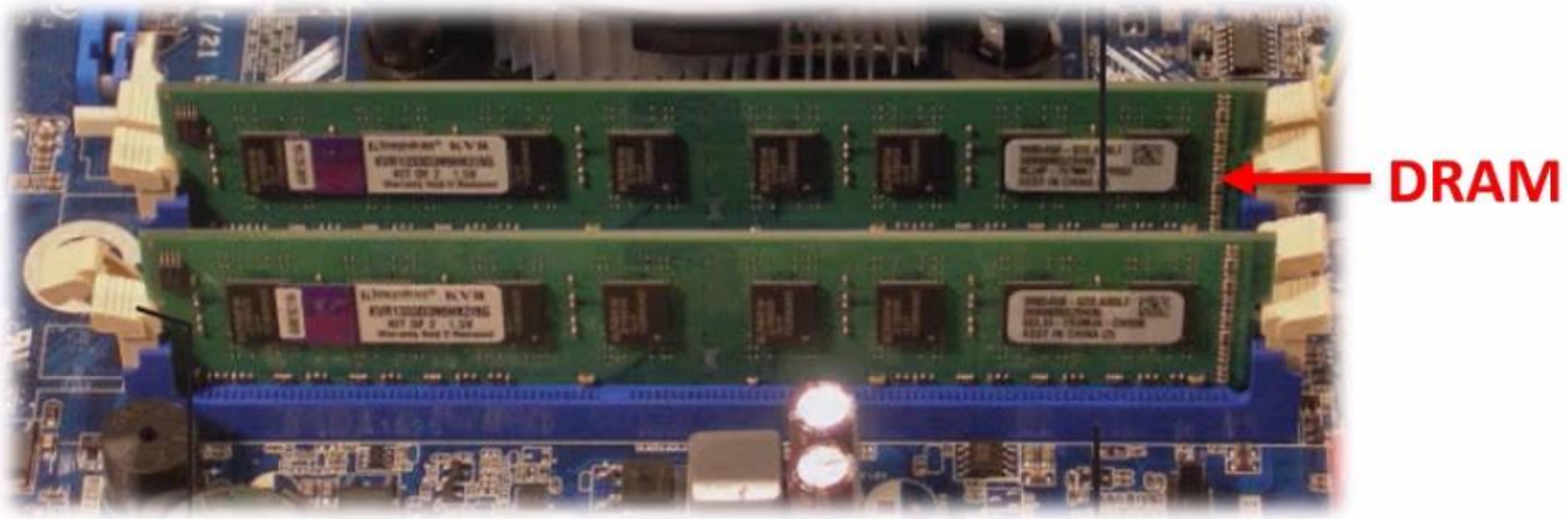
Hardware

RAM, ROM, EXPANSION CARDS, PERIPHERAL DEVICES

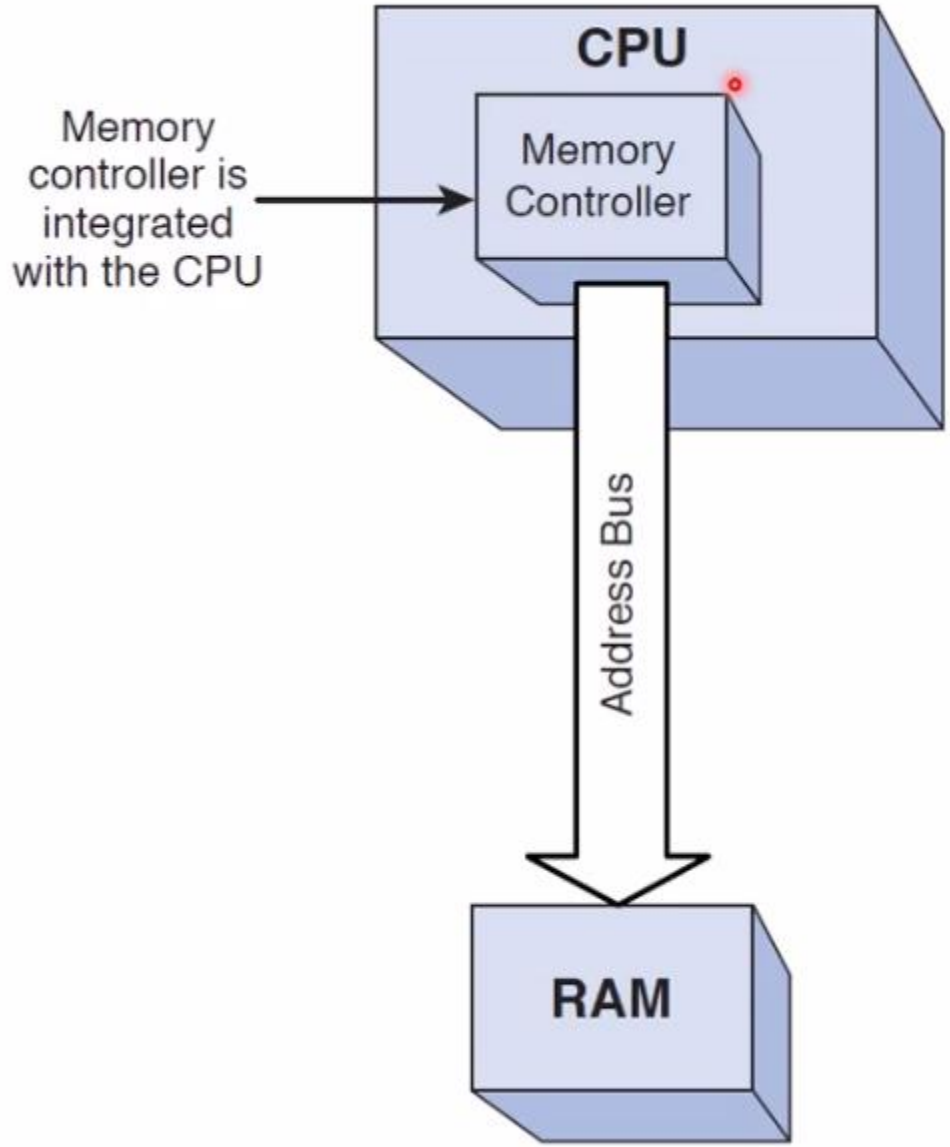
RAM BASICS

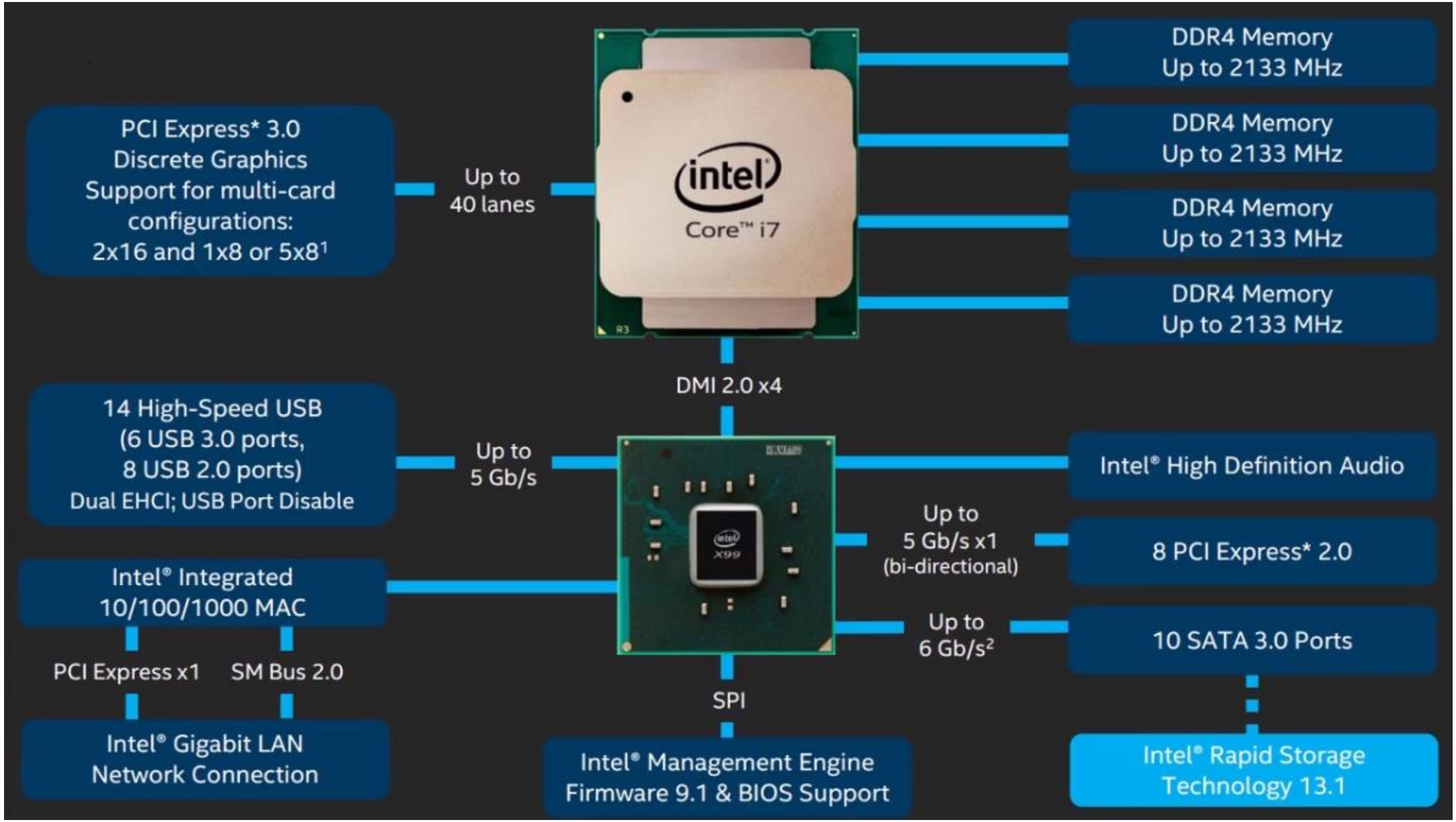
Random Access Memory (RAM) is the workspace for the CPU.

DRAM is volatile – it is cleared when the computer is shut down.



- The memory controller acts as a go-between for the CPU and the RAM.
- It is responsible for storing and retrieving data to and from RAM.
- Compatibility is key!




