CSGE602055 Operating Systems
CSF2600505 Sistem Operasi
Week 03: I/O, BIOS, Loader, & Systemd

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http://rms46.vlsm.org/2/207.html
Always check for the latest revision!

REV130 10-Apr-2018

Operating Systems 2018-1 (Room 3114 Tue/Thu)
Class: A (10:00-12:00) | B (13:00-15:00) | C (16:00-18:00)

Week	Schedule	Topic	OSC9
Week 00	06 Feb - 12 Feb 2018	Overview 1	Ch. 1, 16
Week 01	13 Feb - 19 Feb 2018	Overview 2 & Scripting	Ch. 1, 2
Week 02	20 Feb - 26 Feb 2018	Protection, Security, Privacy, & C-language	Ch. 14, 15
Week 03	27 Feb - 05 Mar 2018	I/O, BIOS, Loader, & Systemd	Ch. 13
Week 04	06 Mar - 12 Mar 2018	Addressing, Shared Lib, & Pointer	Ch. 8
Week 05	13 Mar - 19 Mar 2018	Virtual Memory	Ch. 9
Reserved	20 Mar - 24 Mar 2018		
Mid-Term	03 Apr 2018	13:00 - 15:30 (UTS)	
Week 06	05 Apr - 11 Apr 2018	Concurency: Processes & Threads	Ch. 3, 4
Week 07	12 Apr - 18 Apr 2018	Synchronization	Ch. 5, 7
Week 08	19 Apr - 25 Apr 2018	Scheduling	Ch. 6
Week 09	26 Apr - 07 May 2018	File System & Persistent Storage	Ch. 10, 11, 12
Reserved	08 May - 14 May 2018		
Week 10	15 May - 21 May 2018	I/O Programming & Network Sockets Programming	
Reserved	22 May - 22 May 2018		
Final	23 May - 26 May 2018	(UAS)	
Deadline	07 Jun 2018 16:00	Extra assignment **deadline**	

- The Check List (Operating Systems)
  - **Starting Point**: `http://rms46.vlsm.org/2/207.html`
  - **Text Book**: any recent/decent OS book but map it to **OSC9**.
  - Create **public** project "os181" on your `github.com` account.
    - Create file "`README.md`" and add an extra line every week. For e.g.[1]:

      ```
      ZCZC Sistem Operasi 2018 Awal (1)
      ZCZC W01 Have tried demo for week 01.
      ZCZC W02 Week 02 is done.
      ZCZC W03 Week 03 is done.
      ```

  - Encode your **QRC** with image size of approximately 250x250 pixels: **"OS181 CLASS ID GITHUB-ACCOUNT SSO-ACCOUNT SIAK-Full-Name"** Special for Week 00: Mail your **embedded** QRC to: `os181@vlsm.org` with Subject: [W00] CLASS ID SIAK-NAME.
  - Write your Memo (with QRC) **every week**.
  - Using your **SSO** account, login to `badak.cs.ui.ac.id` via `kawung.cs.ui.ac.id`.
    - Check folder `badak:///extra/Week00/`
    - Every week, copy the weekly demo files to your own home directory. Eg. for Week00:
      `cp -r /extra/Week00/W00-demos/ W00-demos/`

[1] Week 00 line is optional. The following "ZCZC WXX" weekly tags are mandatory.

Agenda

Week 03: I/O, BIOS, Boot, & Systemd

- Reference: (OSC9-ch13 demo-w03)
- Overview
- I/O Hardware
- Application I/O Interface
- Kernel I/O Subsystem
- Transforming I/O Requests to Hardware Operations
- STREAMS
- BIOS
- Boot
- Systemd

I/O (1)

- Direct I/O vs. Memory Mapped I/O
- Interrupts: Non Maskable (NMI) vs Maskable (MI)
- DMA: Direct Memory Access
- I/O Structure:
  - Kernel (S/W).
  - I/O (S/W: Kernel Subsystem)
  - Driver (S/W)
  - Controller (H/W)
  - Device (H/W)
- I/O Streams
  - APP
  - HEAD
  - MODULES
  - DRIVER
  - H/W.

I/O (2)

- I/O Interface Dimensions
  - Character-stream vs. Block;
  - Sequential vs. Random-access;
  - Sharable vs. Dedicated;
  - Parallel vs. Serial;
  - Speed;
  - Read Write – Read Only – Write Only.
  - Synchronous vs. Asynchronous;
  - Blocking vs. Non-Blocking.
- Where should a new algorithm be implemented?
  - APP?
  - Kenel?
  - Driver?
  - Controller?
  - HW?

