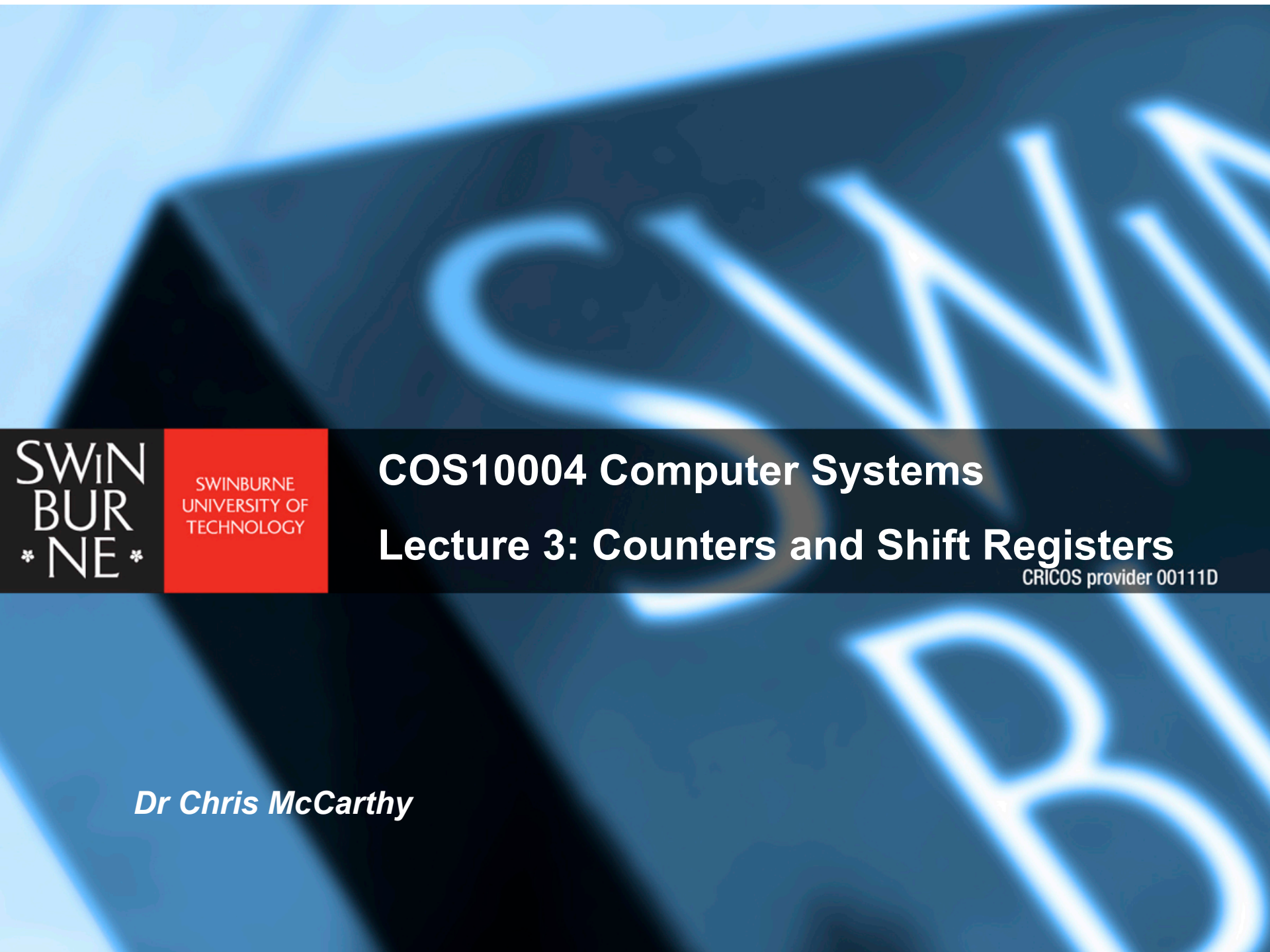


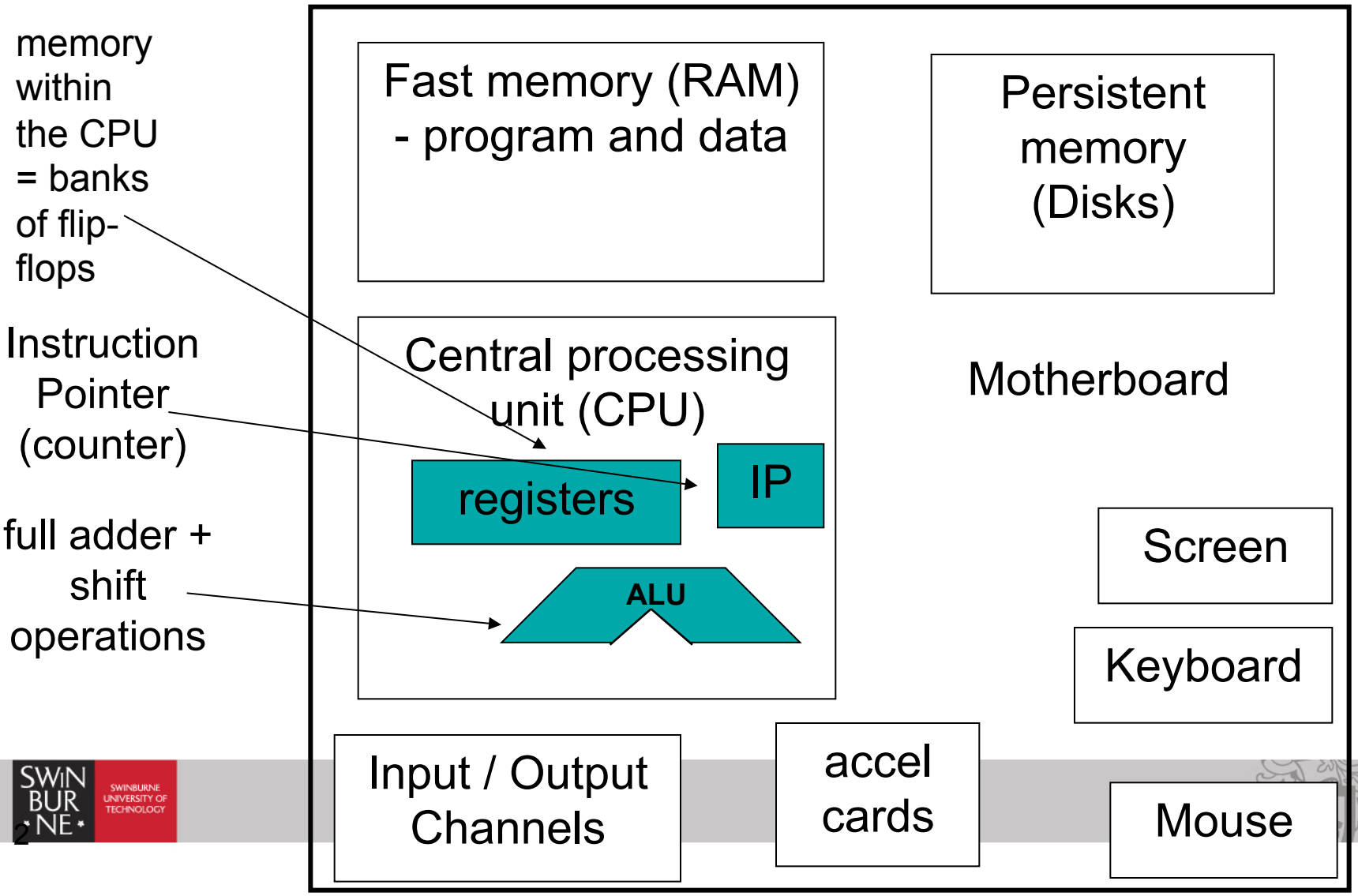
COS10004 Computer Systems

Lecture 3: Counters and Shift Registers

CRICOS provider 00111D

Dr Chris McCarthy

Building a computer? Things we need:



