DEVELOPMENT OF EXPERIMENTAL VIDEOSTREAMING PORTAL SOLUTION

František JAKAB*, Miroslav MICHALKO*
*Department of Computers and Informatics, Faculty of Electrical Engineering and Informatics,
Technical University of Košice, Letná 9, 042 00 Košice, tel. 055/602 4220, e-mail: frantisek.jakab@tuke.sk

ABSTRACT
This paper deals with experimental implementation of multiple IP streaming technologies in environment of Technical University in Kosice. Video streaming helps to bring new videos for comfortable and effective ways of studying. In IP streaming area was built streaming server using newest streaming technology available. Concept of this video server is based on utilization of client-server technology that allows real time data presentation. Available streaming technologies allows delivery of video content over IP network but according to TCP/IP properties there is a big need to find new solutions for high quality streaming. Some concepts, ideas and solution are presented in this paper.

1. INTRODUCTION

Streaming is a method of video/audio delivery in real-time in a way that the recipient can view transferred content while receiving rest of the video/audio file. Basically streaming is not limited only to audio or video, but this paper will focus only on this content. Streaming allows delivery of any content. Advantages of this type of delivery are clear. End users do not need to wait for whole time period to download and store multimedia file. But on the other side, quality and smoothness is given by network infrastructure. Video quality, defined by its size, bit rate and other parameters, needs to convert to end device and network bandwidth limitations. Paper will not deal with end devices; it's a part of matrix which is hard to change and to accommodate in general. Network limitations are given by packet-switched data service type and actual level of utilization. Streaming is sensitive to interruptions so it is important to understand properties of transport network and the ways how to eliminate its weaknesses.

For testing purposes special Videoserver platform was developed. Videoserver streams multimedia content to wide variety of end users and platforms. Platform provides powerful and easy-accessible services for sharing video and audio resources using Flash technology. For mobile clients there are several possibilities how to deliver content. Content is streamed in optimized data stream. Videoserver allows also sharing of audio files and pictures. One of powerful service provided by Videoserver is possibility to create multimedia content in supporting environment. Videoserver also contains several technologies which support access to formats using mobile devices. Implementation of RSS feeds allows simple notification and WAP page provides also short description of last content added into platform. Accessing video streams is possible using Darwin Streaming Server which streams video in on-demand mode for devices capable receiving RTSP streams [1].

Videoserver provides powerful and easy-accessible platform for sharing of multimedia content for users based on intuitive web interface and provides support of wide number of video formats which are automatically transformed into flash video. Content is not only delivered as whole file, like is provided by You Tube (http://www.youtube.com) portal, but is streamed in optimized data stream. Videoserver allows also sharing of audio files and pictures. One of powerful service provided by Videoserver is possibility to create multimedia content in supporting environment. After accessing archive, Videoserver initiates streaming of video stored in server directly to users computer over the network.

Videoserver also contains several technologies which support accessing formats using mobile devices. Implementation of RSS feeds allows simple notification and WAP page provides also short description of last content added into platform. Accessing to video streams is possible by using Helix Streaming solution which streams video in on-demand mode for devices capable received 3GPP content.

Services provided by Videoserver streaming platform are preferably targeting school and universities by allowing them to share educational content by simple way. Thanks to open source and widely used technologies behind, platform is easily accessible and there are no special requirements for end users.

2. STREAMING PROTOCOLS

2.1. Protocol RTSP

Real-time Streaming Protocol (RTSP) is an application-level protocol that aims to provide a robust protocol for streaming multimedia in one-to-many applications over unicast and multicast, and to support interoperability between clients and servers from different vendors. This protocol is intended to control multiple data delivery sessions, provide a means for choosing delivery channels such as UDP (User Datagram Protocol), multicast UDP and TCP, and provide solution for choosing delivery mechanisms based upon RTP. RTSP is considered more of a framework than a protocol. RTSP is designed to work on top of RTP to both control and deliver real-time content (Fig. 1).

Functions of RTSP:
- Provides for on-demand access of multimedia items such as stored real-time audio/video files, live real-time feeds, or stored non-real-time items.
- Allows interoperability between client-server multimedia products from multiple vendors.

