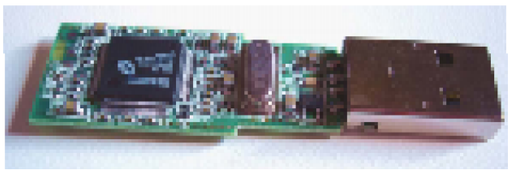
Week 6: Solid-state

- Magnetic and optical drives are mechanical
  – compared to electronics: slow slow slow!
  – lots of energy to power motors etc.
  – huge: macro mechanicals
  – not robust to dust, mechanical shock etc.
- Flash EEPROMs (Flash memory)
  – non-volatile
  – compact, no moving components
  – expensive but getting cheaper
- Solid state disks
  – made of multiple flash memory chips
  – replaces hard drive
- USB key



- Solid-state disk

- Seek time
  – no mechanical parts so access and seek time much better than hard drive
- Write time
  – as with other forms of storage, writing takes much longer than reading as state is being changed rather than just observed
  – writing to flash memory is much slower than reading
- Transfer rate
  – you get what you pay for (cheap flash is much slower than more expensive flash)
- Memory system
  – SLC (Single-level cell): each memory cell can store one of two states (0/1)
  – MLC (Multi-level cell): each memory cell can store one of four or eight states (i.e. 2 or 4 bits of information)
- Wear
  – flash memory cell will wear out after multiple write operations
  – solid-state disks often built with extra memory, to replace worn out cells
  – wear levelling: controller spreads writes out over chip(s)

M.2 solid state drives

- M.2, formerly known as **Next Generation Form Factor**
  – internal mounted computer expansion cards and associated connectors
  – computer bus interfaces provided by the M.2 connector are the PCI Express 3.0 and the NVM Express
  – replaced to mSata, left and M.2 on the right