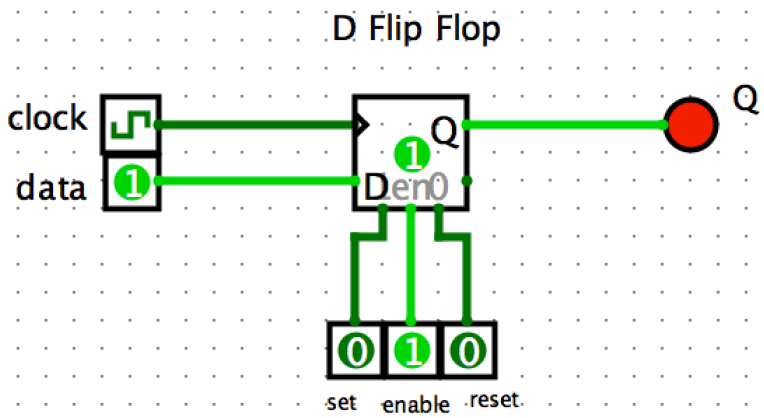
REGISTERS

Fast RAM (uses transistor states)

- Uses clocked flip-flops
- Inside the CPU chip
- Limited number of them (cause it's hardware)
- Let's build one...

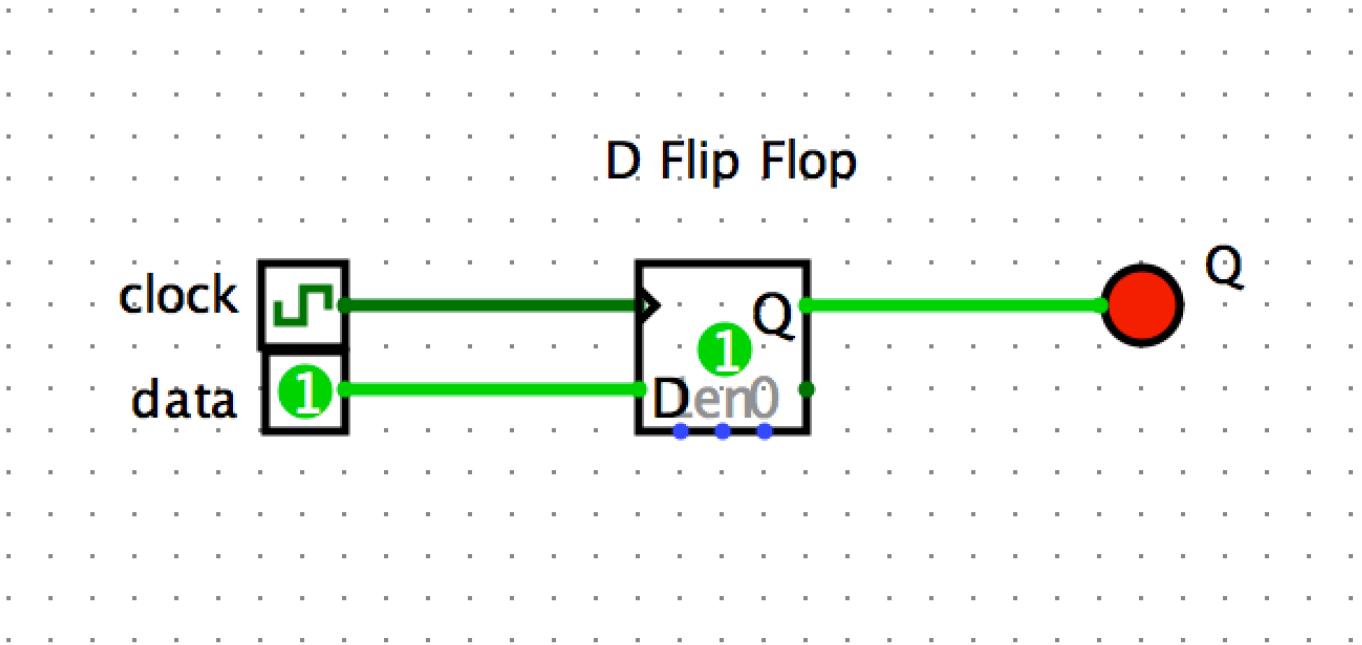
D-TYPE FLIP-FLOP

- Set data to high - Q goes high on next clock pulse. Stays high.
  - Set presets Q to high when pulled high
  - Reset clears Q when pulled high



D-TYPE FLIP-FLOP

> In Logisim we can also leave PR' and CLR' disconnected.

