FIT 1047

Introduction to computer systems, networks and security

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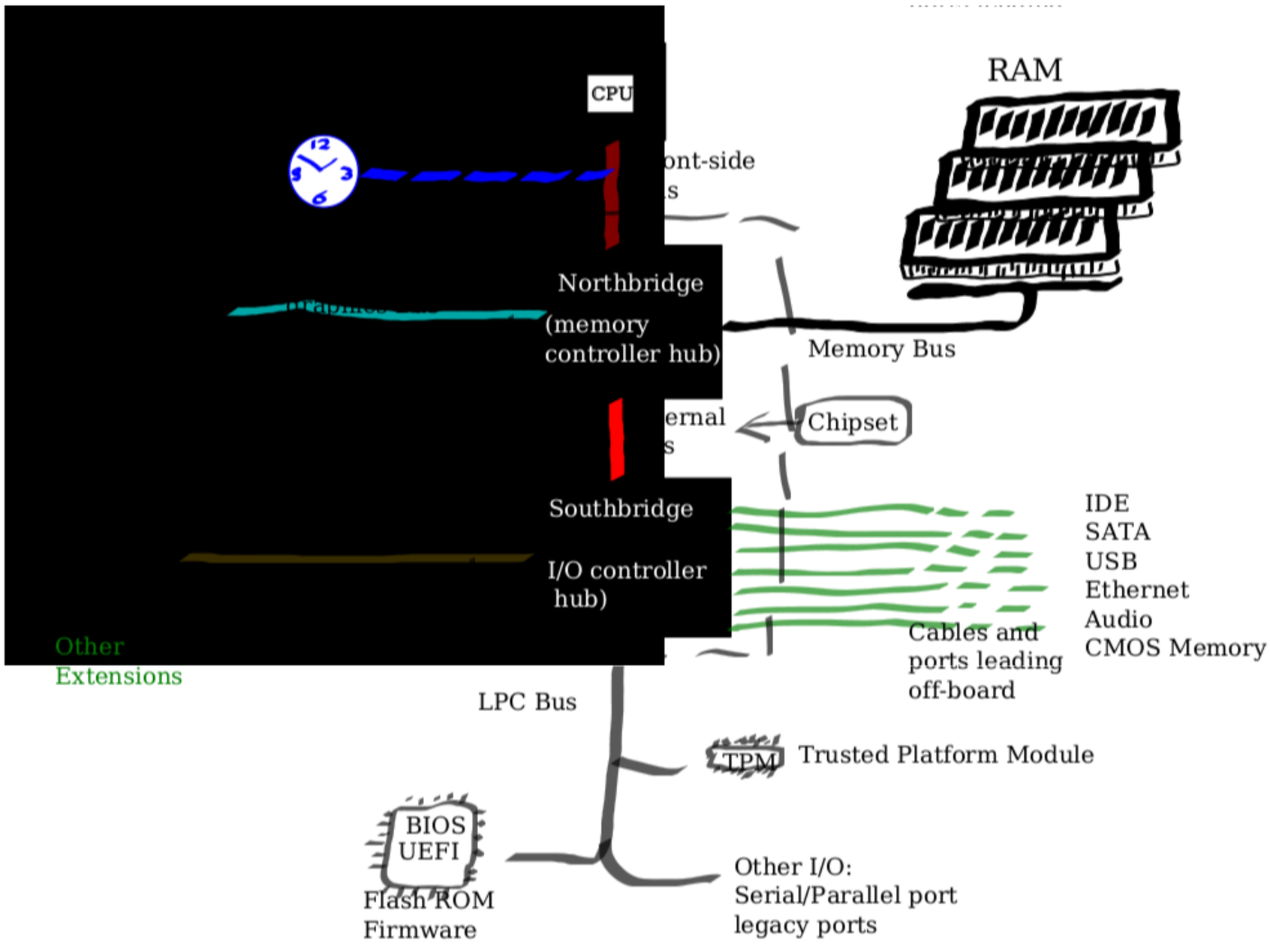
Overview

