PLASTIC OPTICAL FIBER TARGETS FTTH

A consortium of nine European companies and research institutions has been granted financial support within EU's 6th Framework Programme to develop a POF-based high-speed "optical modem"

Ask anybody in Europe what "broadband access" means, the answer will most likely be "ADSL" or "cable" (fig. 1). xDSL technologies actually dominate the broadband offer because of legacy telcos' existing copper-based infrastructures, and cable modem technologies likewise in countries with a high CATV cabling density. The telecom bubble at the end of last century made clear how hazardous it can be to invest in a new and innovative (e.g. optical) infrastructure. Even the few local operators that survived those days' huge CAPEX are now recovering under the umbrella of copper legacy infrastructure.

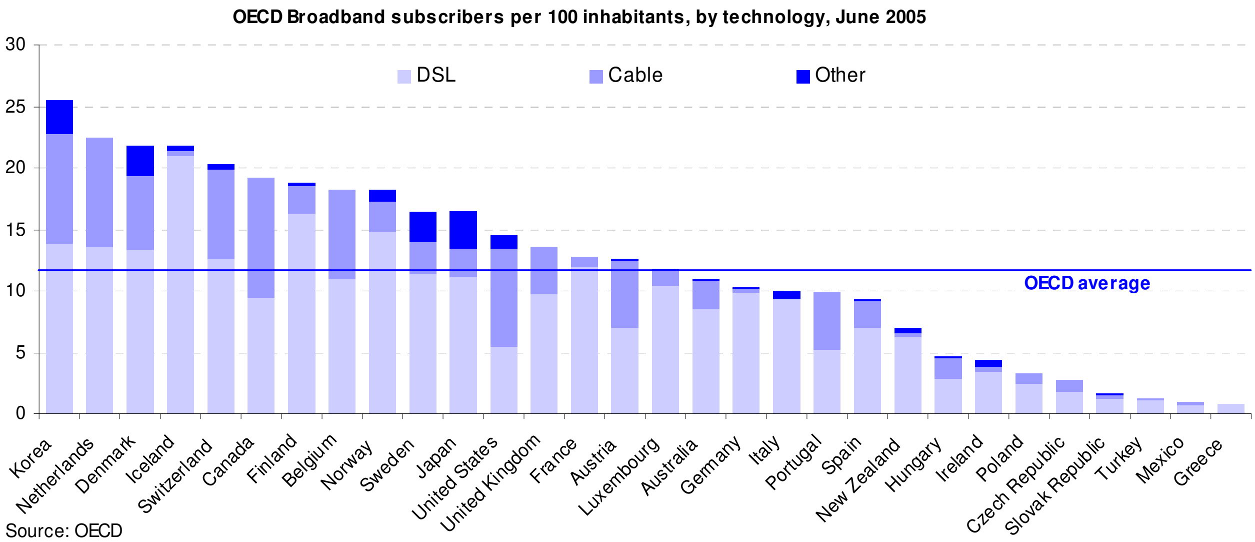


Fig. 1 – Broadband subscribers per 100 inhabitants, by technology, June 2005 (source: OECD)

Still, the explosion of peer-to-peer (P2P) services is rapidly heading for a bandwidth bottleneck. At the end of 2004, 60% of all internet traffic was P2P-based; due to its symmetrical nature, on average 80% of upstream capacity is consumed by P2P daily (source: CacheLogic "Peer-to-peer in 2005", fig. 2).