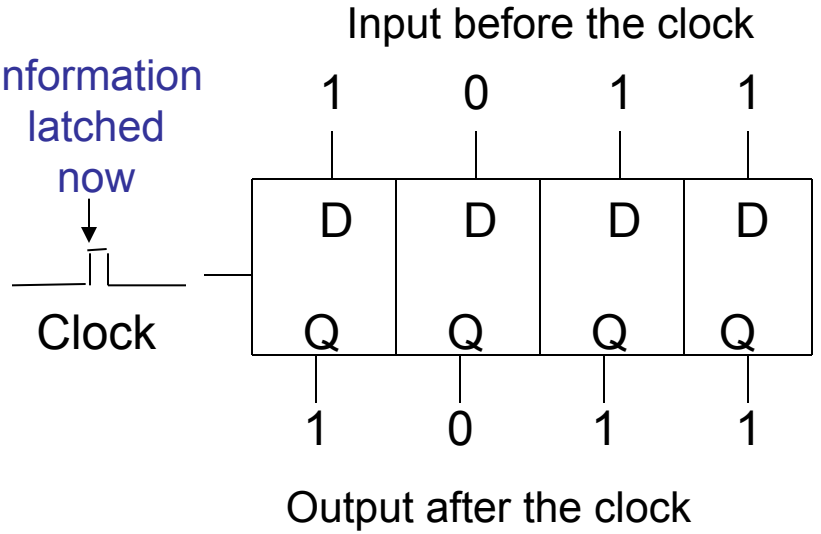


D-Flip-Flops as a Register or Latch

A *register (many bits)* or *latch (usually one bit)* can be made up from a series of D-Flip-Flops driven by a common clock.

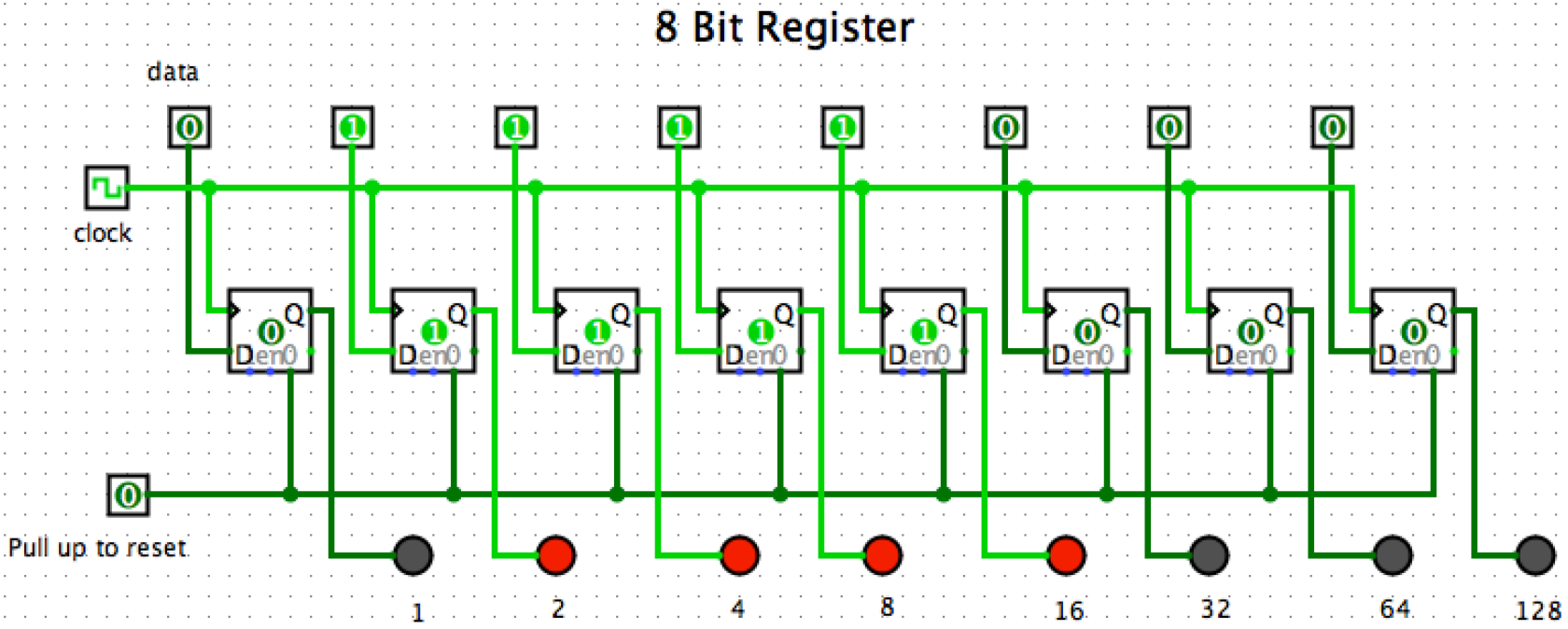
The transfer from the D side to the Q side for all D flip flops occurs simultaneously as this clock changes.

