



Magyar Telekom Group's  
Research and Development Activity 2004

# List of Contents

1	<b>Introduction</b>
3	<b>Research and development activity of Magyar Telekom Ltd.</b>
3	<b>Overview of the R&amp;D activities performed by PKI</b>
7	<b>Key R&amp;D themes</b>
7	Roaming among public WLAN-s
7	Outdoor WLAN in a Magyar Telekom telephone booths
8	Booth HotSpot solution – technical implementation
8	ENUM pilot system
8	Description of GRID technology and the GRID prototype of Magyar Telekom
9	New technical solutions for broadband services
10	Magyar Telekom–T-Mobile network analysis (master plan)
12	Multi-media – the “Digital Home” concept
13	Methodology for the detection and localisation of bottlenecks in the IP network
13	Analysis and planning of NGN architectures
15	Development of L2 VPN technologies
15	Development of 3play system technology
15	Development of multimedia services
18	Telecommunications services developed for impaired users
18	Methodology for the analysis of copper access network
19	<b>R&amp;D consortiums</b>
19	MUPBED-project
20	National Research and Development Program (NKFP) project: adaptive media stream service architecture for the latest mobile telecommunications systems
21	National and international relations
21	Domestic relations
23	International relations
24	Co-operations within Deutsche Telekom Group
24	The role of events organised by PKI in our relations
25	<b>Research and development activity at member companies</b>
25	<b>R&amp;D activity of T-Mobile</b>
27	<b>R&amp;D activity of Emitel</b>
28	<b>R&amp;D activity of T-Kábel</b>
29	<b>R&amp;D activity of T-Online</b>
30	<b>R&amp;D activity of EPT</b>
31	<b>Key financial indicators of R&amp;D activity</b>
31	Indicators of Magyar Telekom Ltd.
33	Indicators of Magyar Telekom Group
34	<b>Outlook</b>

# Introduction

The main purpose of the research and development (R&D) activities of Magyar Telekom Group is to lay down the technical fundamentals of the Company's future business successes. This activity is in line with the Strategy of Magyar Telekom Group and also with the long term trends of communications industry. Our activity provides basis for Magyar Telekom to maintain the possibilities and strengthen its capabilities for the provisioning of high level standards services in order to meet the newer and newer challenges of the information society and to strengthen its market leader position also through the optimised utilisation of the economical, technical results and achievements of R&D activity.

The success of future telecommunications services depends to a great extent on how the still existing bandwidth limits of access networks can be bridged over. Along with the elimination of the barriers of the access networks it is also necessary to prepare the core network, too, for the handling/transmission of the growing traffic. Accordingly, the R&D activity is also focusing on the tasks aiming at the increasing of the bandwidth.

A planned, deliberate and recorded R&D activity has been carried out within Magyar Telekom Rt. recently in PKI Telecommunications Development Institute only. In 2004 – by the impetus of the Act on the Research and Technology

Innovation Fund – the R&D activity of the Group member companies has become animated as well, though the substantial part of R&D is still performed by PKI.

The R&D activity performed by PKI is an activity (primarily experimental development), drawing on existing knowledge gained from research and practical experience utilisable within Magyar Telekom Group, that is directed to producing new products, processes, systems and services (creation of prototype) or to improving substantially those already existing, introduced or installed.

Substantial improvement or further development of existing, already introduced products, processes, systems and services – in general terms – means that as a result of experimental development those have improved quality parameters, lower environmental load, facilitate new modes of use, resolve the originally existing technical uncertainty, open the way towards new market segments or their production and operational costs become lower.

Looking back to the last 10 years, in every case when Magyar Telekom implemented a network or product development project of primary importance, it was always preceded by proactive R&D activity that facilitated and contributed to the economical implementations (for instance: network digitalisation, ISDN, No. 7, ATM, IP,



ADSL, VoIP, Ethernet and other technologies) and to the introduction of services, such as IP Complex Plus product family, WLAN and IN products.

In order to strengthen our professional abilities and innovative thinking we are participating in the work of international innovation (EURESCOM) and standardisation (ETSI, ITU and DSL Forum) organisations. In the interest of efficient utilisation of our internal resources and gaining knowledge, for the execution of certain tasks we give orders to external professional partners (primarily to universities or colleges).