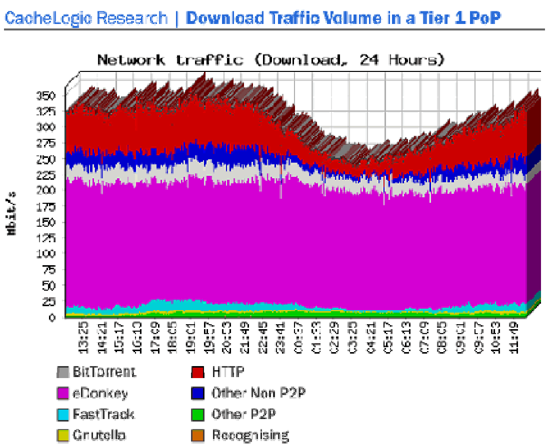
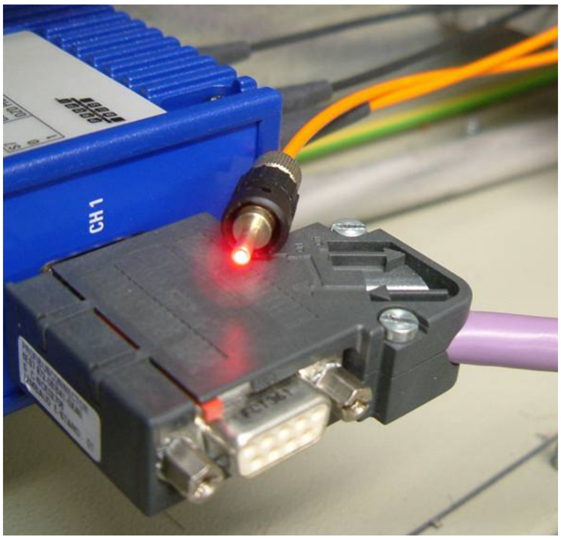


Fig. 2 – P2P flooding: 60% to 80% of existing bandwidth is being used by P2P

Moreover, internet surfers are increasingly using bandwidth-demanding services such as iTunes. In 2005 Apple introduced the possibility to download TV shows and series' episodes; most people will soon look forward to downloading high-resolution movies, or sending an HD digital video of their newborn to grandma.



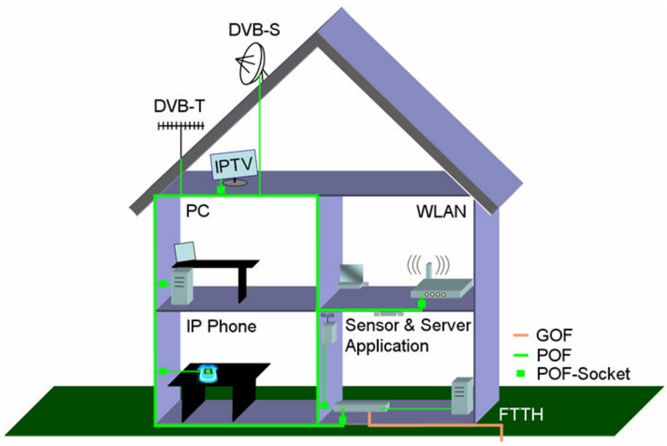
How will telecom companies handle the increasing traffic and offer broadband access to everybody, without a cost-effective and future-proof technology for the so called "edge network" – i.e. the last 1,000ft from the curb or the basement of a building to the apartment? Due to its capillarity, this is where most of the network's CAPEX concentrate; therefore, the part that telecom operators fear most.

On January 1st, 2006 a new project was started, involving four European companies and five renowned research institutes, with the goal to develop an enabling technology for broadband access and home networks at speeds far superior to those of existing ADSL modems, at costs dramatically lower than silica fiber-based solutions.

The project has been dubbed "POF-ALL", for "Paving the Optical Future with Affordable, Lightning-fast Links" (www.ist-pof-all.org). It is led by Istituto Superiore Mario Boella, an ICT research center based in Turin (Italy); participants include Siemens, Luceat, Diemount, Teleconnect, POF Application Center and Fastweb, the leading FTTH operator in Italy, as well as the Fraunhofer Institute for Integrated Circuits IIS, the University of Duisburg-Essen and the Eindhoven University of Technology.

POF-ALL is a 2.6M€ research project; 1.6M€ will be funded by the European Union within the 6th Framework Programme, priority IST-4-2.4.4 "Broadband For All". It will last 30 months and end in June 2008; preliminary technical results shall be presented as early as September 2006, during the 15th International Conference on Plastic Optical Fiber that will be held in Seoul, Korea (www.pof-moc2006.com).

A major and ultimate purpose of POF-ALL is to design and manufacture an "optical modem" up to 100 times faster than traditional ADSL modems, which would allow the download of a DVD-quality movie in less than 3 minutes. Another advantage would be symmetrical communication speed for download and upload, allowing applications such as peer-to-peer transfer of home-made movies, high-quality videoconferencing and video on demand.



Remarkably, the very same technology shall be used to build a low-cost broadband "POF home network" (fig. 3), providing the advantages of optical links (speed, EMI compatibility) at a cost and complexity far lower than silica fiber-based alternatives.

