

Course 303

PC Hardware and Software Architecture Overview

A 3-day Demo-Intensive Course

This course is aimed at engineers, technicians, technical management and others who need a comprehensive understanding of modern x86-based PCs. In addition to covering the latest hardware and software technologies it is an introduction to a wide range of computer concepts and components.

You will benefit from this workshop if you

- Need a quick yet thorough explanation of PC hardware and software fundamentals
- Need to understand the compatibility issues between different generations of PCs
- Configure, test, validate, upgrade, or troubleshoot PC hardware
- Install software/hardware upgrades and want to avoid conflicts
- Need to improve the speed, performance, or stability of your PCs

You will learn

- About the major hardware components and subsystems in a PC
- How the components work, both individually and as a system
- How to configure each component
- How to get around limitations left behind by legacy technology
- The system software architecture

Prerequisites

Attendees are expected to have an engineering/technical orientation. While not required, knowledge of microprocessor technology, memory, and standard peripherals is beneficial.

The training approach

- **Up to date information:** PC technology changes fast and we continuously update our course materials to reflect these changes. The course you attend will be taught using materials updated and printed less than a week before the course, not from a textbook that was out-of-date the day it was printed.
- **Live Demos:** The instructor will use the classroom PC for demonstrations throughout the course and will also show and circulate state-of-the-art hardware, showing you what the components and sub-systems covered during the lecture actually look like.
- **Straightforward explanations:** Technical concepts and terms are explained in plain English. You will walk away with a thorough understanding of what key subsystem do, how they do it, and what support they need from each other to make a working PC.

Course topics

What is inside your PC?

- Computer architecture – CPU, ROM, RAM, Input/Output ports, the different buses
- Clocked logic
- The motherboard
- What the major hardware and software components do

x86 CPUs and chipsets

- Application, system and control registers
- *Real, Protected, 64-bit, and System Management* mode
 - The four different sub-modes
- Caches and cache architecture
- Pipelining concepts and implementations
- Multi-core processors
- Features of the latest desktop, laptop, and server x86 CPUs
 - Intel's *Core™* and *Xeon®* families
 - AMD's *Phenom™ II, Turion™, Opteron™*
- The traditional bus-based chipset architecture
 - MCH, ICH, FWH, and Super I/O
- AMD's, and Intel's new system architecture
 - Integrated memory and graphics controllers
 - Superfast connections to I/O
- Key functions and interfaces of each chipset component

Memory technologies

- How memory is organized and how it works
- Memory timing and latency
- Interleaved paging
- Burst and pipelined memory
- Different kinds of memory: ROM, Flash, SRAM, DRAM, SDRAM, VRAM, GRAM, DDR-, DDR2-, & DDR3-SDRAM, Virtual memory...
- Memory modules: DIP, SIPP, SIMM, and DIMM
- The address and memory maps – How much of your installed memory is available to your operating system, and where does the rest go?

System software

- The PC – A layered architecture
- What happens between pressing the power button and your desktop being available?
- PC operating system boot sequences: Similarities and differences between DOS, Windows XP, Windows Vista, and Linux
- Motherboard ROM functions
 - Legacy BIOS, UEFI, *Tiano*
- System setup – Motherboard configuration
- BIOS, memory resident programs, TSRs, and GUIs
- What is a driver and how does it work?

Buses and expansion slots

- The hidden ISA buses
- The different PCI, and PCI-Express slots
- Other connectors: eSATA, USB, and Firewire (IEEE1394)
- Plug-and-Play – How PCI and USB devices are discovered and configured
- How often is the bus the bottleneck?
- Avoiding potential problems when configuring video, sound, network, or SCSI adapters
- Shadowing expansion card ROMs

Configuring add-in cards

- What to do when Plug-and-Play fails
- System resources add-in cards can claim
- Explaining the hardware and software interrupt concepts
- The three different ways a PC can handle a hardware interrupt
- Who uses I/O ports and for what?
- The I/O port map
- What is DMA (Direct Memory Access)?
- What types of devices use DMA?
- Different DMA implementations in PCs

Hard disks

- What to look out for when you install a new, or additional, hard disk
- How data is stored on a hard disk
- When a megabyte isn't a megabyte, or "Why do I only have 965GB on my 1TB drive?"
- What is a head, a track, a cylinder, a sector, and the landing zone
- The different interfaces – Serial ATA (SATA), Parallel ATA (PATA or IDE), and SCSI
- Key features of each interface – Speed, flexibility, scalability, supported disk size...
- How file systems keep track of files
- FAT, NTFS, and other file system architectures
- Directory, partition, and cluster sizes

Video

- Resolutions and system requirements
- Graphical processors (GPUs)
- How much memory is graphics stealing from your applications?
- WRAM, VRAM, xGRAM and xDRAM video memory
- Monitor size, dot pitch and refresh rates

Demos

The instructor will run demonstrations on the in-class PC to help reinforce the concepts covered during this course. Most demos are impromptu, but typically include

- The layout of the address and memory maps
- IRQ, DMA, I/O Port, and address space tracking
- Windows and Linux boot sequences
- How to navigate a graphical interface *without* a mouse

There will also be plenty of hardware components in the classroom, allowing the instructor to show and circulate devices that help the understanding of concepts covered during the course:

- Different motherboard designs
- CPUs
- Memory modules
- Various add-in card designs
- Open hard disks showing how data is stored
- Different cables