Mainframe

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

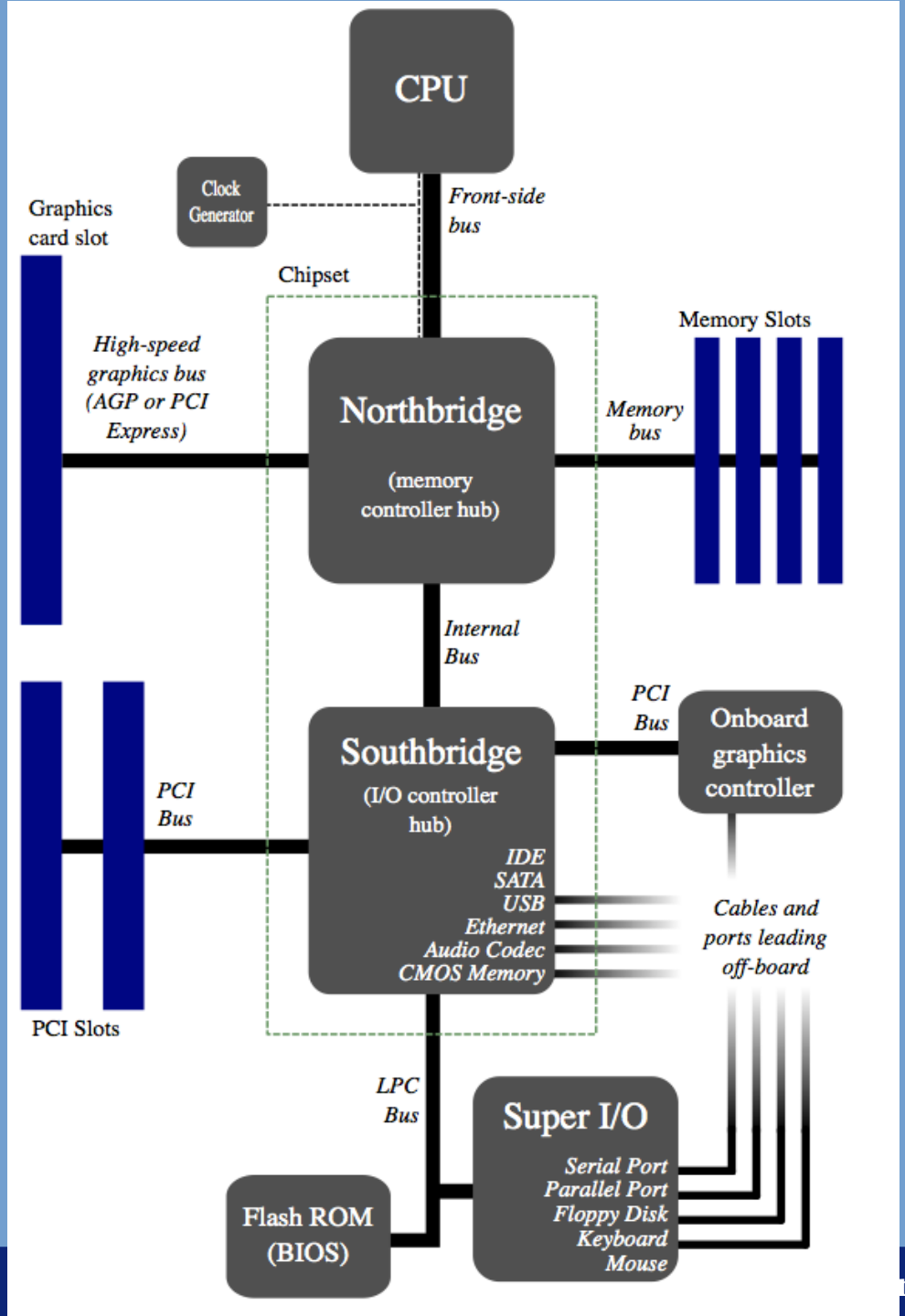
Minicomputer

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

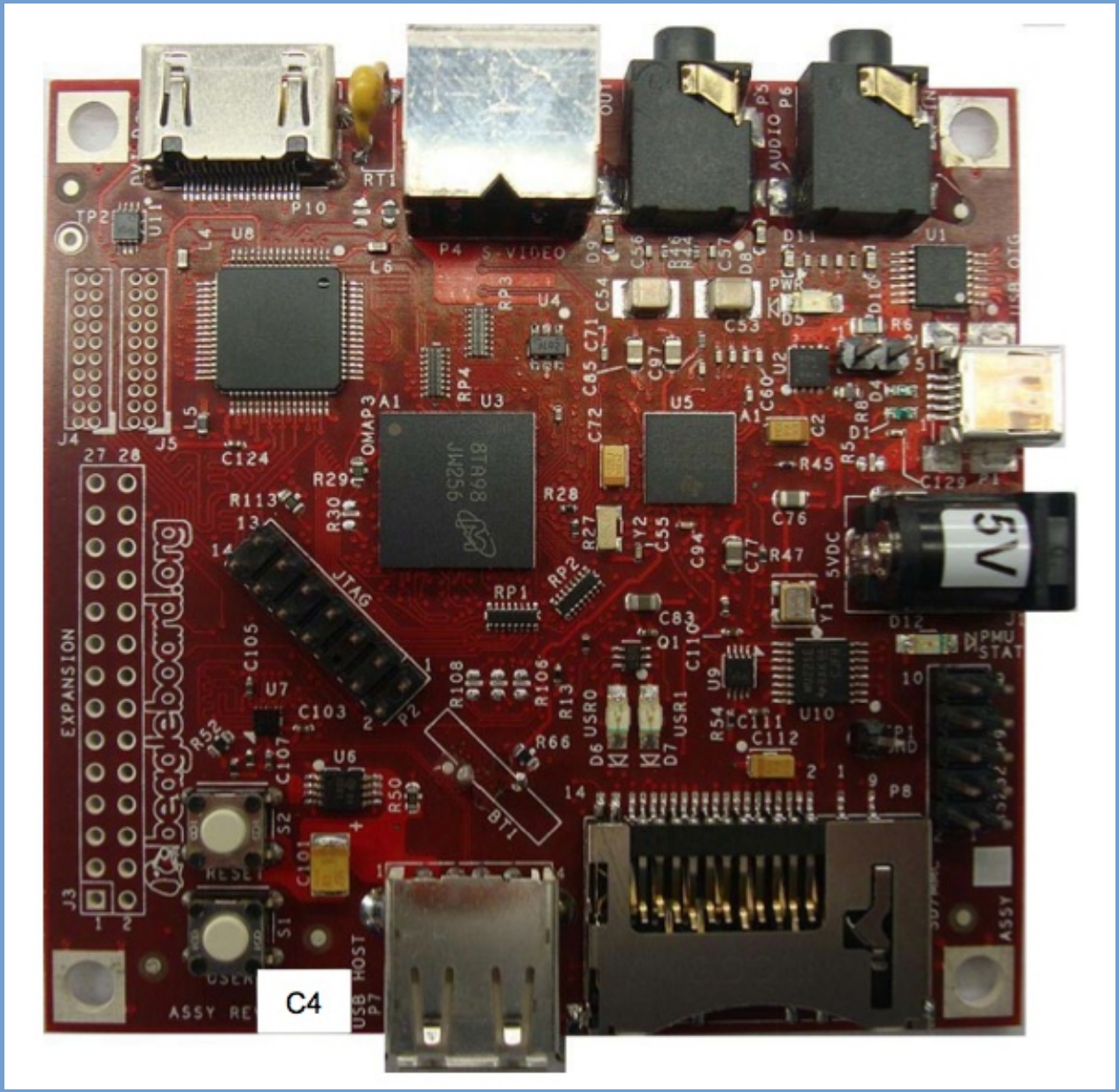
Microcomputer

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


C4

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 µs	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