In addition, the scope of our R&D activities comprises also the gaining of fundamental input information forming the pillars of mid- and long term strategic platform developments of Magyar Telekom. Currently, one of the most important element of it is the future's convergent network, the next generation network (NGN – Next Generation Network) the application of which becomes necessary in the near future.

In the first part of our report we give an overview on the R&D activities of PKI. It is followed by the presentation of our key R&D project results necessary for the achievement of the strategic goals. A special chapter is devoted to the introduction of our work performed in national and

international R&D consortiums and with our national and international relations. The part thereafter consists of the reports of the individual group member companies of Magyar Telekom Group and of financial indicators of R&D. At the end of the report we outline our ideas for the future.

# Research and development activity of Magyar Telekom Ltd.

## Overview of the R&D activities performed by PKI

### Product development

Our R&D activities performed in the field of product development on one hand facilitates the creation of the technical prototypes of future market products and services, on the other hand the substantial further development of the products already introduced on the market.

This early pro-active development activity duly supports the accelerated market entering of the products and along with that the strengthening or in certain segments the maintaining of the market positions of Magyar Telekom. The results of the R&D activity are manifested in well defined and properly designed new platforms that enable us to introduce new, competitive services on the market.

In 2004, in the interest of maintaining or expanding the competition positions of Magyar Telekom – in line with the short and medium term development and business strategy of the Company and with the international trends and market expectations – we have set the target to lay down the fundamentals and technical background through the R&D activities performed in PKI for the introduction of new VoIP and multimedia based services, beside the traditional voice services, utilising the capabilities of next generation (NGN) IP/Ethernet based core and broadband fixed (ADSL, xDSL) and wireless (WLAN, WiFi) accesses.

Today, applied R&D is not limited to getting knowledge on technologies from studies. It is worth to mention our efforts aiming at the creation of laboratory or experimental sample networks, too, since the demonstration of technical developments under laboratory or real conditions to a great extent accelerates the process of product development (and market launch).

Our ability to react fast to market demands and challenges is proven by the fact that in 2004, being the first company in Hungary, Magyar Telekom – utilising the results of its R&D activity – has implemented a roaming type interconnection of its EasyNet service, which is a public WLAN based service for provisioning broadband Internet access, with an other service provider, and also a prototype of hotspot using the infrastructural facilities of telephone booths.

Beside the data services resting upon the new L2 (Layer 2) techniques, high priority was given also to the implementation of the 3play sample system (integrated voice, Internet, IPTV+VoD at the same time, via one access, and billed in one invoice), with the purpose to determine the technical conditions of an IPTV service to be implemented in the near future on the basis of the ADSL access and IP core network capabilities of Magyar Telekom and prove the system's operability by control tests



carried out on the laboratory experimental semi-sample network.

Coming to market with services and products resting upon networks and multi-media based communications forms a part of Magyar Telekom's mid term strategy. With this in view, we have made a ground-work for gaining knowledge on NGN and VoIP systems (ENUM sample system, SIP-based VoIP test system).

The multi-media oriented commitment of Magyar Telekom is proven also by the so called "Digital Home" concept and model that was successfully created with the involvement of external partners. It demonstrates nicely through a concept how a dwelling unit equipped with broadband and Internet access facilities can be made more comfortable with the utilisation of communications and home networking.

One of the greatest examples of the convergence of IT and communications is the realisation of computer networks with distributed architecture. The GRID platform is a global-size distributed IT system that makes it possible to reach according to needs, dynamically the IT resources, the equipment and services (such as, for instance, collection, storage, processing and presentation of information) accessible via the Internet. Utilisation of this

technology bears business potentials, therefore – tailored to the network capabilities of Magyar Telekom – we have developed a multi-site prototype of GRID platform.

The principle of equal opportunity shall be observed by the telco providers as well. With this in view we have addressed the issue of new telecommunications services that can be provided for impaired individuals. The telecommunications, infocommunications technologies of the future open new horizons in this field, too. The VoxAid software developed on the order of PKI at the Telecommunications and Media Informatics Faculty of Budapest University of Technology and Economics (BME TMIT) with the help of displaying text on a computer screen enables in speaking and/or hearing challenged people to use the telephone.

