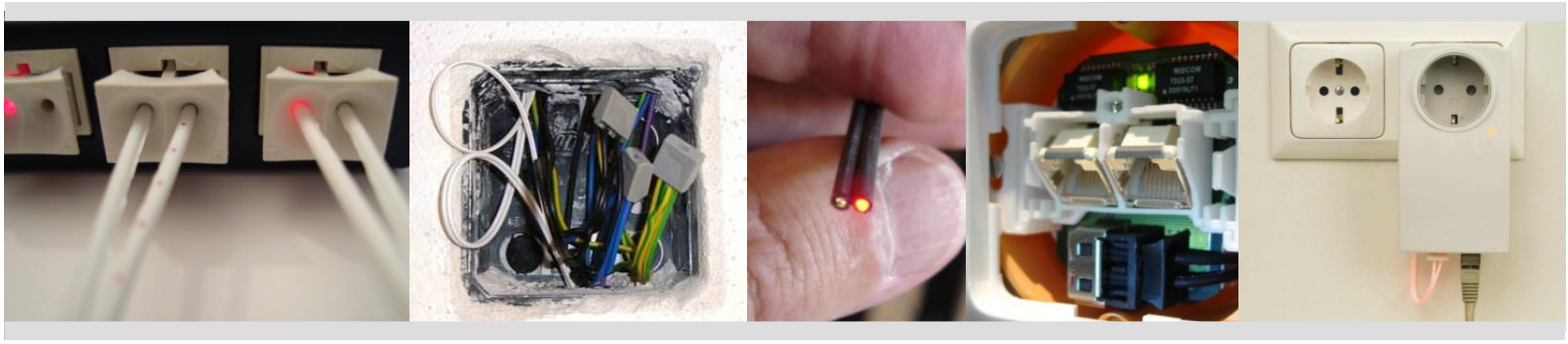
homefibre

Optical Broadband POF Home Network Infrastructure



Technical Concept

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MITSUBISHI RAYON CO.,LTD.

The optical In-House Network in combination with electrical installation

Television, Internet, Music, Photos and Videos as well as home control systems are transmitted today in digital format. The number of network capable products in the market is increasing. IP becomes an integrating protocol for many applications and eco-systems. To ensure reliable transmission of all digital data in the building and in the home an optimised infrastructure is mandatory.

With the concept of the optical home network, homefibre offers a first solution for an entire, future proofed and easy to install system. The used optical cable is a standardised Polymer Optical Fibre (POF), since many years successfully approved in automotive and industrial applications. POF cable is robust and can be terminated in an easy and fast way. It can be installed in manifold ways outside the wall as well as in conduit sharing (or duct sharing) with electrical main power wiring. In this case any main power outlet and any wiring distribution box in the home offers access to the optical cable backbone. Conduit sharing offers unique possibilities to install a reliable optical data network and data backbone by utilisation of existing electrical installations in the huge number of existing buildings and homes.

Due to the combination of POF cabling with electrical wiring all IP based control- and streaming data can be connected together and can be integrated to an interoperable home network.

These advantages can not be achieved with any other network technology today. Twisted pair based cabling systems (e.g. Cat5 or Cat6 etc...) as defined in the „Generic Home Cabling" standard are a first important Step towards an integrated home network. In today's installations only a limited number of data-interfaces are installed in the home since the installation cost for such systems are high compared with a POF system.

The network infrastructure is the key for successful digital services in the home

The optical network goes beyond conventional home network installations. It offers the benefit that IP-based services can be distributed in a reliable and power saving way to a high number of data interfaces in the home.

Case study – Dwelling Unit / Apartment

An apartment is taken as an example to compare the benefits of the optical backbone in comparison or as an extension to other home network technologies like Cat5/Cat6, WLAN and Powerline.

Generic home cabling infrastructure of ICT (Information and Communication Technology), TV-signals (BCT = Broadcast Communication Technology) and control data (CCCB = Control, Commands and Communication in Buildings) is specified e.g. in the ISO/IEC 15018 standard for „Generic Cabling for Homes" and additional national specifications. According this standard each room should be equipped at least with one data (e.g. RJ45) and BCT interface or outlet (coaxial outlet). In some European countries also 2 outlets are recommended.