- PC boot sequence
- BIOS / UEFI


CPU
Northbridge
(memory
controller hub)
Southbridge
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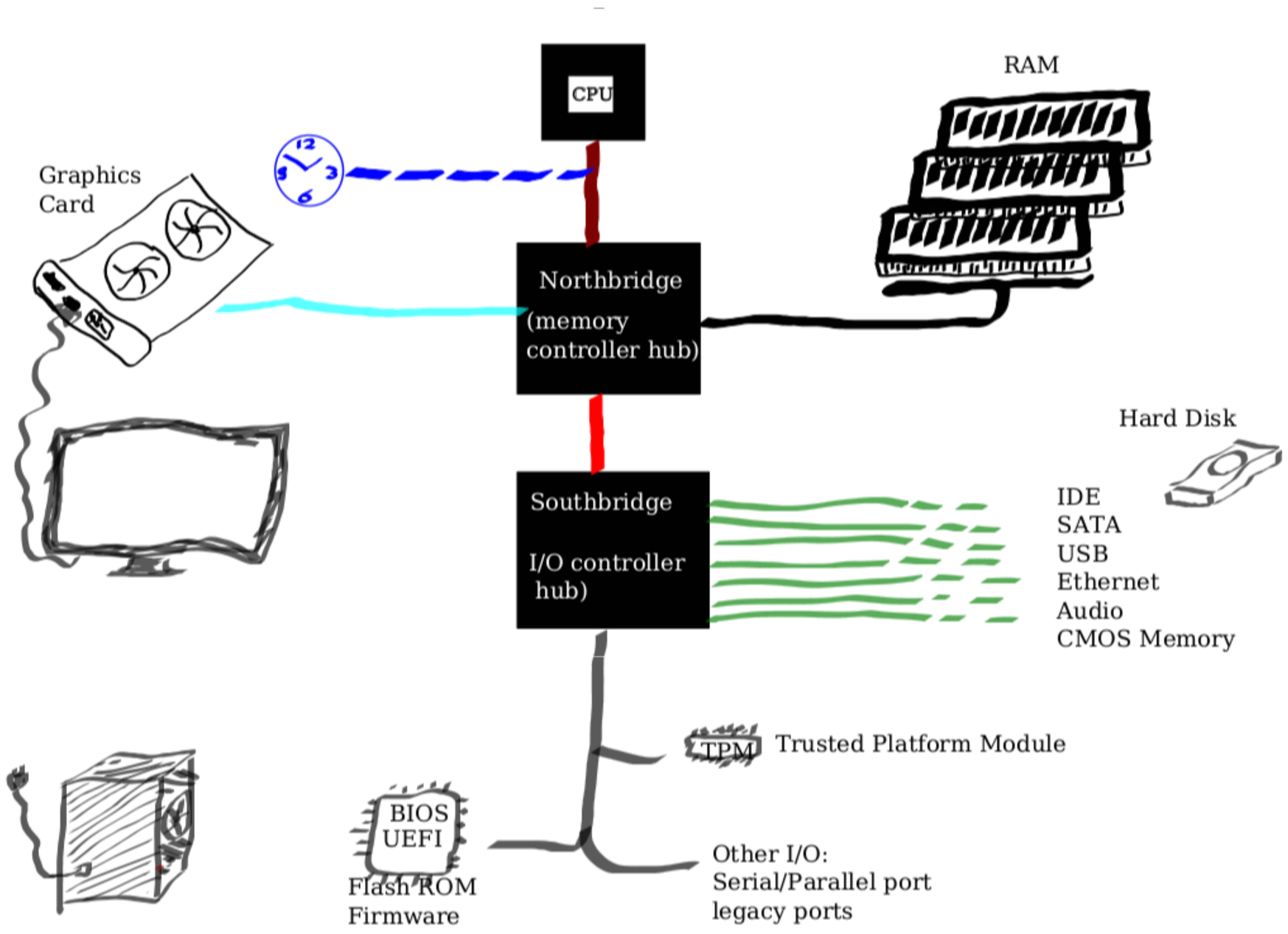
Other
Extensions
RAM
Memory Bus
Chipset
IDE
SATA
USB
Ethernet
Audio
CMOS Memory
