CYBER CONTROL

Royal Academy of Engineering

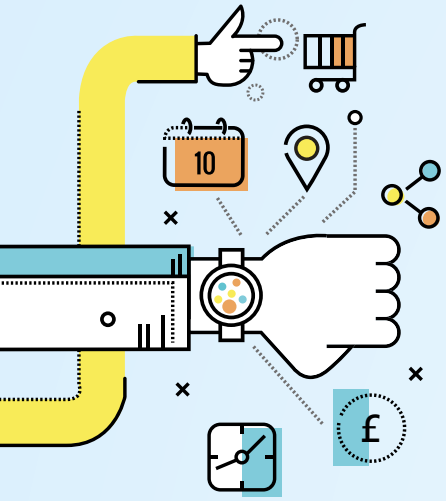
THIS IS ENGINEERING

A STEM learning and teaching resources that shows how engineers have applied their knowledge to improve the security of the internet.

Curriculum links

Computing: use programming languages; understand a range of ways to use technology safely.

CYBER CONTROL



More and more things in the home are able to communicate with each other over the internet.

For example, you can control a kettle with a smartphone, track your fitness on a tablet with a smartwatch, or turn the heating on before you get home.

The network of connected 'things' that can communicate with each other over the internet is called the *internet of things*.

TIME to THINK

Connecting devices with each other could bring many benefits. For example, when your alarm clock wakes you up, it could then notify the toaster to start cooking your breakfast.

? What devices would you connect to each other?

Smart cities aim to link the *internet of things* to the city's infrastructure to improve quality of life and efficiency of services. One example of this in action is in Glasgow, where they have intelligent street lighting. The street lights are controlled by sensors, so that the lights react to movement and only turn on when people need them. This produces a safe and energy efficient environment.

Smart traffic lights are an example of the integration of multiple smart city technologies. Emergency vehicles could get to an incident more quickly by using a mix of GPS and traffic management software that talks to the traffic light systems.

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SCENARIO

Your council has asked for your help to improve public safety around your school.

Things to think about:

? What needs to be done to improve safety around your school?

? What devices could communicate with each other to make the area safer?

? How will these devices communicate?

? What problems could you face?

DANGERS of HACKING

Personal information can be transmitted across the *internet of things*, sometimes automatically, with devices making autonomous decisions.

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This can be beneficial. For example, a car could send out an automatic message in the event of a breakdown, or wearable tech could send information about health to doctors.

However, the *internet of things* opens us up to more security threats. Contact details being taken leads to the irritation of irrelevant marketing communications, as well as the more serious issue of identity theft.

TIME to THINK

? What problems could it cause if hackers could hack into the *internet of things*?

? What can you do to make sure your information is safe?

PROGRAMMING TASK

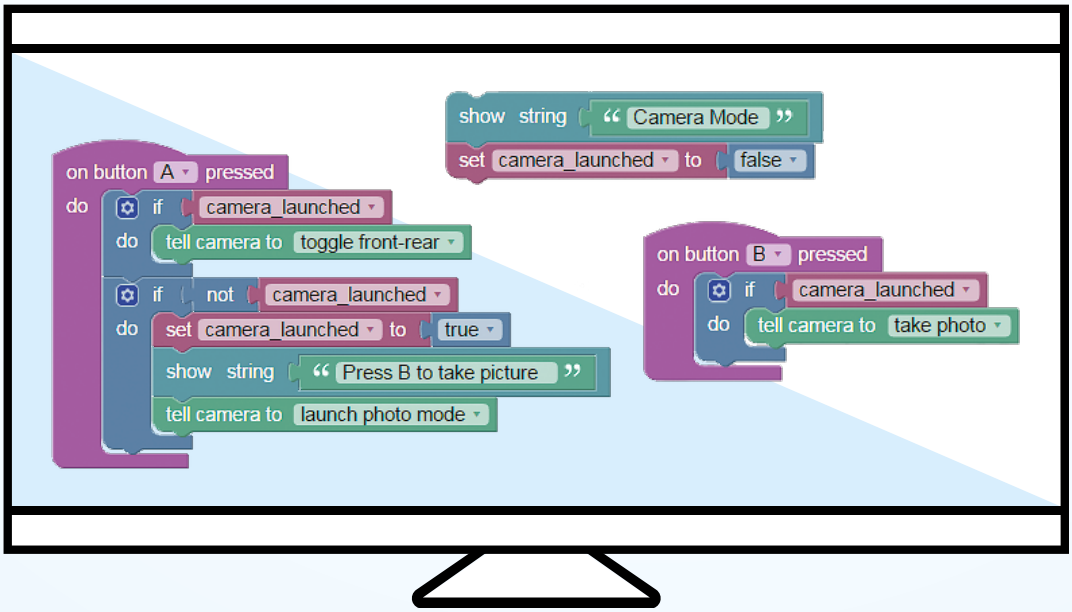
The BBC micro:bit can be used to communicate to smart devices, such as a mobile phone or tablet via Bluetooth.