- Provides for control and delivery of real-time media and associated events between a media server and large numbers of media clients.
- Addresses key concerns of Internet content-providers and users - quality of service, efficiency of delivery, rights management, and measurement.
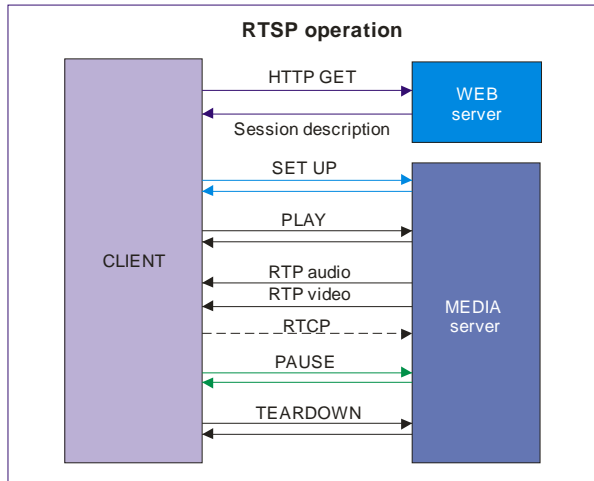

Fig. 1 RTSP protocol communication scheme

A key concept in RTSP is the notion of a session. RTSP works by first requesting a presentation to be started by a server, receiving in return a session identifier which it then uses in all subsequent controls. Eventually, the client can request the teardown of session, which releases the associated resources. The session identifier represents the shared state between the client and server. If the state is lost, for example through one of the machines being rebooted, then the protocol relies on the transport of the media stopping automatically, e.g. through not receiving RTCP messages if using RTP, or the implementation using the GET_PARAMETER method below as a keep-alive.

The control requests and responses may be sent over either TCP or UDP. Since the order of the request matters, the requests are sequenced, so if any requests are lost, they must be retransmitted. Using UDP thus requires the construction of retransmission mechanisms, so there are very few occasions when the application can get away with using UDP.

2.2. Protocol H.323

The H.323 protocol is the international standard for multimedia communication over packet-switched networks, including LANs, WANs, and the Internet (Fig.2).

The scope of Recommendation H.323 can be summarized in the following broad categories:

- Point-to-point and multipoint conferencing support: H.323 conferences may be set up between two or more clients without any specialized multipoint control software or hardware. However, when a multipoint control unit (MCU) is used H.323 supports a flexible topology for multipoint conferences. A multipoint conference may be centralized where new participants can join all the

others in the conference. This is the so-called hub-and-spoke topology.

- Inter-network interoperability: H.323 clients are interoperable with switched-circuit network (SCN) conferencing clients such as those based on Recommendations H.320 (ISDN), H.321 (ATM), and H.324 (PSTN/Wireless).
- Heterogeneous client capabilities: A H.323 client must support audio communication; video and data support is optional. This heterogenity and flexibility does not make the clients incompatible.
- Audio and video codec's: H.323 specifies a required audio and video codec. However, there is no restriction on the use of other codec's and two clients can agree on any codec which is supported by both of them.
- Management and accounting support: H.323 calls can be restricted on a network based on the number of calls already in progress, bandwidth limitations, or time restrictions. Using these policies the network manager can manage H.323 traffic. Further, H.323 also provides accounting facilities that can be used for billing purposes.
- Security: H.323 provides authentication, integrity, privacy, and non-repudiation support.
- Supplementary services: Recommendation-on H.323 recognizes the huge potential for applications based on IP telephony and multimedia. It provides a basic framework for development of such services. An H.323 conference can include endpoints with different capabilities.
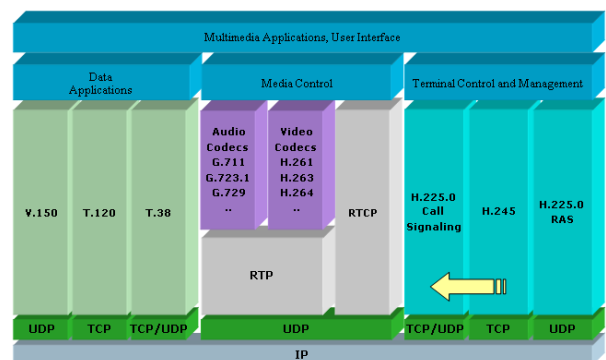

Fig. 2 H.323 Protocol stack

3. STREAMING TECHNOLOGIES

There are a lot of streaming technologies available at the market. Some of them are huge and complex and provides variety of added services to end user, some are simple and flexible. One of primary keys when selecting streaming technology is supported format(s) and price. Selecting the proper format means to be successful or not. End users are tired by installing number of codec's and add-ons. In present time the Flash player is dominant solution for most of the current computers. Complex streaming solutions provided by flash creators – company Adobe is commercial and requires higher initial investments. Fortunately, there are some projects in developing phase which offers flash content streaming and covered by GNU licensing policy.