The optical home network
One network for all

Due to the increasing number of network capable applications and since more and more applications are using IP data communication also more data interfaces and access points to an integrated data backbone will be required. Only such data backbone allows the flexible and reliable integration of various applications in an effective and interoperable way.

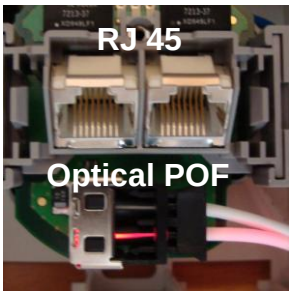
High bandwidth consuming applications like e.g. audio and video streams for IP-TV, 3D gaming and large file data transfer and time critical applications like VoIP or Femto-Cells demand a stable data backbone with support of QoS (Quality of Service).

For today installations it is useful to have installed cabling with Cat6 and coaxial cable for existing analogue devices. In addition to a minimum number of such interfaces we recommend the installation of an extended infrastructure. Such infrastructure should offer a maximum or high density of access and data interfaces in the home.

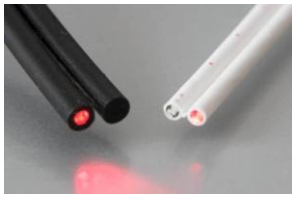
An optical POF network offers flexible access for IP services to an integrated data backbone everywhere in the home

Since POF cable can be installed in parallel with main power wiring the optical backbone is available at each power outlet and distribution box. This installation architecture offers highest density of potential data access points in the home for a minimum of investment.
In distribution boxes the optical cable can be used to connect sensors, cameras and wireless access points (e.g. Femto Cells etc...) or interfaces for visible light – data transmission with the network. Applications can be added to the integrated optical data backbone with sufficient bandwidth capacity according the needs of the user. Devices can be powered by optimised power supplys from the main power, installed together with the POF cable.

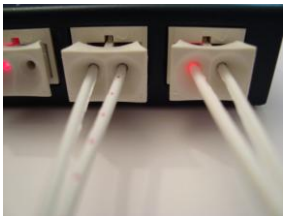
Technology



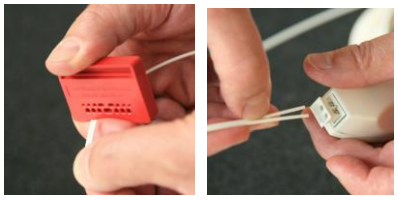
In the optical home network we use 100Mbps Ethernet according IEEE 802.3.u and IP.
For the optical transmission with POF (Polymer Optical Fibre) the electrical signal will be transformed in media converters to an optical signal. The optical transceivers operate with RC-LED with red visible light.



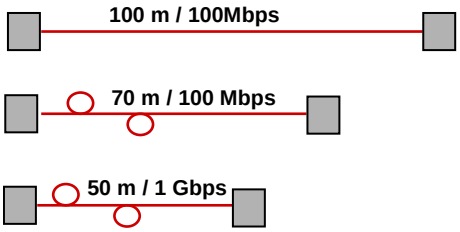
POF cable is robust, EMI resistant and ca be installed and terminated in an easy way. Since POF cable consists of a non galvanic, full insulated material, it can be installed together in conduct sharing with main power wiring.



To build up an optical LAN or Home Network, optical Ethernet switches are used. Optical POF devices operate with low power consumption since the system is resistant against EMI and no processor power to eliminate interferences is needed.



The optical cable can be terminated without expensive tools.

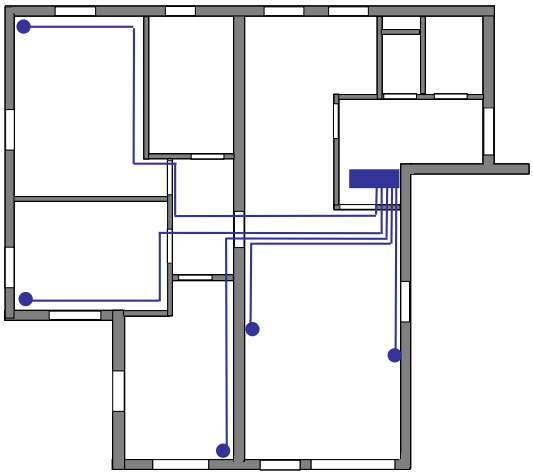


Today the maximum transmission distance for 100Mbps over POF between to media converters is 100m.
With respect to bending loss (~ 0,5dBm per 1 bend with r=1,5cm) we recommend to install links up to 70m.
For future proofed installations up to 1 Gbps we recommend to install a link up to 50m.
The average link length in the home is around 20m.

