I/O

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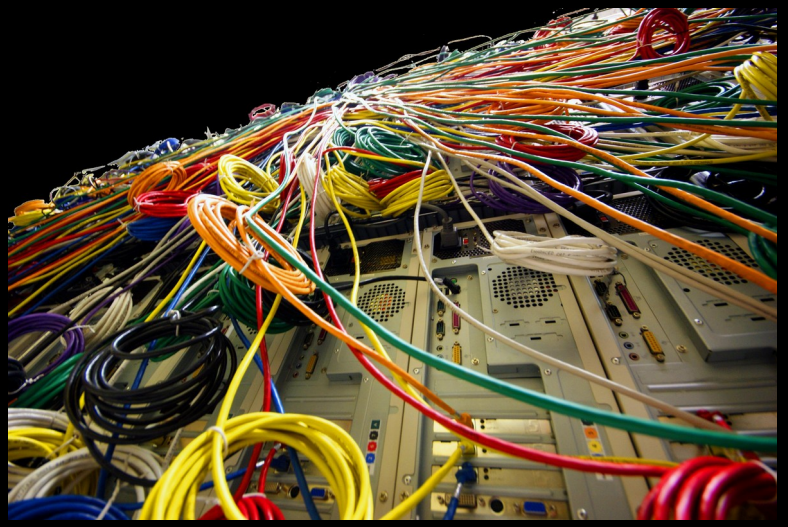
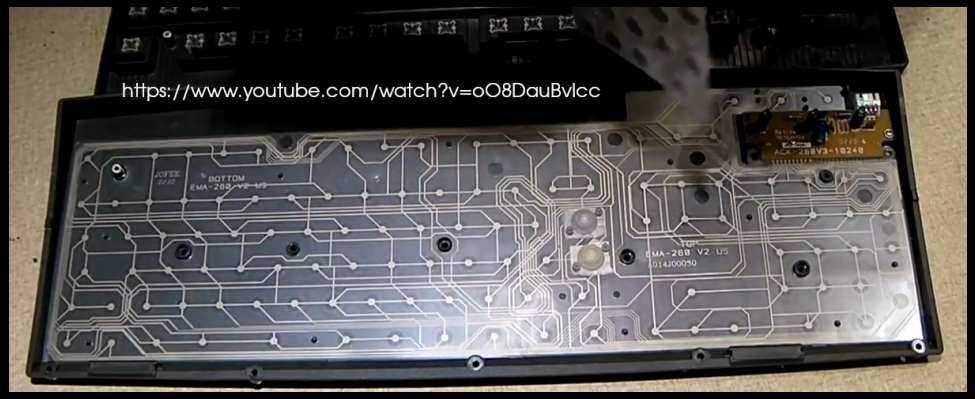
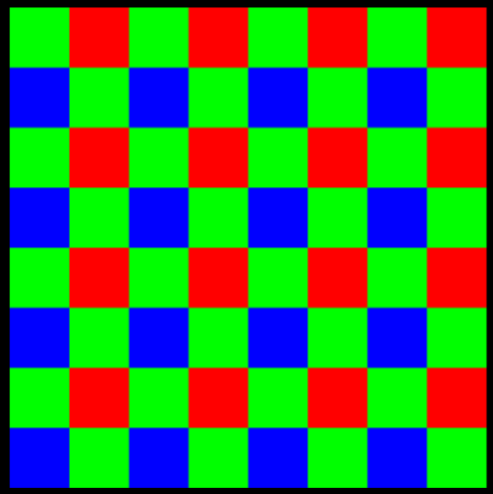
Network Terminology

- SAN, LAN, MAN, WAN – Area Network; System/Storage, Local, Metropolitan, Wide
- Ethernet, DSL (Digital Subscriber Line)
- USB, FireWire
- Hub, Switch, Router
- WiFi, Bluetooth, NFC
- Bandwidth, Latency



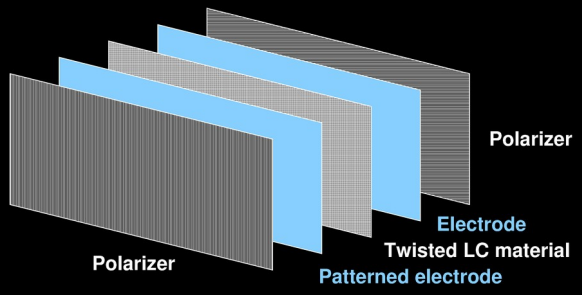
Other I/O Terminology

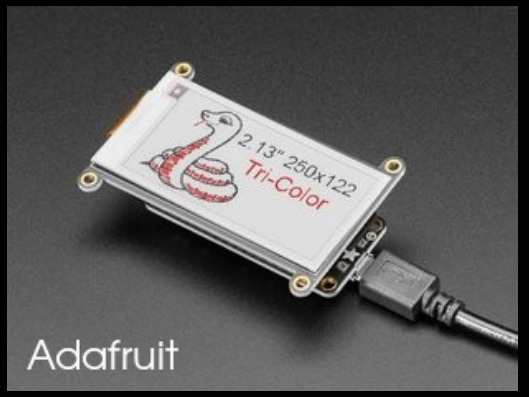




- Keyboard
- Mouse, Trackball, Touchscreen, Lightpen, Touchpad, etc.
- Pixel – Picture Element
- Camera: Charge-Coupled Device, CMOS, BackSide Illuminated, Stacked

Other I/O Terminology





- Display: Cathode Ray Tube, Plasma, Liquid Crystal Display, Digital Micromirror Device aka Digital Light Processor, Organic Light Emitting Diode, eInk

Input / Output

- We've discussed interfaces & device types… here are some external interface connectors:

- What's left is just two universal concepts:
  - How to name I/O device registers
  - How to interact with them

Naming I/O Device Registers

- Memory-mapped I/O
  - Most processors implement this
  - Some physical memory addresses are I/O; use load/store to access, even from HLLs
  - Protection via page table
- Separate I/O address space
  - Implemented on x86 family processors
  - Special port input/output instructions
  - Separate I/O path and protection (`ioperm`)

Interacting With I/O Devices

- Polling
  - Processor loops looking at device registers to see when things have happened
  - Fast, but keeps processor busy
- Interrupts, for infrequent things
  - Device signals processor when ready
  - Poll to discover “who rang” and why
- DMA (Direct Memory Access)
  - Cheap secondary processor moves data
  - Signals done using an interrupt