Domestic multimedia network based on POF

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Abstract—**Plastic Optical Fiber constitutes an advantageous alternative medium to implement domestic data networks. In this proposal, we develop an in-home network prototype for distributing video, audio and data information based on large core step-index plastic optical fibers (SI-POF). The aim is to demonstrate a viable uncluttered application of the POFs where the up to date technologies converge in a homogeneous domestic system.**

Index Terms—**Domestic networking, Plastic optical fiber, Triple play convergence, digital television.**

I. Introduction

THE convergence of Triple - Play (data, image and voice) over the same medium is a key aspect of consumer interest in multimedia entertainment at home [1-6]. However, there are some factors that nowadays are slowing down triple-play convergence. The users have in their homes a lot of consumer electronics such as televisions, DVDs, audio equipments, decoders, personal computers, and many external signals carrying different contents. The market provides the products and technology necessary to satisfy the consumer needs but, at the moment, neither these equipments nor their contents can be satisfactorily and easily unified. The main obstacle for integration is that equipment owners use their own standards and their products cannot interact with others. In addition, wiring into homes is not designed for the new technologies. The present technology allows unifying the different services into the home. However it is necessary a minimum capital investment in home communication networks to envision a future without coaxial and telephone wires.

In this paper we address the various problems of content convergence and transmission by answering the question of how all the home information sources can converge within a single open homogeneous system.

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To be able to develop a home infrastructure where the user can easily enjoy the multimedia content anywhere in the house, an intelligent central node is needed in the network. In our proposal, the role of server node will be performed by a personal computer with some extra hardware and software.

Theoretically both wired and wireless technologies provide enough bandwidth and reliability for A/V communications to be apt candidates as the physical media to implement the network. The particular characteristics and pros and cons of the physical media will be discussed in the paper with a particular emphasis over POF [7-8].

II. The home network proposal

The system is conceived as a hierarchical structure based on one server and several clients interconnected in a Fast Ethernet network.

In our network the more favorable topologies are either a daisy chain or a tree as both reduce installation costs and aesthetical impact over built houses. The backbone of the network is SI-POF operated at a visible wavelength while the final end to the electronic devices is standard RJ45 copper cables. The media conversion is performed by low-cost transceivers or electro-optical switches. We have implemented the physical transmission in our network design based on standard 1-mm SI-POF without connectors by using Optospider 650nm small form-factor pluggable (SFP) duplex and simplex optoelectronics modules from Diemount, POF Fast Ethernet MCE300T-200 convertors from Firecomms and RJ45-SFP hybrid switches CS-Fx2 from Wamin. These devices and the network backbone are shown in Figure 1.

Although the principal transmission medium in our network is POF, we have also introduced a WiFi router to allow wireless connection. In addition, we have used copper cables for some short connections because it is the typical connection for consumer electronics and is massively distributed at home. Thus, we can compare the performance of the three transmission media for audio, video and data signals.

In our configuration, a POF-Fast Ethernet convertor is connected to the server Ethernet card, and the converted signal is conveyed to the first switch using POF and a SFP duplex. For connecting clients closer to the server, we have used RJ45 and SFP mixed switches, and SFP simplex and POF for connecting to the next far switch. At this switch, we also use copper cable for close clients and POF for longer distances.

In the system implemented here, the server is able to manage all the different services that the user wants to share, and to store multimedia contents or digital television.