To measure and report the optical system performance, optical power meter are available.
The power budget of the typical optical POF link is ~ 17dBm. This means an optical power of -7dBm at the transceiver and -24dBm at the receiver.

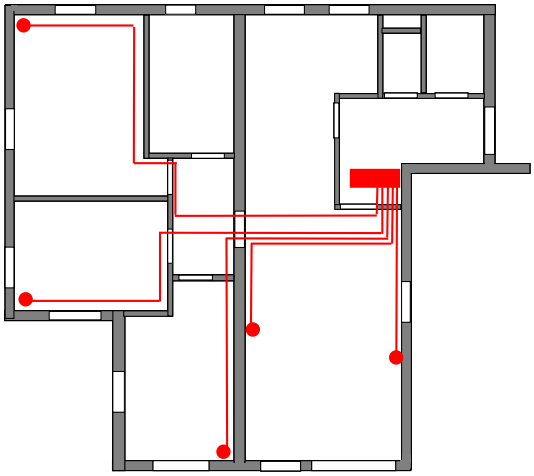
Structured Home Network Cabling with POF

Structured Cabling of an ICT Infrastructure with Cat6 cable.



In this typical star wired architecture the network cable is installed from the central distribution cabinet to one outlet in each room. In this case study 5 data outlets with one RJ45 interfaces are installed. This means 1 passive interface for 1 application without switch function in each room.

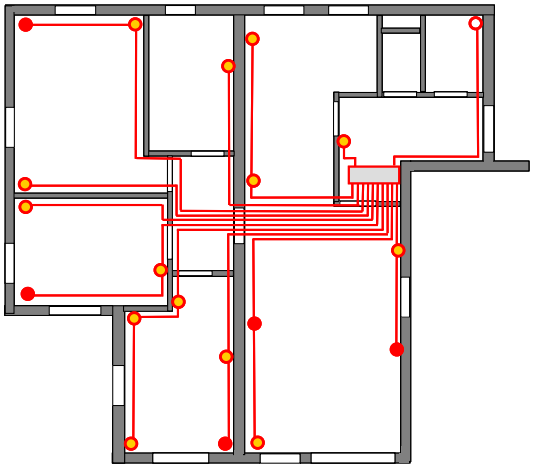
Structured Cabling of an ICT Infrastructure with POF cable



Similar to the copper wiring also 5 data outlets are foreseen. The data cable is POF installed in conduit sharing with the main power wiring of the electric installation.

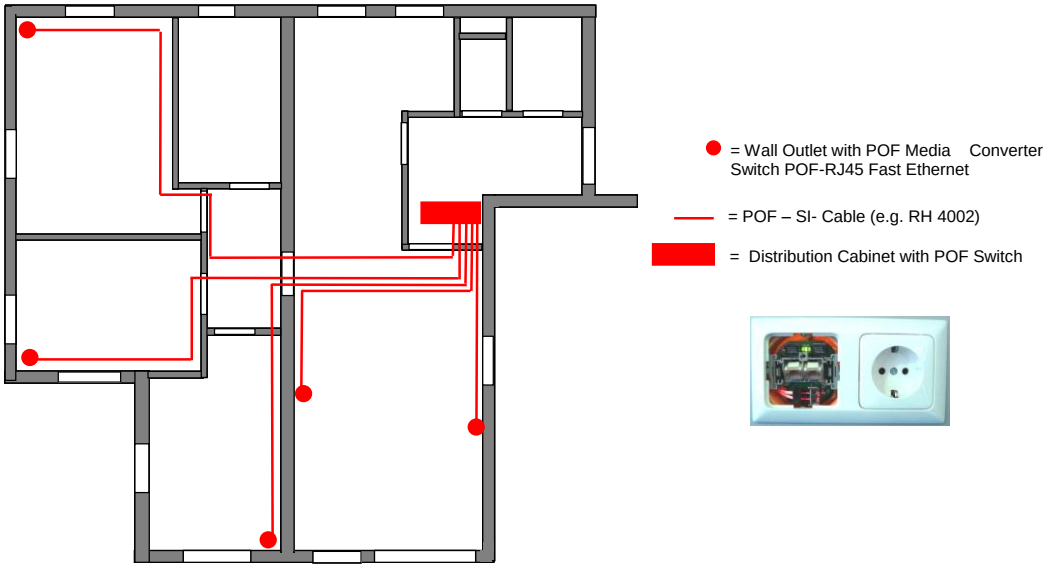
As an additional advantage each room can be equipped with a wall outlet with integrated switch including 2 RJ45 interfaces.