PCI Express* 3.0
Discrete Graphics
Support for multi-card
configurations:
2x16 and 1x8 or 5x8[1]
Up to
40 lanes
intel
Core™ i7
DDR4 Memory
Up to 2133 MHz
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Up to 2133 MHz
DMI 2.0 x4
14 High-Speed USB
(6 USB 3.0 ports,
8 USB 2.0 ports)
Dual EHCI; USB Port Disable
Up to
5 Gb/s
Intel® High Definition Audio
Up to
5 Gb/s x1
(bi-directional)
8 PCI Express* 2.0
Intel® Integrated
10/100/1000 MAC
Up to
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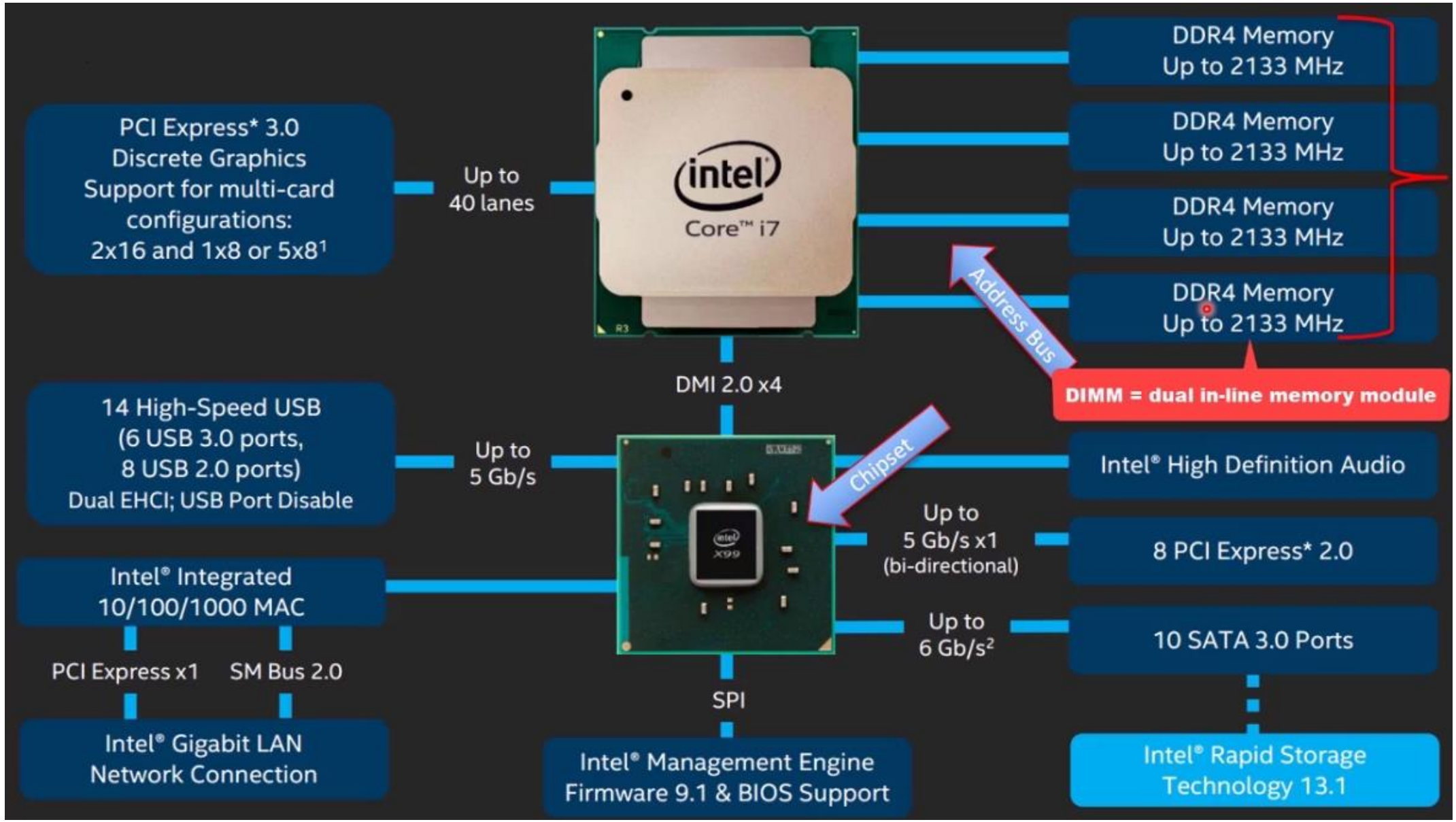
10 SATA 3.0 Ports
PCI Express x1
SM Bus 2.0
SPI
Intel® Gigabit LAN
Network Connection
Intel® Management Engine
Firmware 9.1 & BIOS Support
Intel® Rapid Storage
Technology 13.1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Address Bus
DIMM = dual in-line memory module
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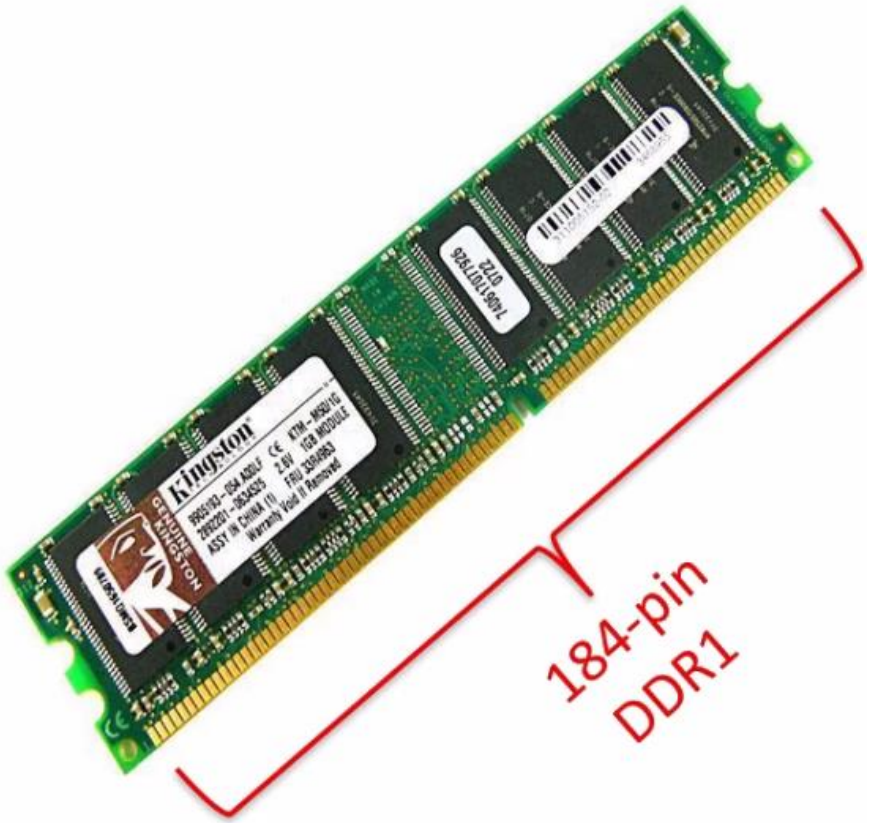
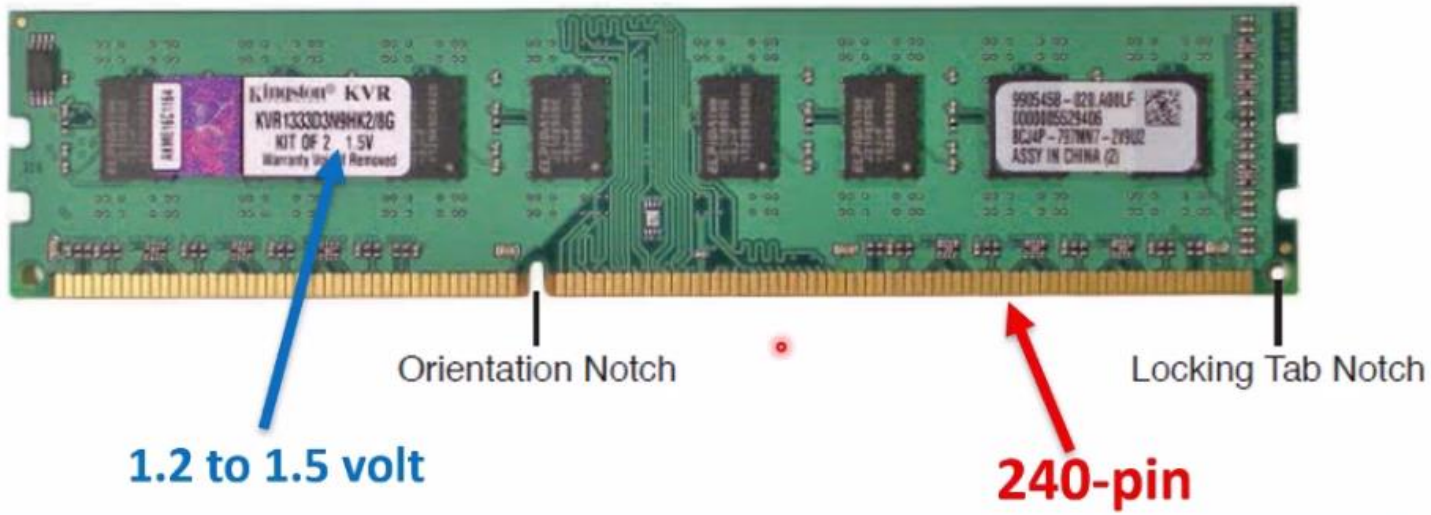
DDR2

- DDR = Double Data Rate
- DDR1 example:
  - DDR-200 (1,600 MB/s)
  - 184-pin
- DDR2 example:
  - DDR2-800 (6,400 MB/s)
  - 240-pin



