

History (Timeline from www.cgonline.com)

- 10/81 — IBM PC (“Personal Computer”) and PC-DOS 1.0
- 3/83 — Microsoft MS-DOS 2.0 (hard disk, file system)
- 11/83 — Windows announced (vaporware!)
- 11/84 — MS-DOS 3.1
- 11/85 — Windows 1.0 (tiled windows, doesn’t do well in market)
- 4/87 — IBM & Microsoft OS/2 1.0 (next generation, DOS-like command lines)
- 12/87 — Windows/386 (uses 80386’s virtual memory to allow safe “preemptive” multitasking)

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History (cont.)

- 10/88 — OS/2 1.1 (Windows-like GUI, end of collaboration when IBM gets upset with Microsoft for improving Windows)
- 5/90 — Windows 3.0 (big success!)
- 4/92 — Windows 3.1 (bug fixes etc.)
- 10/92 — Windows for Workgroups 3.1 (adds networking, but fails in market)
- 5/93 — Windows NT 3.1 (visually like Windows 3.1, but stable 32-bit platform)
- 11/93 — Windows for Workgroups 3.11 (precursor to Windows 95)
- 5/94 — MS-DOS 6.22 (DOS final version)
- 9/94 — Windows NT 3.5
- 6/95 — Windows NT 3.51 (faster)

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History (cont.)

- 8/95 — Windows 95 (originally Windows 4.0) (long file names, plug and play hardware, taskbar and Start menu, HUGE success in market!)
- 7/96 — Windows NT 4.0 (Windows 95 GUI, first successful version of NT)
- 6/98 — Windows 98 (Windows 95 + Internet Explorer 4.0, success in market)
- 2/00 — *Windows 2000 (Windows NT 4.0 + plug and play, DirectX, USB, etc.)*
- 9/00 — Windows Me (Millennium Edition) (Windows 98 + IE 5.0, media support, last version in Windows 9x line)
- 9/01 — *Windows XP (combines Windows 2000 and ME, but based on NT/2000)*

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What is Windows XP?

- 32/64 -bit preemptive multitasking operating system for AMD K6/7, Intel IA32/64 and later microprocessors
 - Replaces Windows 95/98/Me as well as Windows NT/200
- Key goals
 - security, reliability, ease of use
 - Windows and POSIX compliance
 - high performance, extensibility
 - portability, international support
- Various versions: XP Personal, XP Professional, XP Server
- Uses a micro-kernel architecture
 - Subsystems to provide OS personalities for Win32, POSIX, etc.

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Windows XP Design Principles

- Security — C-2 classification (moderal level of protection)
- Reliability — builds on reliability of Windows 2000, extensive testing
- Compatibility — code that follows the POSIX standard can be compiled on 2000 without change, compatibility layer allows older applications to run
- Performance — knows about cache lines and multiprosesors, high-performance message passing (local procedure calls) between subsystems
- International support — supports different locales via the national language support (NLS) API, characters represented in UNICODE

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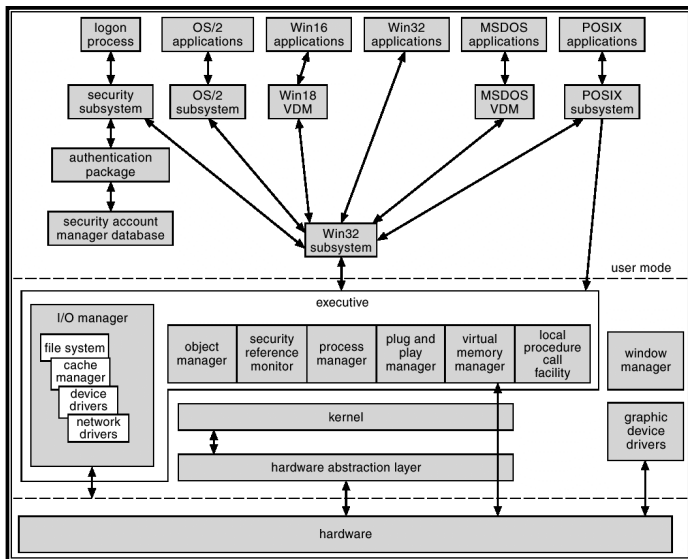
Windows XP Design Principles (cont.)