### Network development

In the field of network development, as a result of our R&D activities, there have been such new planning and analytical methods developed, the direct application of which helps the optimising of the networks of Magyar Telekom from technical and financial/economical points of view.

This activity is not limited to the determination of the methodology relating to a given network, but applying a prototype and a developer system, it covers the testing of the model and the method itself as well. The models are continuously "refined" according to the analyses of the route/path measurements carried out in the real network. Our outstanding results achieved in 2004 in this field are explained in the followings.

The development and planning work for the fulfilment of 100.000 ADSL connections in 2004 was one of our top priority network development tasks. The connections have been implemented first of all on already covered areas and on certain areas of Hytas optical access networks having adequate technical solution. Moreover, connections have been made also in the frame of the small settlement model and the settlement catching up program, too. Along with that the remote  $\mu$ DSLAM-s have been introduced in the network of Magyar Telekom.

In the interest of more efficient utilisation of the network resources and co-ordination of future developments co-operation has been started between Magyar Telekom and T-Mobile Hungary Ltd. As the first step of it a master plan has been elaborated for the satisfaction of the network demands of the base stations. The common Magyar Telekom-T-Mobile network analysis – through the common utilisation of the available resources and the co-ordination of the developments providing results for common utilisation – has furthered the foundation of efficient business operations of Magyar Telekom Group.

In the interest of consolidation of traditional PSTN network services and making the operation more efficient we have continued our program for the replacement of the AR-type electro-mechanical exchanges. In this way, these services are provided for about 116 thousand subscribers via other, alternative technical solutions. The program for the

elimination of the two-party lines continued as well. Provisioning of access and transport network support required for the above was part of the development task.

Within the for the future fundamentally important strategic platform developments we have made preparations for a pilot project for the testing of the VoIP service provisioning on an NGN-T-Cable network.

The proper handling of the growing IP traffic made it necessary to extend the Giga Ethernet network to the level of primary nodes of Magyar Telekom. The major part of the development was realised in 2004.

Enhancing of the quality of the IP network has become one of the key issues in our days. Due to the growing IP traffic it is more and more important to know whether the eventually reduced quality of service is caused by the bottleneck developed in the IP network of Magyar Telekom or by the saturation of the external IP network. A methodology that is based on the packet-level measuring of the IP traffic had got to be elaborated for the localisation of the bottleneck. Analysing the micro-structure of the traffic, we can continue the further development of our methods already applied for the traffic dimensioning of the IP network, too.

Elaboration of new technical solutions for broadbanding is one of the challenging tasks of the present. Magyar Telekom is providing service access via Hytas optical access network for nearly 160.000 POTS and ISDN2 subscribers living in different districts of Budapest or in other cities in the country. The present broadband solution is feasible only at low penetration and with geographical limitations and it does not make it possible to widely deploy ADSL. With the elaboration of alternative solutions we have laid down the fundamentals for the development of broadband provisioning of areas covered with Hytas optical access network.

Taking in use the Ethernet-based DSLAM equipment that had been selected on a tender was the achievement reached in Q4 of 2004.

### Technology development

From among our R&D activities in the field of technology development we mention our examination on the applicability of free space optical connections.

In the frame of this work, on an experimental STM-1 optical link we have examined the impacts of various factors influencing the quality of free space optical connections. The test has been carried out with indirect measuring methods, with measurements carried out over longer period on an STM-1 capacity free space optical link. The atmospheric attenuation that basically determines the quality of the free space optical connections appears as a common parameter of several influencing factors. Modelling of each of these factors is rather difficult and costly. The results gained from bit error rate measurements performed with high quality, accurately adjusted and continuously controlled devices well represent the applicability of the system without having exact information during the tests on the behaviour of the atmosphere or on its parameters. The drawback of the method is that it did not provide information whether the influencing effect of which weather condition has caused the experienced quality deterioration of the transmission. We could nevertheless gain very useful experience over the long observation period.

It is the fog that the most adversely influences the quality of the connection. Rainstorm-like heavy raining, or snowing has caused bit error deterioration, but it resulted in interruption only if these weather conditions were accompanied with high humidity or fog. Under our climate conditions, here in Hungary the "fog statistics" or the "visibility statistics" issued by the meteorologists could well describe the applicability of the free space optical connections. An exact weather-related analysis would be possible, if we could put into operation a system to measure the transparency, i.e. the optical attenuation of the air, because with the present weather observation system neither the fog nor the snowing can be perceived.