DDR3



DDR3-1600	800 MHz	(1600 MT/s)	12800 MB/s PC3-12800
DDR3-1866	933 MHz	(1866 MT/s)	14933 MB/s PC3-14900
DDR3-2133	1066 MHz	(2133 MT/s)	17066 MB/s PC3-17000
DDR3-2400	1200 MHz	(2400 MT/s)	19200 MB/s PC3-19200

DDR5

- DDR5 voltage is 1.1 V
- 288-pin - not backward compatible with DDR4!
- Maximum density is 64 GB

Typical DDR5 Modules

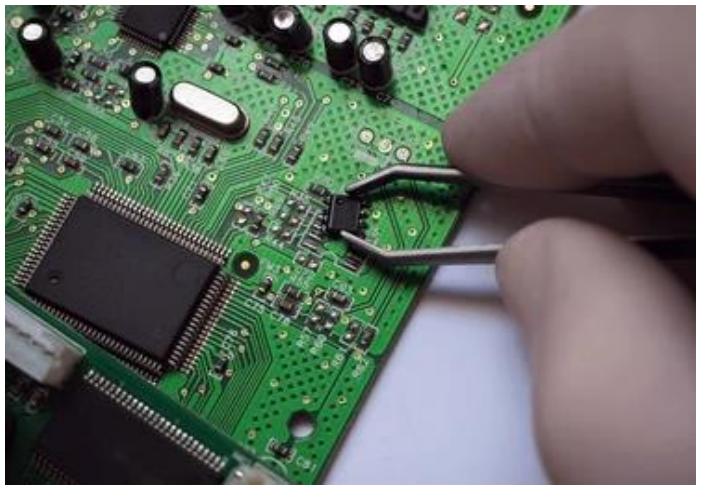
DDR5-4800	38,400 MB/s	PC5-38400
DDR5-6400	51,200 MB/s	PC5-51200
DDR5-7200	57,600 MB/s	PC5-57600

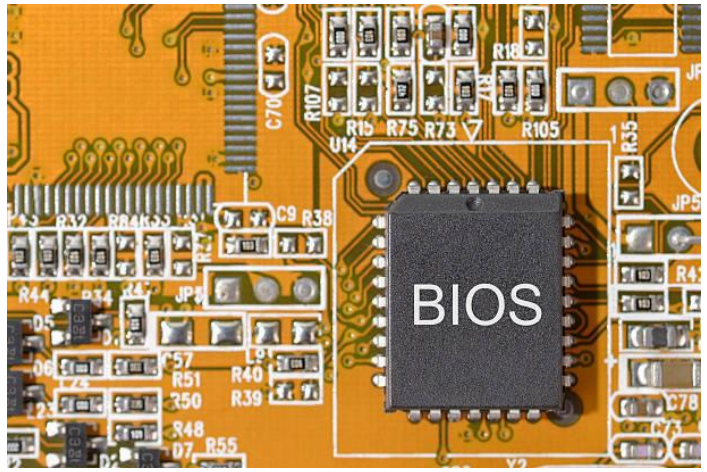
CPU

DDR4-2133 MT/S

ROM AND FIRMWARE

- **ROM** is a type of non-volatile memory used in computers and other electronic devices. It is designed to permanently store data, meaning the data is retained even when the device is powered off.





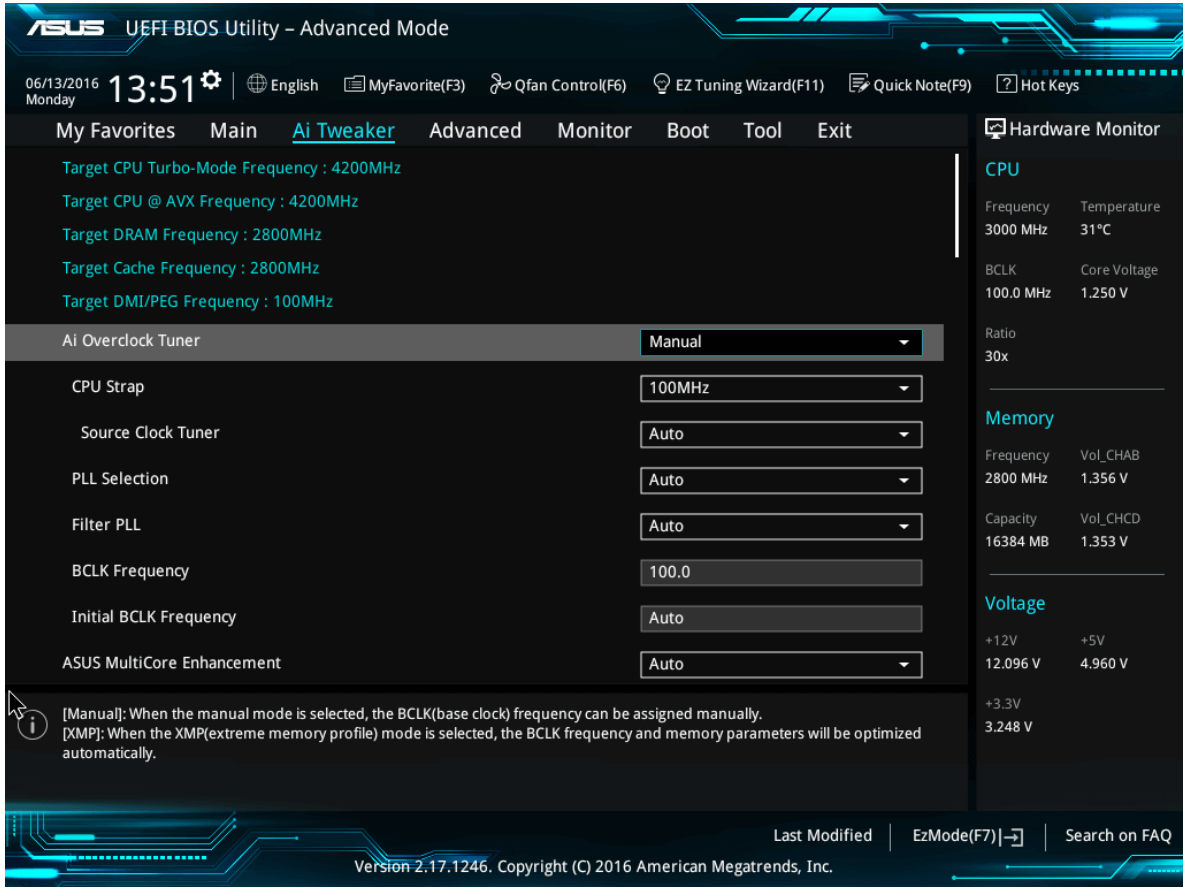
Common Uses:

- **BIOS/UEFI:** Initial startup instructions for a computer.
  - **BIOS** (Basic Input/Output System) and
  - **UEFI** (Unified Extensible Firmware Interface).
- Two types of firmware used to initialize and manage hardware during a computer's startup process before handing control to the operating system (OS).