- Extensibility — layered architecture
 - Executive, which runs in kernel mode, provides the basic system services
 - On top of the executive, several server subsystems operate in user mode
 - Among the subsystems are environmental subsystems, which emulate other OSs to run programs written for MS-DOS, Windows, and POSIX
 - Support for remote procedure calls for distributed processing
- Portability — Windows XP can be moved from one Intel-like hardware architecture to another with few changes
 - Processor-dependent code is isolated in a dynamic link library (DLL) called the “hardware abstraction layer” (HAL)

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Windows 2000/XP Block Diagram



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Windows XP Organization

- Micro-kernel based system
- In protected (kernel mode):
 - Executive — object management, process management, virtual memory management, local procedure calls, plug and play I/O, and security
 - (Micro) Kernel — never paged out of memory, never preempted, does thread scheduling, synchronization, interrupts;
 - Hardware Abstraction Layer (HAL) — hides hardware differences from upper layers; supports multiprocessors
- In user mode:
 - environmental subsystems (support code written for different platforms)
 - other non-kernel parts of OS
 - user programs

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Windows XP Kernel

- Thread scheduling, interrupt & exception handling, processor synchronization
- Events, threads, semaphores, interrupts, etc. are all objects
- Threads have 6 states
 - Ready, standby, running, terminated
 - Standby is next one to run (more than one if multiple processors)
 - Waiting — I/O wait
 - Transition — waiting for resources
- CPU scheduler with 32-level priority feedback queues divided into 2 classes
 - real-time (16-31), variable (0-15)
 - Priority lowered as thread runs, aging depends on device for which a thread has been waiting

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Windows XP Executive

- Object Manager
 - Objects for all services and entities
 - Standard methods of access
 - Security provided via access control list
- Virtual Memory Manager
 - Demand paging with a page size of 4 KB
 - 32-bit virtual address => 4 GB space
 - Each process has a *page directory* that contains 1024 *page directory entries* (PDEs) of size 4 bytes
 - Each PDE points to a *page table* which contains 1024 *page table entries* (PTEs) of size 4 bytes
 - Each PTE points to a 4 KB page frame in physical memory
 - Per-process page replacement
 - Working set starts at 50 pages per process, is adjusted as processes run

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Windows XP Executive (cont.)

- Process Manager
 - Services for creating, deleting, and using threads and processes
- Local Procedure Call Facility
 - Passes requests and results between client and server processes within a single machine (optimized RPC)
- I/O Manager
 - Responsible for file system, device drivers, network drivers
- Cache Manger
 - Centralized cache management
- Security Reference Manager
 - Checks access to objects against the object's access control list

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Windows XP Environmental Systems

- User-mode processes allow programs developed for other OSs to run
- Win32 subsystem is the main operating environment and is used to start all processes
 - Also provides all the keyboard, mouse and graphical display capabilities
- Virtual DOS Machine (VDM) supports DOS applications
 - Translates 16-bit DOS addresses to 32-bit Windows addresses, emulates MS-DOS BIOS, Intel 486 instructions (if Windows is running on a different architecture), etc.
- POSIX subsystem
 - Runs applications that follow the POSIX.1 standard (based on the UNIX model)

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Windows XP File System (NT File System = NTFS)

- Files are treated as objects
- File volumes are based on logical disk partitions, and can span disks if desired
- NTFS uses clusters (not sectors) as the underlying unit of disk allocation
 - A cluster is a number of disk sectors that is a power of two (4 KB for volumes greater than 4 GB)
 - Because the cluster size is smaller than for the 16-bit FAT file system, the amount of internal fragmentation is reduced
- All file system data structure updates are performed inside transactions, to keep file system consistent after a crash
 - Before a data structure is altered, the transaction writes a log record that contains redo and undo information