

Analogue and Digital Systems

an·a·logue also an·a·log (ăn'ə-lôg', -lŏg')

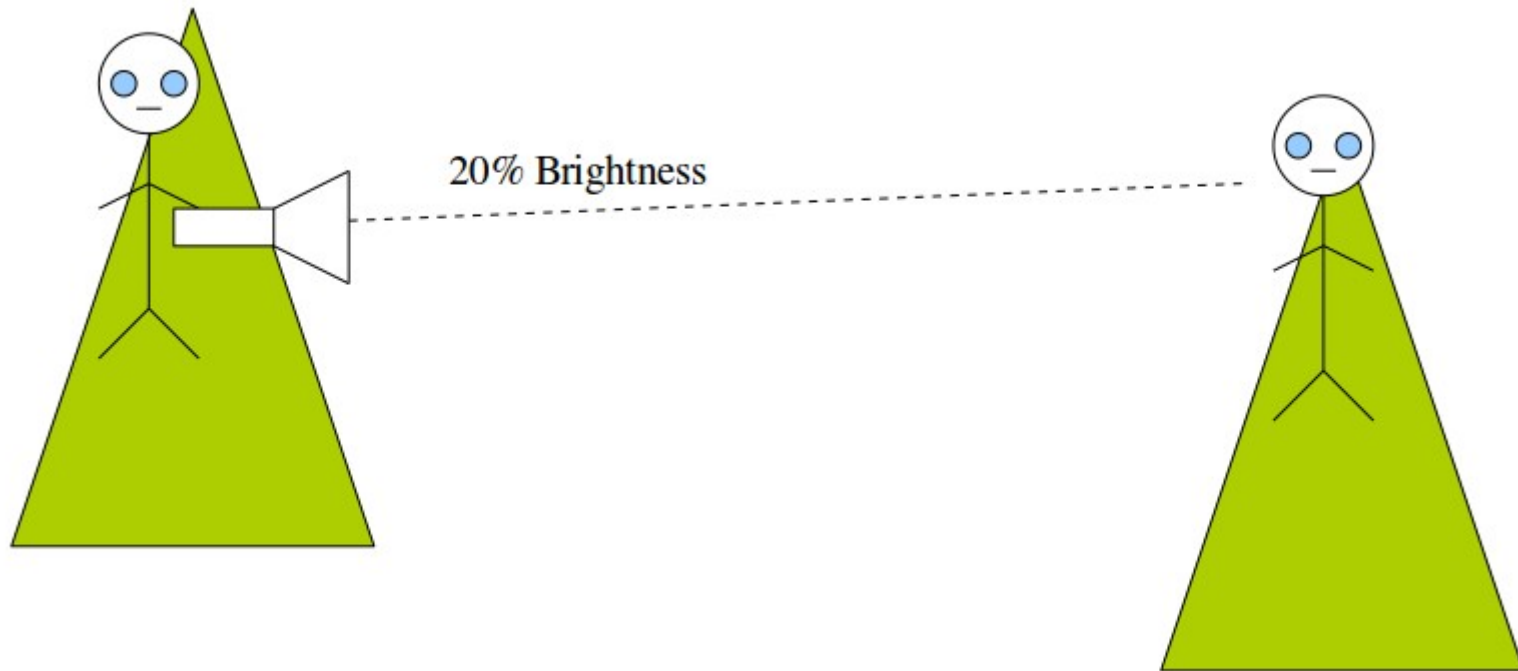
n.

1. Something that bears an analogy to something else: Surimi is marketed as an analogue of crabmeat.
2. Biology An organ or structure that is similar in function to one in another kind of organism but is of dissimilar evolutionary origin.
3. Chemistry A structural derivative of a parent compound that often differs from it by a single element.

adj.

1. often analog Of, relating to, or being a device in which **data are represented by continuously variable, measurable, physical quantities**, such as length, width, **voltage**, or pressure.
2. often analog Computer Science Of or relating to an analog computer.