BIOS, Boot, & Systemd

- Reference: (OSC9-ch13 demo-w03)
- Firmware
  - BIOS: Basic Input Output System.
  - UEFI: Unified Extensible Firmware Interface.
  - ACPI: Advanced Configuration and Power Interface.
- Operating System (Boot) Loader
  - BOOTMGT: Windows Bootmanager / Bootloader.
  - LILO: Linux Loader.
  - GRUB: GRand Unified Bootloader.
- Operating System Initialization
  - Init (legacy)
  - UpStart
  - Systemd
- I/O
  - Interrupt.
  - DMA.
  - ETC.

Legacy BIOS

- Check Settings.
- Initialize CPU & RAM.
- POST: Power-On Self-Test.
- Initialize ports, LANS, etc.
- Load a Boot Loader.
- Handover to the Boot Loader.
- Provides "Native" (obsolete) Drivers only (not loadable).
- Provides "INT" services .
- Limitation.
  - Technology of 1970s.
  - 16 bits software.
  - 20 bits address space (1 MB).
  - 31 bits disk space (2 TB).

BIOS

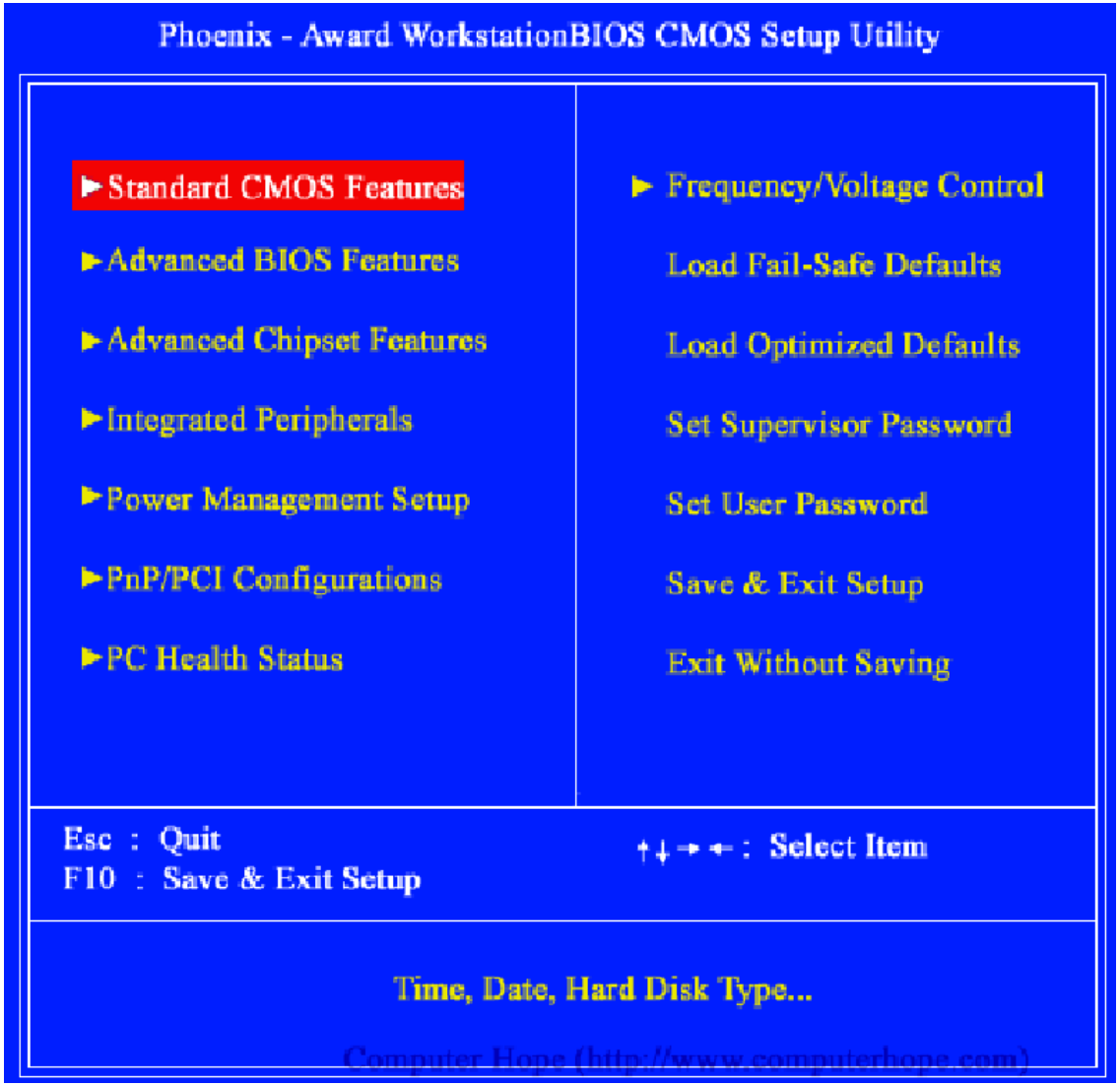

Figure: BIOS

UEFI

- A Firmware Specification, not an Implementation!
- No (INT) service after boot.
- HII: Human Interface Infrastructure.
- Protected Mode.
- Flexible.
  - Technology of 2000s.
  - writen in C.
  - (third party) loadable drivers and tools.
  - Emulate Legacy BIOS transition (MBR block, INT service).
  - UEFI Shell: environment shell for diagnostic (no need for DOS).
- Problems
  - Who controls the Hardware?
  - Is "Secure Boot" a good thing?
  - How about a **NASTY/LOCKING/TROJAN** UEFI implementation?
  - Different **DRIVERS**.

