Li-Fi is a new paradigm for optical wireless technology to provide unprecedented connectivity within a localized data-centric environment. The increasing demand for higher bandwidths, faster and more secure data transmission as well as environmental and undoubtedly human friendly technology heralds the start of a major shift in wireless technology, a shift from RF to optical technologies.

**Micro-LED LiFi: Where every light source in the world is also TV, and provides gigabit internet access**

Researchers at the University of Strathclyde in Scotland has begun the task of bringing high-speed, ubiquitous, LiFi technology to market. If Martin Dawson and Harald Haas have their way, any illuminated device — your TV, your bedside lamp, a road sign, a train or airport timetable — might soon double up as a wireless LiFi hotspot.
LiFi, as you may have guessed, stands for Light-Fidelity — as in, Wireless-Fidelity (WiFi), but using visible light instead of gigahertz radio waves. How LiFi works is very simple: You have an a light on one end (an LED in this case), and a photodetector (light sensor) on the other. If the LED is on, the photodetector registers a binary one; otherwise it’s a binary zero. Flash the LED enough times and you build up a message. Use an array of LEDs, and perhaps a few different colors, and very soon you are dealing with data rates in the range of hundreds or megabits per second.

At the moment, commercial LEDs don’t get much smaller than 1mm². The Scottish researchers, however, are developing LEDs that are just 1μm² — one micron; one thousand times smaller. Not only can you cram more of these micron-sized LEDs into the same space as a larger LED, but apparently they can also flicker on and off 1,000 times faster. A grid of 1,000 micro-LEDs, flashing 1,000 times faster, would be able to transmit data a million times faster than a normal LED.

Furthermore, these micro-LEDs are ultimately just pixels — and at one micron, these LEDs would be a lot smaller than those in your smartphone’s Retina display. You could have a huge array of these LEDs that double up as a room’s light source and a display — and provides networking capability on the side. Perhaps a next-next-gen console would communicate with your gamepad, smartphone, and other peripherals via a LiFi-equipped TV. How about a highway lighting that illuminates the road, provides up-to-date traffic info/warnings, and provides internet access to your car, plus all of the devices on-board?

On a more general level, LiFi might be used to extend wireless networks throughout the home, workplace, and in commercial areas. LiFi is restricted by line of sight, so it won’t ever replace WiFi, but it could augment it nicely. Instead of trying to find the perfect sweet spot for your home’s WiFi router, it would be much simpler if every light in your house simply acted as a wireless network bridge. I can just imagine it now: People clustering underneath street lights, strip lights, and billboards, clamoring for their fix of high-speed interwebs.

The concept of visible light communications (VLC), or LiFi as it is sometimes known, has received a lot of attention in recent years, mostly due to the growing prevalence of LED lighting. Unlike incandescent and fluorescent bulbs, LEDs are solid-state electronics, meaning they can be controlled in much the same way as any other electronic component, and switched at a high speed. VLC is essentially WiFi — but using terahertz radiation (light) instead of microwaves (WiFi). Instead of oscillating a WiFi transmitter,
VLC oscillates an LED bulb — and of course, on the receiving end there’s a photodetector instead of an antenna.

unfortunately the Fraunhofer press release is almost completely devoid of detail, except for the 3Gbps bit — but we do have the technical specifications of Fraunhofer’s previous VLC system, which the 3Gbps system is based on. The previous VLC system was capable of transmitting up to 500Mbps over four meters (13 feet), or 120Mbps over 20 meters (67 feet). Rather than actually using a standard LED bulb, Fraunhofer’s VLC system is a black box, with an LED and photodetector on the front, and an Ethernet jack on the back to connect it to the rest of the network. In this system, the hardware only allowed for 30MHz of bandwidth to be used, limiting the total throughput.

To reach 3Gbps, the HHI researchers have found a way of squeezing 180MHz of bandwidth out of the LEDs — and instead of using just one LED, they now use three different colors. It is not clear whether this new technique has a higher or lower range than the previous, but it is likely the same. In real-world testing at a trade fair, with less-than-optimal atmospheric conditions, 3Gbps becomes 500Mbps — still pretty darn fast.