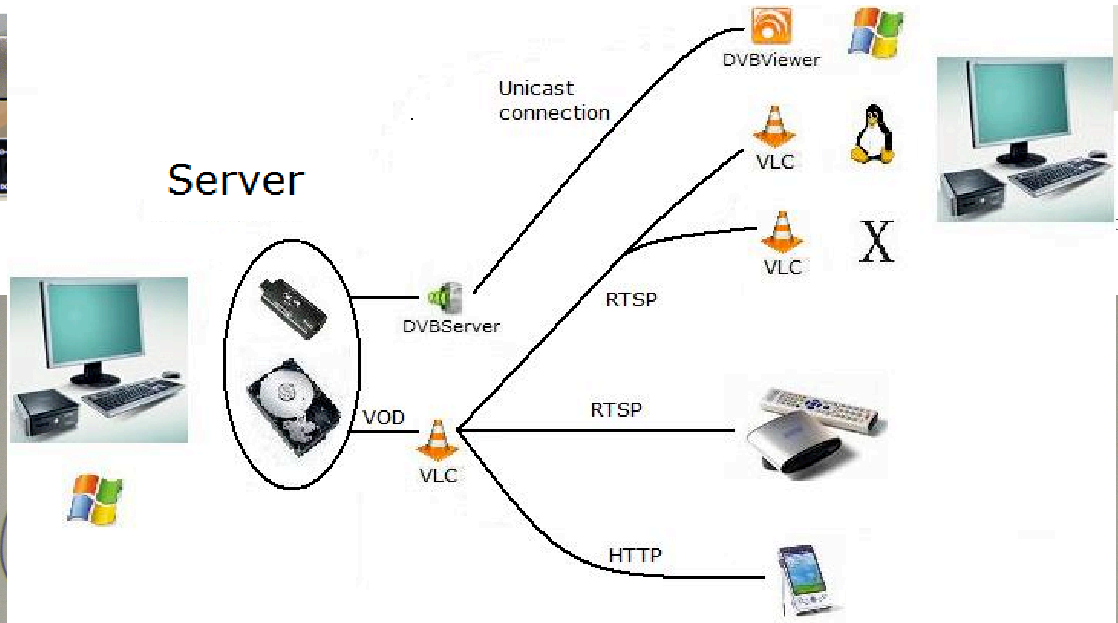
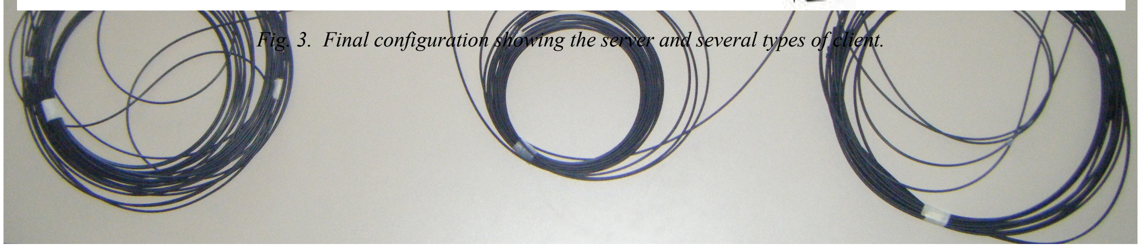


Fig. 3. Final configuration showing the server and several types of client.

or.



d. Network backbone.

Fig. 1. Elements of the network backbone.

The server acquires the digital television signal that is fed through USB decoders and is able to transcode the video signal to adapt them to specific client capabilities.

The clients can be multiplatform, depending on the user needs. Thus, in our prototype, we adopted and configured desktop and laptop PCs, Set Top boxes and Pocket PCs as different clients.

The system uses mainly free open source software such as Videolan VLC [9], or cheap shareware developments as DVBViewer [10] and its accessories, DVBServer, and HTTPServer, which have been configured to meet the required objectives.

III. Results and Discussion

The demand for broadband services such as video on demand raises the need of a high bandwidth service. As people who buy the technology are not experts, its installation and operation has to be cheap and easy, preferably "do-it-yourself". Thus, we propose a single broadband network to provide an efficient solution for present and future devices.

In our configuration, all the home information sources converge within a single homogeneous open system. This system is based on standard equipment, devices and protocols allowing scalability and future trend accommodation. Moreover, costs are kept as low as possible since this application is addressed to a domestic market.

Fig. 2. PC-server connected to the USB decoders. Frontal and top views.

A. Server and clients

Nowadays, the best cost-effective server can be implemented on a standard PC platform. In our system, the server is able to record simultaneously multiple live contents on demand and can also follow a programmable schedule. Moreover, the server stores films, music, pictures and live recordings to serve them later to each client on demand. The technical requirements to be a server-PC in our system are lower than those of a modern desktop PC. That, in addition, can act itself as a client.