Cables and
ports leading
off-board
LPC Bus
TPM
Trusted Platform Module
BIOS
UEFI
Flash ROM
Firmware
Other I/O:
Serial/Parallel port
legacy ports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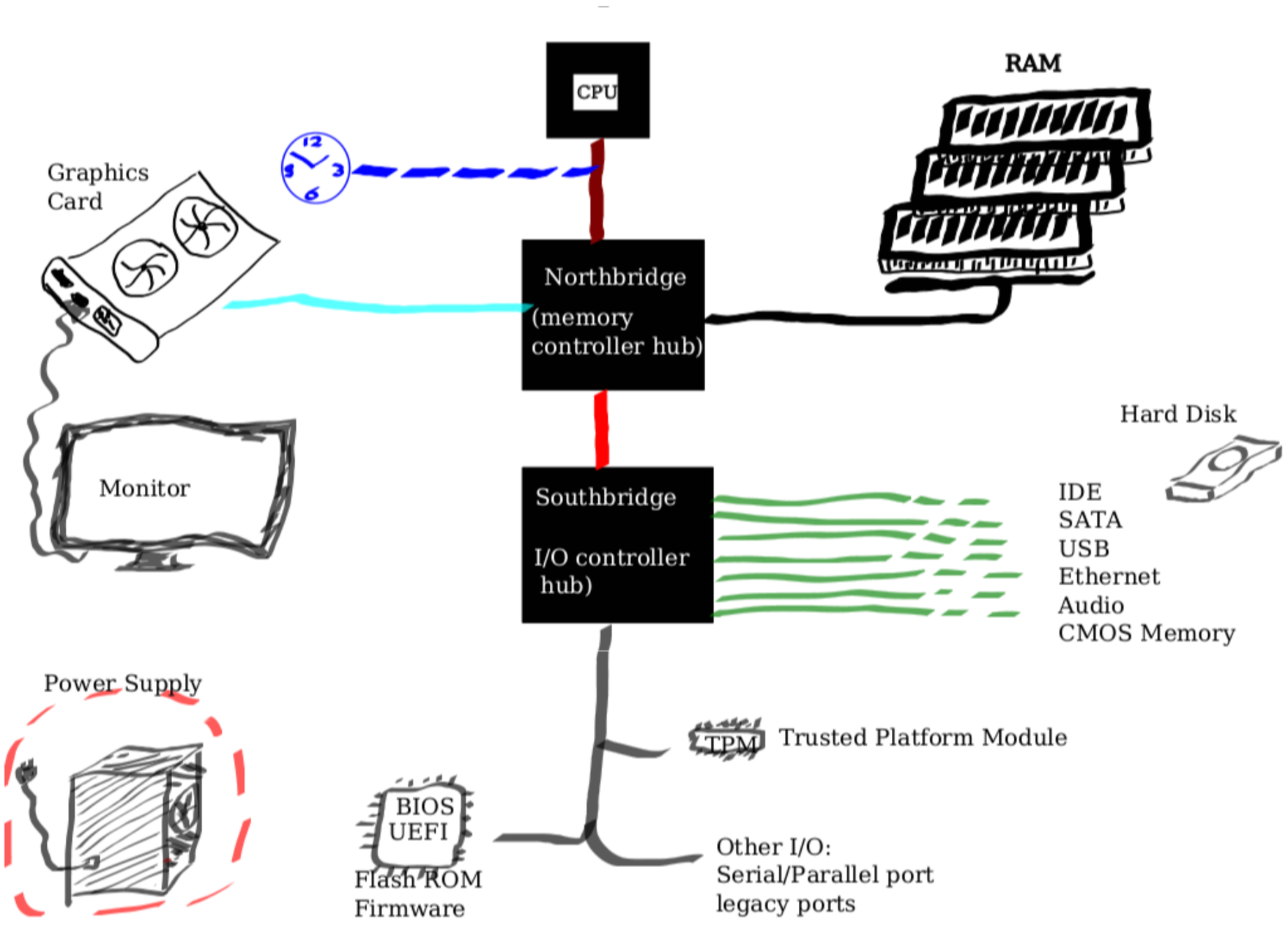
Boot process: Turn power on