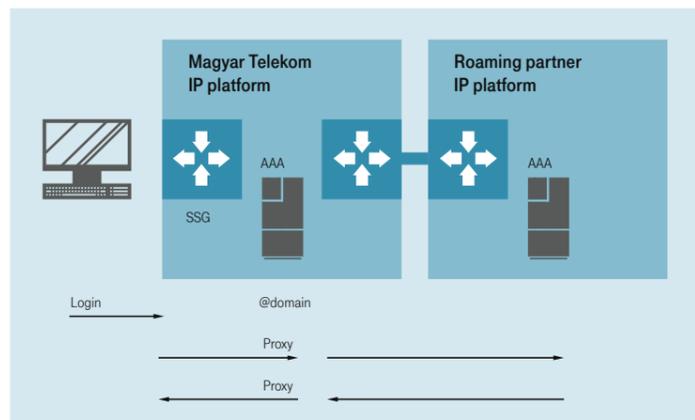
The most important and factual result of the tests was that the in average 98,68% availability that can be reached at installations within a 1,2... 1,3 km distance is not suitable for professional telecommunication services. According to our calculations and measurements carried out with the given equipment parameters and also on the basis of information taken from the literature we assume that under our climatic conditions, a 99,95% or better availability (reflected to a whole annual observation period) cannot be achieved in case of connections longer than 600 m. From the availability diagrams produced on the basis of the measured values it can be seen as well that the availability is not equally distributed in time. The period from late autumn till early spring can be considered as critical period.

## Key R&D themes

### Roaming between public WLANs

To elaborate the technical conditions needed for allowing inter-network traffic flow (by providing gateways) was a target set by Magyar Telekom in 2004 in connection with the application of WLAN that was gradually gaining ground. The objective of the development was to find out how the roaming function known in GSM technology could be implemented in wireless LAN (WLAN) environment.

The development was realized with own specialists. The key element of the development project was the so-called AAA (Authentication, Authorization and Accounting) system used for the management of user rights and data information (authentication and accounting). Data communication and interworking with the similar AAA system of the roaming partner could be ensured through the appropriate settings of this system.

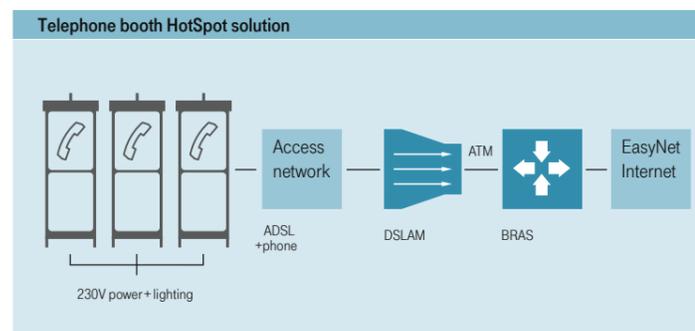


The solution received as the result of development was adapted by Magyar Telekom to its already existing WLAN service – the so-called EasyNet Plus product. This way the customers of Magyar Telekom's roaming partner can use the HotSpots of Magyar Telekom, and the HotSpots of the roaming partner are available to the EasyNet Plus customers of Magyar Telekom as well. The conclusion of a so-called roaming agreement between the roaming partners is a precondition of mutual roaming. In the course of roaming wireless Internet access is available to users for the currently applicable tariffs specified by their original service provider, while the settlement between the service providers (the roaming partners) is based on the actual traffic.

### Outdoor WLAN in Magyar Telekom's telephone booths

Problems of partly technological (power supply, resistance to heat, secure placement, etc.) and partly telecommunications (antenna type, layout, integrated with router or realized without router, etc.) character, arising in connection with the installation of outdoor WLANs, represent one of the main obstacles hindering the application of WLAN based Internet service in a wider range. The installation of WLAN devices in telephone booths, however, may have such a major impact on the gaining ground of WLAN that in 2004 Magyar Telekom set as aim to identify the problems more exactly and to start their comprehensive analysis using a prototype for this purpose.

