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AN EXPERIMENTAL ARCHITECTURE FOR BASIC IPTV CONCEPTS IMPLEMENTATION AND TESTING

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Abstract: The paper describes basic concepts and a practical implementation of a simple architecture for IPTV content creation and distribution. The architecture is conceived to make possible extensive tests. Audio-video content is acquired using different conventional technologies: DVB-S, CATV Headend, video streaming servers. This experimental network is intended to be used for throughput, QoS and audio-video quality measurements. Some of the most relevant features and tests (still in progress) are described in the final part of the paper.

Key words: *IPTV, Network, Audio-video streaming, Content management*

I. IPTV BASIC CONCEPTS

IPTV is a basic concept for a future TV distribution after the successful launching and development of digital TV infrastructures (satellite, terrestrial and cable).

There is a lot of access technologies able to distribute a large number of services in residential areas ([1]) not necessary related with IPTV, but with conventional technologies.

Advantages of IPTV are related with ubiquitous data networks for Internet access and the necessity to offer triple-play or even quadruple-play services, the goal for every service provider, traditional (Telecom company) or modern (Internet provider) ([2]).

In this manner it is possible to share a common hardware infrastructure and the same management for informational streams.

General view[3]

Figure 1 describes a sample IPTV system. This general diagram shows the IPTV system gathering content from a variety of sources including network feeds, stored media, communication links and live studio sources. The IP headend, very similar to a CATV headend, is converting the media sources into a new form, possible to be managed and distributed. The system for content management is designed to store, move and send out (play) the media at scheduled times. The distribution system simultaneously transfers multiple channels to users who are connected to the IPTV system. Each user can view IPTV programming on analog televisions converted by an adapter box (IP set top box), on a multimedia computer or, rarely, on IP televisions (data only televisions).

Viewing devices (STB)[4]

Figure 2 shows a functional block diagram of an IP STB. In fact with few modifications, it corresponds to the schematic of any Digital Video Broadcasting system. This diagram shows that an IP STB typically receives IP packets that are encapsulated in Ethernet packets. The IP STB extracts the IP packets to obtain the transport stream (TS). The channel decoder detects and corrects errors and provides the transport stream to the descrambler assembly. The descrambler assembly receives key information from either a smart card or from an external conditional access

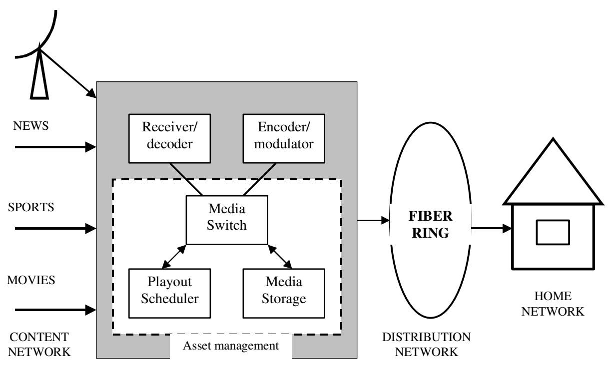

Figure 1. Basic IPTV architecture

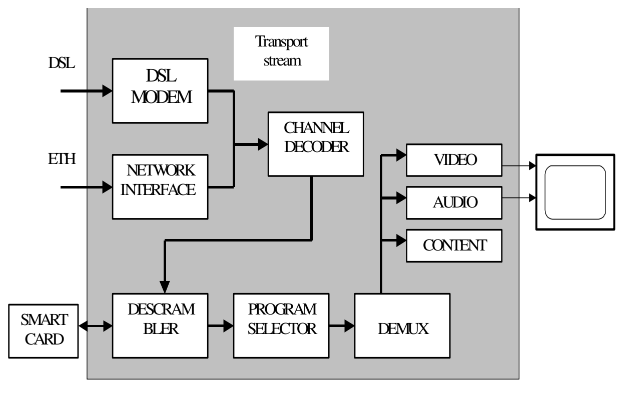

Figure 2. Architecture of a generic IPTV Set-Top-Box

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system (e.g. via a return channel). Using the key(s), the STB can decode the transport stream and the program selector can extract the specific program stream that the user has selected. The IP STB then demultiplexes the transport stream to obtain the program information. The program table allows the IP STB to know which streams are for video, audio and other media for that program. The program stream is then divided into its elementary streams (voice, audio and control) which is supplied to a compositor that create the video signal that the television can display.