Analogue signalling

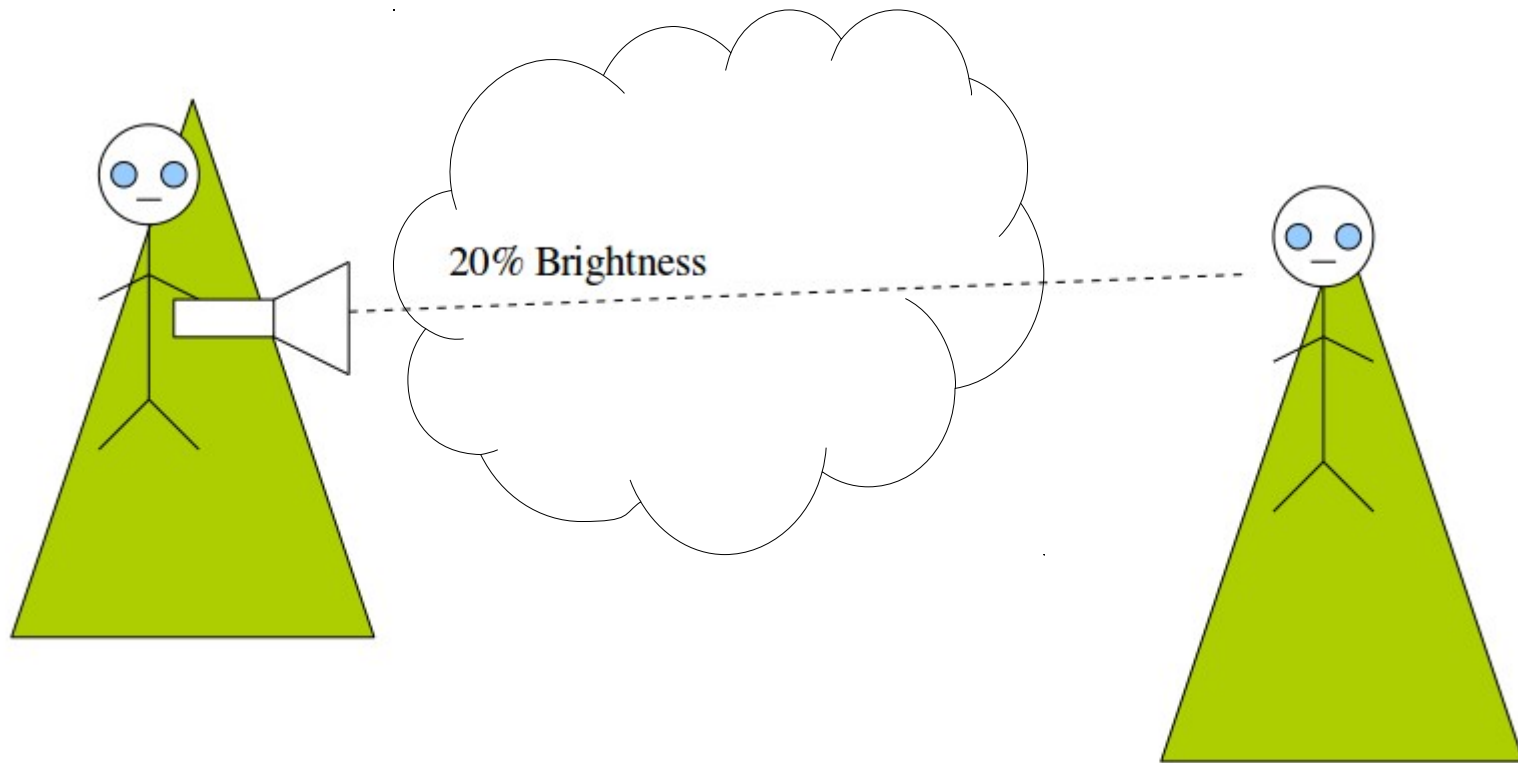


Send the
number 20

Receive the
number 20

Brightness is an analogue of the value

