Photo: BAE Systems

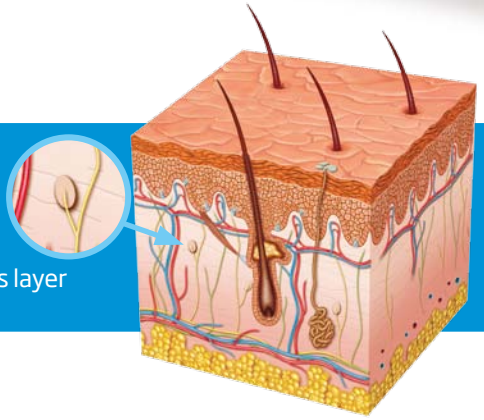
The dots on the surface of this aircraft represent motes, which are sensors that collect data

Motes on the surface of an aircraft can be used to monitor its condition and environment

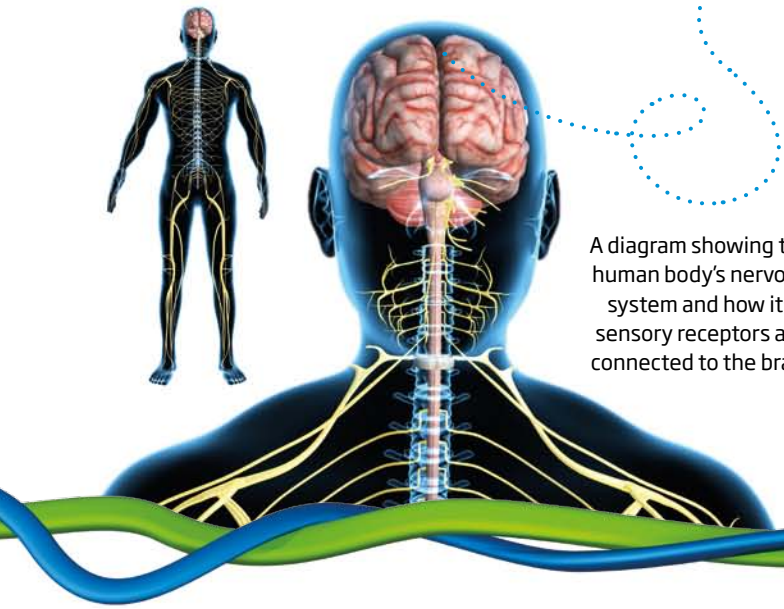
Receptors under our skin send signals to our brains about the world around us.

These receptors help us to sense how hot or cold the air around us is, whether something is touching our skin or the texture of an object (what it feels like to touch).

Engineers at BAE Systems are borrowing this idea from the human body to create a 'smart skin' for aircraft. By covering the surface of an aircraft with tiny sensors called motes, engineers and pilots will be able to see areas that require repair much earlier, which is great for safety. It will also help an aircraft to sense changes in its environment and automatically change the way it flies.



A touch sensor located just beneath the skin's epidermis layer



A diagram showing the human body's nervous system and how its sensory receptors are connected to the brain

TIME TO THINK

Discuss the following questions:

- What information do you think the motes on the surface of the aircraft above would collect?
- What would need to happen to the information captured by the motes?
- Can you think of any other uses for a network of motes? (See the back page for suggestions if you are stuck)

CURRICULUM LINKS
This resource could provide a context for the following curriculum subjects:

- **Mathematics** - geometry and measures
- **Science** - waves
- **Computing** – how components communicate
- **Design and technology** - technical knowledge

ROYAL ACADEMY OF ENGINEERING

BAE SYSTEMS INSPIRED WORK

ROYAL AIR FORCE

Tomorrow's Engineers

WIRELESS DATA

Sending and receiving data without the use of wires is now part of many people's lives.

Surfing the internet on a smartphone, or any another mobile device, relies on wireless data transmission, as does using a contactless payment card. If you have a pet that is 'chipped', a tiny electronic circuit, not much bigger than a grain of rice, has been inserted under its skin. The circuit contains data (information) about the pet and can be accessed using a device that uses radio frequency identification technology (RFID) to read the data on the chip.

Pets can be identified using electronic tags

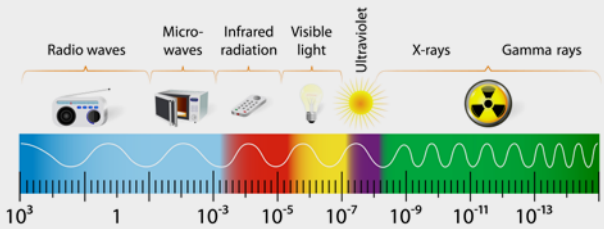
An RFID tag that is used to 'chip' pets

Contactless payment cards use radio frequency (RF) technology to transmit data

The Electromagnetic Spectrum

RFID tags and motes transmit signals using radio waves, which range in frequency from 3 kHz to 300 GHz. The distance radio waves can transmit signals can range from 1 mm to 100 km.