Video StreamDistribution [4] [6]

Figure 3 shows how live video is processed to be send via an IP transmission system. This diagram shows that an IP video system digitizes and eventually reformats the original video, encodes and/or compresses the data, adds IP address information to each packet, transfers the packets through a packet data network, recombines the packets and extracts the digitized video, decodes the data and converts the digital video back into its original video form.

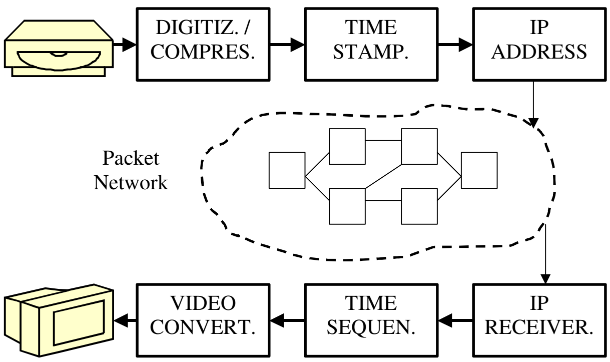

Figure 3. Processing stages of information in IPTV networks

This IPTV architecture has a promising future, but also being very new, it will take few years until all compatible equipment will be affordable for homes ([7]) and attractive for service providers. For example, in Romania only a small private company is trying to offer IPTV using optical fiber.

It seems that the future of IPTV is sure, but the necessary investments will be not negligible.

This is the main reason that leads us to investigate options able to verify the basic concepts without acquiring all the IPTV specialized components. This simplified architecture, built and investigated in our research, is described in the following paragraph.

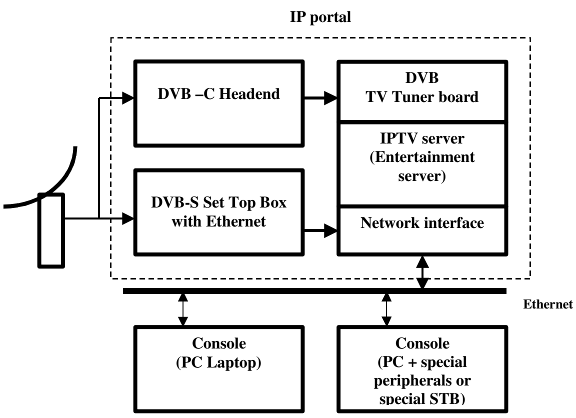

Figure 4. IPTV Test system architecture

II. IPTV NETWORK ARCHITECTURE (EXPERIMENTAL SYSTEM)

IPTV has multiple challenges in testing and evaluation. Briefly the most important challenging aspects are as follows:

- Mixed Media
- Content Dependent
- Multiple Conversions
- Content Protection
- Error Concealment

Full functional tests of an IPTV distribution system has multiple aspects as described in [5].

It is possible to have a large number of test types, at different levels:

- Operational and Functional
- Feature Function or End-to-End Testing
- Multilayer Testing
- Acceptance Testing
- Field or diagnostic Testing
- Loopback Testing
- Laboratory Testing
- Alpha / Beta Testing
- Performance Testing
- Interoperability Testing
- Load Testing
- Stress Testing
- Service Capacity Testing

In time, our goal is to perform all the mentioned tests. For this stage of our research our goal was to build a basic system able to allow only the basic tests of the hardware and software to be used in future experiments. To build the prototype of the server we used a conventional PC, with few multimedia and networking capabilities, and a variable number of external audio-video devices, to deliver most of the multimedia content. It is not necessary to have a very effective architecture since the role of the server is only to generate the content in a small local network. The

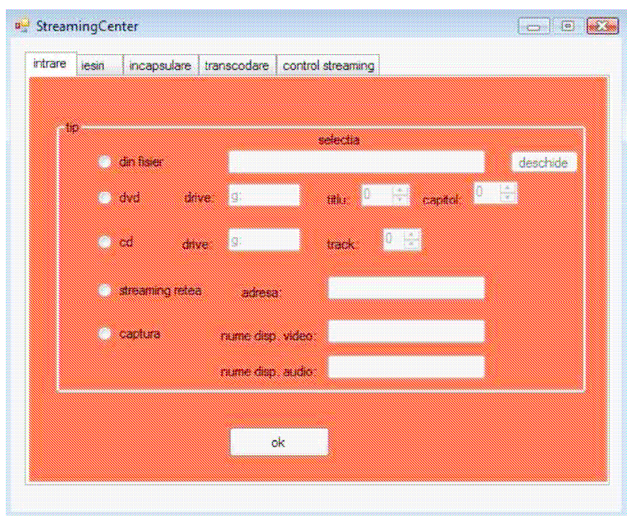

Figure 5. StreamingCenter – control panel

visualization is performed either at the console, or, only for control purposes, at server ([7]).