Analogue signalling

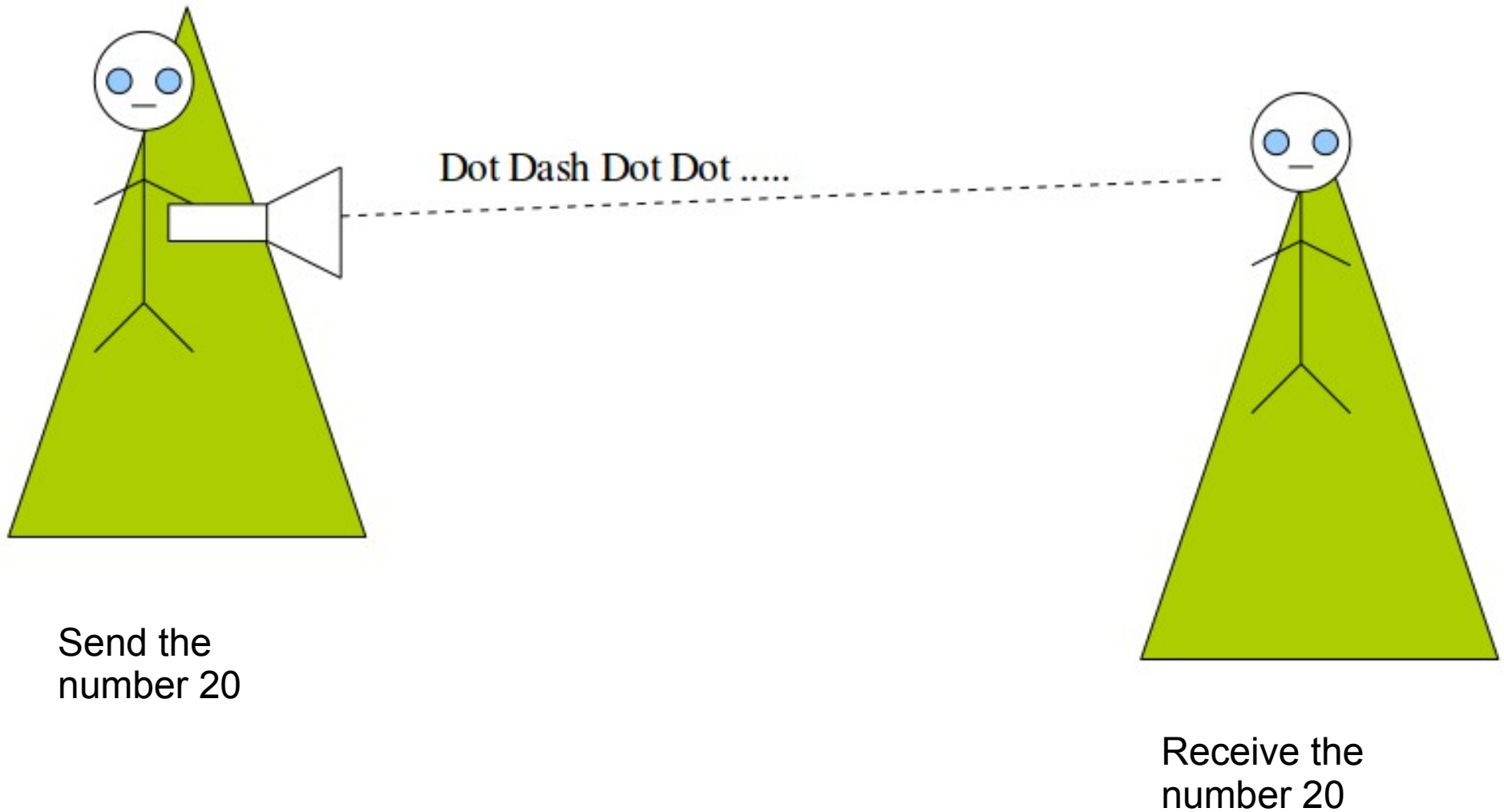


Send the
number 20

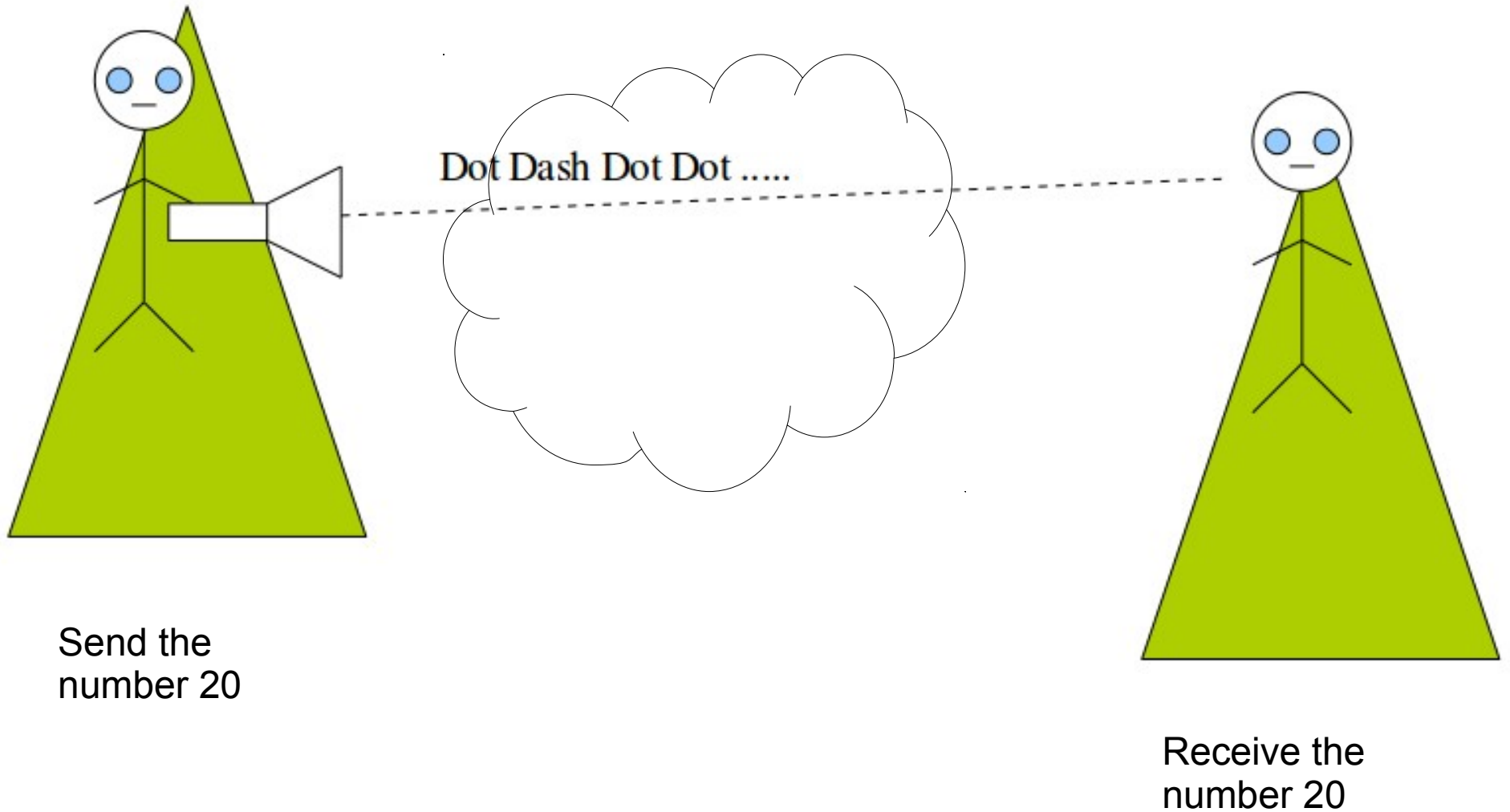
Receive the
number 15(ish)