Videoserver at the first phase of development was build on proprietary Microsoft technology Windows Media Services included within Windows Server editions. Windows Media Services is powerful and stable platform covering most of the end users by Windows native supported codec's. But this streaming server supports only Windows Media Video and in picture quality compared to other technologies in loosing scores. For this reason future development by using this technology was cancelled.

As vital platform comparable to Windows Media Services is Helix streaming solution. Natively it support only Real Media codec's but thanks to extension provided by Real Company it is possible to play some other video formats. Unfortunately full package with support of all codec is not free and makes from Real one of the most expensive solution on the market. Videoserver platform uses only open-source Helix streaming server for mobile streaming.

Following text will describe in detail key technologies and its implementation within Videoserver platform.

3.1. Helix Streaming Server

Helix streams audio, video, images, animation, text, and other data types to client computers. This newest version of Helix fully support users multimedia needs as they continue to change.

Helix Server is server software that streams both live and pre-recorded media over a network. The streamed data can originate either on the Internet or within an intranet. The client receives the media in real time, and without having to wait for clips to be downloaded [7].

Helix Server uses two connections, known as channels, to communicate with clients: one for communication with the client, and one for actual data. The communication channel is known as the control channel, as it is over this line that Helix Server requests and receives passwords and clients send instructions such as fast-forward, pause, and stop.

3.2. Red5

Red5 is a free, open source Flash server that supports streaming and recording audio/video, lives stream publishing and Flash remoting [8]. Big advantage of this Java based application is cooperation with FFMPEG software package. Videoserver use Red5 as the main streaming technology. Red5 is easy to install and maintain. Unfortunately still lack some important features in compare to Adobe Flash Streaming server.

3.3. VideoLAN VLC

VideoLAN VLC streaming technology allows streaming of video and audio content of multiple formats. VideoLAN is free cross-platform solution released under GNU license. One of the advantages of this technology is powerful command line configuration possibilities and large amount of developers all around the world. VLC is in use for multicast HDTV streaming, configuration is made as extension module into CMS and driven by command line. This module allows changing of IP multicast address, TTL value and video as requested by end user [9].

3.4. FFMPEG

FFmpeg is a collection of software libraries that can record, convert and stream digital audio and video in numerous formats. It includes libavcodec, an audio/video codec library used by several other projects, and libavformat, an audio/video container mux and demux library. The name of the project comes from the MPEG video standards group, together with "FF" for "fast forward" [10]. After submitting video using portal Upload form ffmpeg is used to automatically convert video into flash format. During converting phase user is allowed to see partial video output of encoded video.

3.5. Microsoft Media Services

Microsoft Media Services technology allows delivering hi-quality video and audio across the Internet or enterprise networks. The streaming media components of the Windows Media Technologies provide a complete solution for integrating audio and video into online applications, bringing the power of networked multimedia to the Internet and corporate intranets.
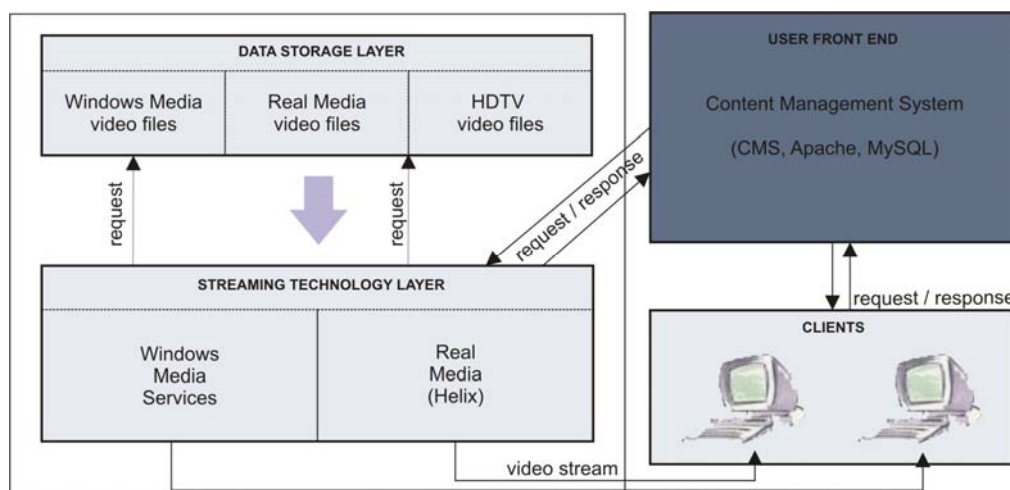

