Memory and Addressing

How and Where Information is Stored
What is Stored

• Strings of bits
  • doubleword = 64 bits
  • word = 32 bits

• doubleword may represent:
  – an address in memory
  – a value
    • signed integer
    • positive integer
    • four or eight characters

• Word may represent:
  • Any of the values above
  • An instruction (based on the ISA)
Where Things are Stored

Registers on CPU

- general purpose registers (32)
- PC  Program Counter
  - holds address of next instruction to be executed
- IR  Instruction Register
  - holds current instruction

Memory

- A very very large array of memory locations
  - byte addresses
  - word (32 bits) addresses are multiples of 4
  - doubleword (64 bits) addresses are multiples of 8
Where Things are Stored

CPU

- PC
- IR
- General purpose registers

Memory
Addressing Modes

Purpose

- to find a value (operand)
- to find an instruction

Places where target or address can be found

- anywhere some bits can be
  in the instruction
  in a register
  in memory
ARMv8 Addressing Modes

• Register Direct
  – value found in register

• Immediate
  – value is part of instruction

• Register Indirect with offset
  – value found in memory, address in register plus offset

• PC-relative
  – address of next instruction is offset plus PC
Register Direct

R-Type Instructions

| opcode | rm | shamt | rn | rd |

Register
## Immediate

**Arithmetic Immediate Instructions**

<table>
<thead>
<tr>
<th>opcode</th>
<th>immediate</th>
<th>rn</th>
<th>rt</th>
</tr>
</thead>
</table>
Register Indirect with Base
Load / Store Instructions

opcode  offset  rn  rt

Register

Memory
PC-relative
Conditional Branch Instructions (cbz, cbnz)

opcode  offset  rt

PC

Memory