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Lights, signal, networking

LED bulbs not only make your home more green – they could also be used to run its appliances

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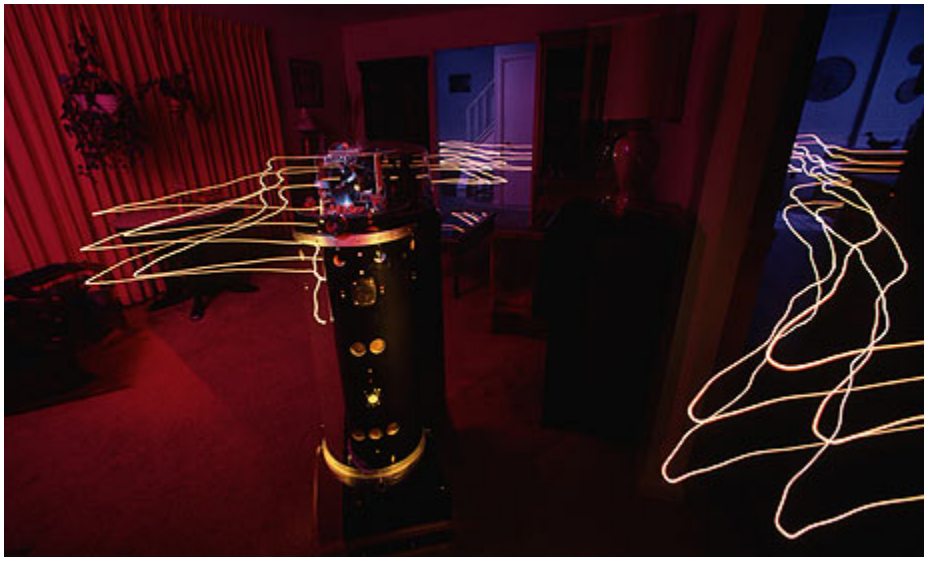

Smart-lighting technology means your house lights could communicate with your stereo. Photograph: Kevin Fleming/CORBIS

Professor Thomas Little of Boston University would like your house lighting to communicate with your computer, TV, and even the heating thermostat. By piggybacking data communications on to LED lightbulbs, he hopes "smart lighting" will become the next generation of wireless communications technology. But has it got a hope against existing technologies?

The idea of modulating light for signalling isn't new. Think of signallers using Aldis lamps; or even your TV remote's invisible infrared LED. The replacement of existing bulbs with low-energy LEDs reduces carbon emissions while offering an opportunity for smart lighting.

Flicker of interest

If you rapidly switch an LED lightbulb on and off, you can use the switching to transmit information to a receiver. The trick is to do it very quickly. "I don't know the exact rate at which the human eye can see flicker here, but we expect to operate at a speed well above the perception threshold," says Little. "For example, one of our lab prototypes can operate at speeds as low as 2,400 bits per second (bps). No flicker is visible."

Little anticipates smart-lighting data rates of "1Mbps to 10Mbps with visible light this year and a 100Mbps to 500Mbps range with future prototypes". Such speeds are impressive except for one thing: exactly how will smart lighting challenge two-way wireless home networking?

"We expect it to be two-way with the use of LEDs at the receiver. In practice, the channel will be asymmetric – just like cable modems or DSL [broadband] systems – due to the overhead lighting being intended to distribute light and the receiver intended to be passive," he says. "At the receiving end we will use a smaller LED and will investigate other wavelengths if visible light proves annoying in the back channel."

Mark Leeson, an associate professor at the University of Warwick's school of engineering, has a research interest in optical communications systems. "Lighting is there anyway so using it seems a good idea for communications," says Leeson. "The disadvantage of optical wireless can be that it works best with a line of sight, otherwise speeds are low using diffuse systems."

There are some comparisons to be made with short-range wireless Bluetooth or IrDA (infrared light communications) as well as the more powerful Wi-Fi that's in many homes. Leeson points out that for small amounts of data – such as exchanging photographs between mobile phones – 3 Mbps Bluetooth is sufficient, while IrDA offers up to 16 Mbps (faster is promised). "Transferring large quantities of data is much quicker using an optical link."

Professor David Payne is a fibre-optic pioneer and photonics researcher at the University of Southampton. He is also the director of its optoelectronics research centre. While optical technologies such as IrDA or smart-lighting need line of sight, clearly Wi-Fi or Bluetooth do not. There is an obvious problem, Payne suggests, with using visible light for data communications rather than infrared. "One should never underestimate people. People have habits – such as switching the light off."

Leaving that drawback aside, you also have to modulate the visible LED lighting to carry your data. "It's not easy to do and it takes quite a lot of electrical power," adds Payne. As light happily bounces around the room, it will create indirect paths between transmitter and receiver. These "multipaths" cause interference issues leading Payne to say that infrared – such as the battery-powered TV remote control – can be more effectively filtered. "My conclusion is I'd be better off with an infrared beam."

Red, green and blue

But has infrared really got what it takes? Payne recalls an old TV advertisement for Palm of a man and woman on adjacent trains exchanging phone numbers with their handheld computers over an infrared optical link. It's something you're unlikely to see today. "What has changed is an awful lot of completion from Bluetooth," he adds. Optical, on the other hand, has found a good niche in "free space optics" for high bandwidth line-of-sight communications at sporting events.

A five-year $18.5m (£13m) research programme between Boston University, Rensselaer Polytechnic Institute in New York, and the University of New Mexico is now under way. It will endeavour to show that smart lighting is faster and more secure than current Wi-Fi for some uses. An LED lightbulb also uses less energy than radio frequency technology and its light won't go through walls – helping to eliminate eavesdropping. Existing wiring could carry data to smart lightbulbs, providing easy network access points throughout home or office.

The concept of smart lighting may not stop indoors. Little is considering outdoor applications such as smart LED brake lights or even data-transmitting road signs. "LED lighting is a green technology. If we enable all future lighting to provide network connectivity we will have a far deeper penetration than current wireless tech. We will do this without the additional energy cost of these other technologies," he says.