Fig. 3 Videoserver - Communication scheme

3.6. Real Media

RealServer streams audio, video, images, animation, text, and other data types to client computers - streams both live and prerecorded media over a network. The streamed data can originate either on the Internet or within an intranet. The client receives the media in real time, and without having to wait for clips to be downloaded.

RealServer uses two connections, known as channels, to communicate with clients: one for communication with the client, and one for actual data. The communication channel is known as the control channel, as it is over this

Line that RealServer requests and receives passwords and clients send instructions such as fast-forward, pause, and stop.

Media clips themselves, on the other hand, are actually streamed over a separate data channel. Every link to content begins with a protocol identifier, such as rtsp, pnm, or http [7].

4. WEB INTERFACE

If considering to build complex streaming portal there are two possibilities. First, most time consuming one is to make code from scratch. Second, more simple and preferred by many users is to use existing Content Management Systems (CMS) available at the market. The most known are Mambo, Joomla, Drupal, E107 and others. Those systems use PostgreSQL, MySQL or MSSQL databases and script languages and tool such as Oldfusion, PHP, jsp and asp so in global they do not have any special requirements. One of the greatest advantages of web content management systems is their modular structure which allows system to be expanded of required features. The base of web content management systems allow to include different modules developed for actual web CMS.

It took a while to select the best one, there were many criteria considered such as stability, security, modularity, future development and others. Videoserver is currently running on CMS Drupal [11].

Drupal is a free modular content management system written in PHP. It has a basic layer, or core, which supports pluggable modules which enable additional behaviours.

The integration between the core and the modules is achieved via a system of hooks, or call-backs, to allow modules to insert functions into Drupal's path of execution. Drupal core provides protection against many of the usual security problems, like SQL injection. Drupal offers many advantages to its users. For its ease installations and configuration and very few requirement of special technical acknowledge it is very popular between administrators. After creation of web site or portal it offers simple and clear navigation trough the site and organization of the content.

One of the Drupal greatest advantages and popular features which does not have any other CMS is taxonomy module. It is a core module, it means, taxonomy module is automatically installed when installing Drupal. The great power of taxonomy module comes from its ability to organize content by type. The taxonomy module can automatically classify new content on-the-fly. The

taxonomy module also allows user to define vocabularies or sets of categories which are used to classify content.

5. HDTV STREAMING

There are only few streaming technologies available with HDTV streaming capability. Most known are Microsoft Media Services with its own proprietary HDWMV codec, Helix based solution provided by Real, QuickTime and VLC. Two most suitable technologies VLC and Helix are implemented and provide multicast and unicast on-demand streaming. For unicast streaming special module is developed and implemented into IP streaming platform running on CMS Drupal. Screenshot of user web interface for HDTV streaming is shown in Fig. 4.

Fig. 4 Web interface for accessing HDTV content

Due to limitations of multicast streaming content is accessible only within local intranet of Technical University in Kosice – TUNET. In order not to overload network with unnecessary data stream platform allows also editing TTL value in TCP packet header. After reaching value equal to zero packets is destroyed by any active layer 3 packet devices. HDTV video streams are propagated using SAP play list what makes system more user friendly in compare to use only IP multicast address to remember. For extranet viewers interested in multimedia content there is only on-demand streaming available using specially developed web interface. Due to higher data bandwidth requirements only users with capable connection are ready to access content.

Implementation of these streaming technologies into TUNET shows the capabilities of the intranet network and allows sharing knowledge using new multimedia content delivery technologies. HDTV is unfortunately fighting with problems like high bandwidth requirements and high overhead in RTP protocol.

6. VIDEOSERVER SERVICES

The Videoserver (http//videoserver.cnl.tuke.sk) allows a realization of IP video streaming presentations and supporting presentation services. It provides both multicast and on-demand services with an unlimited number of channels/selections in addition to a full range

of interaction and integration with Internet services. The advantage to all of this capability is that it is available through the same networks that provide Internet connection-providing cost-effective bandwidth sharing.