1..... Program a micro:bit to take a photograph with your phone camera.

2..... Adapt the code so that the camera turns off when buttons A and B are pressed together.

3..... Change the code so that the smart device will take a video instead of a photograph.

? What are the security risks of accessing your phone with Bluetooth?



STORING IMAGES

Computers understand two states, on or off. Computers use binary digits, or bits, to represent these states. All data that a computer processes needs to be converted into this binary format.

In everyday life people use the decimal number system, also known as denary, which is a base-10 system. This system has 10 digits that we can use: 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9. Binary numbers are a base-2 number system in which there are only two digits to select from, 0 and 1.

In denary the place values are 1, 10, 100 and 1000, meaning that each place value is 10 times bigger than the last.

Working out the value of 3097:

Thousands (1000)	Hundreds (100)	Tens (10)	Units (1)
3	0	9	7
3 × 1000 +	0 × 100 +	9 × 10 +	7 × 1

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In binary, each place value is two times bigger than the last. The first few binary place numbers are:

64	32	16	8	4	2	1

Working out the value of 10110:

16	8	4	2	1
1	0	1	1	0
1 x 16 +	0 x 8 +	1 x 4 +	1 x 2 +	0 x 1
16 +	0 +	4 +	2 +	0

So 10110 in binary is equal to 22 in denary.

TIME to CALCULATE

1. Work out the value of 1010110 in denary.
2. Work out the value of 1101101 in denary.
3. Work out the value of 76 as a binary number.

A quick way to check whether your binary number is likely to be correct is by looking at the last digit. If the denary number was odd, the last binary digit should be a 1. If it was an even number, the last binary digit should be a 0.

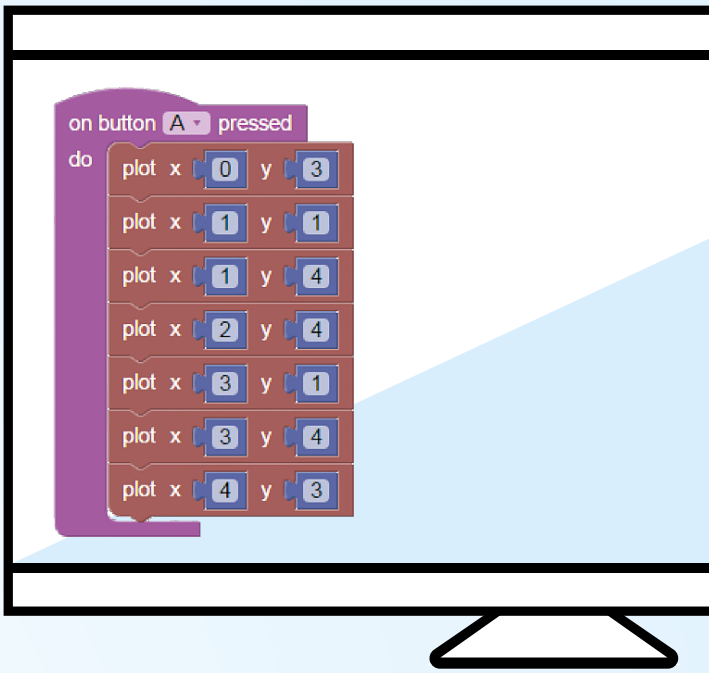
Images, like all data on computers, need to be converted into binary to be stored or viewed on screen. Digital images are made up of pixels. If the binary digit 1 represents a black pixel and 0 represents a white pixel, then a simple black and white picture can be created using one bit of information per pixel. The image on the right is an example of a 5 x 5 pixel image represented in binary form:

0	0	0	0	0
0	1	0	1	0
0	0	0	0	0
1	0	0	0	1
0	1	1	1	0

PROGRAMMING TASK

The micro:bit can display a monochrome 5 x 5 pixel image.

Program the micro:bit to display a happy face when you press A and a sad face when you press B.



The program has been started for you:

1..... Write a simpler version of the program which gives the same outputs.

2..... What are the advantages of writing more simple computer programs?

To represent colours, more bits are used to store each pixel. The number of bits used to store each pixel is called the colour depth.

If two bits of information is used per pixel, then the pixel can be one of four colours. For example:

00 = White
01 = Red
10 = Green
11 = Blue

00	00	00	00	00
00	10	00	10	00
00	00	00	00	00
01	00	00	00	01
00	01	01	01	00

TIME to THINK

? How many colours are available if three bits of information are used per pixel?

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Royal Academy of Engineering

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In collaboration with our Fellows and partners, we're growing talent and developing skills for the future, driving innovation and building global partnerships, and influencing policy and engaging the public.

Together we're working to tackle the greatest challenges of our age.

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We're influencing policy through the National Engineering Policy Centre – providing independent expert support to policymakers on issues of importance.

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