Extended Optical Broadband Home Network with POF



The optical cable is installed with the electrical main power cabling in conduit sharing to each main power outlet in the home. At places which require the active data connection point media-converter or media-converter switches are installed. All other outlets can be prepared with either optical interfaces or empty wall boxes with pre-installed POF cable. The POF cable is also available with main power in all distribution boxes of the electrical installation. Wireless access points or sensors etc. can be installed at those boxes.

Structured Home Network Cabling with POF



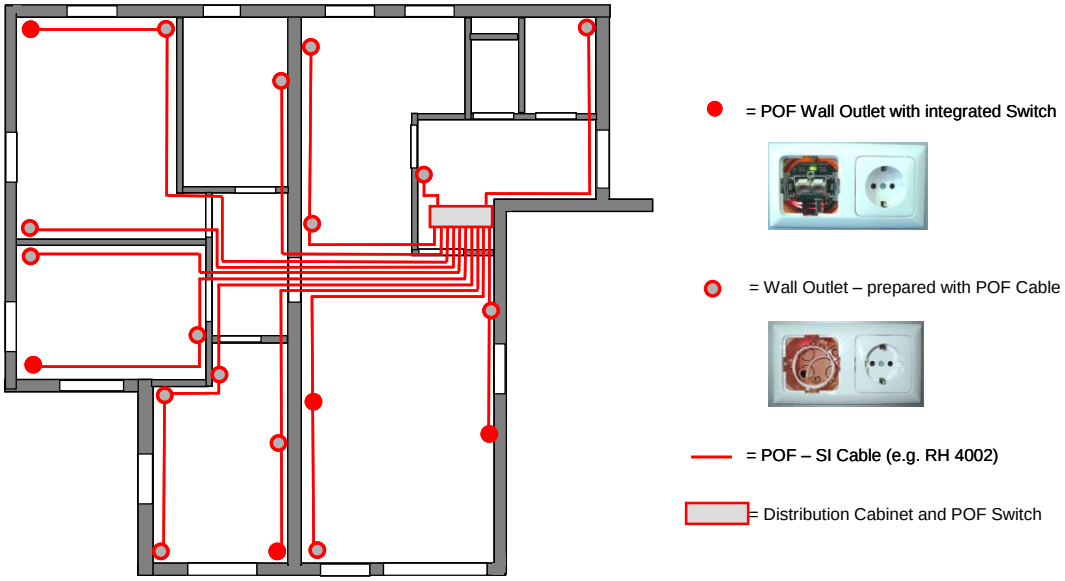
In this example a basic infrastructure for 5 data outlets is installed in conduct sharing way together with the electrical mains wiring. The advantage of this method is saving more than 50% of installation cost for the pure pre-cabling due to saving the installation of separated conduits for data cabling. An additional advatange of this kind of installation are optical 2 port switches installed in each room.

This version can also be applied for retrofitting and up-grade of existing apartments with a reliable home network (or optical LAN) by using the conduits of the existing electrical wiring.

Advantages

- **Ideal for retrofit and installation of a wired LAN in existing homes.**
- Clean retrofit-installation of LAN by electrician – no stemming,no drilling, no dust
- Conduit sharing with electrical wiring – safes installation cost
- Saving the cost of conduits for network wiring in new buildings
- POF cable can be installed outside the wall under carpets and behind the baseboard
- POF cable is available at distribution boxes (with main power) to integrate sensors or wireless access points.
- No grounding and lightning issues in the data network
- **Each data outlet can be equipped with a wall mount Ethernet switch**

Extended Optical POF In-House Broadband Infrastructure



This schematic shows an apartment with optical wiring for 20 data outlets (red lines and circles). The POF cable is installed in conduits sharing with electrical mains wiring. 5 of 20 data outlets are equipped with an active media converter (e.g. OMC 100 UP) or media converter switch (e.g. OMS 121 UP). The use of the media converter switch allows to connect 10 Ethernet devices to the network. Today devices can be changed by wireless access points and vice versa. Pre-installed optical wall outlets with POF inside can be upgraded according the needs of the owner.