In a later phase will intend to add software modules for content quality measurements options:

- Objective Quality
  - Mean Square Error (MSE)
  - Peak Signal to Noise Ratio (PSNR)
- Subjective Quality

General Architectural Concepts

The block schematic of the test system is shown in figure 4. The content is generated by IP server using primary information from Satellite TV STB (AB IPBox 200s), equipped with an Ethernet interface.

The second source is the headend (Grundig 316) allowing DVB-C compatible information to be acquired and sent in the distribution network. This information is captured with a DVB-C receiver (Samsung DCB-1560G).

It is possible to stream multimedia information from traditional local sources (DVD unit, file) but this case is not specific only for IPTV.

The clients are composed of either normal PC (or laptops) with network interface, or special STB with Ethernet interface. In this phase we own a single Samsung DCB-1560G STB for DVB-C connection. For streaming capability the firmware should be modified, but we do not intend to do it in this phase of the research.

III. IPTV CONTENT GENERATION

The most important functional feature of the IP portal is to facilitate the multimedia streaming in the internal network. A specific user can visualize a video clip from a streaming server or even an IPTV station or a satellite delivered TV station. The main principle of the streaming process is simple: streaming client program receives from network a part of the video file content, which is placed into a buffer memory; in the moment when the buffer contains enough data to start the video content playback, it will do so.

In background, stream buffering is performed till the streaming process will end.

Software tools

The streaming process is controlled using a software application called StreamingCenter. StreamingCenter application is able to work on all Windows XP and Vista versions. The application was developed as a Console Application, with a main window, allowing settings modification, and a secondary Console window, able to show the status of the server, and debug eventually any problems.

This application is using the main library components of VLC Media player, a standard open source implementation for most known codecs [8].

The application has three main parts: multimedia input information, information processing unit, where is possible to transcode, process and re-encapsulate the multimedia content, and the output unit.

To allow the visualization of the streamed content, the application has a built-in streaming client.

The main screen of the application is presented in figure 5.

The application has five tabs:

- Input – used to set the multimedia source;
- Output – used to set the destination(s);
- Encapsulation – defines the encapsulation method;
- Transcoding – setup of video-audio codecs for both input and output streams;
- Streaming control – control the process

The second window of the application is a console type

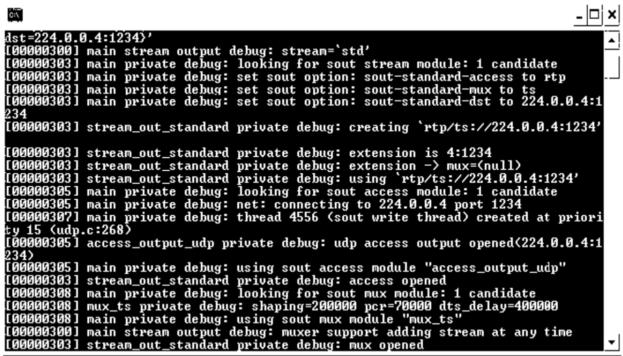

Figure 6. Secondary window of StreamingCenter

window (figure 6) and allows the user to visualize server status and the main performed tasks.

It is possible to find information regarding the codecs suitable for decoding, the address of the stream destination, or the encapsulation methods. This window is also useful to display the errors generated from *libvlc* library, regarding the codecs characteristics, container formats or the opened filenames.

For details of this test architecture construction, we used mainly the basic concepts and solutions described in [9].

IV. TESTS AND MEASUREMENTS

Goals for the measurement

There are few parameters investigated in a traffic analysis. The traffic analysis is done to solve or improve the engineering tradeoffs in an IPTV real system.

The process of engineering tradeoffs takes into account five dimensions:

- Capacity – such as disk I/O throughput and network bandwidth utilization;
- Time – such as start-up delay and response time;
- Space – such as storage requirement and buffer requirement;
- Quality – such as media quality and service quality;
- Complexity – such as computational complexity and implementation complexity.

Traffic Analysis

A possible analysis using the described system and the software tools, is illustrated in figure 7 for RTP unicast packets. The packets are sent from address 10.150.2.250 to address 10.150.2.249 on port 8086. The analysis is performed using Wireshark. Using the described program it is possible to evaluate the useful (multimedia) traffic and parasitic traffic, and to visualize for example messages between IP Multicast source and the destination. This could be useful to eventually debug, if necessary, the connection.