Brightness is an analogue of the value

Digital signalling



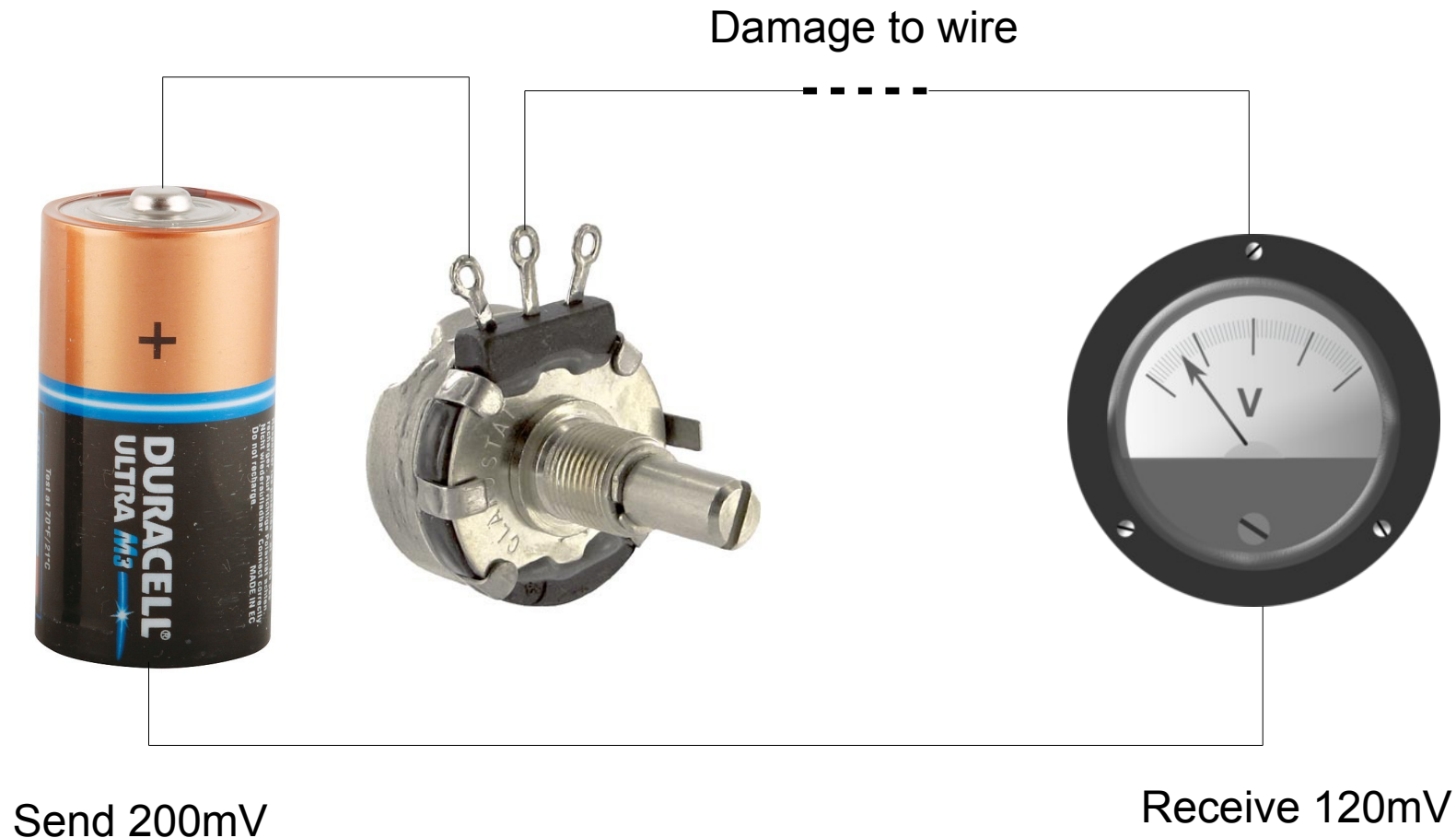
Digital signalling



Analogue electrical signalling

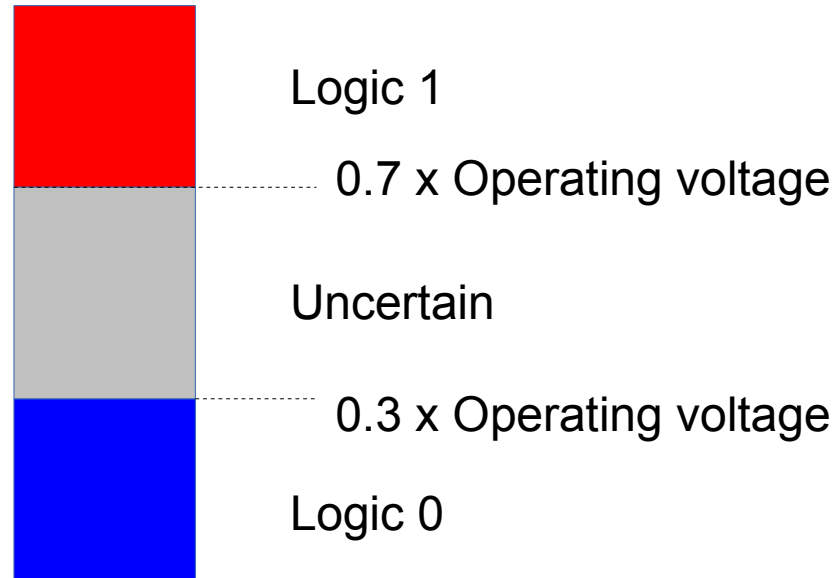


Analogue electrical signalling



Digital signal bands

Logic levels



Digital electrical signalling

Voltage

1
0
1
1
0
1
1
0



Voltage

0.9
0.1
0.8
0.9
0.1
0.9
1
0.2

Digital electrical signalling

Bit value

1
0
1
1
0
1
1
0



Bit Value

1
0
1
1
0
1
1
0

Tolerant of some signal loss and interference

Bits, bytes, nibbles and words

- Byte
 - A contraction of the words By and Eight
 - Contains 8 bits
 - Values in range
 - 0000 0000 to 1111 1111
 - Decimal 0 to 255

Bits, bytes, nibbles and words

- Nibble
 - Half a byte
 - Contains 4 bits
 - Can be represented as a single Hexadecimal digit

Bits, bytes, nibbles and words

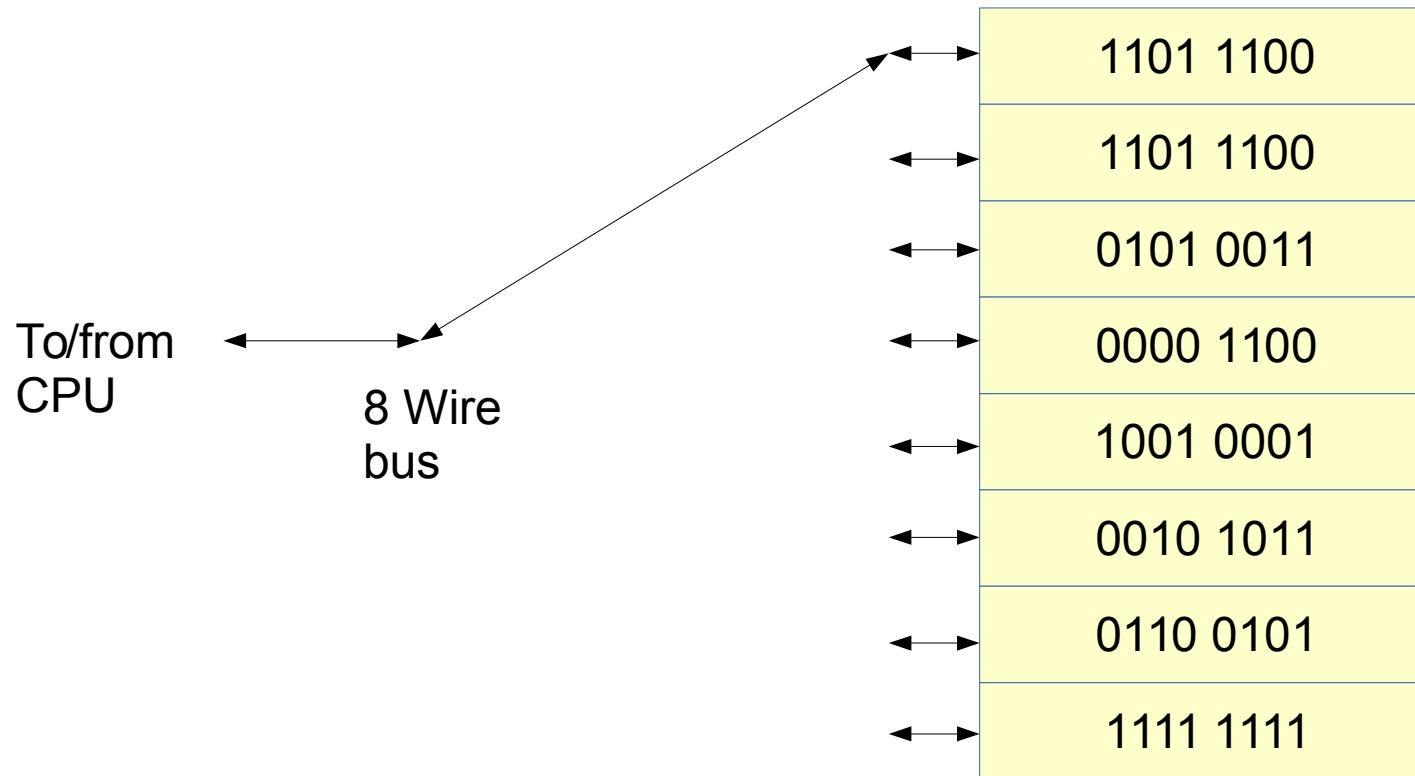
- Word
 - Architecture dependant
 - Sometimes 16 bits (2 bytes)
 - Sometimes 32 bits (4 bytes)
 - 16 bits : 0 to 65535
 - 32 bits : 0 to 4294967296