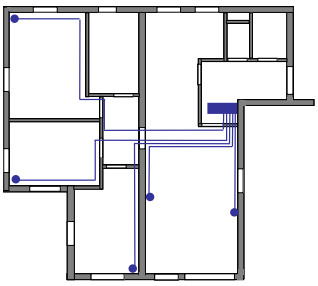
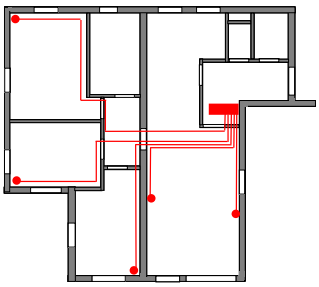
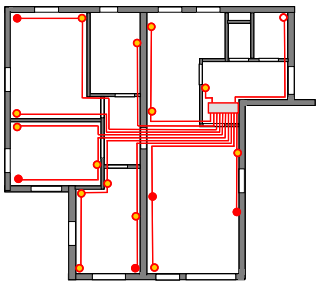
The POF cable is passing all main wiring distribution boxes or is directly linked to the electrical distribution cabinet. Thus it can be used to install all kind of access gateways, cameras or sensors with optical interfaces and to home automation systems to be integrated in an entire and interoperable home network.

For pre-installation the POF cable will be terminated in an empty flush mount wall box next to a 230 V main power outlet. If needed an active network switch, wireless access point or media converter can be installed. The devices will be powered direct with a small wire from the nearby 230V main power outlet.

Advantages

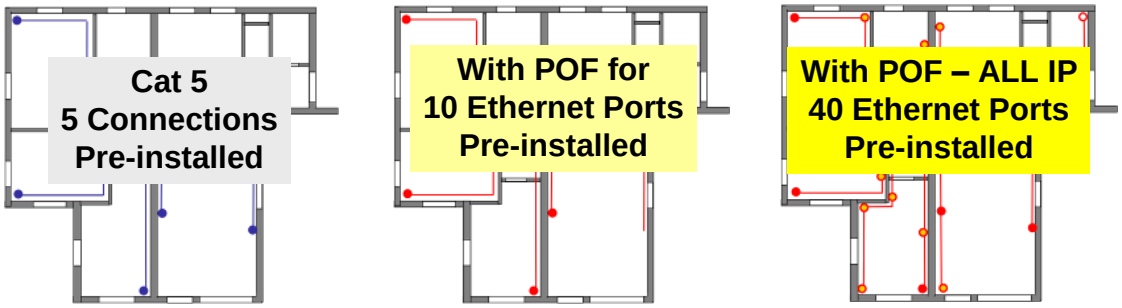
- Conduits sharing safes installation cost
- The optical cable is installed to almost each power outlet in the home – this offers a flexible network up-grade and access everywhere in the home
- Future proofed infrastructure with multiple access to the optical data backbone in the home
- **A comprehensive, reliable and low power consuming network with high density of data access points in the home**
- The everywhere with electrical wiring available data backbone supports interoperability and easy integration of all IP-based applications and services in the home
- No grounding and lightning issues in the data- and home network

Comparison

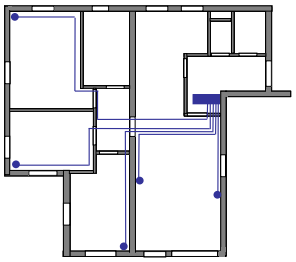
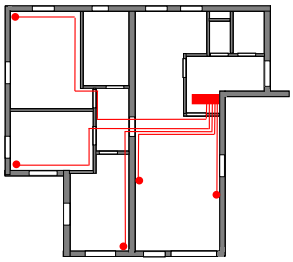
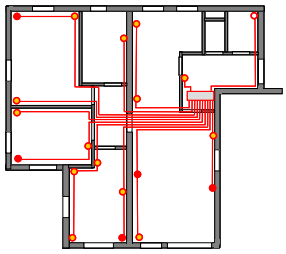
		
