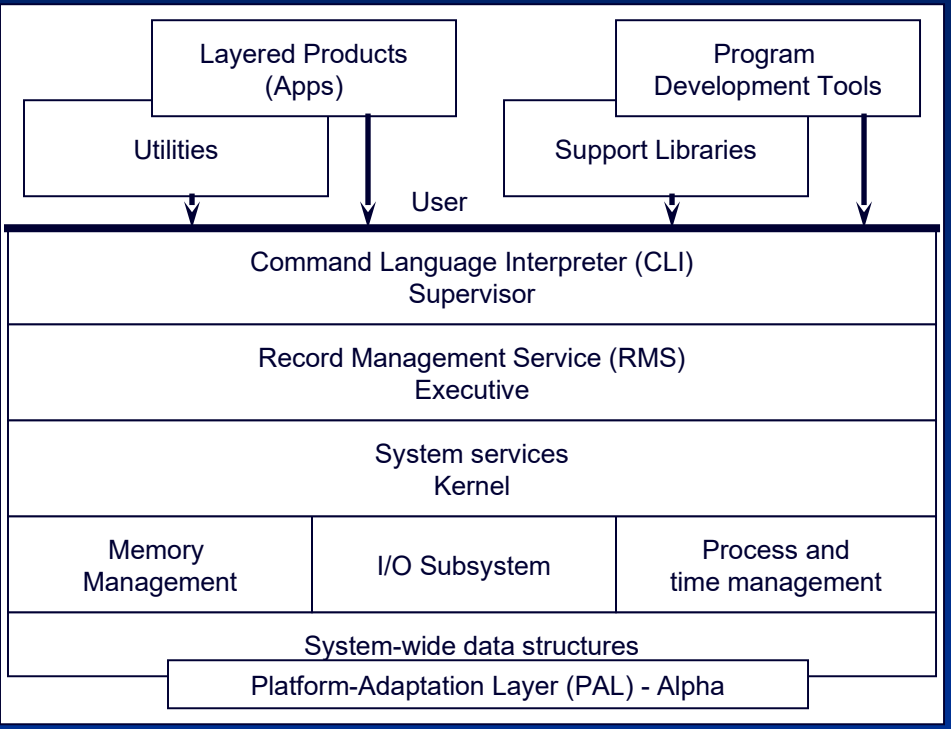
Windows NT Origins

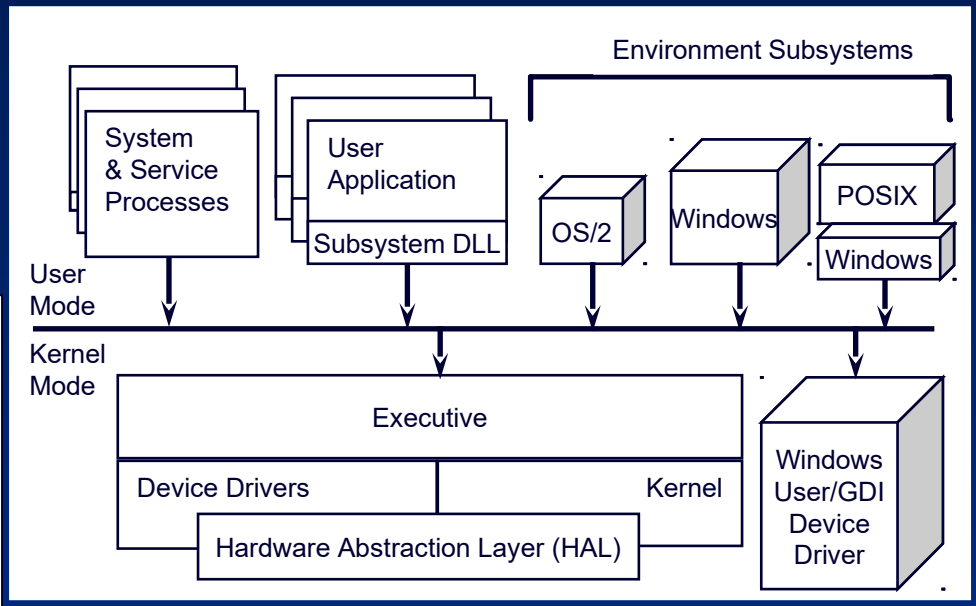
- **Design began in late 1988/early 1989 after Dave Cutler and a handful of Digital employees started at Microsoft**
  - Dave Cutler—legend in the operating system world
    - Project leader for Digital's VMS (Virtual Memory System)
  - Internally, Windows NT has many similarities to Digital's VMS (scheduling, 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 NT, version XP & Srv2003