The development was carried out by PKI in cooperation with Tele-Informatika Kft., a company operating the telephone booths therefore fairly familiar with these facilities. The wireless unit (AP – Access Point) and the power supply unit operated from the electric network of the booth were put in separate boxes; this configuration installed in one of the public booths of Ráday utca, Budapest was also tested in the frame of pilot operation.



### Booth HotSpot solution – technical implementation

The emplacement of devices in the smallest possible box necessitated by the available tight space was a serious challenge.

As the continuation of the theme we are planning further tests to find a complex solution to power supply, placement and environment resistance problems based on the experience gained during the pilot operation. Taking into account the outcome of the new tests we are going to work out standardized solutions.

### ENUM pilot system

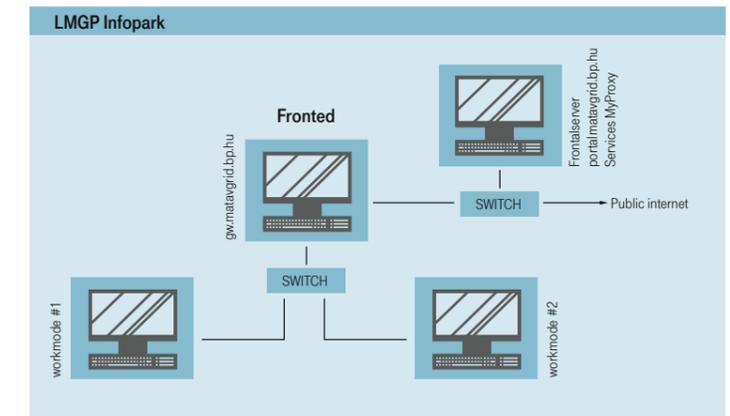
The name ENUM refers to enumeration and is also an acronym: it stands for tElephone NUmber Mapping. The purpose of ENUM is to form DNS names from telephone numbers; as for the DNS names they are to orientate us on how the called party can be accessed. One of the possible access methods is the addressing using SIP protocol, but a mobile phone number or even an e-mail address can also be given. In the frame of the ENUM R+D project in 2004 we have developed a pilot ENUM system at PKI which allows to assign ENUM identifiers to users and to access them at several different addresses. The system can be used for the time being only with software user agents because of the applied security protocols. A web based graphical user interface is provided for both administration and the management of user profiles. During the elaboration of the theme the system was supplemented so as to make possible the use of provided services securely, with hardware based SIP-clients as well. In addition, the call branching capability provided by the central unit of the system (SIP Express Router) was also integrated with a view to allow both serial and parallel call branching solutions.

The ENUM based click-to-dial service from the mailing list of Microsoft Outlook was also implemented.

In the frame of the development we succeeded in making available services offered by ENUM not only from the IP network but from the PSTN as well.

### Description of GRID technology and the GRID prototype of Magyar Telekom

The GRID (Global Resource Information Database) is a global, distributed IT system which allows dynamic, on-demand access to resources and services.



The resources embrace all information technology resources (computers, storage devices, databases, network equipment, etc.) and all further resources that can be accessed via the Internet (for example telescopes, nuclear accelerators, medical equipment, etc.).

The services are components that – connected with the above resources – are capable of collecting, storing, processing and presenting the information.

With the arbitrary interconnection of these resources and services the GRID technology makes possible the development of heterogeneous, dynamic and distributed systems meeting any specific demands (corporate, company group, ministerial, public administration, university, etc. applications).

The GRID technology has been developed for the solution of resource intensive problems therefore its application areas can be for example the following:

- pharmaceutical research and chemical applications;
- data mining, bank applications;
- disaster recovery and meteorological applications;
- nuclear energy sector;
- engineer's design;
- digital modeling, computer animation.

The prototype of Magyar Telekom's GRID Platform (MGP) has been created with the application of GRID technology, during the research and development cooperation between SZTAKI (Computer and Automation Research Institute of the Hungarian Academy of Sciences) and PKI.