- Power supply starts and provides energy to the motherboard and other components in the computer. Components should only really start to work after a stable power level is established.
- A power good signal can be sent to the motherboard which triggers the timer chip to reset the processor and start clock ticks.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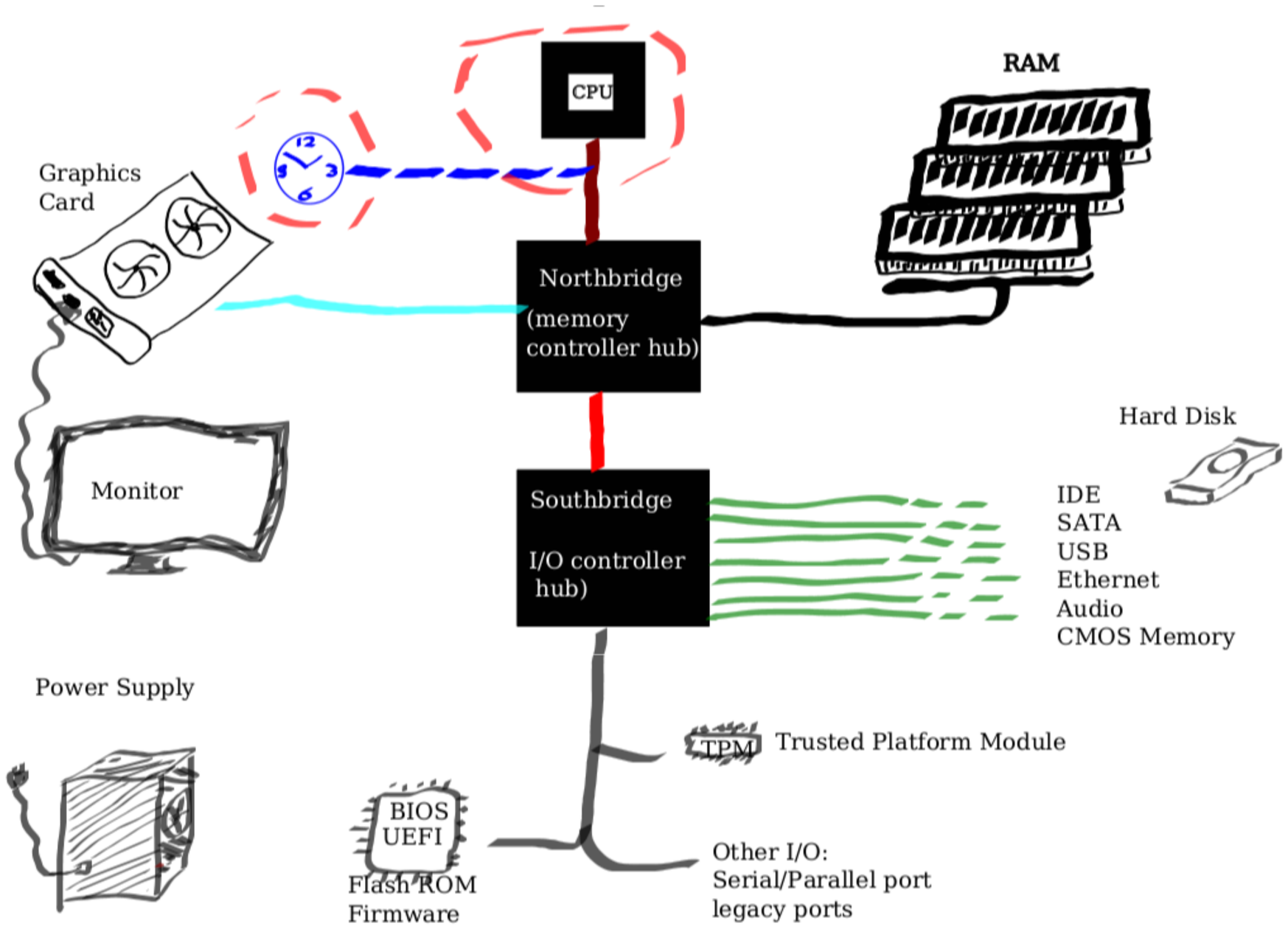
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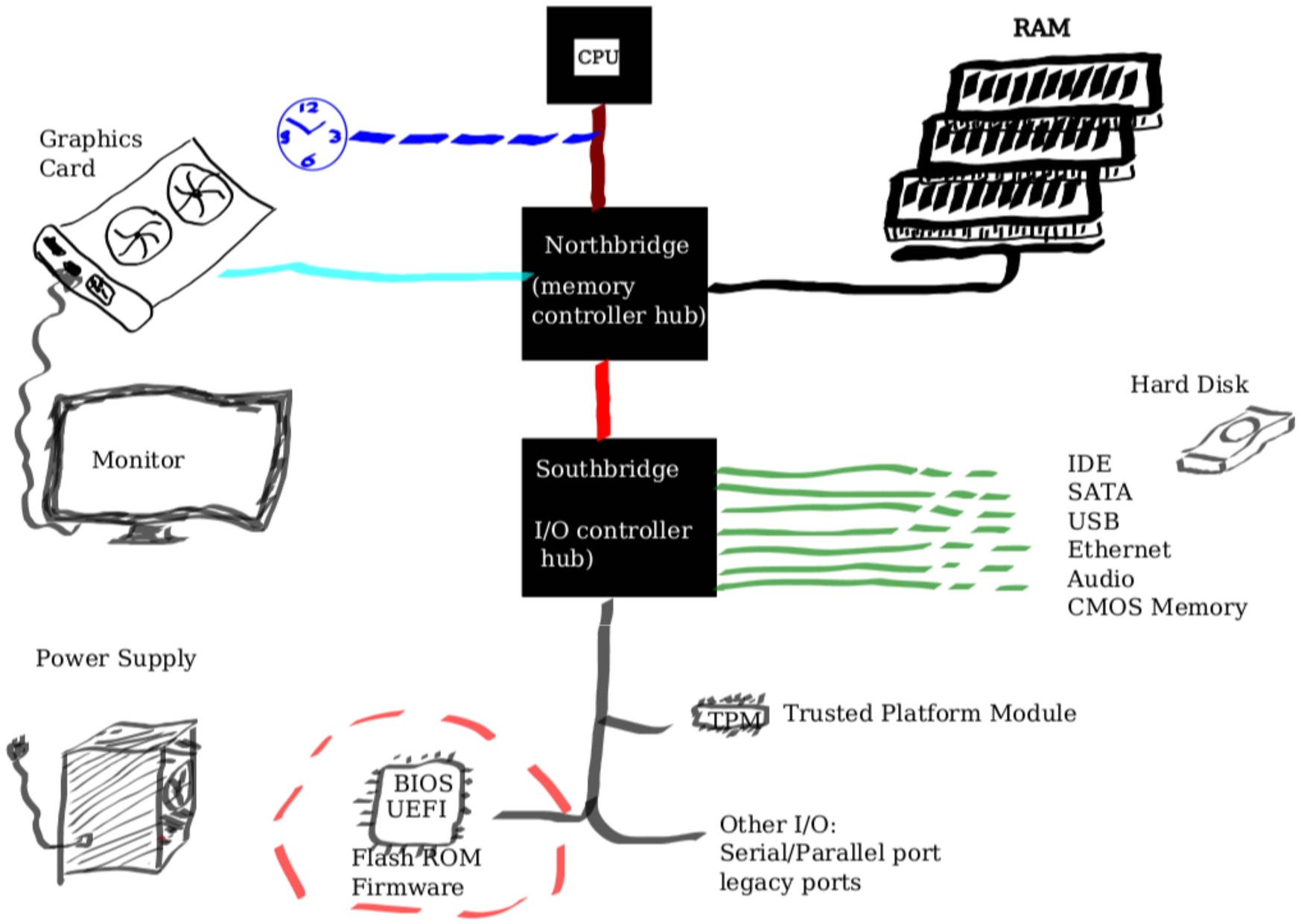
Boot process: Processor starts

