Internet at warp speed, captain!

November 7 2007

The ultra-high data speeds possible on optical fibre networks will only come into their own when the fibres reach the last mile into everyone's home. But that will require miniaturisation and integration of optical components on a scale not yet seen. European researchers may have some of the answers.

Broadband access has transformed the economic potential of the internet. But the ADSL technology that delivers broadband to homes over traditional copper telephone wires is reaching its limit of around 10 megabits per second. If we want speeds ten times faster then we need to replace the copper with optical fibres.

Optical fibres carry signals with light rather than electricity. They have been used in telecommunications for many years, especially over 'longhaul' links such as transatlantic cables and other trunk routes. Professor Henri Benisty, of the Institute of Optics Graduate School near Paris, likens them to motorways, carrying a lot of traffic but with only a small number of entrances and exits. The challenge now, he says, is developing the equivalent of secondary and feeder roads to connect the motorway to everyone's home.

"The issue is what is often called the 'last mile', whether it will be electrical or optical," he says. "Optical is gaining attention, especially in Japan where they are approaching ten-million subscribers with fibre to the home."

Economies of scale

The problem in extending optical networks into every home is that the switching and routing components needed to distribute optical signals are expensive, much more so than in electronic networks, and it is not yet economical to mass produce them on the scale needed to wire up a city.

"Miniaturisation and integration are key to lowering the cost and both are hard in optics, unlike microelectronics," says Prof. Benisty who coordinates the EU-funded FUNFOX project. "You probably have a few hundred million transistors in the computer next to you, but an optical chip at the moment has, at best, a few tens of devices on a big chip of several square centimetres. The price of a single packaged device will be typically €200."

FUNFOX aims to cut costs by designing integrated optical circuits very much smaller and more integrated than the components currently in use. The nine partners from six countries are building on work done in three earlier EU projects to exploit the potential of photonic crystals.

Photonic crystals, developed in the 1980s, can be used to control light in much the same way as semiconductor crystals can be used to control electrical signals. In particular, they allow optical components to be integrated on to small, flat chips.

To and fro

FUNFOX tackled two basic problems for handling data rates up to several gigabits per second: transmitting a signal down a fibre and receiving it at the other end.

The light used in optical fibres is produced by a laser. The problem is to control the wavelength. If the wavelength drifts from its set value, perhaps through changes in temperature, the signal may not be fully received at the other end of the fibre. Until now, this has required several different devices, but the FUNFOX team has created a single, integrated chip including the laser itself and a monitor that measures the wavelength and ensures that it remains stable, no matter what the environmental conditions.

Of course, a transmitter is little use without a receiver, and that is the second device built by the team. A single optical fibre can carry several signals, each using a slightly different wavelength of light, a technique called multiplexing. So the receiver – a demultiplexer – must separate out the wavelengths so each can be detected separately and converted into an electrical signal. As before, the team has integrated all the functions onto a single chip so the fibre comes in one side of the chip and the separated electrical signals come out the other.

The FUNFOX chips are tiny and more integrated compared with the devices they are intended to replace – more than 800 four-channel demultiplexers could fit into a square millimetre!

Technology choices

These two innovations hold the promise of cheap, mass produced chips for rolling out optical telecommunications networks on a big scale. But there is more work to be done to bring them to the market. The group's industrial partner, Alcatel, merged with US company Lucent last year and, after the subsequent restructuring, it is yet not clear how the work will be taken forward. Prof. Benisty thinks the devices they have developed could be commercialised in three to six years if a manufacturing partner could be found.

One problem is that optical technologies are more diverse than electronics, and it is hard to foresee which type of technology will prevail in future.

"Optical technology is not like microelectronic technology, it doesn't have a single stream like silicon and its shared roadmap," Prof. Benisty explains. "It can use different materials and it has always had the problem of whether to focus on a particular material or not. A single material cannot do everything in optics."

The FUNFOX devices are based on indium phosphide chips, while other researchers are trying to do similar things on silicon or a combination of both.

"Our great asset was the capability to incorporate knowledge of building blocks, physics and technology integration," he says. "Our achievements are unique, really."

Source: ICT Results