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Plastic optical fibre could offer a low-cost solution for providing high-speed optical access throughout Europe. The upper images show the testing of POF-based media converters (left) and the preparation of components (right) for polymerization. The lower images show POF being cut, stripped, crimped and polished.

<< [Back to article](#)

Plastic fibre promises ubiquitous optical access

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Plastic optical fibre could provide a low-cost and easy-to-install solution for fibre-to-the-home networks. Alessandro Nocivelli of Luceat explains how a new European consortium is developing the technology needed to deliver real broadband to consumers.

It is becoming obvious that Europe is lagging behind in the deployment of fibre-to-the-home (FTTH) networks. What's more, according to Hartwig Tauber, president of the FTTH Council Europe, only 8% of optical access networks have been deployed by incumbent operators, while the vast majority have been installed by municipalities, power utilities and alternative operators.

Indeed, broadband access in Europe has largely become synonymous with Asymmetric Digital Subscriber Line (ADSL). Some 61% of broadband connections in Europe exploit this copper-based technology, while cable accounts for a further 32%, predominantly in northern European countries. This dominance of ADSL has resulted from the incumbent telcos' post-bubble strategy, which was to squeeze as much money as possible out of their existing copper-based infrastructures. Incumbents aren't eager to invest huge amounts of money to go optical - unless they're forced to.



[Plastic packs a punch](#)



At the same time, however, Internet surfers are increasingly using bandwidth-intensive services to download music and films. The explosion of peer-to-peer (P2P) services in particular is rapidly creating a bandwidth bottleneck: 60% of all Internet traffic was P2P-based at the end of 2004, and the symmetrical nature of these services mean that on average 80% of upstream capacity is consumed by P2P every day.

Focus on price

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Telecoms operators can't handle this increasing traffic without a cost-effective and future-proof technology that can fill the connectivity gap between their metropolitan optical networks and the end users. Bandwidth must be distributed from the kerb or the basement of a building to individual apartments and households, which requires a link that is typically less than 300 m long. This part of the infrastructure, also called the edge network, requires the most capital investment of all because of its highly granular nature. It's therefore the part of the network that telecoms operators fear most.

To address this cost issue, nine European companies and research institutes initiated a project at the beginning of 2006 to develop an enabling technology for FTTH that would be substantially cheaper than silica fibre-based solutions. The project, which has been dubbed POF-ALL (Paving the Optical Future with Affordable, Lightning-fast Links), is funded by a €1.6 m grant from the European Union (EU), and will run until June 2008. However, preliminary technical results will be presented as early as September 2006, during the 15th International Conference on Plastic Optical Fiber in Seoul, Korea.

The POF-ALL consortium is led by Istituto Superiore Mario Boella, a research centre based in Turin, Italy. Industrial participants include Switzerland-headquartered STMicroelectronics, Luceat of Italy, DieMount of Germany and FastWeb, the leading FTTH operator in Italy. Academic partners are the POF Application Center, the Fraunhofer Institute for Integrated Circuits, the University of Duisburg-Essen - all in Germany - as well as the Eindhoven University of Technology in the Netherlands.

The ultimate goal of POF-ALL is to develop an optical modem for FTTH systems that will operate at speeds of 100 Mbit/s to 1 Gbit/s over distances of 100-300 m. This will be achieved using large-diameter plastic optical fibre (POF) as the transmission medium, rather than standard glass fibre. The advantages of POF are clear for this application: it is easy to handle and terminate with common tools, it transmits visible light, and it is also mechanically resilient. Large-diameter POF has an external diameter greater than 0.5 mm (possibly up to 1.0 mm, see figure 1), which enables easier installation.

POF is most commonly known for its widespread use for in-car data networks based on standards such as MOST and ByteFlight. As of today, more than 25 million MOST transceivers have been installed in 40 different models of cars manufactured by the likes of BMW, Daimler-Chrysler, Porsche, Audi and Saab. The success of POF in this sector is testimony to the reliability of the technology, and has helped to reduce the prices of the associated transceivers down to €2-4.



[Fig. 1](#)

The lower target speed for the POF-based modem, 100 Mbit/s, is 20-100 times faster than existing DSL connections. This would allow a DVD-quality movie to be downloaded in less than 3 min, and would also

enable high-definition video-on-demand and real-time video surveillance of remote sites. Moreover, POF would deliver equal download and upload speeds, rather than DSL's asymmetric bandwidth, which would enable applications such as P2P transfer of home-made movies and high-quality videoconferencing.

The distance limit of 100-300 m also matches the typical requirement of FTTH edge networks in European urban areas - that is, the distance between the optical fibre that reaches the basement of large residential buildings and the data outlet within individual apartments. Based on FastWeb's data, 85% of the links in edge networks in Italy fall within the 0-300 m range, with a similar picture seen in most European countries.