BIOS


ThinkPad T480s (20L7,20L8)
ThinkPad Setup
Lenovo PCSD Service Enablement - DFS Team
Main Config Date/Time Security Startup Restart
UEFI BIOS Version N22ET33W
UEFI BIOS Date (Year-Month-Day) 2018-02-28
Embedded Controller Version N22ET33W
ME Firmware Version x.x.x.x
Machine Type Model 20L7
System-unit serial number PF123
System board serial number W1KS6123
Asset Tag No Asset Information
CPU Type Intel(R) Core(TM) ix-xx00U CPU
CPU Speed 2.x00GHz
Installed memory xxxx MB
UUID e23b804c-36a8-11b2-a85c-1
MAC Address (Internal LAN) 54 XX 75 XX 31 XX
UEFI Secure Boot On
OA2 Yes
F1 Help Select Item +/- Change Values F9 Setup Defaults
Esc Exit Select Menu Enter Select > Sub-Menu F10 Save and Exit
Contributed by Zongquan, V6.0, 2018/03/29

UEFI


UEFI BIOS Utility – Advanced Mode
06/13/2016 Monday 13:51
English MyFavorite(F3) Qfan Control(F6) EZ Tuning Wizard(F11) Quick Note(F9) Hot Keys
My Favorites Main Ai Tweaker Advanced Monitor Boot Tool Exit
Target CPU Turbo-Mode Frequency : 4200MHz
Target CPU @ AVX Frequency : 4200MHz
Target DRAM Frequency : 2800MHz
Target Cache Frequency : 2800MHz
Target DMI/PEG Frequency : 100MHz
Ai Overclock Tuner Manual
CPU Strap 100MHz
Source Clock Tuner Auto
PLL Selection Auto
Filter PLL Auto
BCLK Frequency 100.0
Initial BCLK Frequency Auto
ASUS MultiCore Enhancement Auto
[Manual]: When the manual mode is selected, the BCLK(base clock) frequency can be assigned manually.
[XMP]: When the XMP(extreme memory profile) mode is selected, the BCLK frequency and memory parameters will be optimized automatically.
Hardware Monitor
CPU
Frequency 3000 MHz
Temperature 31°C
BCLK 100.0 MHz
Core Voltage 1.250 V
Ratio 30x
Memory
Frequency 2800 MHz
Vol_CHAB 1.356 V
Capacity 16384 MB
Vol_CHCD 1.353 V
Voltage
+12V 12.096 V
+5V 4.960 V
+3.3V 3.248 V
Last Modified
EzMode(F7)
Search on FAQ
Version 2.17.1246. Copyright (C) 2016 American Megatrends, Inc.

- Embedded systems in devices like TVs, washing machines, and routers.

- Firmware is stored in non-volatile memory – either read-only memory (ROM) or programmable memory such as EPROM, EEPROM, or flash.

- A traditional firmware that dates back to the 1970s. BIOS can have limited storage capacity, slow boot times, and lack modern features.
- **UEFI**
- A modern replacement for BIOS that offers a faster, more secure boot process, and additional features. UEFI is compatible with BIOS and is expected to eventually replace it.

Here are some differences between BIOS and UEFI:

Security

- UEFI has more sophisticated security features, including Secure Boot, which prevents unauthorized apps from booting up.

Partition support

- BIOS uses 32-bit entries in its partition table, which limits the total physical partitions to four. UEFI uses 64-bit entries and supports up to 128 physical partitions.

To access the UEFI or BIOS firmware setup on a Dell system, you can:

1. Boot to the sign-in screen
2. Click the Power button on the sign-in screen
3. Press and hold down the Shift key and click Restart

4. Select UEFI Firmware Settings

- To save and exit BIOS or UEFI settings, you can:
- Select the option that says Save and Exit, Save Changes and Exit, or Exit Saving Changes

- Use the F10 key
- To discard your changes and exit without saving, you can:
- Select the option that says Exit Without Saving, Discard Changes and Exit, or Exit Discarding Changes
- Use the Esc key