Data storage

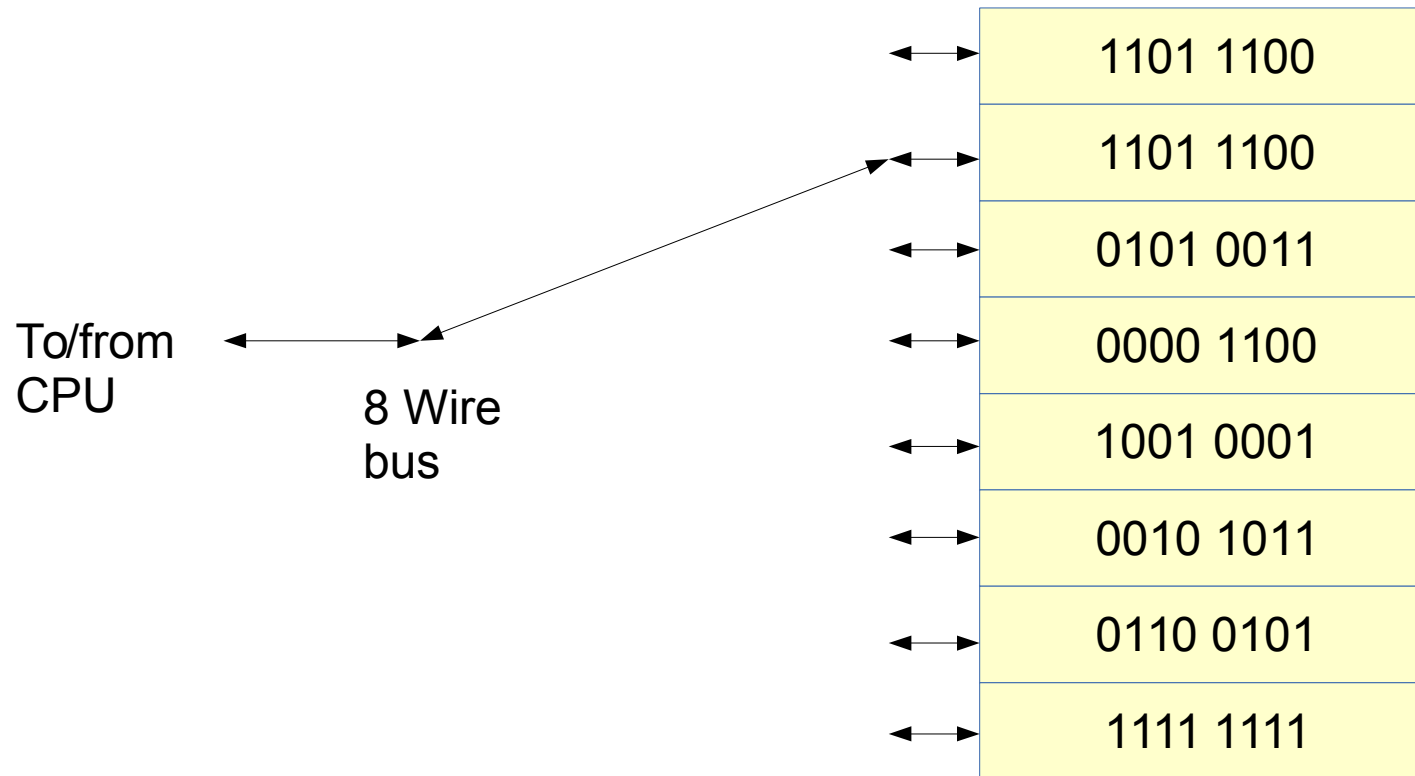
How many wires do we
need to access all bits?
Suppose there were 1024
bytes (1KiB)?