- First the main fan starts (or other cooling) and motherboards clock-cycle starts.
- CPU gets power and starts working.
- CPU cannot do much without software.

When a computer starts it is really not able to do much. The CPU does not know about a hard-disk an operating system might sit on or any peripherals connected to the computer (mouse, keyboard, monitor, hardware, DVD-drive, printer, etc.).

Booting means to load software step-by-step and activate all components one step after the other.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Boot process: Initial software

- BIOS (Basic Input Output System or UEFI Unified Extensible Firmware Interface in modern PCs) is stored in non-volatile memory (ROM - read only memory) on the motherboard.
- It controls the start-up steps, provides initial system configuration (power saving, security, etc.), and initially configures accessible hardware.

Boot process: Initial software

- The reset command in the CPU triggers the execution of an instruction at a specific location in the BIOS chip.
- Location contains a Jump instruction that points to the actual BIOS start-up program in the chip.
- Booting really starts with the execution of this start-up program.

Boot process: POST

BIOS starts with a power-on-self-test POST:

- System memory is OK
- System clock / timer is running
- Processor is OK
- Keyboard is present
- Screen display memory is working
- BIOS is not corrupted

Results of POST can only be communicated through system beep.

Boot process: Video card

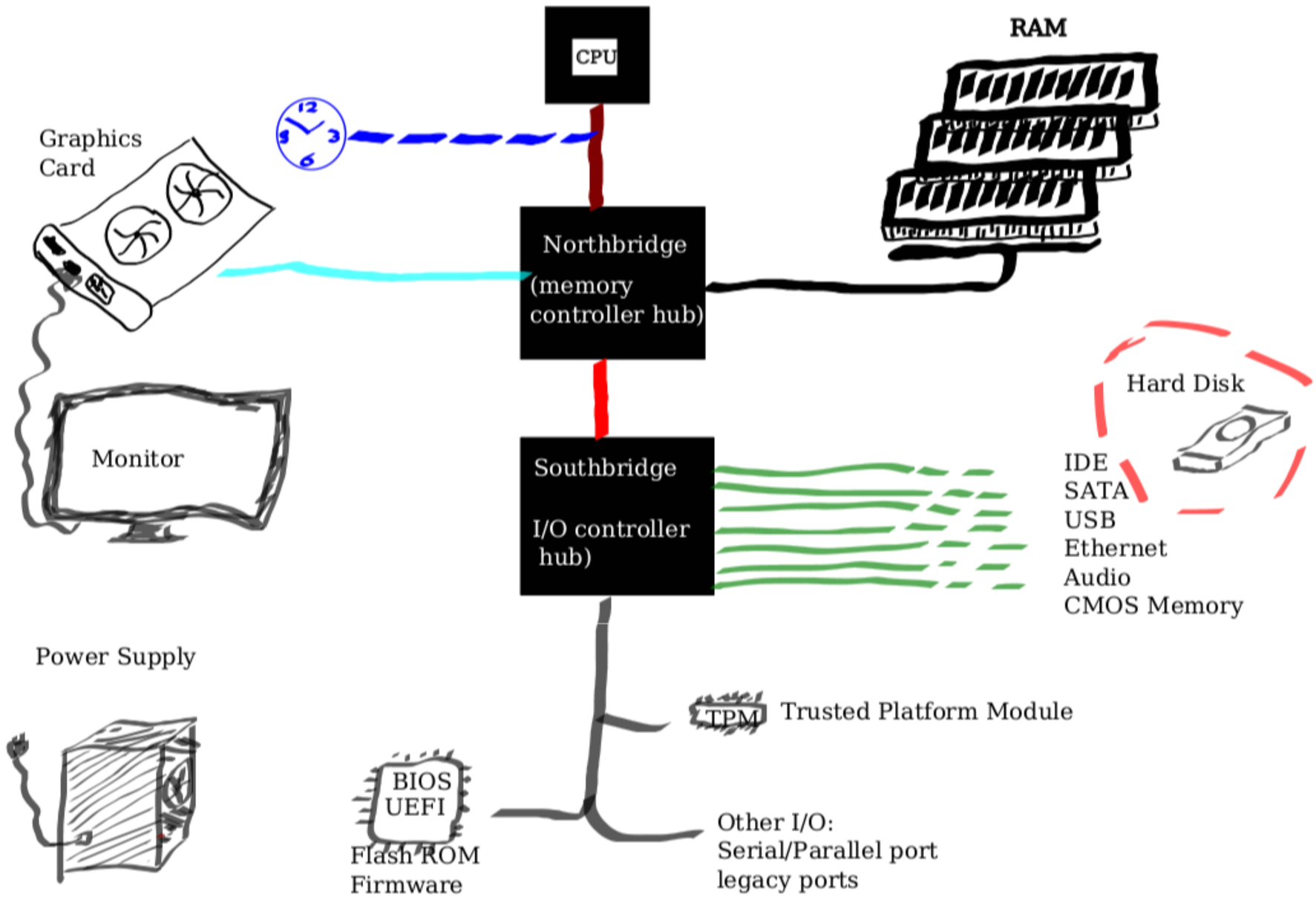
- The first thing after a successful POST is to initialize the video card and show some initial message on the screen.
- Note that the BIOS can only do a rudimentary initialization. Use of 3D, fancy graphics, etc. needs additional software, the so-called driver.

Boot process: Other hardware

- Then, the BIOS goes through all available hardware and initializes as far as possible without more complex driver software (UEFI has more options)
- Examples are type and size of hard-disk, DVD drive, timing of RAM (random access memory) chips, networking, sound, etc.