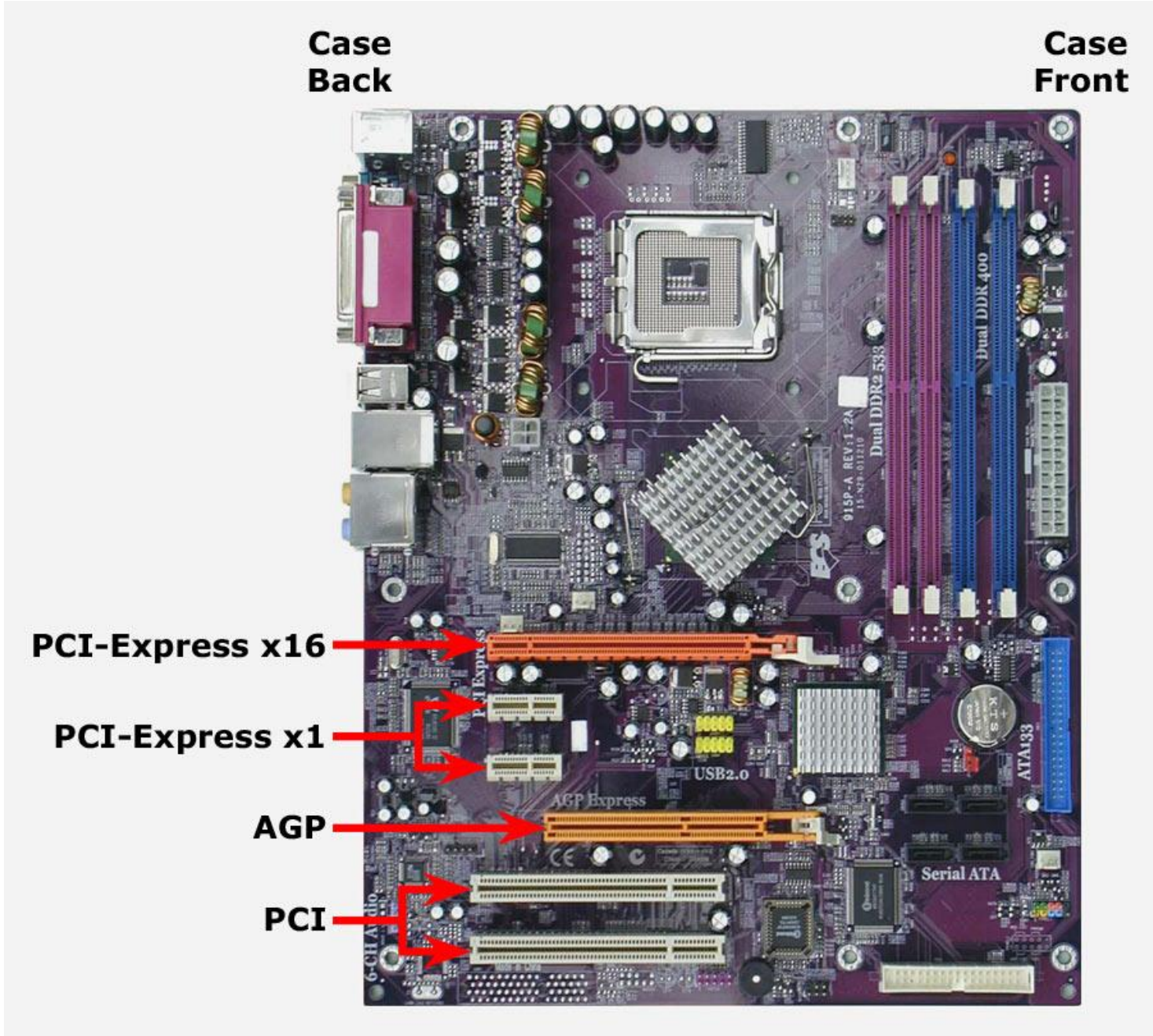
EXPANSION SLOTS / CARDS

- Expansion slots are physical connectors on a computer motherboard that allow additional hardware components to be added to the system.

- These slots are critical for upgrading or customizing a computer's functionality by adding peripherals like graphics cards, sound cards, network cards, and storage controllers.

PCI Express Connectors

	Bandwidth
x1 	**Single Direction:** 2.5 Gbps/200MBps **Dual Direction:** 5 Gbps/400MBps
x4 	**Single Direction:** 10 Gbps/800MBps **Dual Direction:** 20 Gbps/1.6 GBps
x8 	**Single Direction:** 20 Gbps/1.6 GBps **Dual Direction:** 40 Gbps/3.2 GBps
x16 	**Single Direction:** 40 Gbps/3.2 GBps **Dual Direction:** 80 Gbps/6.4 GBps


Case
Back
Case
Front
PCI-Express x16
PCI-Express x1
AGP
PCI
Dual DDR 400
Dual DDR2 533
USB2.0
AGP Express
Serial ATA
ATA133

Common Uses of Expansion Slots

- **Graphics Cards:** High-performance GPUs (e.g., NVIDIA, AMD) use PCIe x16 slots.

- **Sound Cards:** Enhance audio quality for gaming, music, or professional audio work.

- **Network Cards:** Provide additional or faster Ethernet/Wi-Fi connectivity.
- **Storage Controllers:** Add support for RAID arrays or additional drives.
- **Capture Cards:** Record video from external sources for streaming or editing.

Computer peripheral device

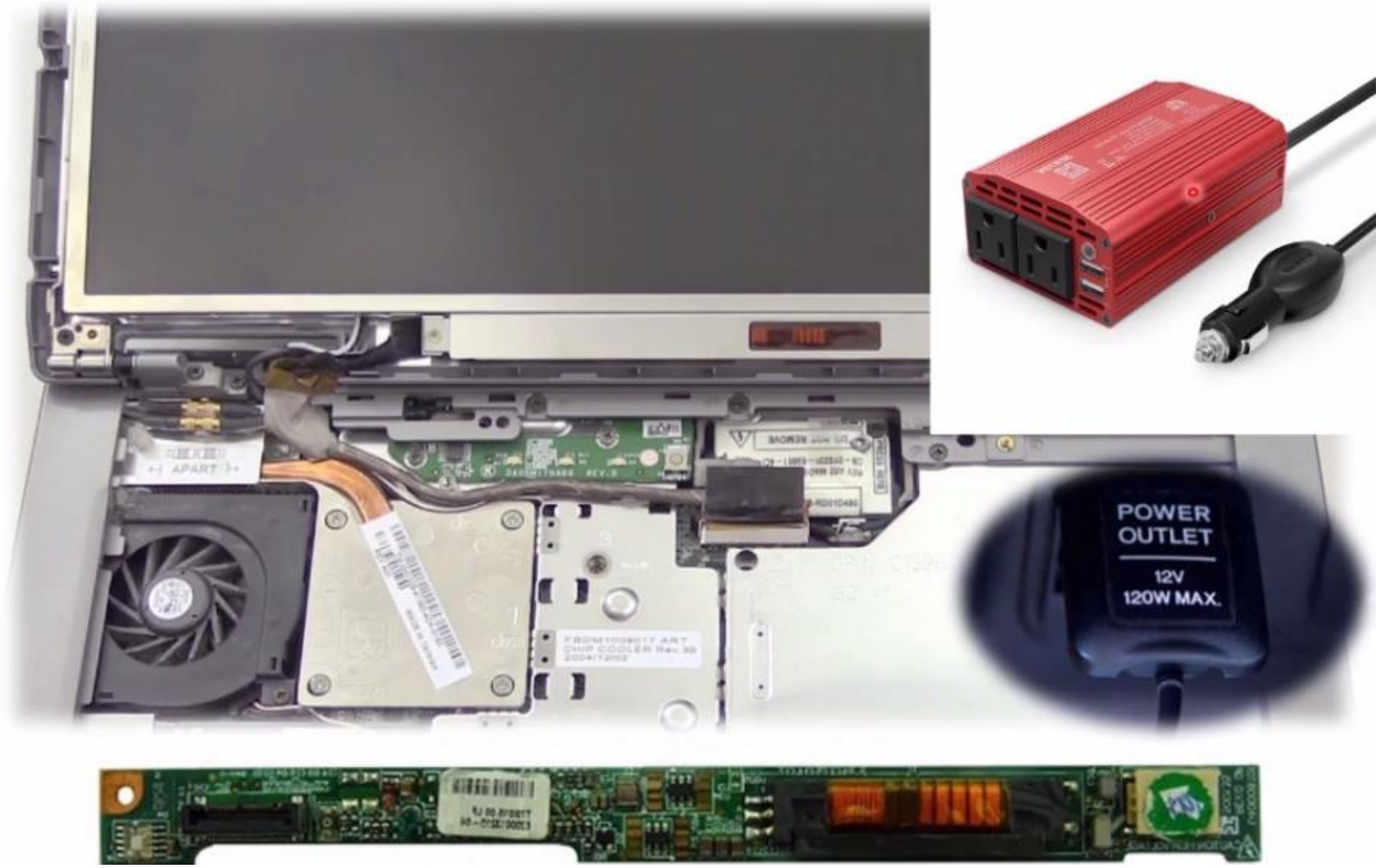
- A computer peripheral, also known as a peripheral device, is an external device that connects to a computer to expand its capabilities.