Which travel further, low or high frequency waves?



HOW DO YOU MAKE A MOTE?

The most advanced motes are similar in size to the RFID tag shown in the picture above. However, they don't just send data, they can collect it too.

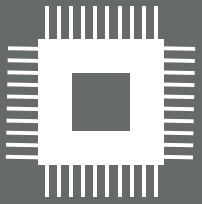
Motes are made up of the following parts.

Sensor

TYPES OF SENSOR
- Accelerometer
- Air flow
- Global positioning system (GPS)
- Gyroscope
- Magnetometer
- Strain gauge
- Temperature sensor

Power source

Processor



Transmitter

SMART SKIN
STUDENT
ACTIVITY

DESIGNING A MOTE NETWORK

> Scenario

Aerospace engineers wish to collect data about the temperature of the whole surface of an aircraft wing.

They plan to use a mote that can collect temperature data within a 25 mm radius.

The engineers start by placing the motes 50 mm apart.

Figure 1 is a diagram that shows the motes located within a 100 mm square on the aircraft wing's surface.

1. **Are there enough motes to collect temperature data from all of the square in Figure 1?**
2. **How much of the wing's area shown in Figure 1 can the motes collect data from? Give your answer in cm².**
3. **How much of the wing's area, shown in Figure 1, is not providing data? Give your answer in cm².**
4. **How many motes are required to make sure data is collected from all of the area shown in Figure 1?**
5. **How many motes would be required to collect data from the whole wing shown in Figure 2?**

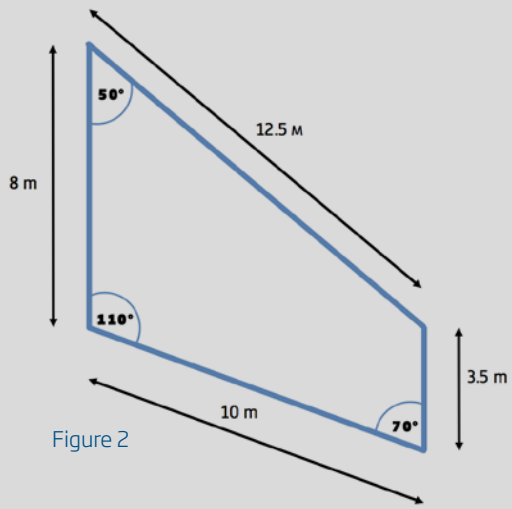


Figure 2

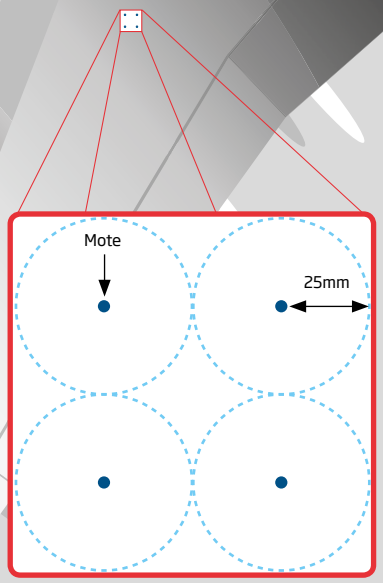


Figure 1

Lydia Hyde

Lydia is a Senior Scientist at BAE Systems where she researches future sensor technologies.

Lydia studied physics at university, specialising in theoretical physics, quantum optics and particle theory.

Her groundbreaking 'Smart Skins' research is very exciting and has been presented to MPs at the Houses of Parliament as part of the Set for Britain competition.

As well as working on engineering projects for BAE Systems, Lydia runs outreach activities to promote science and engineering to school pupils. She is an active member of Girlguiding UK and leads activities for girls aged 10-18 every week. She also volunteers regularly and has been awarded the nationally recognized 'Vfifty' award for over fifty hours of volunteering.

Other ideas for mote networks

- **Human health monitoring**
- **Water quality monitoring**
- **Landslide detection**
- **Air pollution monitoring**
- **River level monitoring**
- **Forest fire detection**
- **Monitoring the structure and condition of buildings, bridges and roads**

All images: Fotolia, unless labelled otherwise

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