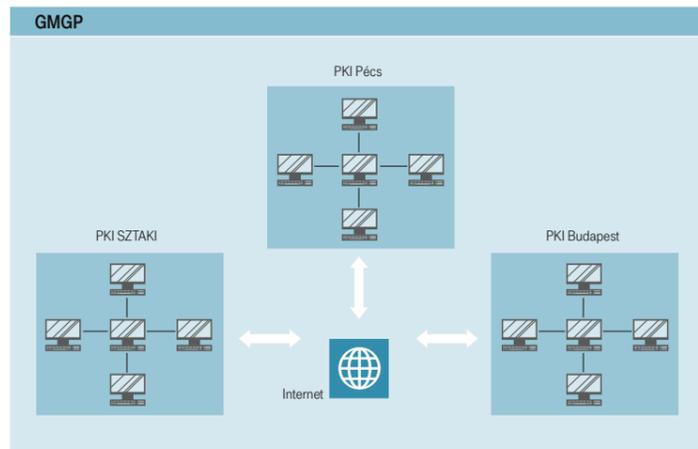
The MGP ensures the construction and comfortable use of both so-called local (within a given institution) and global (between institutions and/or sites) GRID systems.

**Local Magyar Telekom GRID Platform (LMGP)**

Using the Local Magyar Telekom GRID Platform we can combine and allocate according to demand heterogeneous IT resources within an institution or company. In the course of creating the prototype we have constructed two LMGPs at the Infopark and Pécs site of PKI.

**Global Magyar Telekom GRID Platform (GMGP)**

The Global Magyar Telekom GRID Platform system allows the integration of local GRID systems into one larger GRID system. The developed P-GRADE portal makes possible flexible access to GRID services via the Internet from any point of the country. In addition, we can run complex workflow applications as well, where individual components are running parallel on various local GRIDs, and we are able to graphically create, run, monitor and visualize the execution of these complex workflow applications. In the course of the establishment of GMGP prototype we integrated 3 local GRID systems. One of the local system operated at SZTAKI while the other two at the Infopark and Pécs sites of the Institute.



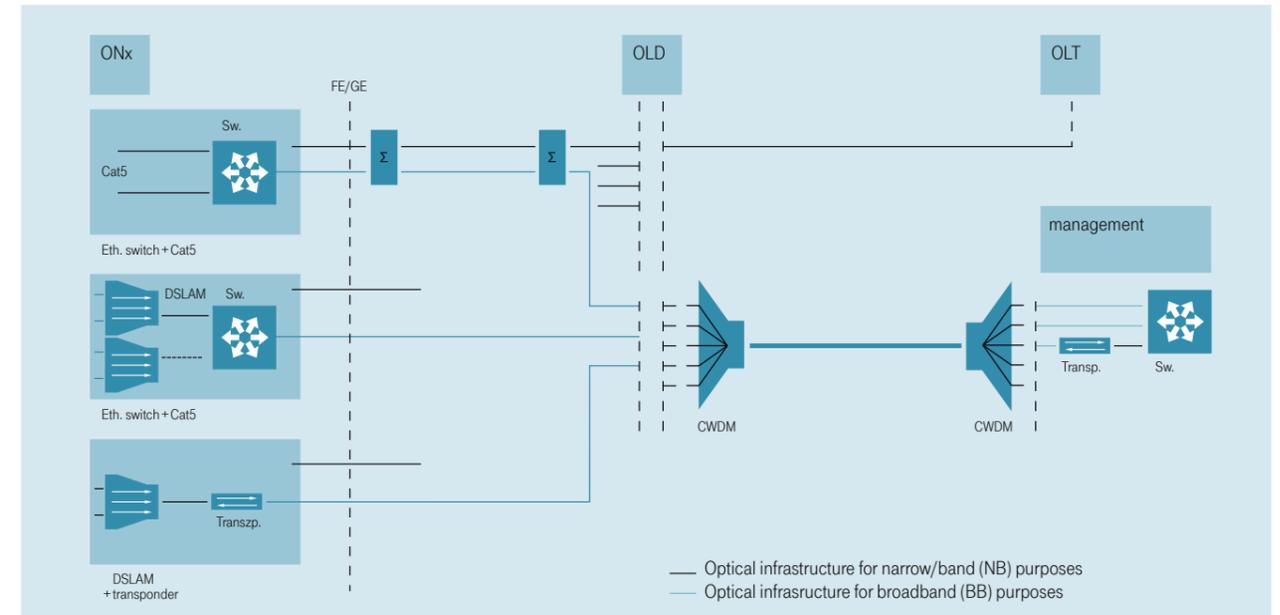
**New technical solutions for broadband services**

Magyar Telekom provides close to 160,000 POTS- and ISDN2 subscriber service accesses on Hytas optical access network in several districts of Budapest and in some country towns. At present minimum 4,000 ONx and ONU-Vx optical termination points are in operation. More than 90 % of these termination points are located in the Budapest network, serving more than 85 % of Hytas subscribers.