Videoserver portal is based on Windows 2003 platform in co-operation with web server (apache 1.3) and database server (MySQL). For content creation as well as for content distribution and playback the Windows Media Service version 9 is used. WWW environment utilizes PHP and allows administration the server from any client station in the network (Fig. 4).

6.1. Microsoft Media Services

After registration form is filled user is added into database as new user with corresponding level of privileges (system has four various levels of user privileges). If you are already registered then entering of login name and password into login form is enough.

6.2. Microsoft Media Services

The user interface (Fig. 6) is divided in four basic parts (with various levels of user privileges).

- unregistered users
- registered users/students
- registered teachers
- system administrator

As unregistered user has no direct access to the content of Videoserver, but only to the first – informational part. Registered users are allowed to view the content, enter or react on questions, watch the live transmission. Teachers have same privileges as previous group. In addition, they are allowed to book one of three virtual rooms for their presentation.

System administrator belongs into the fourth group. The administrator is allowed to delete, or according to filled in registration form add users into the system. He has also possibility to create new publishing points in Windows media services [12].

6.3. Microsoft Media Services

One of powerful service provided by Videoserver is possibility to create multimedia content in supporting environment. After accessing archive, Videoserver initiates streaming of video stored in server directly to your computer over the network (Fig. 5).

ASF 1.0 format is used for IP streaming. The transmitting speed is max. 250 Kbps or 56 Kbps for slow connections like dial-up. The format supports saving in multiple transmit speed. Presentation material is saved in JPEG format in resolution of 320x240 pixels, for larger view also in 640x480 pixels.

6.4. Microsoft Media Services

Our server also provides live streams in three separate virtual rooms. Teacher or administrator is allowed to book virtual room where video stream should be presented for selected community. Virtual room should be also password protected if necessary. After live presentation is finished video recording is added into archive, but this feature is controlled by room creator. Live event

presentation system also allows to share slides and allows interactivity using portal chat service. WSX format is used to control Windows Media Services video source list.
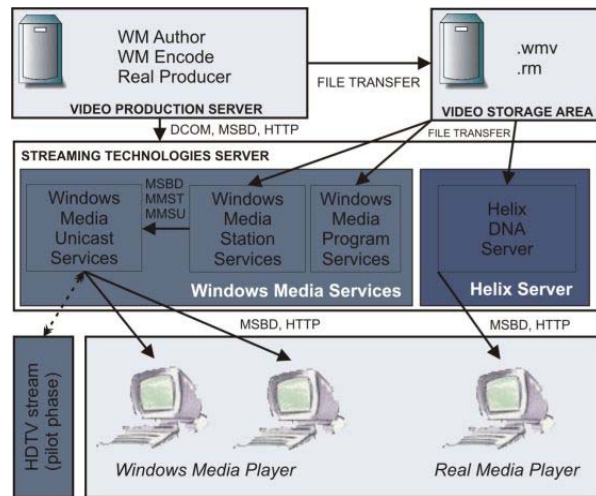

Fig. 5 Web interface for accessing HDTV content

Fig. 6 Videoserver – front page

7. CONCLUSIONS

Videoserver platform provides complex service for sharing multimedia content using latest streaming technologies. Implementation of mobile streaming extension is unique in compare to similar web portals. Next development will focus on higher level of user interactivity, streaming adaptability based on continuously changing conditions within provider's network environment, distributed access to video content and automatic metadata recognition.

There are several forms of emerging content that may be important offerings in the future. Videoserver will focus mostly on interactive content and simple communication user interface but with latest streaming capabilities offering services anytime and everywhere.

Technologies presented in this paper show only few examples of utilization of new streaming and processing technologies connected together in order to provide services with added value. Videoserver is up and ready solution for educational institution for delivering content to online learners.

Videoserver portal was developed as video on demand system which allows streaming of video archive using latest multiple video streaming technologies. For this reason there was need to make this system simple to use and manage. By adding latest offerings of Helix server now we are ready to provide video also in HDTV quality with lower network utilization with application of QoS module.

Our development is now focused on content searching and user interactivity in order to make this system more flexible and interesting for students what makes portal different to other portals. Sharing of video materials, web-based curriculum and on-line exams is part of e-learning and blended learning. Implementation of these learning techniques is powerful and effective strategy how to increase quality of education process at schools.