Copper Cat Infrastructure **5 Data Outlets RJ45**	**Optical POF Infrastructure** **5 Active Data Outlets with 2Port Switch RJ45**	**Optical POF Infrastructure** **5 Active Data Outlets with 2Port Switch RJ45** **Additional 15 Data-Outlets pre-wired**
Conventional Minimum Installation of apartments	Conventional Minimum Installation of apartments	**High coverage of available data outlets in the home**
Limited number of Data outlets available	Limited number of Data outlets available	**Multiple Data-Outlets prepared for touch-screens, sensors and cameras in parallel to electrical wiring.**
Limited number of Data outlets offer un-flexible connectivity in the home	Limited number of Data outlets offer un-flexible connectivity in the home	**Multiple data connection points offers high flexible connectivity! (e.g. usage of apartments, office, furnishing etc...)**
Gigabit Devices already available	**Gigabit** transmission possible, **available 2011**	**Gigabit** transmission possible, **available 2011**
No room- or cluster switches included, additional devices required.	**Room-and Cluster Switches included in Media-Converter and powered with optimised integrated power supplies.**	**Room-and Cluster Switches included and powered with optimised integrated power supplies.**
	Interactive distributed wireless gateways can be integrated	**Interactive distributed wireless gateways can be integrated**
Grounding- and safety problems	**No grounding and safety problems**	**No grounding and safety problems**
	Very low pre-installation cost for cabling	**Very low pre-installation cost for cabling**

It is the combination of two facts which makes POF a medium for the most efficient home network installation:

- New electrical installation methods use pre-cabled flexible conduits laid from the central cabinet directly to the wall socket. Most of the main power sockets are directly connected to the central cabinet. The POF cable is included in the flexible tube and installed in one task with electrical wires.
- Homefibre wall outlet media converter have already an integrated Ethernet switch offering 2 RJ45 ports (and in future also wirelss interfaces), thus the double or even tenfold number of access connections can prepared for an even lower investment compared to today network installations.

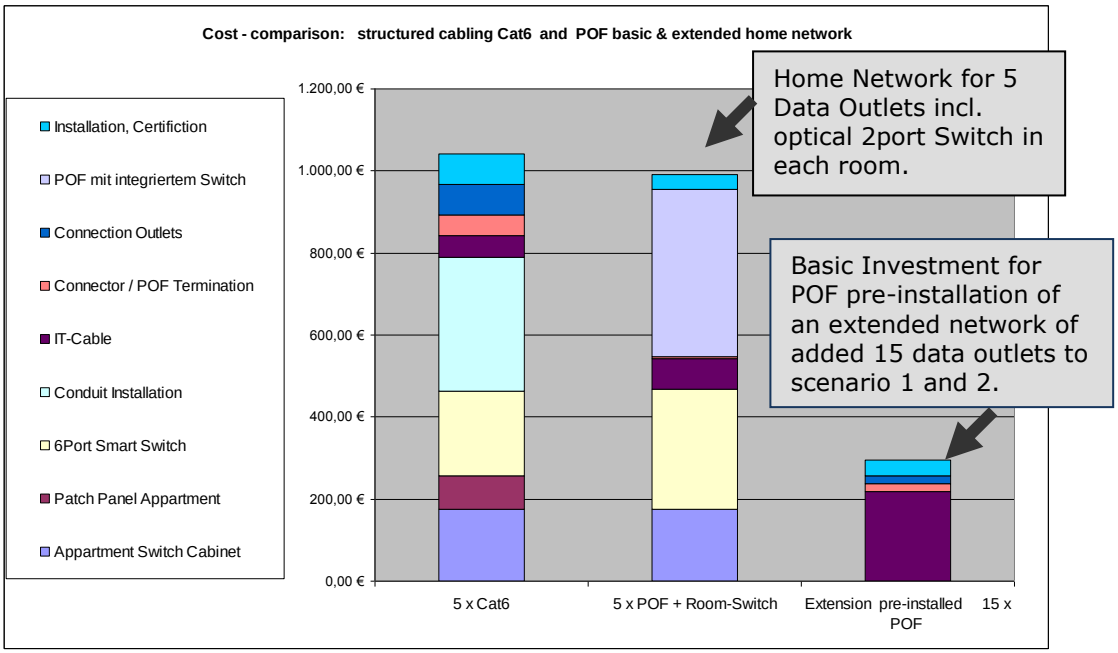


Cost comparison of various installations

		
Scenario 1 5 Cat6 Data Outlets – Star Wired; 1 Data Outlet in each room.	Scenario 2 5 optical data outlets including optical 2port switch in each room.	Scenario 3 - Extension 5 active POF outlets with 2port switch in each room, additional 15 POF interfaces pre-installed