Fig. 3 – POF-based home network

European telcos focused on ADSL as the preferred broadband access solution to small home offices and households for cost reasons only. Optical access is restricted to big companies which can afford the cost of deploying a fiber optic-based infrastructure, or to lucky inhabitants of some European cities covered by FTTH under the umbrella of some governmental funding. Japan has the highest penetration of FTTH today, with more than 7 million homes connected and a growth rate of more than 150 thousand homes per month; Korea and the US are similarly committed. In Europe FTTH is taking off at increasing pace, particularly in Italy, The Netherlands and Sweden, but its reach is still limited to minor percentages of the population. The use of plastic optical fiber (POF) would dramatically lower installation costs of the edge network, allowing telecom companies to deliver "triple play" (voice, video, and data) to all of their customers and to provide Average Joe with a high-speed optical access to the internet.

The major advantage of POF is that anyone can install it in 30 seconds with common tools: a pair of scissors to cut it, a stripping tool to remove the jacket and a crimping tool to connect it (fig. 4). Some devices even work without connector, by just cutting the cable with a blade and inserting it – remarkably easier than handling and terminating a glass fiber cable.

POF cables are extremely thin and flexible and can be laid down in electrical conduits or alongside walls. Moreover, POF uses visible light instead of infrared, avoiding eye-safety related issues and pioneering a revolutionarily simple test procedure: if you see light coming out the fiber's tip, then the system works.

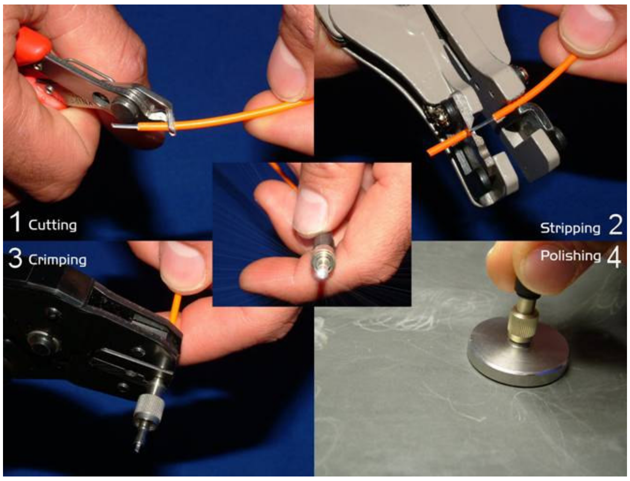


Fig. 4 – Termination of a Plastic Optical Fiber

POF is the ideal compromise between EMI- and bandwidth-limited copper cables and hard-to-install optical fiber not only for edge networks, but for home networks as well. Its main advantages – easy installation without training, eye- and EMI-safety – go along with its affordability: more than 3 million cars equipped with POF have been sold in the last 5 years by European car manufacturers, and the cost of standard transceivers is in the range from 2 to 4€.

Future home networks with multimedia distribution capabilities will require 100Mbps to 1Gbps of bandwidth: these actually are POF-ALL's technical goals. Performances of fast Ethernet over POF will ease delivery of triple play at home: the cabling infrastructure will likely consist of a hybrid "power + POF" cable, to distribute and grant access from "data outlet" as it's done today with electrical sockets. POF shall be used to create the "information backbone", granting tap-proof and maintenance-free installation combined with zero electromagnetic pollution. The topology could either be that of a ring, a star or a mesh network, to accommodate varying standards and needs.

Will POF be the future technology we'll se in every European household in five to ten years? Maybe. It will depend on industry backing and on the success of joint co-operations between major European companies and universities, such as the POF-ALL project. However, the future looks bright – and the light is visible, for once.

POF-ALL: TECHNICAL DETAILS

The project aims at developing an optical interface for digital signals at speed of 100Mbps to 1Gbps over distances of 100m to 300m, focusing on large diameter Plastic Optical Fiber (POF) as the transmitting medium.
POF has been chosen because it's easy to handle and terminate, uses visible light and it's mechanically resilient. "Large diameter" means an external diameter greater than 0.5mm, possibly 1.0mm, in order to reduce installation complexity with respect to CYTOP-based POF, or even more glass optical fibre (see fig. A.1).

