FOR SALE: OBSOLETE COMPUTER - CHEAP! CHEAP! CHEAP!

- Compact Computer
- Intel i7 Quad Core, 4.20 GHz
- 2400 MHZ 32 GB DDR4 SDRAM
- 128KB L1 Cache
- Dual storage (7200 RPM SATA 1TB HDD, 128GB SSD)
- Wireless 802.11 + Bluetooth 4.0
- 7-in-1 card reader
- 10 USB ports, 1 serial port, 4 PCI expansion slots (1 PCI, 1 PCI x 16, 2 PCI x 1), HDMI
- 24" widescreen LCD monitor, 16:10 aspect ratio, 1920 x 1200 WUXGA 30 cd/m^2, active matrix, 1000:1 (static), 8ms, 24-bit color (16.7 million colors),VGA/DVI input, 2 USB ports
- 16x CD/DVD +/- RW drive
- 1 GB PCIe video card
- PCIe sound card
- Gigabit Ethernet

Figure 1.1 A Typical Computer Advertisement

Prefix	Symbol	Power of 10	Power of 2
Kilo	K	1 thousand = 10^3	$2^{10} = 1024$
Mega	M	1 million = 10^6	2^{20}
Giga	G	1 billion = 10^9	2^{30}
Tera	T	1 trillion = 10^{12}	2^{40}
Peta	P	1 quadrillion = 10^{15}	2^{50}
Exa	E	1 quintillion = 10^{18}	2^{60}
Zetta	Z	1 sextillion = 10^{21}	2^{70}
Yotta	Y	1 septillion = 10^{24}	2^{80}

Prefix	Symbol	Power of 10	Power of 2
Milli	m	1 thousandth = 10^{-3}	2^{-10}
Micro	μ	1 millionth = 10^{-6}	2^{-20}
Nano	n	1 billionth = 10^{-9}	2^{-30}
Pico	p	1 trillionth = 10^{-12}	2^{-40}
Femto	f	1 quadrillionth = 10^{-15}	2^{-50}
Atto	a	1 quintillionth = 10^{-18}	2^{-60}
Zepto	z	1 sextillionth = 10^{-21}	2^{-70}
Yocto	y	1 septillionth = 10^{-24}	2^{-80}

- **1 Hertz is equal to one cycle per second**
- **b/s is equal to 1 bit per second**
- **B/s is equal to 1 byte (8 bits) per second**

Processor – Intel i7 Quad Core 3.9GHz

- **Intel** is the designer and manufacturer. Other manufacturers include AMD (Advanced Micro Devices), National Semiconductor, and Motorola.
- **i7** is the model designation. i7 processors were first available in November, 2008.
- **Quad Core** means four (4) central processing units (CPUs)
- **3.9GHz** means that the main CPU clock that controls instruction sequencing runs at 3.9×10^9 Hertz. We will see that the speed of clock is only one of many factors that determine how fast a computer executes. *Remember, instructions can only be executed as fast as they can be read from memory.*

Main Memory (Main Store – RAM)

- **1600MHz** refers to the speed of the bus that connects the processor to main memory.
- A **bus** is a collection of conductors employed to carry electrical signals that originate from one component to one or more components that are interconnected.
- This bus can carry up to $1{,}600 \times 10^6 = 1.6 \times 10^9$ signals per second. If the number of conductors is equal to 8 (or possibly 9 for parity), then the bus capacity is 1.6×10^9 bytes per second or 1.6×10^9B/s. If the number of conductors is equal to 32, then the bus capacity is $4 \times 1.6 \times 10^9 = 6.4 \times 10^9$B/s.
- 1 byte (B) has come to mean 8 bits, the number of bits required to store a character.
- Bit (b) is a contraction of binary digit. A bit is a unit of storage whose binary values are usually charged and not charged.
- **32GB** refers to the size of the memory. This memory has approximately 32×10^9 bytes of storage. The memory has exactly 32×2^{30} bytes.
- **SDRAM** is an acronym for Synchronous Dynamic Random Access Memory.
- Random Access Memory (RAM) means that every byte in the memory can be accessed (read or written) in about the same time. Contrast RAM to data stored on tape. Bytes stored on the front of the tape can be accessed more quickly than bytes stored at the end of the tape if the tape head is positioned at the beginning of the tape. Tape is called Sequential Access Memory (SAM).
- Synchronous refers to the protocol that the processor employs to communicate with the RAM. The processor, the memory bus, and the memory are synchronized so that data are available on the edge of a clock cycle.