		Scenario 1	Scenario 2	Scenario 3
Pos.	Beschreibung	5 x Cat6	5 x POF + Room-Switch	Extension pre-installed 15 x POF
1	Appartment Switch Cabinet	175,00 €	175,00 €	0,00 €
2	Patch Panel Appartment	81,25 €	0,00 €	0,00 €
3	6Port Smart Switch	206,25 €	293,75 €	0,00 €
4	Conduit Installation	328,13 €	0,00 €	0,00 €
5	IT-Cable	51,56 €	73,13 €	219,38 €
6	Connector / POF Termination	50,00 €	6,25 €	18,75 €
7	Connection Outlets	75,00 €	0,00 €	18,75 €
8	POF mit integriertem Switch	0,00 €	406,25 €	0,00 €
9	Installation, Certifiction	75,00 €	37,50 €	37,50 €
		1.042,19 €	991,88 €	294,38 €

Orientation prices excl.VAT

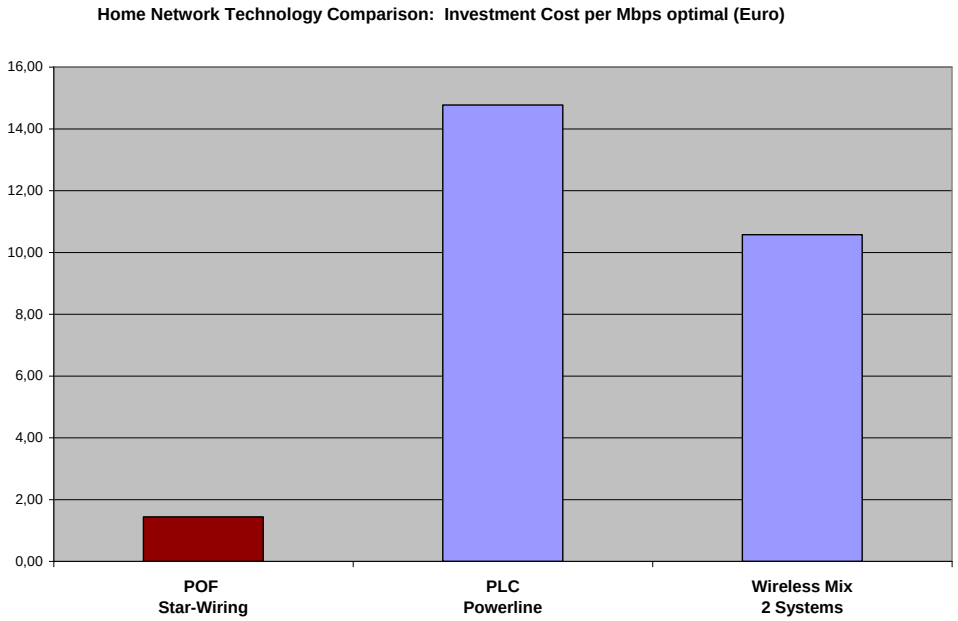


Comparison of Investment- and Operation Cost between POF and Shared Medium Technologies (Powerline, Wireless)

In this comparison the installation cost and operation cost of the home network are allocated to the network performance / bandwith in Mbps.

