

Mainframe



Source: https://www-03.ibm.com/ibm/history/exhibits/mainframe/mainframe_2423PH3165.html

Minicomputer



Source: <http://nl.wikipedia.org/wiki/Minicomputer#mediaviewer/File:Pdp-11-40.jpg>

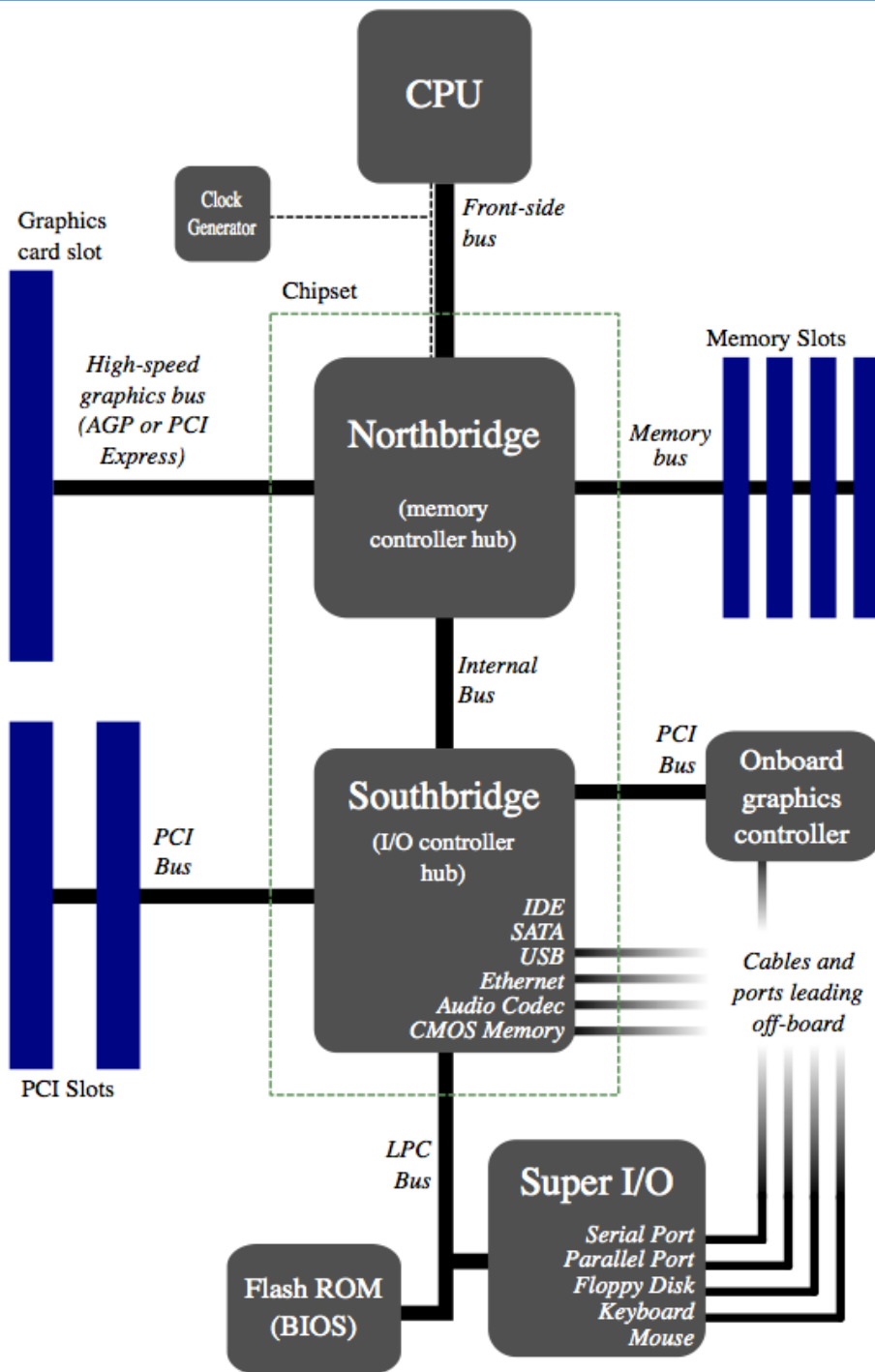
Microcomputer



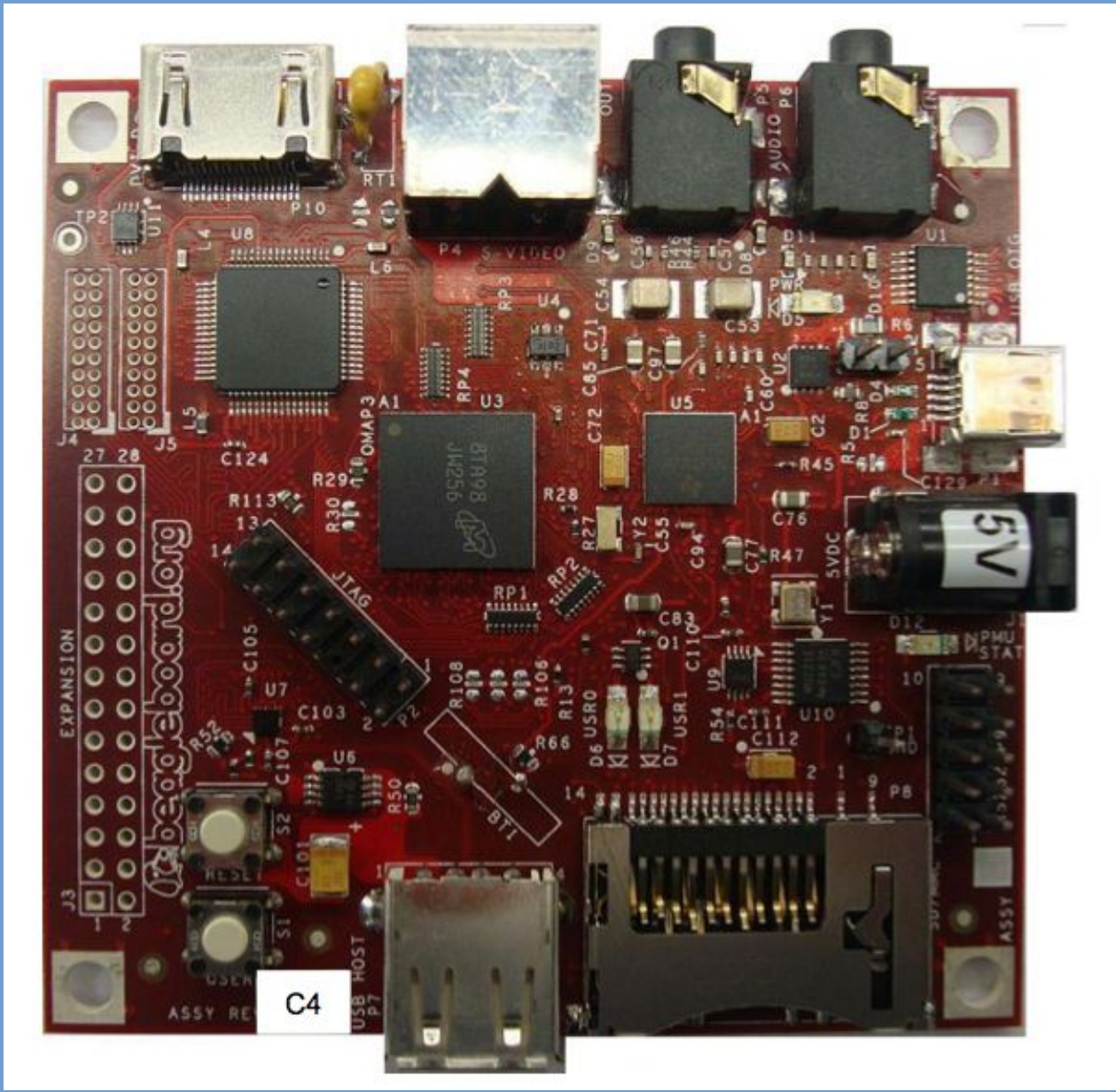
Source: http://www.tpsoft.com/museum_images/IBM%20PC.JPG