## ACKNOWLEDGMENTS

REFERENCES

[1] JAKAB, F., - MICHALKO, M.: IP streaming videoserver, 5th PhD Student Conference and Scientific and Technical Competition of Students of Faculty of Electrical Engineering and Informatics Technical University of Košice, Kosice, 22.05.2005, Kosice, Equilibrium s.r.o., 2005

[2] KLIMO, M. et col..: Širokopásmové siete / Martin Klimo, Matilda Drozdová, Tatiana Kováčiková, Roman Kaloč, Martin Vaculík. - 1. vyd. - Žilina : Žilinská univerzita v EDIS, 1999. - 215 s., AH 14,44 VH 14,95 : obr. 96, tab. 28. - Lit. 37., ISBN 80-7100-590-8

[3] JAKAB, F.: Blended learning in practice, Implementation of the Cisco Networking Academy Program to educational process at schools in Slovakia, ICETA 2005 - Conference Proceedings of the 4th International Conference on Emerging e-learning Technologies and Applications, and Communications Technologies in Education, Košice, 13-14 September, 2005, Košice, elfa, s.r.o., 2005, pp. 465-473

[4] JAKAB, F., - BISTAK, P. – DIRNER, A. – GIERTL, J. – MURIN, P. – FILANOVA, J. MEDVECKY, M. - HUBA, M. - GALEZ, P.: Utilization of Videoconferencing for Education, Project eEDUSER, Kosice, elfa, s.r.o., 2005, Leonardo da Vinci, 188 pp..

[5] KOVÁČIKOVÁ, T. – KLIMO, M.: Architecture and Protocols for NGN, in Next Generations Networks and Beyond, VITEL 2002, International Symposium on Telecommu-nications, Portorož, Slovenia, May 2002

[6] FALK, L. – KLIMO, M.: Basic Probabilistic Routing Problem with Flow Control, Reports on Communication Systems, Technical Report – 108, TTS 1991, KF-Sigma, Lund, Sweden, 1991, ISSN 1101-3931, ISRN LUTEDX/TETS-1016-SE+88P

[7] Helix Community: The Fundation of Great Multimedia Applications. 2008 [online]. RealNetworks Inc.. [cit. 2008-3-11]. Available at WWW: < https://helixcommunity.org/>

[8] Red5: Open Source Flash Server. 2008 [online]. OS Flash. [cit. 2008-3-13]. Available at WWW: <http://osflash.org/red5>

[9] VideoLAN VLC: VLC media player. 2008 [online]. VideoLAN. [cit. 2008-3-14]. Available at WWW: <http://www.videolan.org/>

[10] FFmpeg: Multimedia solution. 2008 [online]. FFMPEG Community. [cit. 2008-3-14]. Available at WWW: < http://ffmpeg.mplayerhq.hu/>

[11] Drupal: Content Management Platform. 2008 [online]. Drupal. [cit. 2008-3-17]. Available at WWW: < http://www.drupal.org/>

[12] Microsoft: Windows Media Services. 2008 [online]. Microsoft Media. [cit. 2008-3-19]. Available at WWW: < http:// www.microsoft.com/windows/ windowsmedia/>

BIOGRAPHIES

Frantisek Jakab (Ing., PhD.) was born in 1959. He received the MSc.degree in Systemotechnic engineering from the St. Petersburg Electrotechnical Institute (Rusia) in 1984 and the PhD. degree in 2005. He is employed as an assistant professor at the Dept. of Computers and Informatics, Technical university of Kosice, Slovakia. He is a head of Computer Networks Laboratory (www.cnl.tuke.sk). His research interests include projecting of computer network, modeling, simulation and network management, new form of multimedia-based communication, QoS, telelearning systems, intelligent tutoring systems. He has been a coordinator of several large international e-learning oriented projects supported by EC. He is a coordinator of the Cisco Networking Academy Program for the Slovakia and head of the Application Section of the Communication Technology Forum Association in Slovakia.
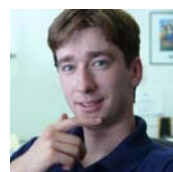
Miroslav Michalko (Ing.) is internal PhD student at Technical University of Kosice. his research activities are related to streaming, mobile multimedia technology and web services. He is responsible for Videoserver platform development as project manager and member of video@lab team at Computer Networks Laboratory. You can contact him at miroslav.michalko@tuke.sk.