Visible light communication has a slew of advantages. In essence, LiFi can turn any LED lamp into a network connection. LiFi, by virtue of operating at such high frequencies (hundreds of terahertz), is well beyond the sticky tentacles of the wireless spectrum crunch and regulatory licensing. For the same reason, LiFi can be used in areas where there’s extensive RF noise (conventions, trade fairs), or where RF noise is generally prohibited (hospitals, airplanes). The Fraunhofer researchers even claim that VLC improves privacy, because your signal can be easily obscured from prying eyes with opaque materials — but as you can imagine, that’s also a tick in the “con” column as well
The principle is simple: turn a light on and off so rapidly that the human eye can't see the flicker, but a photodetector can nonetheless pick up the stream of 1s and 0s the blinking bulb is transmitting. Compress the data, and you up the throughput even more. Old-style filament bulbs and fluorescent tubes aren't up to the task, but new, LED-based lighting is.

It's not hard to envisage home lighting with an integrated photodetector - to pick up signals sent back from networked devices - and perhaps a powerline adaptor on board to maintain a connection over electrical wiring back to the router.

The technique is called Visible Light Communications - or VLC, not to be confused with the open source media player of the same name - but the companies springing up to deliver the technology are already branding it "Li-Fi". The similarity to the name "Wi-Fi" is deliberate: they hope VLC will become as ubiquitous a networking technology as 802.11 has become.

One of VLC's key proponents, Harald Haas of the University of Edinburgh, reckons that isn't hyperbole. With tens of billions of regular lightbulbs installed in homes and offices across the globe, as they're replaced with LED light sources, Li-Fi can be a communications technology that can be found almost everywhere.
Li-Fi bulbs will inevitably be more costly than regular LED bulbs, but then the potential volumes will, Haas reckons, push prices right down.

More to the point, Li-Fi could be used in almost every location where regulations forbid the use of Wi-Fi: aircraft cabins and hospitals, to name but two. And light isn’t affected by the spectrum regulations that govern how radio frequencies can be used.

Of course, getting it out of the lab and into the living room - and every other space illuminated by a lightbulb - is another matter

**Chinese scientists** have successfully developed a new cheaper way of getting connected to internet by using signals sent through light bulbs instead of radio frequencies as in 'Wi-Fi', a move expected to radically change process of online connectivity. Four computers can be connected to internet through one-watt LED bulb using light as a carrier instead of traditional radio frequencies, as in Wi-Fi, said Chi Nan, an information technology professor with Shanghai’s Fudan University. Under the new discovery dubbed as 'Li-Fi', a light bulb with embedded microchips can produce data rates as fast as 150 megabits per second, which is speedier than the average broadband connection in China, said Chi,
who leads a Li-Fi research team including scientists from the Shanghai Institute of Technical Physics of the Chinese Academy of Sciences.

The term Li-Fi was coined by Harald Haas from the University of Edinburgh in the UK and refers to a type of visible light communication technology that delivers a networked, mobile, high-speed communication solution in a similar manner as Wi-Fi. With Li-Fi cost-effective as well as efficient, netizens should be excited to view 10 sample Li-Fi kits that will be on display at the China International Industry Fair that will kick off on November 5 in Shanghai.

The current wireless signal transmission equipment is expensive and low in efficiency, Chi said.

"As for cell phones, millions of base stations have been established around the world to strengthen the signal but most of the energy is consumed on their cooling systems," she said.

"The energy utilisation rate is only 5 per cent," state-run Xinhua news agency quoted her as saying. Li-Fi was touted as a boon to China netizen community, the highest in the world with about 600 million connections.

Compared with base stations, the number of light bulbs that can be used is practically limitless. Meanwhile, Chinese people are replacing the old-fashioned incandescent bulbs with LED light bulbs at a fast pace.
"Wherever there is an LED light bulb, there is an Internet signal. Turn off the light and there is no signal," Chi said. However, there is still a long way to go to make Li-Fi a commercial success. "If the light is blocked, then the signal will be cut off," Chi said.

More importantly, according to the scientist, the development of a series of key related pieces of technology, including light communication controls as well as microchip design and manufacturing, is still in an experimental period.