The technology developed within POF-ALL could also be used to build a low-cost broadband home network, which would provide all the advantages of optical links at a much lower cost and complexity than would be possible with glass-fibre-based alternatives. Indeed, the key advantage of POF is that anyone can install it in less than 30 s with readily available tools. Unlike glass-fibre connectors, which require tedious gluing and curing, POF can be cut with scissors, the jacket can be removed with a stripping tool, and the metal connector's ferrule can be fixed to the fibre's jacket with a crimping tool. What's more, POF connections can tolerate residual dust on connectors' end-faces - a major issue with glass-fibre connectors, which must be carefully prepared, cleaned and polished.

Some devices even work without a connector: the cable can just be cut with a blade and inserted wherever required - much quicker and cheaper than handling and terminating a glass fibre. For the first time, individuals will be able to cable their premises themselves, which would also relieve incumbents of the cost burden associated with installation. POF cables are also tough enough to withstand hammering, while still being flexible and thin enough to fit into electrical conduits or to be laid alongside walls.

See the light

Another key advantage of POF is that the devices use visible light instead of infrared, which avoids any concerns over eye safety. This eliminates the risk of infrared-related retinal burns and blindness that arise when using glass fibre, which is unacceptable in an unprotected environment, such as a living room or an apartment, where children could inadvertently be harmed by simply looking at the transceiver.

The use of visible light carries the additional advantage of visual testing - in other words, if light is emitted from the fibre's tip, you can be sure that the signal's there and the system is working. This feature alone is a real gift for helpdesk operators who must help customers to debug their optical link - and could save millions of euros for telecoms operators.



Fig. 2

Two wavelengths will be used in the POF-ALL project: 520 nm for 100 Mbit/s transmission over 300 m, and most probably 650 nm for 1 Gbit/s transmission over 100 m. Attenuation of POF at these wavelengths is around 140 dB/km at 650 nm and 80 dB/km at 520 nm (see figure 2). Regardless of bandwidth, this implies a minimum theoretical power range of 14 dB for 1 Gbit/s transmission at 650 nm, and 24 dB for 100 Mbit/s transmission at 520 nm.

Unfortunately, the bandwidth for standard step-index POF is generally limited to 30 MHz per 100 m, which means that multilevel coding schemes will be needed at 100 Mbit/s to attain the desired combination of distance and bandwidth. Transmission at 1 Gbit/s will probably require a move to graded-index POF, although alternative solutions are being investigated. In both cases, additional power penalties must be taken into account. For comparison, today's most advanced Ethernet-over-POF media converters operate at 10 Mbit/s over 200 m or 100 Mbit/s over 100 m of step-index POF.

Achieving the goal

A key element of the project will be to extend both the reach and bit-rate of POF systems, which will be achieved by optimizing the transmitter-receiver pairs and by using innovative modulation and coding schemes. To achieve this, the project is structured over five technical "work packages" and one demonstration activity. The first two work packages deal with advanced transmission techniques to achieve data rates of 100 Mbit/s over long distances (more than 300 m), and experiments for 1 Gbit/s transmission over intermediate distances (more than 100 m). Two supporting work packages will investigate improved components and plastic fibres to address the needs of the first two work packages and to provide the "hardware" to work on.

Real-life applications of the technology developed by POF-ALL will be demonstrated using two test-beds: the FastWeb network test-bed, which will connect some 100 FTTH users with POF technology, and the POF-house test-bed at the POF Application Centre in Nuremberg.

A pre-commercial testing and implementation phase is also expected, eventually including a full validation by FastWeb as the end-user representative in the consortium.

POF-ALL's participants tout the idea that the use of POF will dramatically lower installation costs in the edge network, allowing telecoms companies to deliver high-speed optical access - and the triple play of voice, video and data - to all of their customers.

To stay focused on this goal, POF-ALL will constantly gauge market potential and assess customers' requirements to ensure that the outcome will be cost-effective and economically viable. An appraisal of the project's economic impact at EU level will also be carried out, including an evaluation of how a low-cost solution for edge-access networks could accelerate the deployment of an infrastructure that would turn the EU's broadband-for-all policy into a reality. The consortium will also deliver information on the project on a regular basis, to attract interest, share results within the EU, increase knowledge and accelerate adoption of POF-ALL's technical achievements.

Europe urgently needs a low-cost FTTH technology for telecoms operators to deliver real broadband to businesses and households. It also needs to become independent of non-EU companies and technologies for the implementation of access networks, as is the case today for ADSL technologies.

Could POF provide the solution? The answer depends on how much the industry will back it, and on the success of collaborative efforts between European companies and universities, such as the POF-ALL project. To us, the future looks bright. And, for once, the light is visible.

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About the author

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