Boot process: Find Operating System

- BIOS needs to look for a bootable drive
- Can be on a hard-disk, USB Stick, DVD, floppy disk,...
- Order is defined in BIOS configuration (usually accessible by holding a particular key while start-up screen is shown).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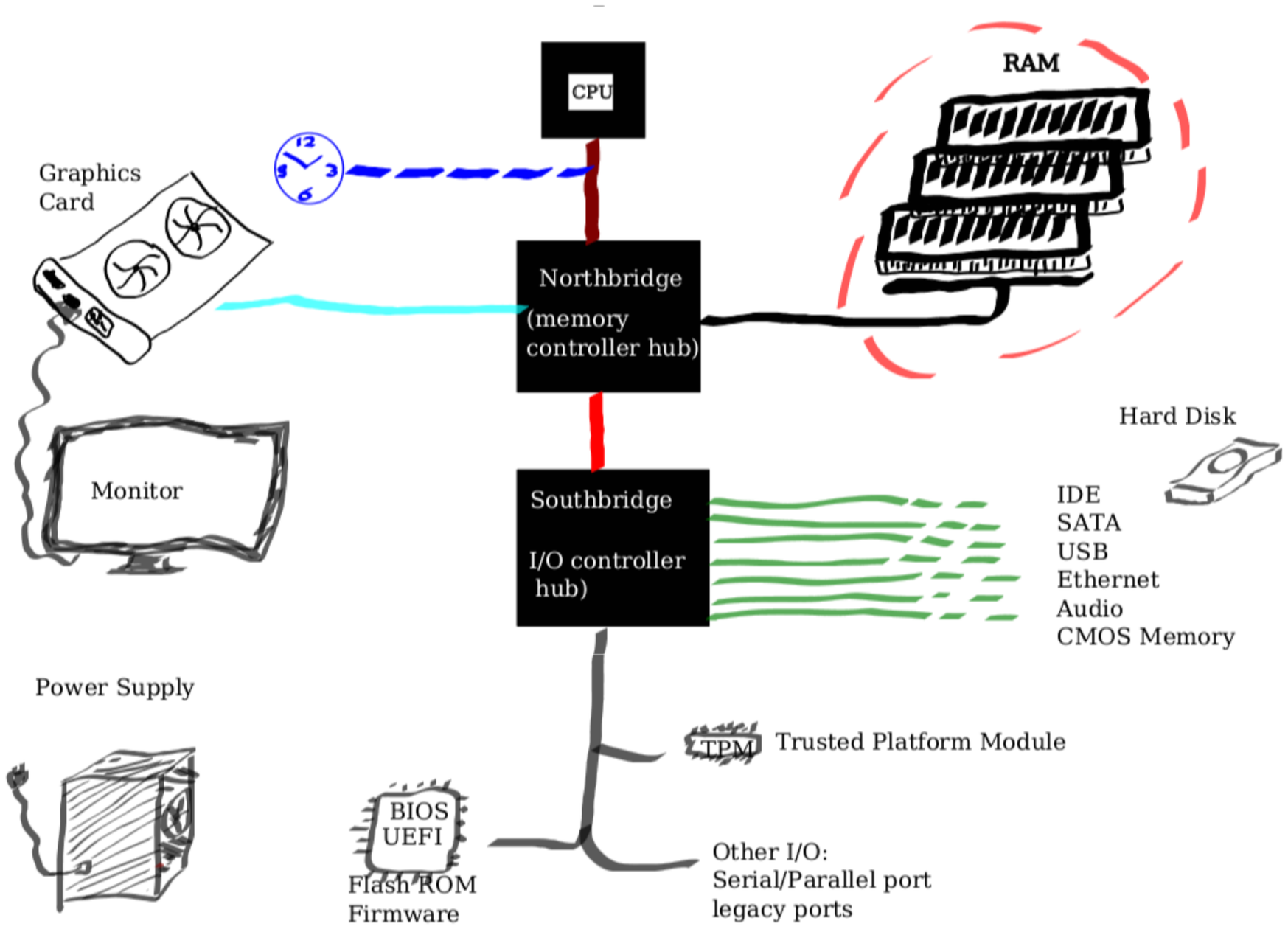
Boot process: Boot sector

- On a bootable drive, there needs to be a boot sector with code to be executed (boot loader).