UEFI

Figure: UEFI

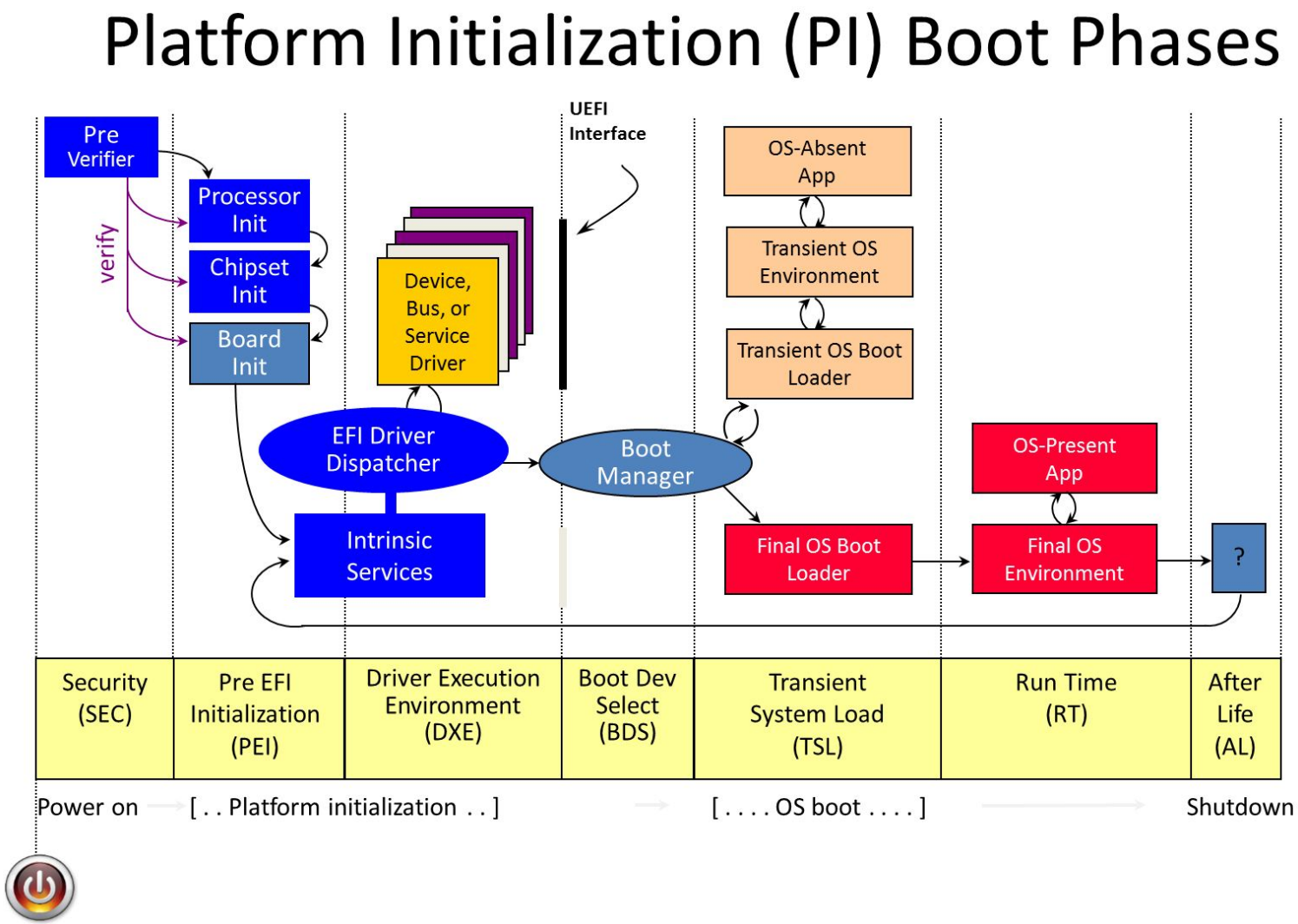

Figure: UEFI Boot Process[1].

[1]

Operating System (Boot) Loader

- General
  - How/Where to start the operating system?
  - What to do?
  - How many ways to boot?
  - How many types of OS?
- GRUB/GRUB2: GRand Unified Boot system
  - Stage 1 (boot.img): MBR (Master Boot Record) – Where is everything
  - Stage 1.5 (core.img): generated from diskboot.img
  - Stage 2: Kernel Selection: Windows, Linux, BSD, etc.
- GRUB2
  - More flexible than GRUB legacy
  - More automated than GRUB legacy
- Disk Partition
  - MBR: Master Boot Record (1983).
  - GPT: GUID Partition Table (2010s).

