

5 Booting the System

Central Processing Unit (CPU)

- Does all the processing and computations but require program and data
- Programs and data are stored in the memory

CPU Allocation

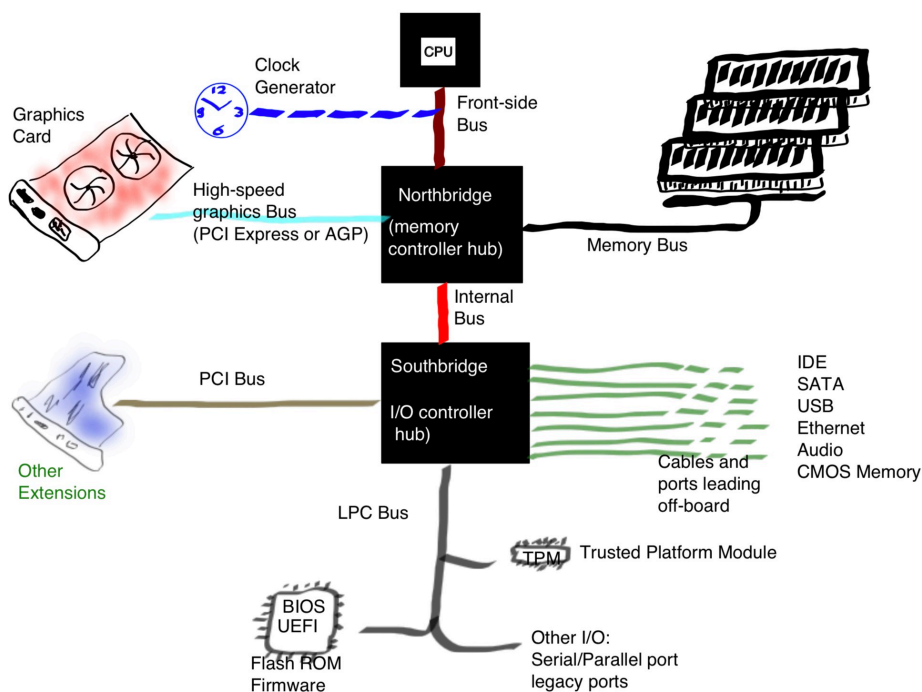
- 32-bit CPU means a word is 32-bit long
- Uses 32-bit for addressing
- Address up to 2^{32} locations

Assembly

- A programming language that translates other languages (Python, C++, etc.) into opcodes (0s and 1s)
- CPU needs assembly to read instructions in opcodes

Instructions Implementation in CPU

- CPU works on registers
- Register Transfer Language (RTL) define what needs to be done
- Uses fetch-decode-execute cycle
- 4GHz CPU means 4 Billion cycles per second



Boot Process

Step 1: Turn on power [Gain power]	<ul style="list-style-type: none"> • Power gives energy to motherboard and other components • Good power causes timer chip to reset processor and start clock ticks • CPU gets powered but cannot do much without software
Step 2: Initial software: BIOS and UEFI [5 steps to boot, each step must pass]	<ul style="list-style-type: none"> • Stored in non-volatile memory (Read-Only Memory, ROM) • Provides: <ul style="list-style-type: none"> ⇒ Start-up steps (control) ⇒ Initial system configuration ⇒ Configurable hardware • Reset command triggers execution of an instruction at specific location in BIOS chip • Booting starts with this execution
	1. Power-On-Self-Test (POST)
	<ul style="list-style-type: none"> • System memory OK • System clock running • Processor OK • Keyboard present • Screen display memory OK • BIOS not corrupted
	2. Video Card
	<ul style="list-style-type: none"> • After POST, initialize video card to show initial message on screen • Heavy work (3D, graphics) need drivers
	3. Other Hardware
	<ul style="list-style-type: none"> • BIOS tests all hardware and start them • E.g.: DVD drive, RAM timing, networking, sound
	4. Find Operating System
	<ul style="list-style-type: none"> • BIOS finds bootable drive
	5. Boot Sector
	<p>Two methods:</p> <ul style="list-style-type: none"> • On bootable drive: <ul style="list-style-type: none"> ⇒ Boot sector is executed • On hard disk: <ul style="list-style-type: none"> ⇒ OS in Master Boot Record (MBR) <p>Steps to boot a computer:</p> <ol style="list-style-type: none"> a) Load OS (kernel) b) Load various drivers c) Load Graphical User Interface (GUI)

BIOS and UEFI

	BIOS	UEFI
Advantages	-	<ul style="list-style-type: none">• Modern• Does not replace firmware and OS• Works on top of computer's firmware• Address up to 9.4 zettabytes• Faster hardware initialization• Higher security• Allow network access during booting
Disadvantage	<ul style="list-style-type: none">• Outdated• Restricted to 1024 kilobytes (kb)• Slow	<ul style="list-style-type: none">• Prevent users from installing their OS• More complexities, higher chance of errors and attacks

System-on-Chip (SoC) in CPU

Components of integrated single chip	<ul style="list-style-type: none">• Processor• Memory controller• GPU• RAM• I/O Interfaces• Network
Benefits	<ul style="list-style-type: none">• Consume low power• Smaller• Simplified motherboard