1101 1100
1101 1100
0101 0011
0000 1100
1001 0001
0010 1011
0110 0101
1111 1111

Data storage

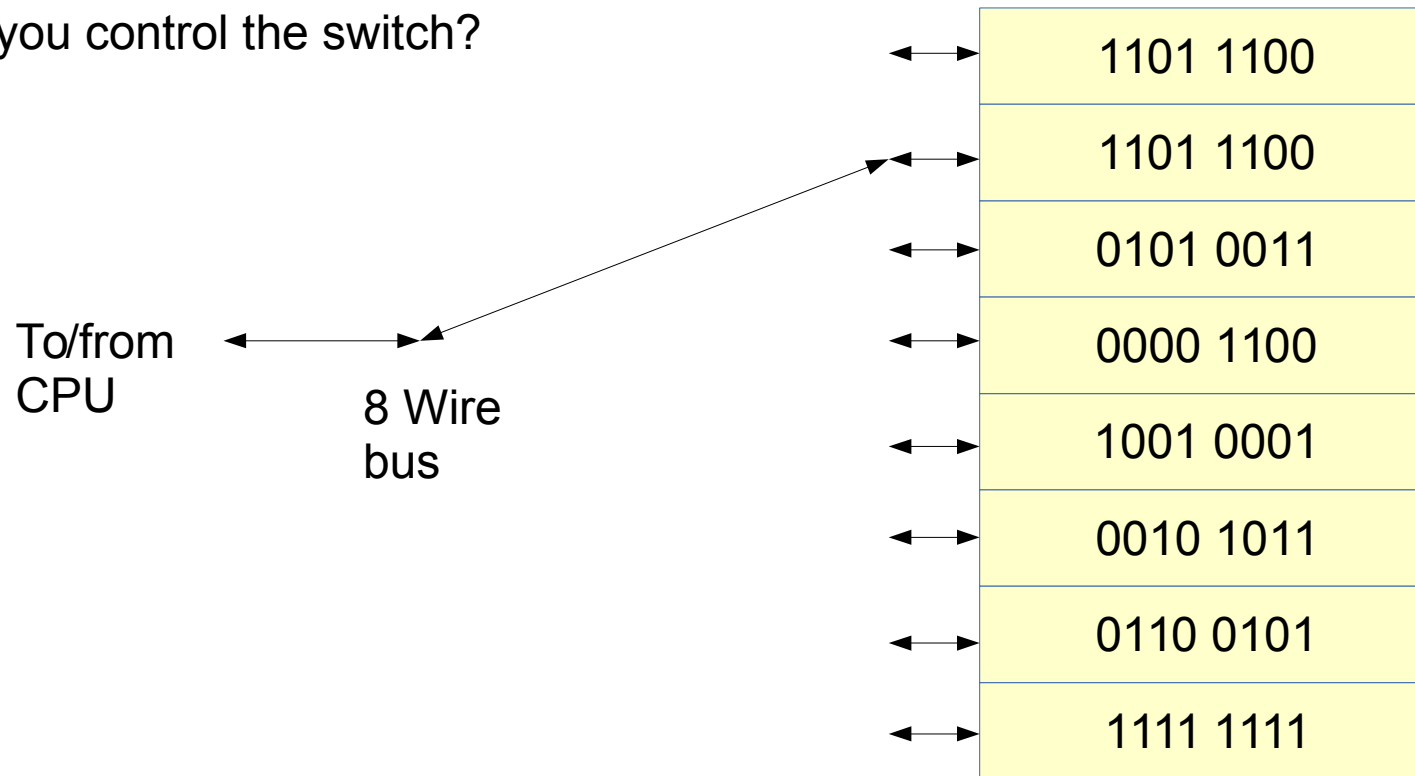


Data storage



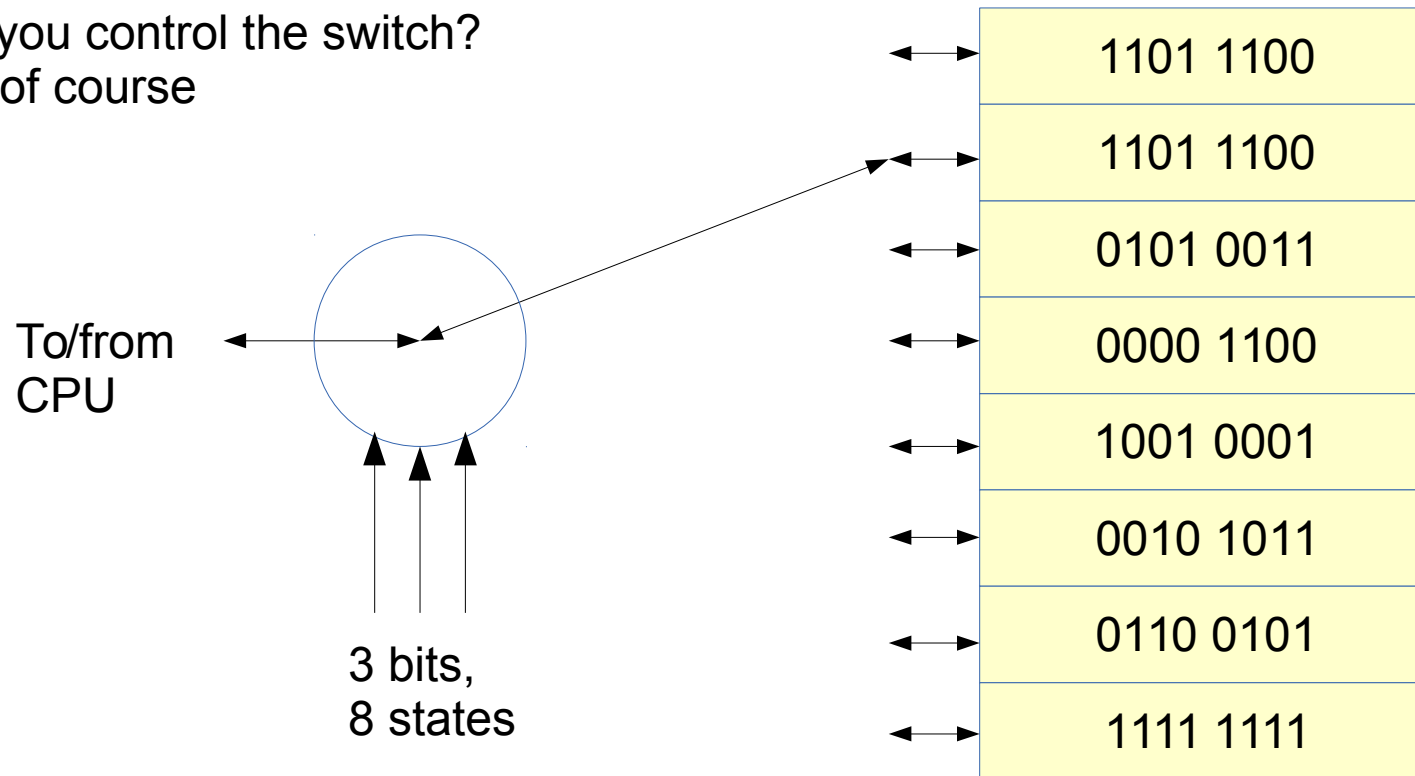
Data storage

How do you control the switch?