The number of USB decoders needed to connect the server to the TDT signal depends on the number of transponders that we want the system to be able to access simultaneously. In order to avoid restrictions, the system should have as many decoders as TDT transponders. We concluded, however, that a good compromise is reached if we use only one decoder per client. In this way, the system will be cheaper than in the first design but it still will be able to meet all the requirements. As it is not frequent to have all the clients working simultaneously in this type of application, there will always remain some unused decoders that the server can use for recording.

Regarding the software, we have ascertained that VLC and DVBViewer complement themselves and can support different client types.

Each client can display any of the TDT channels in real time or any of the files stored on the server. Moreover, the users can easily program recordings from the client to be stored either on this same client or on the server. The client management is user-friendly and can be achieved through an infrared remote control.

Our clients are mainly PCs and Amino Set Top Boxes [11] which can be used in any home dependence. The Set Top Boxes are less versatile than PCs because they are designed only for this particular multimedia application, while on the other hand PCs have many other applications. Therefore, having tested both types of client in practice, and as they have a similar price nowadays, we recommend the use of a PC in any home dependence.

Finally, the rise of so many television standards (HD ready, HD TV, Full HD, etc) has confused the average user. For example, many people acquire HD ready televisions because of their lower prize relative to the other standards, only to realize that the HD ready televisions are incapable of decoding HD television signals. Instead, our implemented system has not this type of limitation and it is capable of decoding HD television.

B. Network

We must bear in mind that any normal quality video TDT channel uses around 4 Mbit/s and high quality video channels use around 10 Mbit/s. If we use an 802.11g wireless router that supports 56 Mbit/s traffic, theoretically there should be enough bandwidth. We have verified, however, that it is not always true. In our system, if a client uses a wireless connection, the signal suffers fading. The fading increases when the client moves away from the router and even more if there is a wall between the client and the router. Moreover, as the number of clients increases, the effect of fading intensifies because the router divides its carrying capacity between the clients causing unacceptable signal interruptions. In this type of application a constant transmission rate is essential and any communication break is unacceptable. For all this reasons, we do not recommend wireless connection for recording or when high quality is required.

Fig. 4. POF and RJ45 cooper cable.

As to the different wired media, we have compared standard RJ45 copper cables with POF. The advantages of the POF over the RJ45 copper cables are basically physical and aesthetical. In a home network the aim is to use a communication medium that causes a minimum environmental shock. Nowadays RJ45 copper cable is very widely used in LANs but has a number of disadvantages when compared to POF: Copper cable is thicker and less malleable than POF while small size and curvature resistance is imperative in this type of network. Besides, electromagnetic radiation can interfere with the transmitted signal in copper cables, while electrical background noise does not affect optical wires. Therefore, optical fibre could be installed through the same conduits that provide electricity.

In addition, we have verified the ease to manage a POF based optical network. First, only when using POF a connection can be easily checked because it operates at a visible wavelength. Also, the hand-made network assembly is rendered simpler as the visible light facilitates the connection of the fiber with its components. Therefore, we can state that POF and its components are at least as easy to install as copper cable is.

Finally, we must emphasize that our system backbone has behaved correctly and that both the POF and the prototypes used in the implemented network (switches, convertors and connectors) have shown a high reliability. Thus, we conclude that the joint use of both copper and fiber cable is the most functional approach as the physical layer for signal transmission inside the home.

IV. Conclusion

In this paper we have analyzed the scope of multimedia home applications, we have evaluated the different possibilities of software and network topology and we have verified the proper behavior of a multimedia home system prototype.

There exist already the necessary software applications to implement home systems where all home multimedia information sources converge. If the network is based only in personal computers we recommend the use of DVBViewer and its applications. However, if the clients are multiplatform we suggest the use of VLC.

Although wireless is the best-positioned technology as the transmission medium for houses, it does not reach the effective bandwidth requirements due to wall-material problems and thus, its reliability remains in question. Between the wired media, POF offers considerable advantages. Being a new technology it has still had low penetration in the user market. However, the simplicity of POF installation and the flexibility of POF cable down to a small radius make it ideal for narrow cable shafts where installing POF will be faster than installing conventional cooper cable. All these reasons raise great expectations as to the standardized use of POFs.

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