  On a hard disk, this information is in the Master Boot Record (MBR).
- The boot loader first loads the core part of the operating system, the kernel. Then it loads various device drivers (e.g. for the graphics card).
- Once all drivers are loaded, the Graphical User interface is started and personal settings are loaded.
- The computer is ready to use.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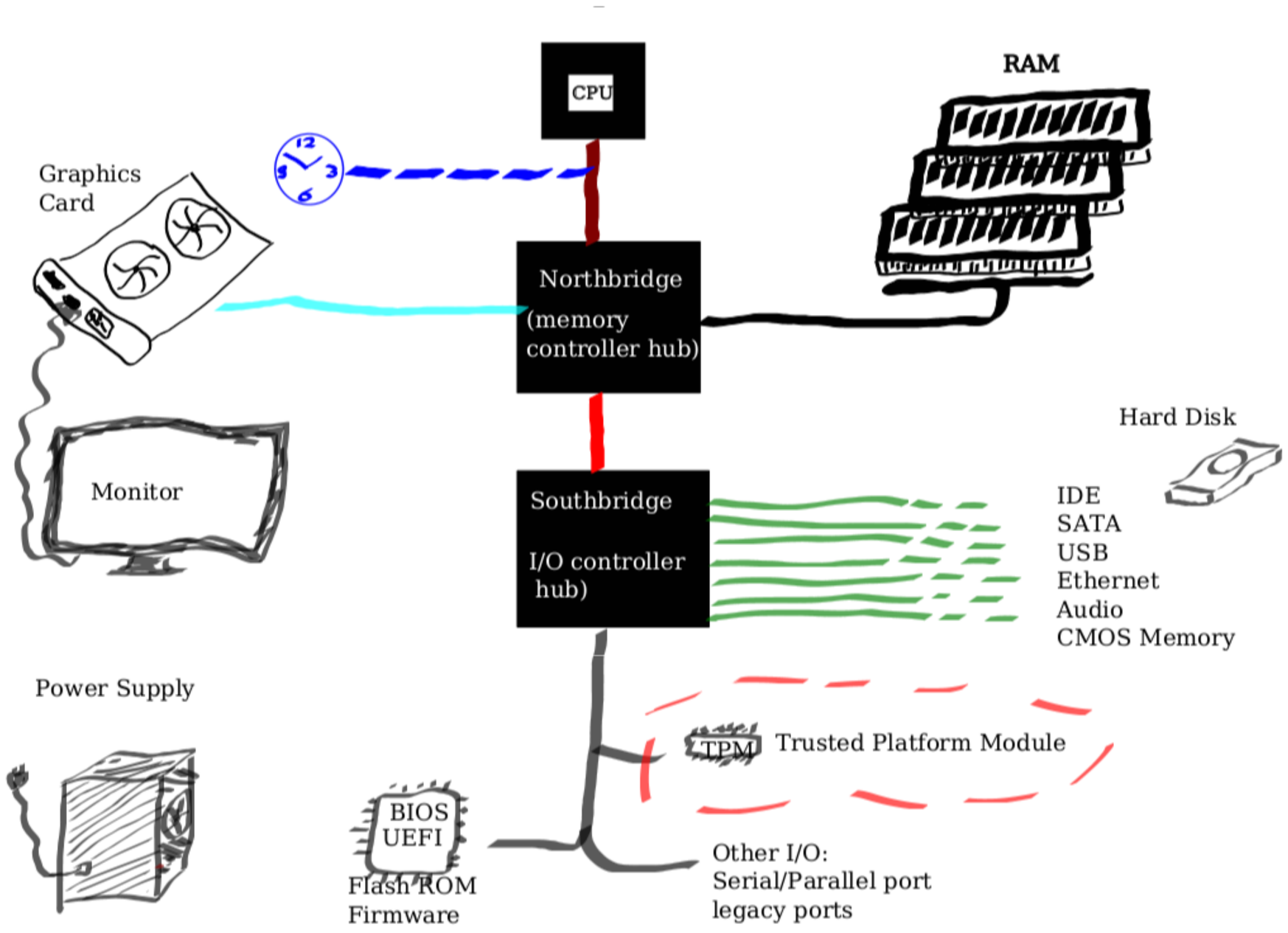
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BIOS versus UEFI