GRUB Map

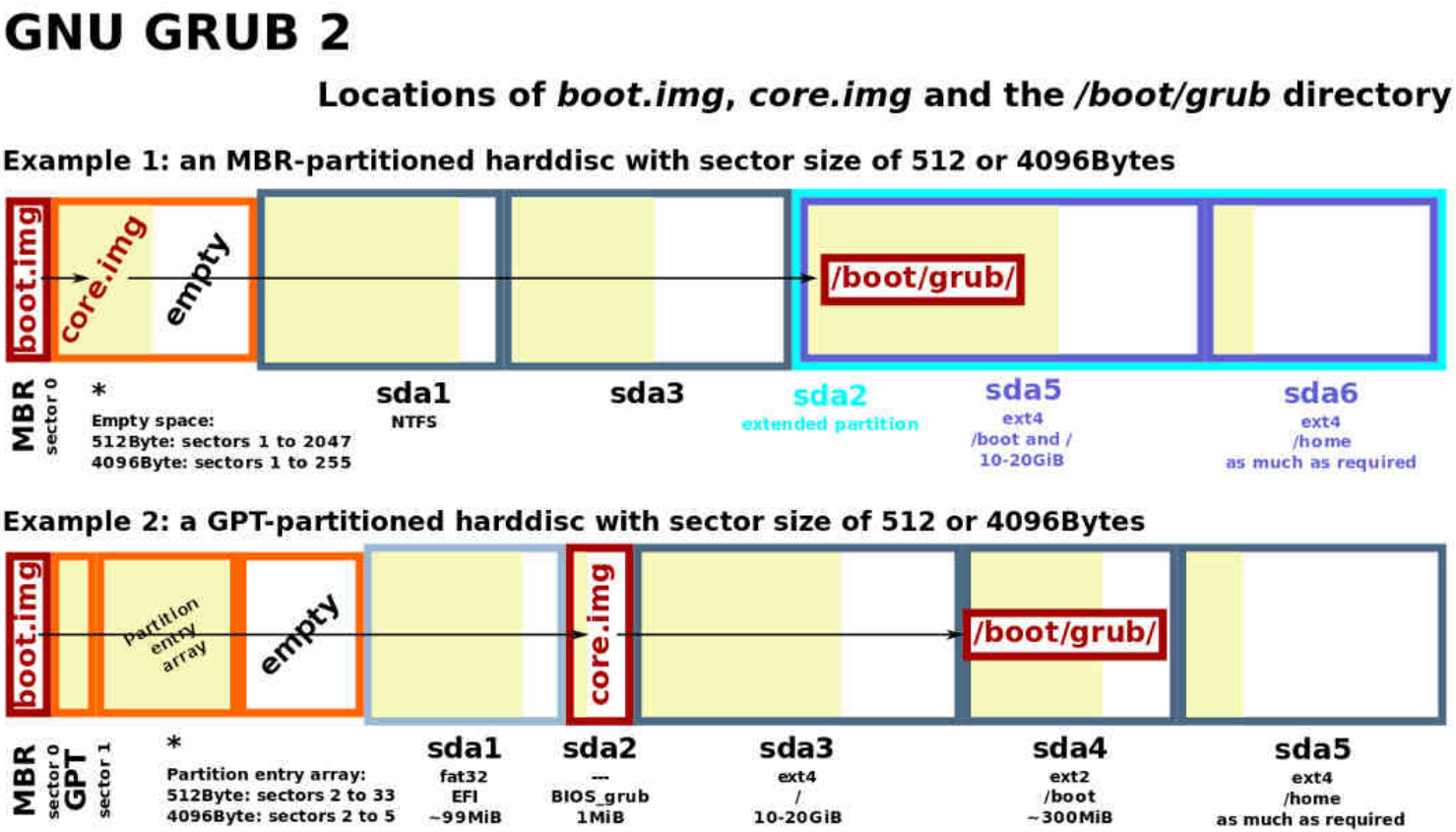

Figure: GRUB[1].

[1] Source Shmuel Csaba Otto Traian 2013

init (SYSV legacy)

- File: `/etc/inittab`.
- Folders: `/etc/rcX.d` — X = runlevel.
  - Seven (7) different runlevels:
    - 0 (shutdown).
    - 1 (single-user/admin).
    - 2 (multi-user non net).
    - 3 (standard).
    - 4 (N/A).
    - 5 (3+GUI).
    - 6 (reboot).
  - SXX-YYY: Start
  - KXX-YYY: Kill.
- One script at a time in order.
- dependency is set manually.

UpStart - Ubuntu

- Developer: Ubuntu.
- Folder: `/etc/init/`.
- Control: `initctl`.
  - `initctl list` – listing all processes managed by upstart.
- better support for hotplug devices.
- cleaner service management.
- faster service management.
- asynchronous.

The All New "systemd"

- Replaces (SYSV) init and UpStart.
  - better concurency handling: Faster!
  - better dependencies handling: No more "S(tarts)" and "K(ills)".
  - better crash handling: automatic restart option.
  - better security: group protection from anyone including superusers.
  - simpler config files: reliable and clean scripts.
  - hotplug: dynamic start/stop.
  - supports legacy systems (init).
  - overhead reducing.
  - unified management way for all distros.
  - bloated: doing more with more resources.
  - linux specific: NOT portable.

systemctl

```
for II in       \
    'systemctl list-unit-files | head -8; echo "(...)";
        systemctl list-unit-files| tail -8' \
    'systemd-analyze blame | wc -l; echo "===";
        systemd-analyze blame | head -15' \
    'systemctl --full  | wc -l; echo "===";
        systemctl --full  | head -10' \
    'systemctl list-units  | wc -l; echo "===";
        systemctl list-units  | head -10' \
    'systemctl list-units |grep .service|wc -l;echo "===";
        systemctl list-units|grep .service|head -10' \
    'systemctl list-units  | grep ssh.service' \
    'systemctl status ssh.service' \
    'systemctl is-enabled ssh' \
    'journalctl' \
    'journalctl -b' \
do
...
```