Bron: <http://tazalink.blogspot.nl/2011/02/some-useful-parts-of-your-pc.html>



Source:
http://en.wikipedia.org/wiki/Northbridge_%28computing%29



Example interrupts

- Keyboard controller:
 - When key strokes are present in the internal buffer, the keyboard controller generates an interrupt.
- Disk drive:
 - OS requests transfer of disk blocks.
 - Once done, disk I/O controller generates an interrupt.
- Networking:
 - OS has enabled the network interface card.
 - Once a packet comes in, an interrupt is generated.

Computer-System Architecture

- Computer systems can be organized in different ways.
- Single-processor system
 - Actually becoming very hard to come by.
 - Only general-purpose CPUs are counted.
- Multi-processor system
 - Choice of multiple “cores” on one chip, or multiple CPUs within a single system (or both!).

Clustered Systems

- Combine multiple computers (nodes) into a single system.
 - Compare with multiple CPUs in one computer.
- Often interconnected with high-speed network.
- Require specially written software (parallelized software).
- Used for e.g. High Performance Computing.

Table 2.2 Example Time Scale of System Latencies

Event	Latency	Scaled
1 CPU cycle	0.3 ns	1 s
Level 1 cache access	0.9 ns	3 s
Level 2 cache access	2.8 ns	9 s
Level 3 cache access	12.9 ns	43 s
Main memory access (DRAM, from CPU)	120 ns	6 min
Solid-state disk I/O (flash memory)	50–150 μ s	2–6 days
Rotational disk I/O	1–10 ms	1–12 months
Internet: San Francisco to New York	40 ms	4 years
Internet: San Francisco to United Kingdom	81 ms	8 years
Internet: San Francisco to Australia	183 ms	19 years
TCP packet retransmit	1–3 s	105–317 years
OS virtualization system reboot	4 s	423 years
SCSI command time-out	30 s	3 millennia
Hardware (HW) virtualization system reboot	40 s	4 millennia
Physical system reboot	5 m	32 millennia

Source: *Systems Performance: Enterprise and the Cloud*, Brendan Gregg.

Data structures

- Various data structures are used in OS implementation, we assume you are familiar with these.
 - Linked list (single, double)
 - Trees
 - Hash tables
 - Bitmaps

UNIX, Linux, FreeBSD, POSIX, ...

What are the differences between UNIX and Linux?

- First UNIX was developed end of '60, beginning of '70.
- Late '70s/beginning 80's, many derivatives of the original UNIX system appeared: BSD, Solaris, HP-UX, AIX, etc.
- Are these different systems compatible?
- People started to work on standardization:
 - Single UNIX Specification (SUS)
 - POSIX
 - Common definition of SUS and POSIX: Open Group Base specification

UNIX, Linux, FreeBSD, POSIX, ... (2)

So when is a system a UNIX?

- Officially, only these systems that are SUS certified (and thus compliant) may be called UNIX systems.
- All others that try to adhere to these standards are "UNIX-like".

Linux, FreeBSD, etc are *UNIX-like* operating systems

- E.g. Linux: implemented from scratch but tries to be fully compliant.
- Linux is just the kernel!
- System utilities typically the GNU utilities.
- (This is why Debian is called GNU/Linux).

UNIX, Linux, FreeBSD, POSIX, ... (3)

Practical differences between UNIX and UNIX-like:

- Differences in file system organization. Some things are put a different locations.
- Subtle differences in command line tools. GNU tools often have more options and are easier to use (less picky).
 - For example, BSD “cp” does not allow options to be specified **after** the file names, GNU “cp” does.
- GNU sometimes has extensions to the C library. Such extensions are not available on other systems.