- BIOS is outdated. Was intended to be an abstraction layer to access I/O, but it is no longer used for this.
- Restricted to 1,024 kilobytes of space, only works with hard-drives up to 2.2 terabyte hard-disks, cannot work with lots of current technology (and future technology)
- UEFI does not really replace the firmware. It sits between firmware and operating system. Like a mini-operating system.

UEFI

- Can address hard-disks up to 9.4 zettabytes (1 zettabyte is about a billion terabytes).
- Provides access to all hardware. Faster hardware initialization.
- Security and authentication features before the OS has started.
- Network access before the OS has started.

UEFI criticism

- Boot restrictions (i.e. secure boot) can prevent users from installing the operating system of their choice.
- Additional complexity provides additional possibilities for errors and new attack vectors.

Most new PCs now use UEFI.

Some more on secure boot in the security part of the unit.

A little bit on values/sizes/measurements

- What is all this Tera, Giga, Kilo, nano, pico, …?
- And sometimes its powers of 10 and sometimes powers of 2?

Prefix	Symbol	Factor
	Base	$10^0 = 1$
deka-	da	$10^1 = 10$
hecto-	h	$10^2 = 100$
kilo-	k	$10^3 = 1{,}000$
mega-	M	$10^6 = 1{,}000{,}000$
giga-	G	$10^9 = 1{,}000{,}000{,}000$
tera-	T	$10^{12} = 1{,}000{,}000{,}000{,}000$
peta-	P	$10^{15} = 1{,}000{,}000{,}000{,}000{,}000$

Prefix	Symbol	Factor
	Base	$10^0 = 1$
deci-	d	$10^{-1} = 0.1$
centi-	c	$10^{-2} = 0.01$
milli-	m	$10^{-3} = 0.001$
micro-	□	$10^{-6} = 0.000,001$
nano-	n	$10^{-9} = 0.000,000,001$
pico-	p	$10^{-12} = 0.000,000,000,001$
femto-	f	$10^{-15} = 0,000,000,000,000,001$

For Bytes (bits) in powers of 2:

Prefix	Symbol	Factor
Bytes (Bits)	B (bit)	$2^0 = 1$
Kibi-	KiB (Kibit)	$2^{10} = 1024$
Mebi-	MiB (Mibit)	$2^{20} = 1,048,576$
Gibi-	GiB (Gibit)	$2^{30} = 1,073,741,824$
Tebi-	TiB (Tibit)	$2^{40} = 1,099,511,627,776$
Pebi-	PiB (Pibit)	$2^{50} = 1,125,899,906,842,624$

This continues with Exbi-, Zebi, and Yobi,...