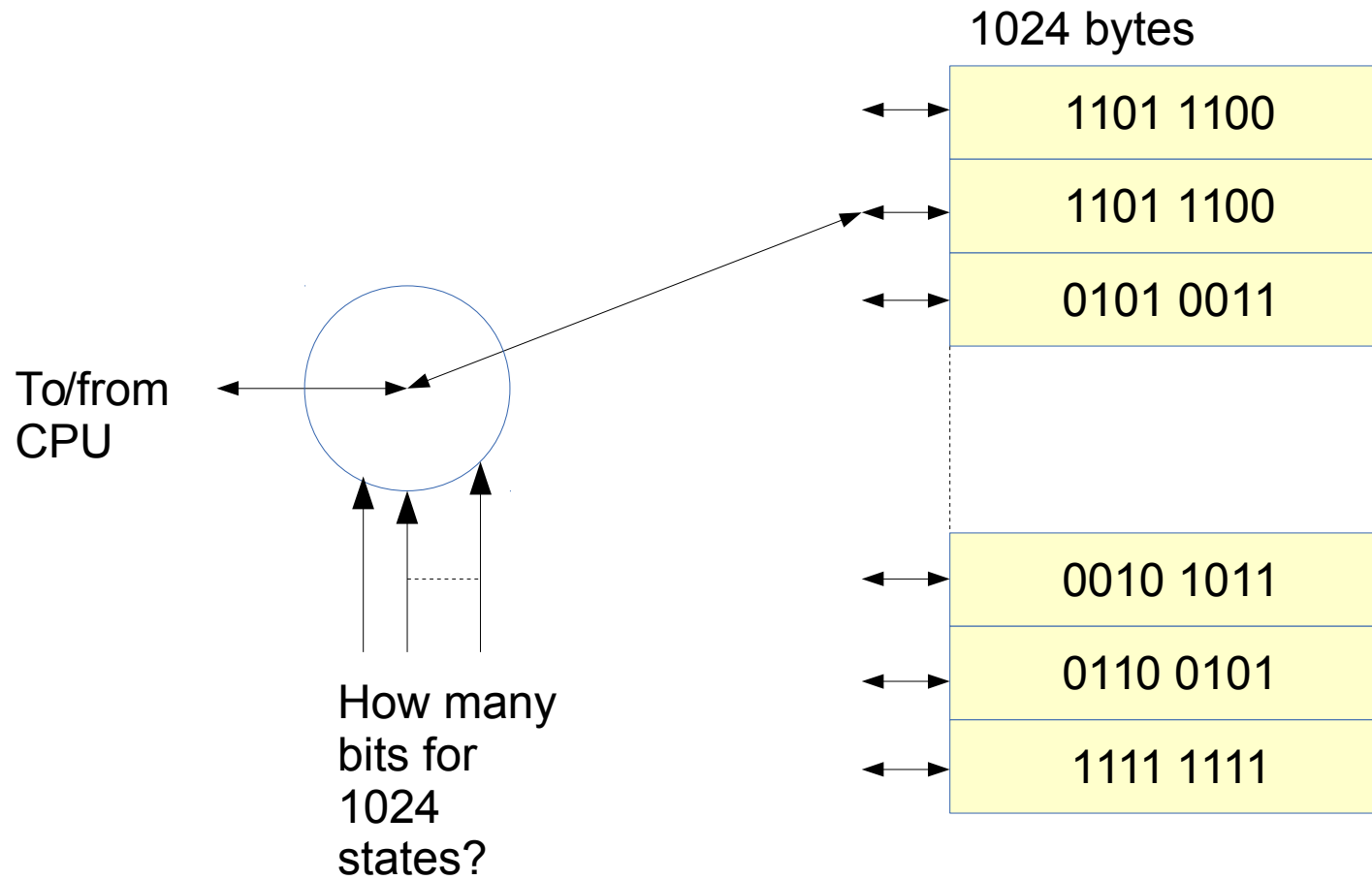


Data storage

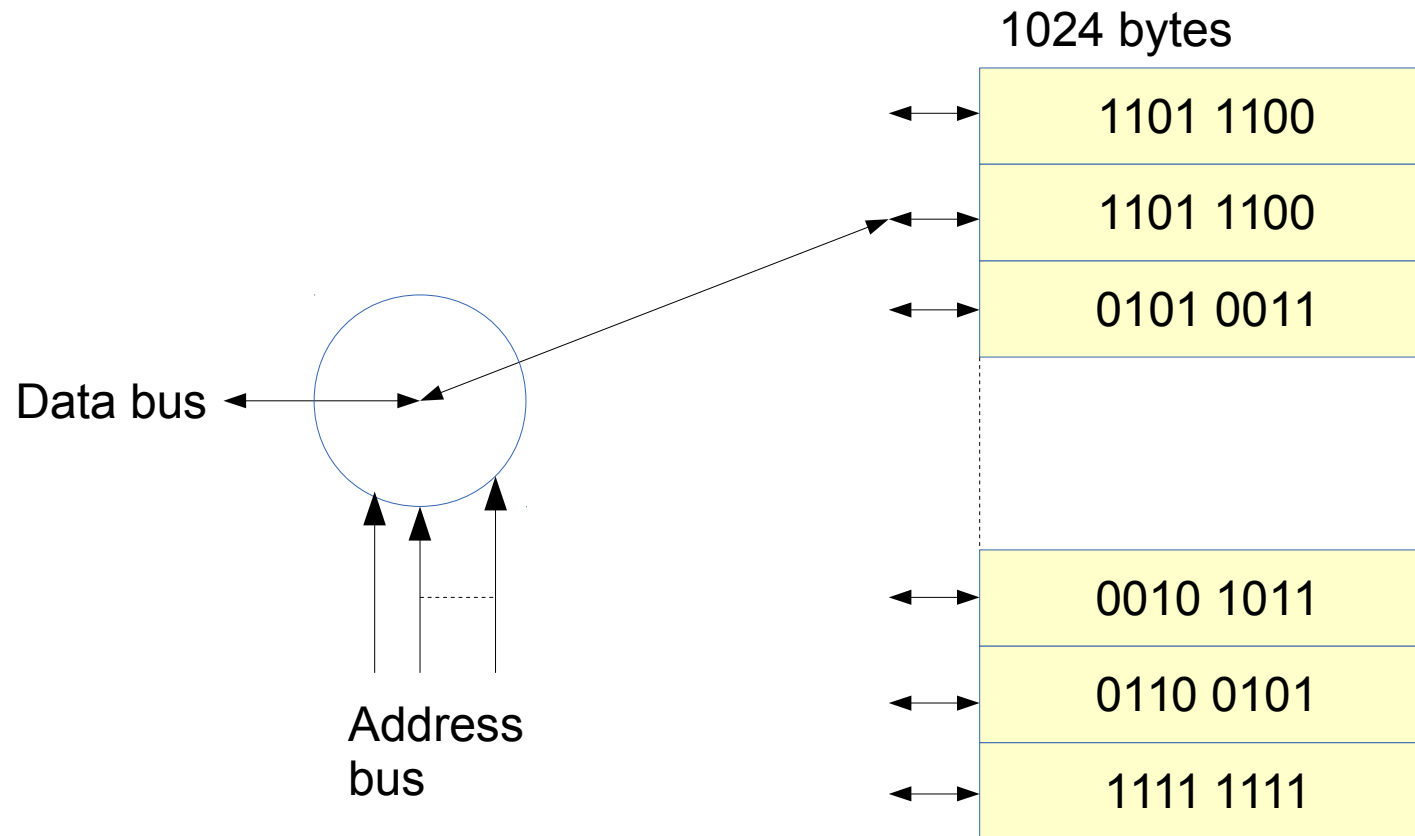
How do you control the switch?
Digitally of course

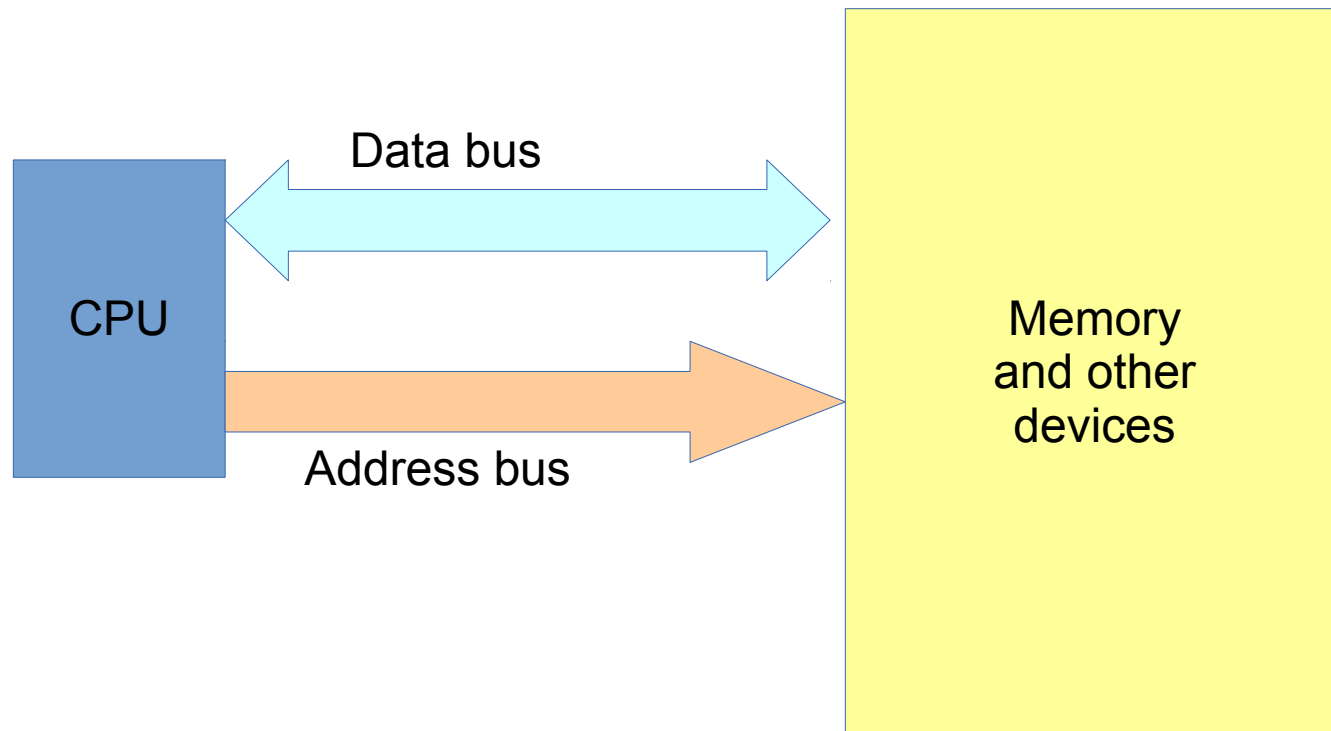


Data storage



Data storage





Accessing particular memory locations from C

- Pointers allow us access particular memory locations in C

```
int *ptr;
```

```
ptr=0x12345678;
```

```
*ptr = 0;
```

Accessing particular memory locations from C

- The * operator implies “contents of”
- The & operator implies “address of”

Accessing particular memory locations from C

- Pointer are typed

```
int *iptr=0x12345678;
```

```
char *cptr=0x12345678;
```

```
iptr++;
```

```
cptr++;
```

- What addresses do these pointers point to now?