This arrangement is found in CPU registers



http://www.electronics-tutorials.ws/sequential/seq_4.html

8 BIT REGISTER



Little Endian

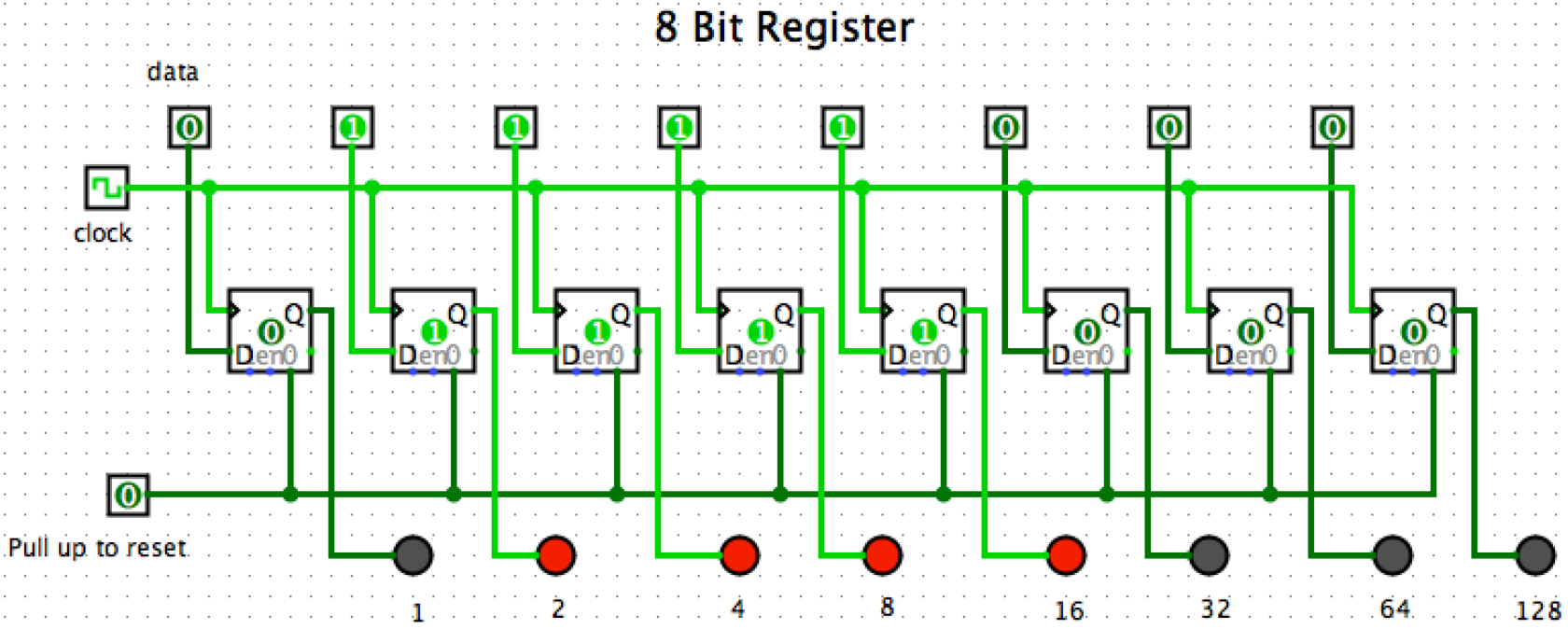
Big Endian and Little Endian Data Format

- Technical definition for the order of bytes:
  - Big Endian:
    - The most signficant byte resides in the smallest memory address
  - Little Endian:
    - The least significant byte resides in the smallest memory address