  Contrast a synchronous communication protocol with an asynchronous handshaking protocol. Several signal conductors are used to coordinate the transfer of data: such handshaking is not needed in a synchronous protocol.
- Dynamic RAM refers to the technology used to implement the memory. Each memory cell, each bit, is implemented as a single transistor that is either charged or not charged. A few more transistors are employed to control the reading and writing of the memory cell. Over time a dynamic RAM cell degrades and loses its charge requiring that the cell be refreshed. When the cell is being refreshed it cannot be accessed making dynamic RAM slower than static RAM. Static RAM requires more transistors for each bit but is faster than dynamic RAM.
- **DDR3** is an acronym for double data rate type 3. A double data rate protocol permits the memory to be accessed at twice the speed of a single data rate protocol.

Cache

- 128KB L1 cache, 2MB L2 cache

The principle of "locality of reference" is exploited in a computer's memory hierarchy. From fastest to slowest and most expensive to least expensive, the list below shows the memory hierarchy.
- o Registers
- o On-chip cache
- o Off-chip cache
- o Main store (RAM)
- o Hard disk

The on-chip cache is a small quantity of very fast memory that permits the processor to access the most frequently referenced data. Remember, the processor can only execute instructions as fast as they can be fetched from memory. The 128KB L1 cache is the on-chip cache. That means that there is $2^{17} = 131,072 = 128\text{KB}$ bytes of very fast memory on the Intel i7 processor chip.

The off-chip cache serves the same function as the on-chip cache but is larger. In this case the off-chip cache is the L2 cache and has $2\text{MB} = 2 \times 2^{20} = 2,097,152$ bytes of storage.

The processor asserts an address on the bus. First, the data are sought in the on-chip cache. If the data are not found in the on-chip cache, data are sought in the off-chip cache. The search continues in main store and terminates in the virtual memory representation on hard disk.

Hard drive
- 1TB SATA hard drive (7200 RPM)
  1TB – 1 Terabyte = 2^{40} Bytes $\cong 10^{12}$ Bytes
  SATA – Serial Advanced Technology Attachment. Replaced IDE (Integrated Drive Electronics).
  7200 RPM – Disk surfaces rotate at 7,200 revolutions per minute.

External interfaces
- 10 USB ports - Universal Serial Bus.
  A serial transmission means that one bit is transferred at a time.
  A parallel transmission means that multiple bits or signals are transferred simultaneously. Usually one conductor is used for each bit that is transferred in a bit-parallel transmission.
- 1 serial port
- 4 PCI expansion slots (1 PCI, 1 PCIx16, 1 PCIx1), Bluetooth, and HDMI
  PCI – Peripheral Component Interconnect. Operates at high speeds designed for high performance graphic interface cards.
  Bluetooth – a wireless technology allowing the transfer of information over short distances.
  HDMI – High-Definition Multimedia Interface

Monitor or Display

- 24" widescreen LCD monitor, 16:10 aspect ratio, 1920x1200 WUXGA, 300 cd/m2, active matrix, 1000:1 (static) 8ms, 24bit color (16.7 million colors), VGA/DVI input, 2 USB ports
  24" means the diagonal from the upper left to the lower right of the display is 24 inches.
  LCD – Liquid Crystal Display
  1920 X 1200 means that there are $1,920\ columns\ \times 1,200\ rows = 2,304,000$ pixel on the display.
  A pixel is a "picture element" – a single dot on the screen
  8ms refers to the response time which indicates the rate at which the pixels can change colors.

CD/DVD drive

- 16x CD/DVD +/- RW drive
  CD – Compact Disc – an optical disc capable of storing up t0 650 – 700 MB.
  DVD – Digital Versatile Disc – an optical disc capable of storing up to 4.37 GB.
  +/- RW means that the drive has the capability to read and write both CDs and DVDs
  16x refers to the speed at which data are transferred. $1x\ =\ 1.39MB/s. 16x - 16\ \times\ 1.39MB/s$

Video card

- 1 GB PCIe video card
  1 GB – The video card has 1 Gigabyte of storage.
  PCIe – Peripheral Component Interconnect Express – a high speed serial interface
  This video card also has a high speed Graphics Processor Unit (GPU)

Sound card

- PCIe sound card

Network Interface

- Integrated 10/100/1000 Ethernet
  NIC – Network Interface Card
  10/100/1000 – 10 Mb/s, 100 Mb/, 1000 Mb/s