All the measurements were done in a local (laboratory) network and revealed that the server is able to deliver information (video content) for 3-4 clients simultaneously. This can be done without interrupting the main data traffic from network.

V. CONCLUSIONS

Multimedia content delivery in real time has a great potential in the future "intelligent home", and the number of software solutions to solve this sort of applications is increasing daily.

A complete solution for each user should be able to support for visualization and re-encoding most of the codecs already used, and all container formats. Taking into account the complexity of a multimedia application most developers are implementing only the most well-known codecs, or eventually, like Microsoft or Apple, their proprietary codecs.

It is proven during the experiments, that Streaming Center is capable to take and generate streams, using the most common container formats and codecs.

The experiments using StreamingCenter intended to clarify the following items:

- performance evaluation of the application in processor and network card management;
- analysis of received and sent packets.

This research make possible to evaluate the potential of IP based, dedicated architecture, in multimedia (entertainment) information creation and distribution within a small network, characteristic for a common home. The research proved that this kind of configuration could be useful and affordable, with features satisfactory for a normal home (up to five streams simultaneously). In fact, this research is continuing the exploration of "Home Gateway" concept already presented, in a slight different architecture, in reference [10].

Using this system it will be possible to explore further IPTV achievements modifying the software components, and possible, in a low degree, the hardware architecture.

Among other future tests for improvements we are intending to implement:

- Encryption for personalized delivery;
- A study of server resource optimization;
- Compatibility between traditional delivery infrastructure (cable TV, DSL, Internet) and IPTV

A main advantage of this architecture (using IPTV for distribution and Home Gateway concept as the streaming server) is the fact that it is possible to conserve for a longer period the internal structure (and investments) of the network, and apply the modifications (hardware, drivers) only in the Home Gateway, if it is necessary to adapt the network to technical progress offered by the new IT technologies.

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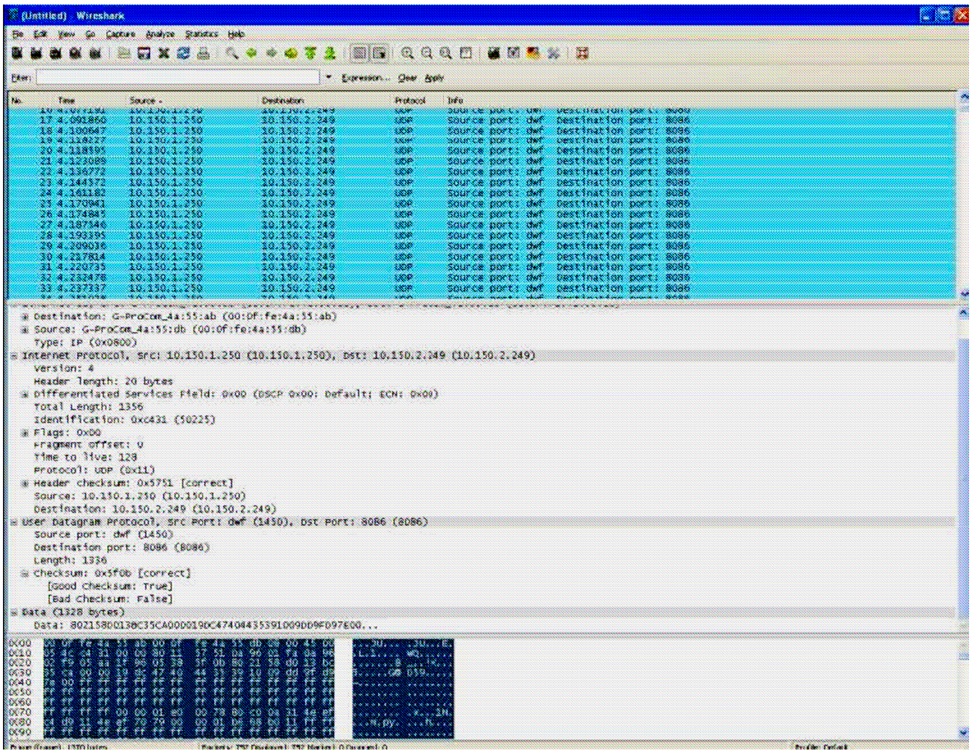

Figure 7. Packet manipulation in StreamingCenter