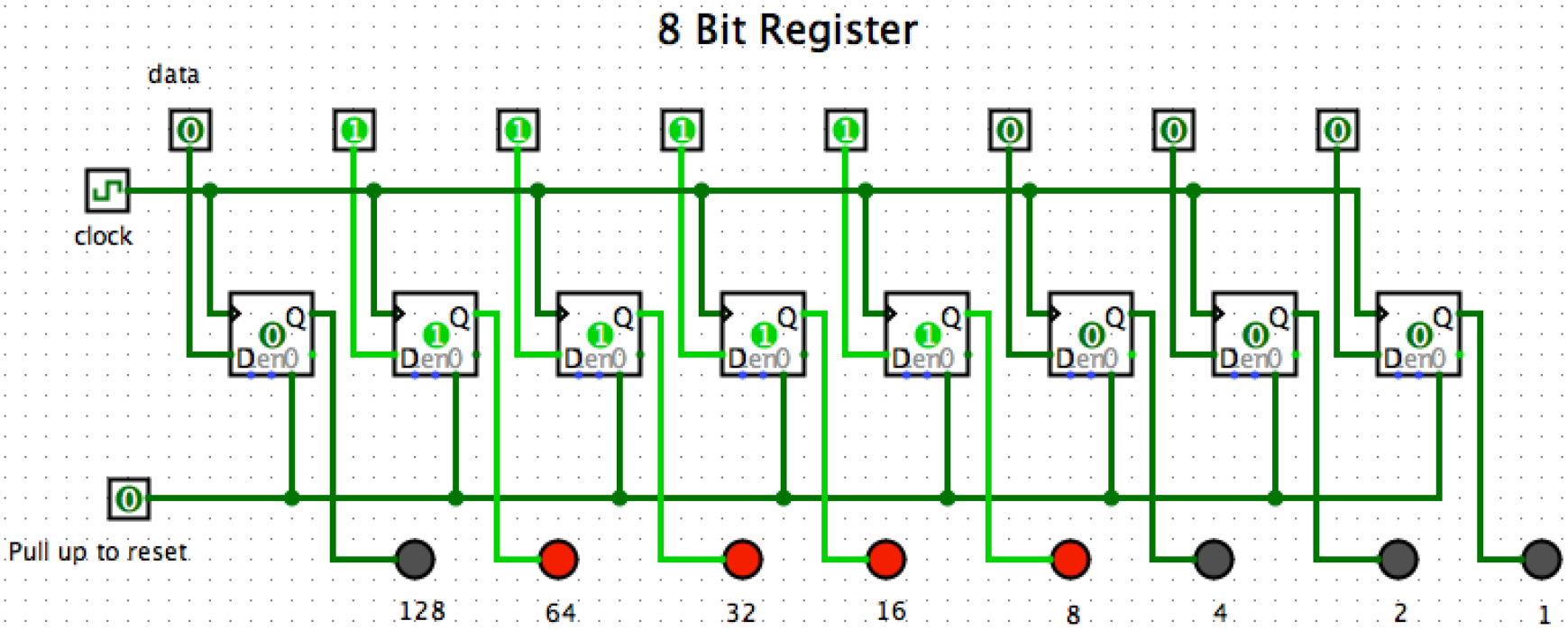
BIT ENDIANNESS

- Bits generally don't have an address, so definitions refer to the positional order of bits
- Big Endian:
  - The most significant bit comes first
- Little Endian:
  - The least significant bit comes first
- This matters for interpreting the value of a bit string (especially if bits are received as a serial stream!)
  - Eg What is 1011 in decimal ?
  - 11_{10} (Big endian), or 13_{10} (Little endian)

8 BIT REGISTER



Little Endian


8 Bit Register
data
clock
Pull up to reset
Den0
Q
128
64
32
16
8
4
2
1

Big Endian

SUMMARY

- D Flip Flops generally form the building blocks of registers
- Registers:
  - Allow us to store bit strings that represent data
  - Reside close to the CPU, allowing fast and easy access
- Bit Endianness determines how we interpret bit strings:
  - Big Endian: most significant bit comes first
  - Little Endian: least significant bit comes first
- Next Lecture: ripple counters with JK Flip Flops