PCH: Platform Controller Hub

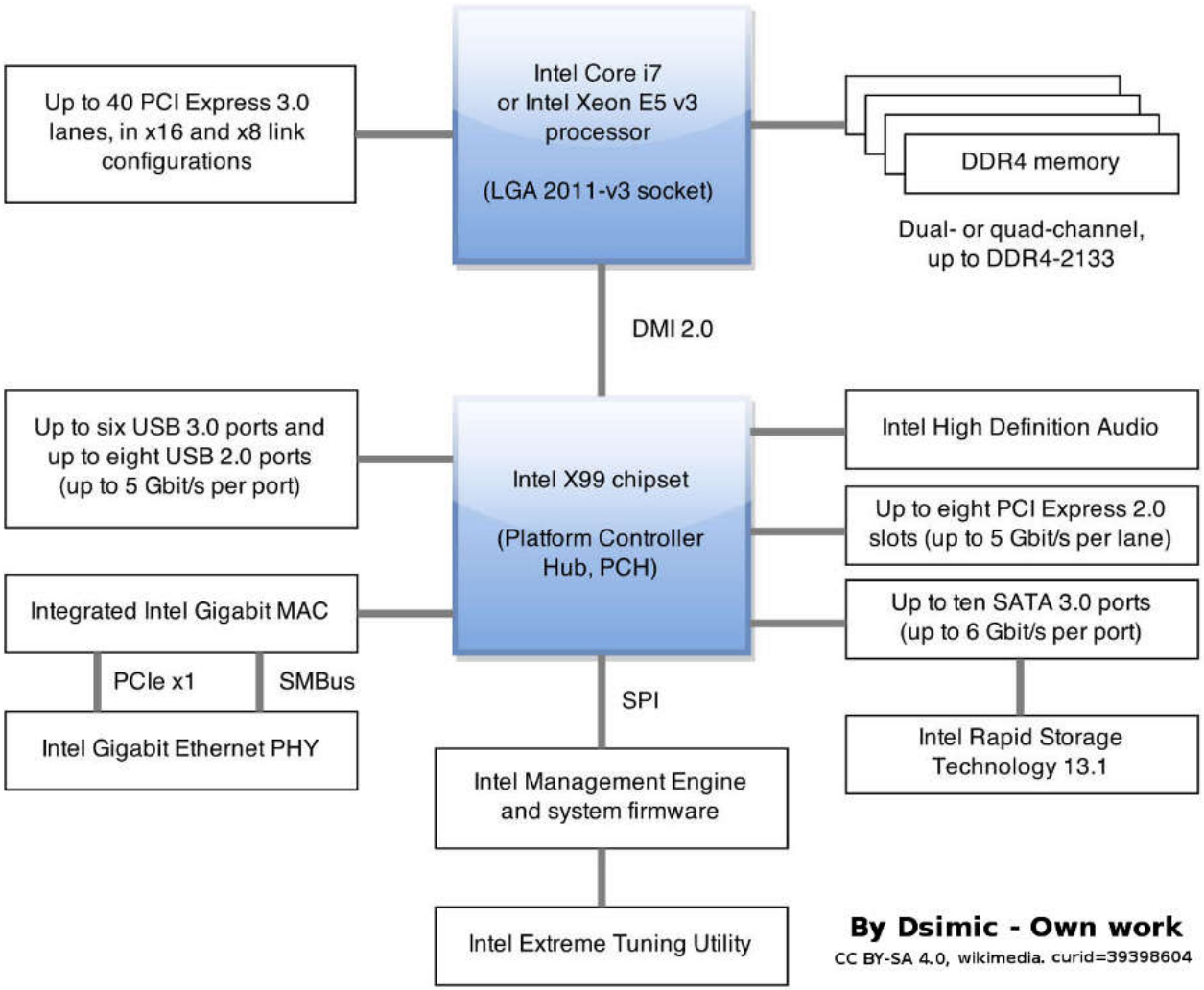

Figure: PCH: Platform Controller Hub

Some Terms

- PCH: Platform Controller Hub
- PCIe: Peripheral Component Interconnect Express — 32 bits for (16 * 1x or 8 * 2x or 4 * 4x or 2 * 8x or 1 * 16x) * (2 direction) lanes.
- DMI: Direct Media Interface. Eg. DMI 2.0 (2 GB/s; 4x)
- GT/s: GigaTransfers per second
- 1 KB (KiloByte) = 1000 bytes — 1 KiB (Kibibyte) = 1024 bytes[1]
- SMB: System Management Bus
- SPI: Serial Peripheral Interface, a de facto standard bus.
- SATA: Serial AT Attachment. Eg. SATA 3.2 $\approx$ 2 GB/s.
- DDR4 SDRAM: Double Data Rate Fourth-generation Synchronous Dynamic Random-Access Memory: 2 x DDR2 (DDR2 = 2 x DDR (DDR = 2 x SDRAM)). Eg. DDR4-3200 (8x SDRAM); Memory Clock: 400 MHz; Data Rate: 3200 MT/s; Module Name PC4-25600; Peak Transfer Rate: 25600 MB/s,

[1] In IT tradition; 1 KB = 1024 bytes

The End

- ☐ This is the end of the presentation.
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