VMS and Windows
- a bird's-eye view on architectures

Layered design for VAX/VMS operating system





Windows high-level architecture

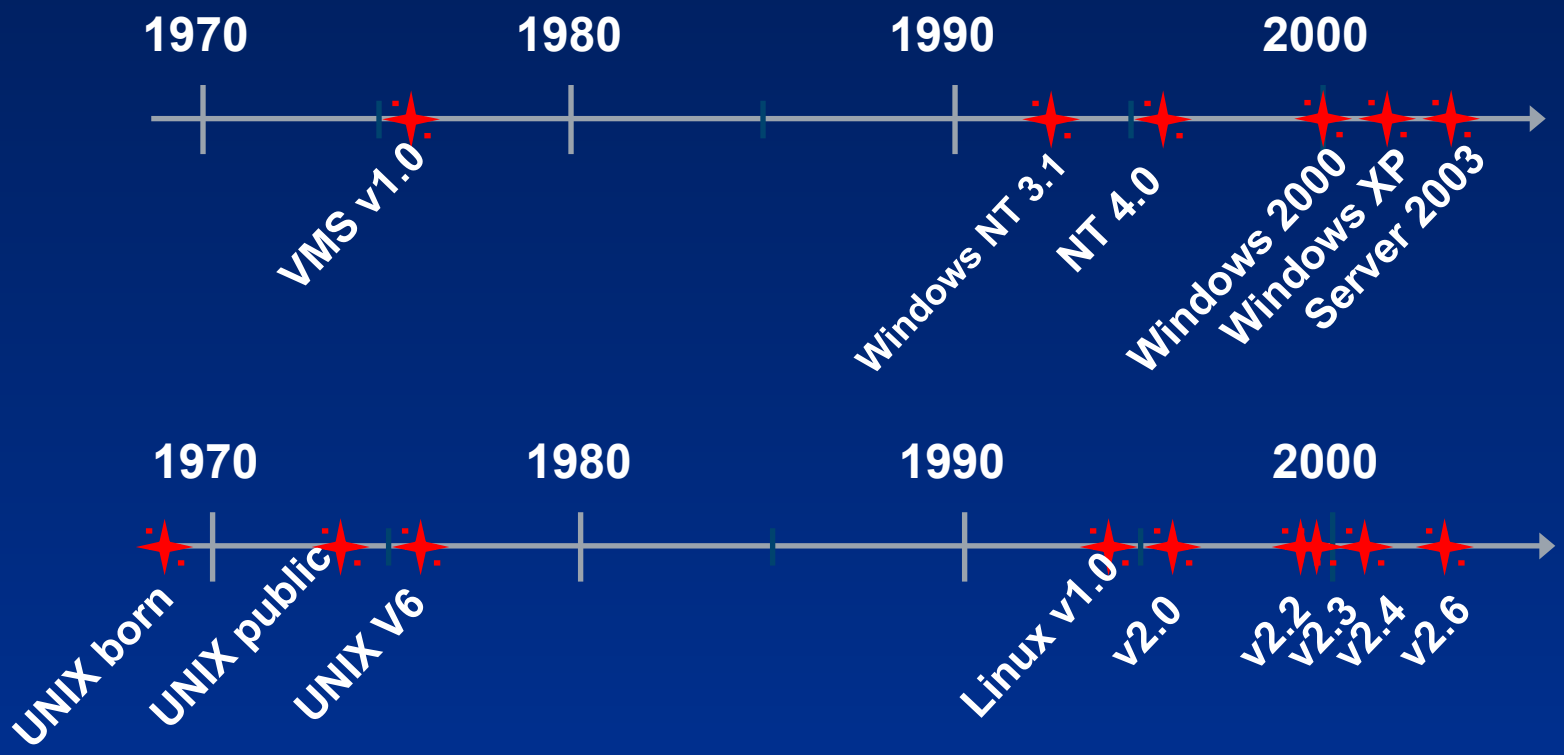
Release History

- Although product name has varied, internally each version is identified by a "build number" (i.e., an internal identification - increments each time NT is built from source)

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
6000	Windows Vista (NT 6.0)	Jan 2007
6001	Windows Server 2008 (NT 6.0)	Mar 2008
7600	Windows 7 (NT 6.1)	Oct 2009
7600	Windows Server 2008 R2 (NT 6.1)	Oct 2009
9200	Windows 8 & Server 2012 (NT 6.2)	Aug 2012
9600	Windows 8.1 & Server 2012 R2 (NT 6.3)	Oct 2013
10240	Windows 10 version 1507 (NT 10.0)	Jul 2015
10586	Windows 10 version 1511 (NT 10.0)	Nov 2015
14393	Windows 10 version 1607 (NT 10.0)	Jul 2016
14393	Windows Server 2016 v1607 (NT 10.0)	Sep 2016
15063	Windows 10 version 1703 (NT 10.0)	Apr 2017
?????	Windows 10 version 1709 (NT 10.0)	Oct 2017

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)

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)
- G. Pascal Zachary, Show Stopper! The Breakneck Race to Create Windows NT and the Next Generation at Microsoft,
  - ISBN: 0029356717, Free Press, 1994.