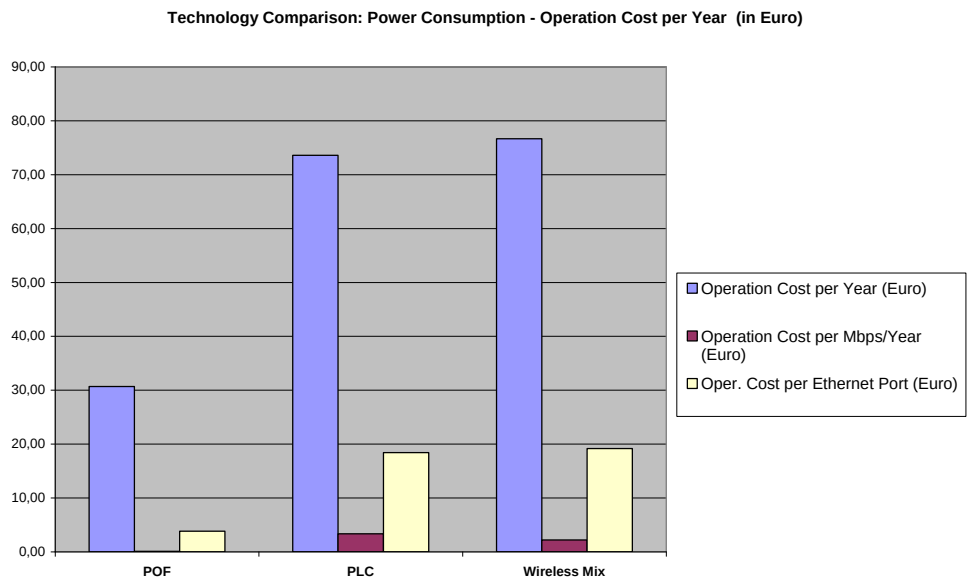
The table below compares a home network with 4 rooms.
Remark: Due to the active media converter switch used in the POF network, in each room at least 2 RJ45 ports are available.
The average netto data rate of the shared medium technologies is based on tests and experiences done by homefibre and also published in various reviews.

Home Network Comparison - 4 Rooms Investment per Mbps			
Material - and Installation Cost	**POF Star-Wiring**	**PLC Powerline**	**Wireless Mix 2 Systems**
Brutto Data Rate (Mbps)	400	200	22 plus 20
Netto Data Rate max (Mbps).	**400**	**22**	**35**
see Test Scenario	4 x 100Mbps; 1 Switch; 4 Outlets	4 PLC Modems	e.g. 2x Ruckus + WLAN Modem
Average System Price	450	300	320
Installation Time (hours)	2,5	0,5	1
Installation Cost (est. ~ 50Eur/hour)	125	25	50
Total System Cost (Euro)	575	325	370
Price per Mbps optimal (Euro)	**1,44**	**14,77**	**10,57**



Power consumption and related operation cost can also be compared in different ways. We compare the total power consumption of the system as well as the power consumption per Mbps of the available system netto data rate. Another value is regarding the operation cost per available RJ45 Ethernet port.

Operation Cost	POF	PLC	Wireless Mix
Average Sysetm Raw Data Rate (Mbps)	400	22	35
	4 x 100Mbps; 1 Switch; 4 Outlets	Powerline; shared medium	shared mdium
Price per Mbps optimal (Euro)	**1,44**	**14,77**	**10,57**
Power Consumption - (Watt)	**10**	**24**	**25**
Power Consumption - (kW)	0,010	0,024	**0,025**
price per kWh (Euro)	0,35	0,35	0,35
Operation Cost per Year (Euro)	**30,66**	**73,58**	**76,65**
Operation Cost per Mbps/Year (Euro)	**0,08**	**3,34**	**2,19**
Oper. Cost per Ethernet Port (Euro)	**3,83**	**18,40**	**19,16**
Remarks	incl. Centr. Switch 4pcs room 2-port switch! 8 RJ45 Ports	No central switch, no room switch 4 RJ45 Ports	No central switch, no room switch 4 devices; no RJ45 Port



This comprions shows that a POF home network is a highly efficient and power saving technology and sustainable investment.

Summary of system comparison:

A combined installation of POF cable in conduit sharing with electrical mains wiring offers many advantages against today conventional copper cabling:

- Low installation cost for up to **5 x more data connections in the home**
- Low CAPEX for pre-installation of an optical infrastructure
- With an investment of 300 Euro it is possible to install more that 20 data access points in an average home
- Scalable up-grade to Gigabit according the real need of bandwidth performance
- Radiation free and EMI resistance network infrastructure
- Low power consumption of all optical devices since no processor performance and power is needed to eliminate interferences.
- **No grounding and potential loop issues / no interferences = less reclamation and maintenance cost**
- **Integrated wall outlet switches and access gateways** – hidden in the wall, integrated in the installation.

Partners

Our work has been done with support and in co-operation of project- and business partners.

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www.pofeska.com

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