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My bright idea: Light bulbs can be used to transmit data

With a device you can buy in any high street, Professor Harald Haas is perfecting a revolutionary method of controlling digital information at the flick of a switch

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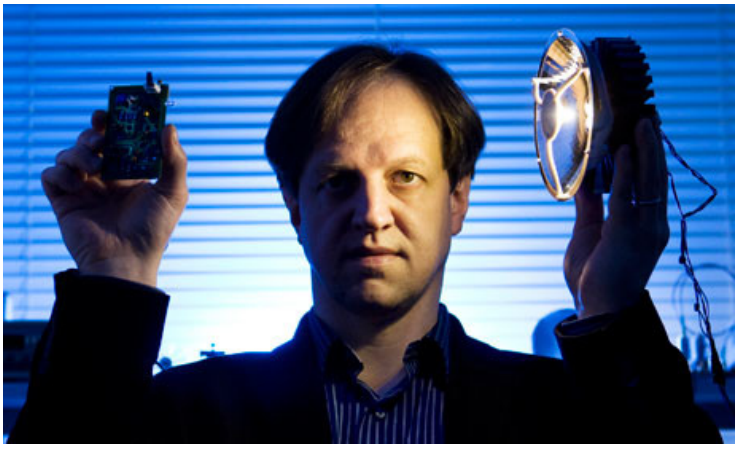

Professor Harald Haas with a light transmitter and receiver in his lab at Edinburgh University. Photograph: Murdo Macleod for the Observer

"Light can be gentle, dangerous, dream-like, bare, living, dead, misty, clear, hot, dark, violet, spring-like, falling, straight, sensual, limited, poisonous, calm and soft," said the great Swedish cinematographer Sven Nykvist. It is also extraordinarily useful, he could easily have added, a point that scientists have been recently exploiting with some striking new uses for light, both in the home and in industry.

Using light-emitting diodes – or LEDs – it will soon be possible to manipulate optical signals in order to build super-fast data links for personal computers, construct simple crash-avoidance systems for cars, design cable-free communication links with submarines and underwater robots and develop a host of other intriguing devices. Such projects currently are now being studied by engineers like 42-year-old Professor Harald Haas, once a projects manager for Siemens, now professor of mobile communications at Edinburgh University – and a man with a bright future.

So what is the basis of the technology that you are working on?

We use standard light-emitting diodes, LEDs, which you can buy at Homebase or B&Q. They have several important features. For a start, they are highly power-efficient. Standard lightbulbs have an efficiency of 2%. In other words, only 2% of the energy put

into them is turned to light. The rest is wasted.

By contrast, LEDs have efficiencies of around 15% or more. The US Department of Energy has calculated that if everyone on Earth turned to the use of LEDs, the planet would require 100 fewer nuclear power stations.

But there is another very nice feature about LEDs. They are electronic devices based on silicon and so can be switched on and off very quickly. Lightbulbs cannot do that. A standard lightbulb works by heating up a wire so that it glows brightly. This takes time, however; too long for use as a means to transmit large amounts of data at a rapid rate.

Because these LEDS *can* be switched on and off extremely quickly, they can be used for signalling. This opens a new avenue for their use: data transmission.

How do these device work then?

Essentially, we use a mathematical trick that we apply to LEDs. This is known as OFDM – orthogonal frequency division multiplexing. Using this, you can vary the intensity of the LEDs' outputs and these signals can then be picked up by simple receivers.

There are two key points about this system. The first is that it is incredibly rapid. We can get data rates of 100 megabits a second. That compares with wireless Lan (local area network), which gets around 50 megabits while broadband today is about 10 megabits, perhaps up to 50. Rates like that are bread and butter for our system, however. Our aim is to get to data transmission rates of a gigabit a second and more.The other point is that the rate of transmission is so fast, the human eye cannot detect it. The LEDs switch so fast that you cannot see they are going on and off. They just appear to glow like a normal LED.

In other words, the lights shining round your home and office would actually be transmitting huge amounts of data without you being able to see that going on. How do you see this being exploited?

One simple use would be as a substitute for broadband for your computer. You would have clusters of LEDs on your ceiling and a receiver on your computer. You would be able to download data at really fast rates.

Ideas like that take advantage of the rapid data rates that are possible with LED systems. But more than that, there's one other clear benefit: LEDs can transmit data without using radio waves.That has real advantages. For example, LEDs could be used in hospitals to transmit data from MRI scanners to laptop computers. Because there are such intense magnetic fields around devices like these, it is impossible to transmit data using radio waves. LEDs get round that problem. Indeed, we are already working on such a system.

Using light to transmit data would also be useful in the oil and gas industries. In oil platforms, for example, radio waves are not allowed because they can cause sparks. They can ignite. In contrast, light is intrinsically safe.

At the heart of your system, you have a light-emitting silicon device that is capable of switching on and off with incredible rapidity. What other uses are you working on?

You cannot use electromagnetic waves underwater because salt water is electrically conductive. So LEDs offer the option of transmitting data to underwater robotic vehicles or submarines. Robot craft could be guided without cables. We are in discussions about this use with one company. Similarly, we are also discussing using LED data transmission as the basis for a crash-avoidance system for road vehicles. If you have LEDs used as car headlights – and these are being introduced for road vehicles – you have the means to communicate from one car to another and set up a data link that could help a driver take early action that could help avoid having a collision.

Or you could use them in aircraft to transmit internet data to passengers without using radiowaves that disrupt the operation of the aircraft. All these ideas are now being discussed between my department and companies.

Those talks are at quite an advanced state. For example we have a project funded by Scottish Enterprise called D-Light which aims to establish a spin-off company by 2011. Certainly I would hope that we will see some of these devices in action in two or three years.

There is light ahead, in other words.