LPC1114 GPIO Address space

```
#define REGISTER_32(ADDRESS) (*((volatile unsigned int *)(ADDRESS)))  
  
#define GPIO0_BASE      0x50000000  
  
#define GPIO0DATA      REGISTER_32(GPIO0_BASE + 0x3ffc)  
  
#define GPIO0DIR        REGISTER_32(GPIO0_BASE + 0x8000)  
  
:  
  
:  
  
GPIODATA = 0x12345678
```

LPC1114 GPIO Address space

```
#define REGISTER_32(ADDRESS) (*((volatile unsigned int *)(ADDRESS)))
```

```
#define GPIO0DATA      REGISTER_32(0x50000000 + 0x3ffc)
```

LPC1114 GPIO Address space

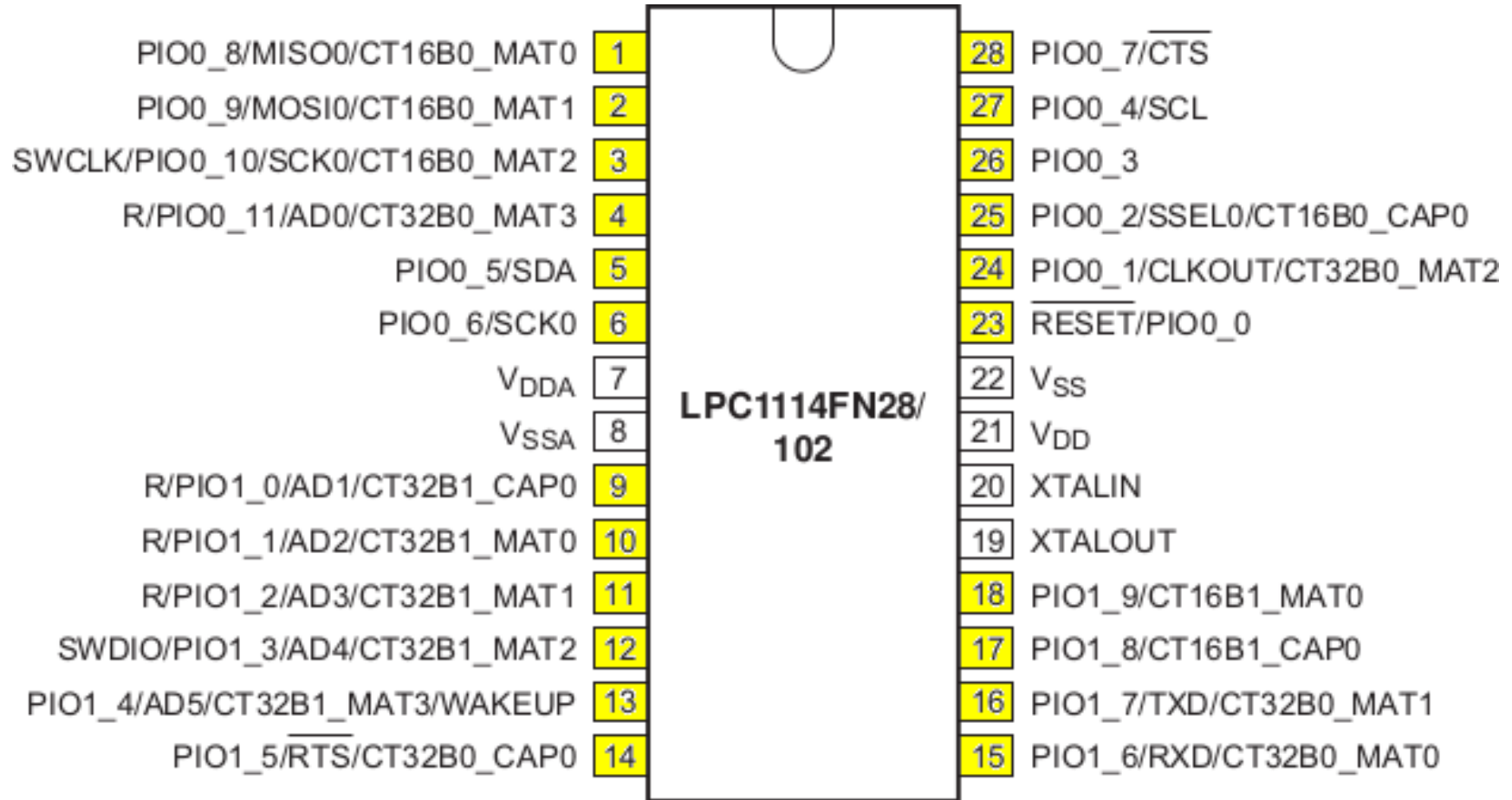
```
#define GPIO0DATA      (*((volatile unsigned int *)(0x50000000 + 0x3ffc)))  
:  
:  
GPIODATA = 0x12345678
```

LPC1114 GPIO Address space

```
((volatile unsigned int *) (0x50000000 + 0x3ffc)) = 0x12345678
```

What does the word volatile mean?

LPC1114 I/O Pins



Blinky

```
#include "lpc111x.h"

void delay(unsigned len)
{
    while(len--);
}

void ConfigPins()
{
    SYSAHBCLKCTRL |= BIT6 + BIT16; // Turn on clock for GPIO and IOCON
    IOCON_PIO0_2 &= ~(BIT1+BIT0); // ensure Pin 25 behaves as GPIO
    GPIO0DIR |= BIT2; // Make Pin 25 an output
    GPIO0DIR &= ~BIT8; // Make Pin 0 an input
    GPIO0DATA = 0; // 0 output initially
}
```

Blinky

```
int main()
{
    ConfigPins();

    while(1)
    {
        if (GPIO0DATA & BIT8)
        {
            GPIO0DATA ^= BIT2;
            delay(1000000);
        }
    }
}
```

LPC1114 GPIO Address space

- Manufacturer's data sheet defines all of the addresses for the device
- Definitions are associated with these definitions in a header file
- Header file is included in application programs