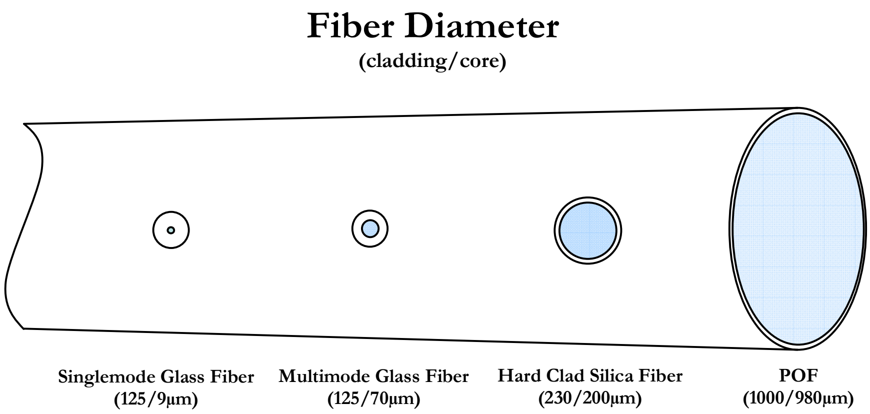


Fig. A.1 – Diameter comparison of various type of optical fiber

Wavelength used will be green (520nm) for 100Mbps transmission over 300m and most probably red (650nm) for 1Gbps transmission over 100m.
Attenuation of POF (see fig. A.2) is in the order of 140dB/km in red and 80dB/km in green: regardless of bandwidth, this would mean a minimum theoretical power range of 14dB for 1Gbps transmission at 650nm, and of 24dB for 100Mbps transmission at 520nm. Unfortunately, bandwidth for step index POF is limited to 30Mhz per 100m: this requires to use multilevel coding schemes at 100Mbps, and to move to graded index POF for 1Gbps transmission. In both cases, additional power penalties must be taken into account.

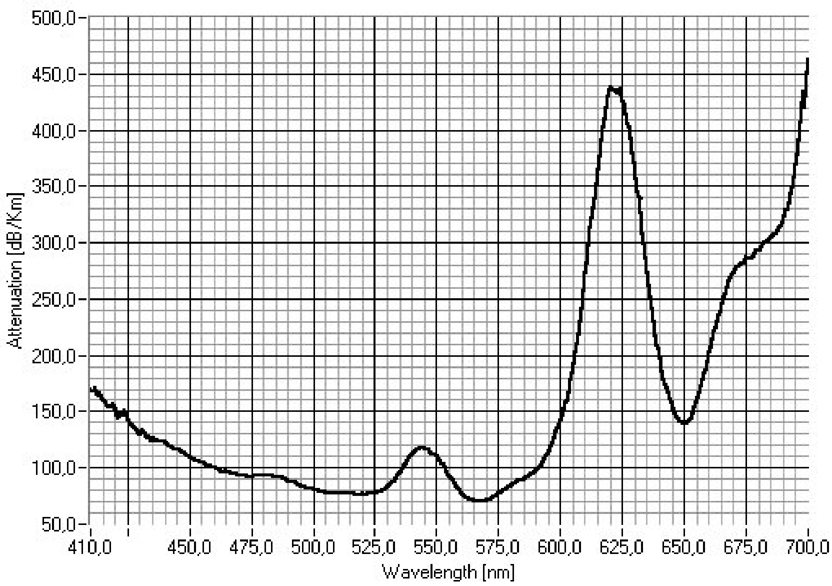


Fig. A.2 – Attenuation spectrum of PMMA step index Plastic Optical Fiber

The state of the art is today represented by Ethernet-over-POF media converters, working at 10Mbps over 200m or 100Mbps over 100m of standard SI-POF (www.luceat.it).

POF is mainly known because of its widespread use for in-car data networks based on standards such as MOST, ByteFlight and the forthcoming FlexRay. As of today, more than 25 million MOST transceivers have been installed in more than 40 models of cars from BMW, Daimler-Chrysler, Porsche, Audi, Saab and others.
POF proved to be the most reliable and affordable medium for in-car data networks, thanks to its resilience, easy installation, and the low cost of active devices. Future developments include the adoption of IEEE 1394.b (FireWire) as the transmission protocol and an increase of performances in terms of speed and temperature range.