- Peripheral devices are not essential to the functioning of a computer, but they enhance its functionality. These devices can be input devices, output devices, or both.

DISPLAY

- Liquid Crystal Display (LCD)
  - LCD technologies include TFT and active-matrix.
  - The original LCDs used a lamp as the backlight and an inverter for changing DC power to AC.
- Light-emitting diode (LED)
  - Use RGB diodes which consume less power.
  - DC power - no inverter needed.
- Organic LED (OLED)
  - Can be printed on just about anything.

- Changes power from DC to AC.
- Has the potential for failure.
- It is less common today.



INVERTER

- Changes power from DC to AC.
- Has the potential for failure.
- It is less common today.
- Differences between an inverter and a rectifier.

↑ Rectifier: Changes AC to DC

↓ Inverter: Changes DC to AC

PORTS

USB & Vendor-Specific Ports

Used for:

- Charging
- Synchronization
- Moving of files
- OTG functionality
- Tethering

Mini-USB Type B Port

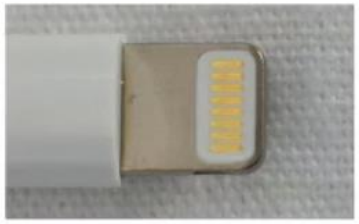
Mini-USB Type B Connector

Micro-USB Type B Port

Micro-USB Type B Connector

USB-C Port

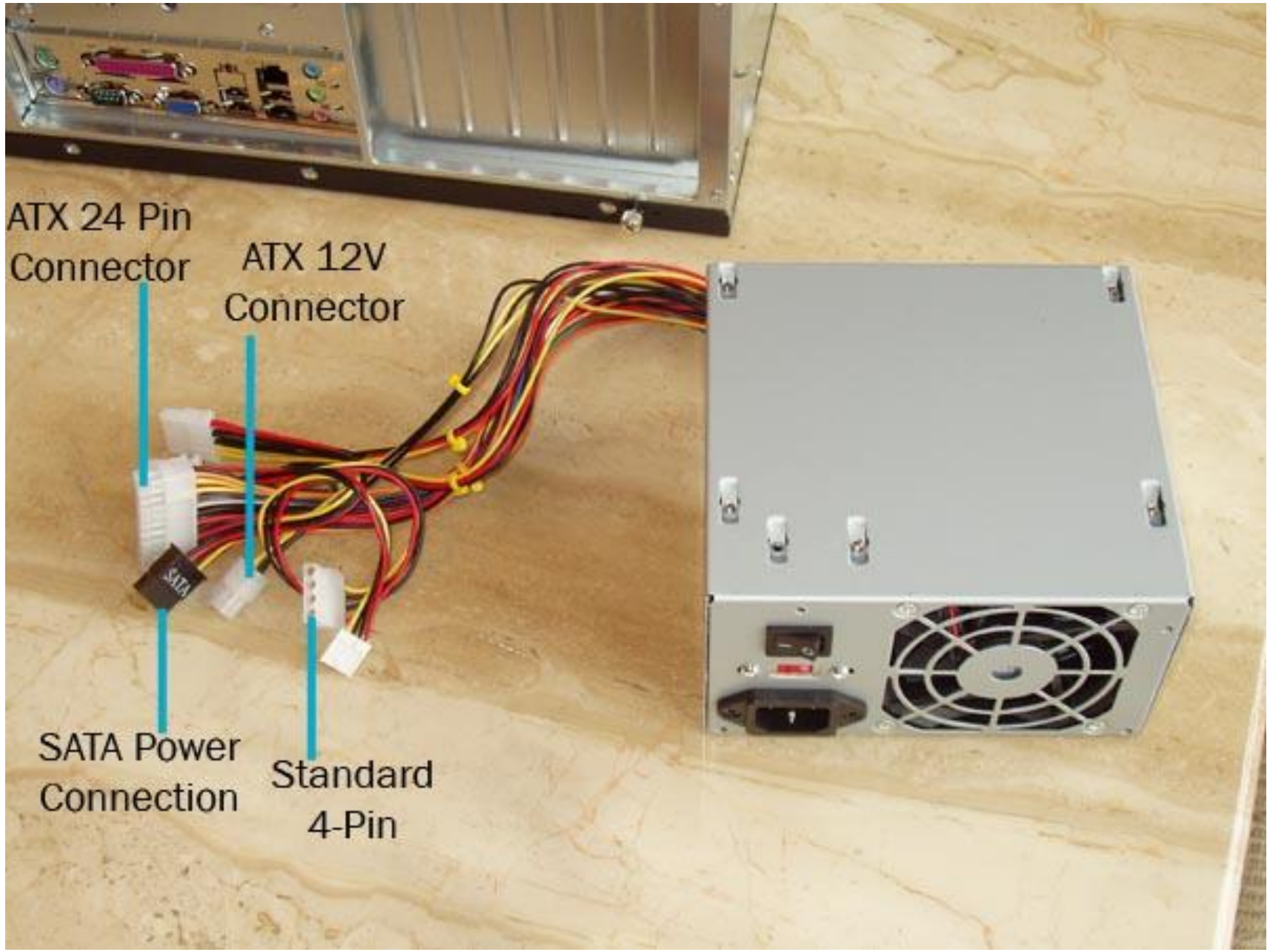
USB-C Connector

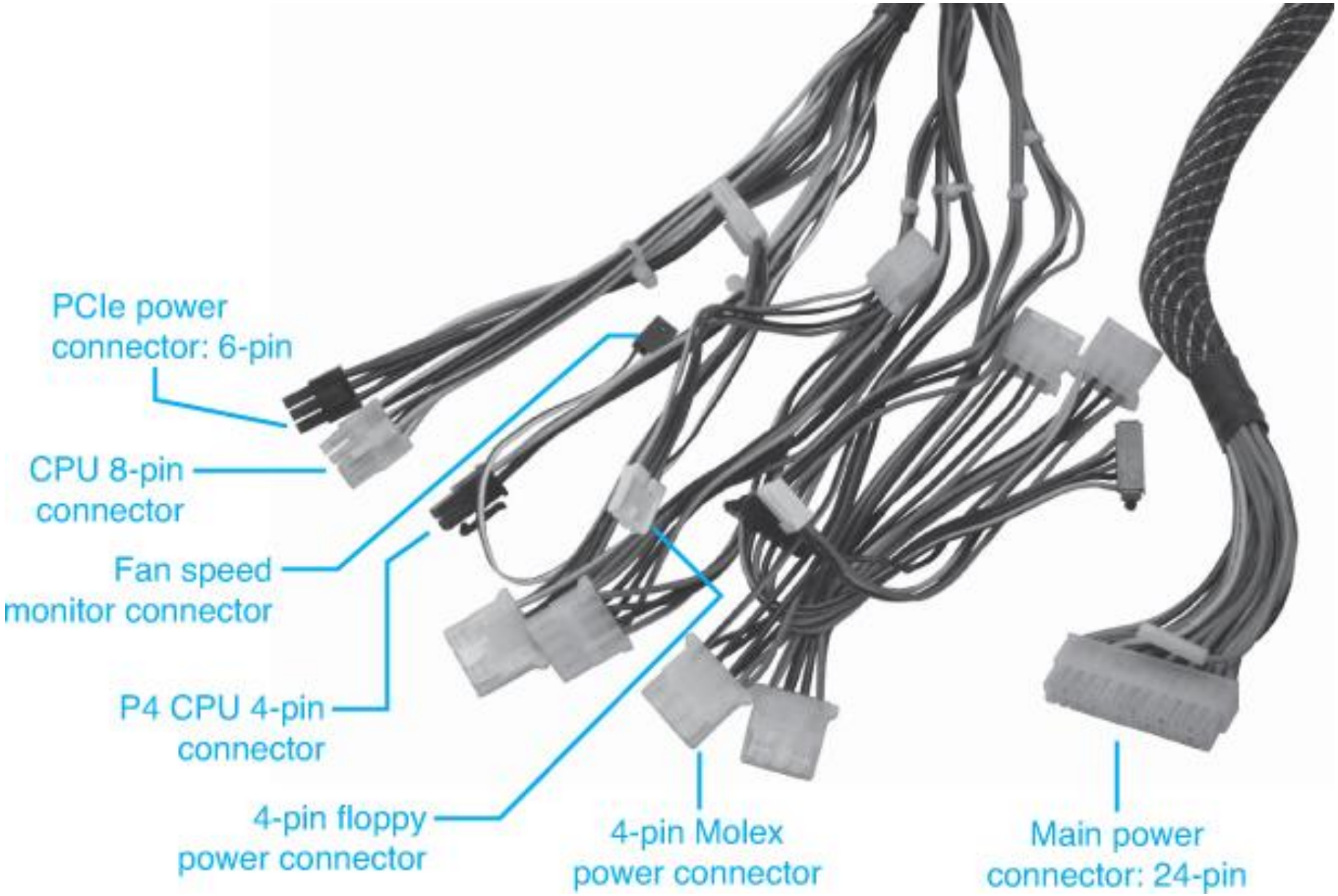


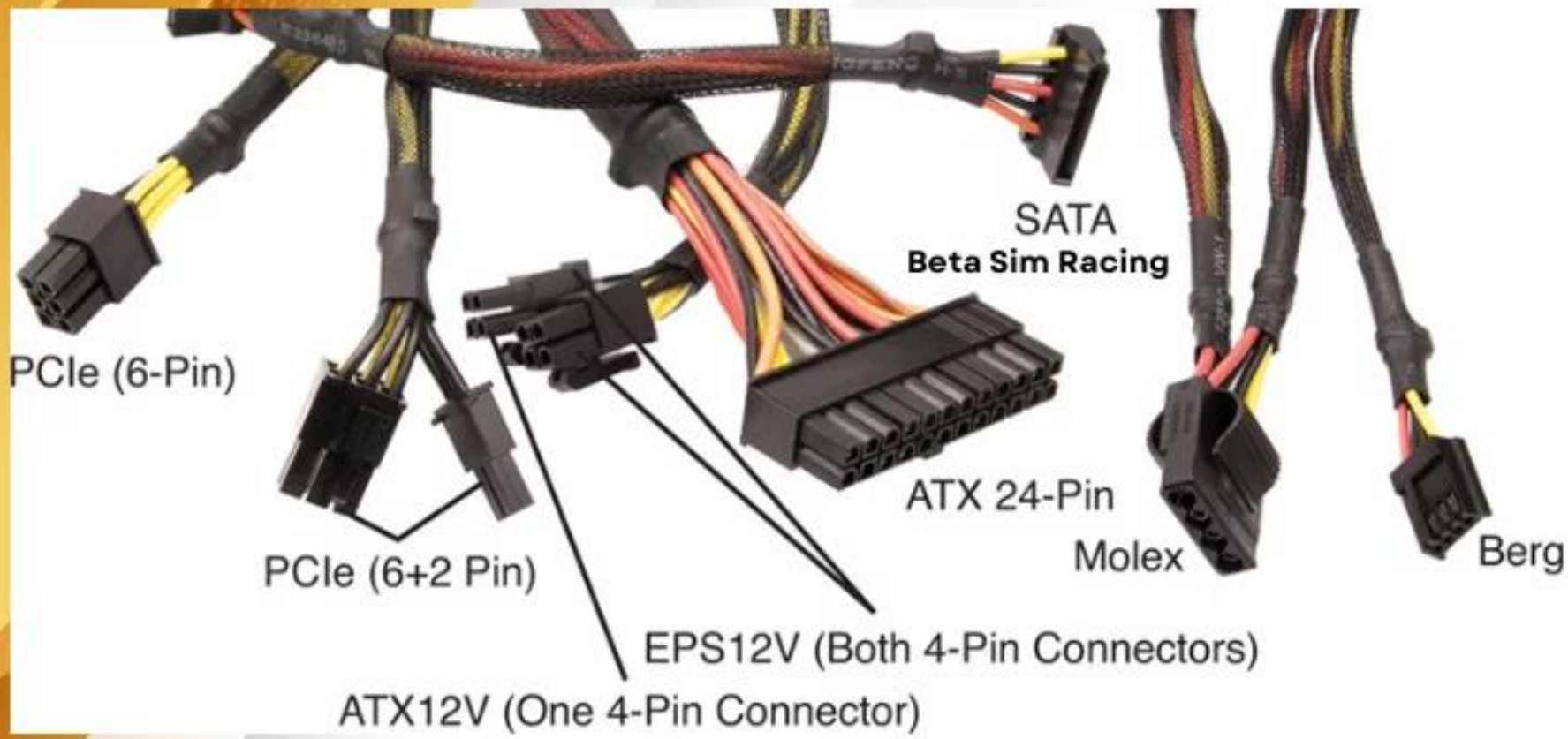
Lightning Connector

Power Supply

- critical component in a computer system, responsible for converting electrical energy from an external source (like a wall outlet) into the appropriate voltage, current, and form needed to power the computer's internal components.


ATX 24 Pin
Connector
ATX 12V
Connector
SATA Power
Connection
Standard
4-Pin


PCIe power connector: 6-pin
CPU 8-pin connector
Fan speed monitor connector
P4 CPU 4-pin connector
4-pin floppy power connector
4-pin Molex power connector
Main power connector: 24-pin



Power Supply Cables Connectors