The current broadband solution can be applied for the many ONU-B and ONT-B termination points, for nearly 70% of devices installed in Budapest only with regional restrictions, assuming low penetration. The capacity limits of the system do not make possible the use of ADSL service in a wide range.

The new, proposed concept allows the provision of broadband services in Hytas areas. The most important principles of the solution were as follows:

- Utilize the existing Hytas optical cable network with a view to avoid new cable constructions.
- Utilize with CWDM devices further wavelengths of the optical fibers in addition to the 1310 nm wavelength, first of all in OLT-OLD main cable relations.
- Provide – if required - as fast as GigaEthernet transmission connection to the higher capacity Ethernet local loop at the ONx termination points, using various Ethernet switch and Ethernet DSLAM tools.
- Support the introduction of new 3play broadband services.



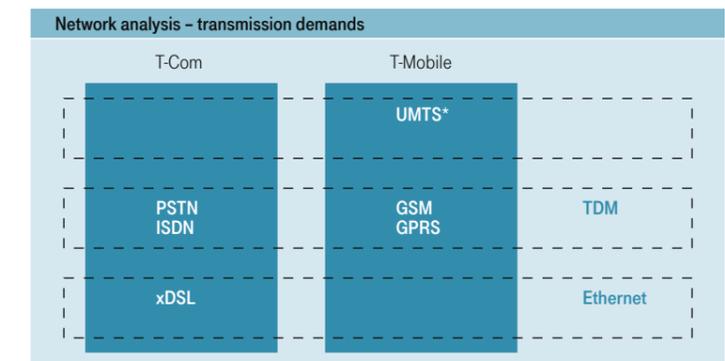
To prove the functionality of the broadband system we have implemented – based on the system engineering proposals – a pilot system on Hytas area in Angyalföld, Budapest with 2 ONU-B and 1 ONT-B, involving pilot subscribers. In the course of the pilot the subscribers were granted access to Video on Demand service as well. When setting the access bandwidth a total of 6 Mbit/s was provided, allocating 3 Mbit/s to broadband Internet service and 3 Mbit/s to testing the Video on Demand service.

On the basis of test results Magyar Telekom began to procure devices applied in the system technology solutions that were tried and found suitable. As a result of our efforts the company can launch during 2005 the broadband service in a part of areas that previously could not be covered.

**Magyar Telekom-T-Mobile Hungary network analysis (master plan)**

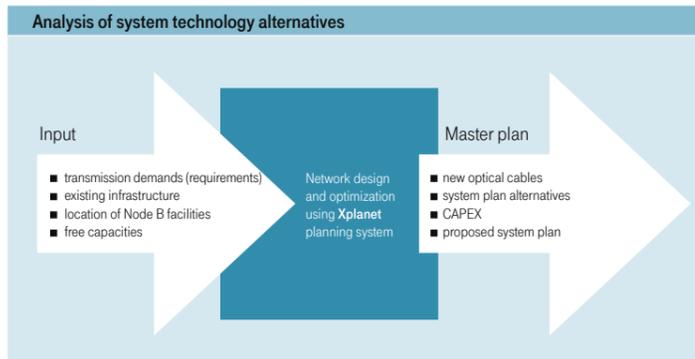
One of the bases ensuring the efficient operation of Magyar Telekom Group from business aspect is the joint exploitation of existing resources and the coordination of developments producing results that can be utilized in common with others. The objectives of Magyar Telekom – T-Mobile network analysis can be summed up as follows:

- examine the possibility of joint network development by T-Mobile and Magyar Telekom, taking into account the existing infrastructure of Magyar Telekom,
- harmonize developments on the access network plane,
- support the making of decisions on long term development. In the course of network analysis we calculated with the following transmission demands:



\* Later migration on Ethernet

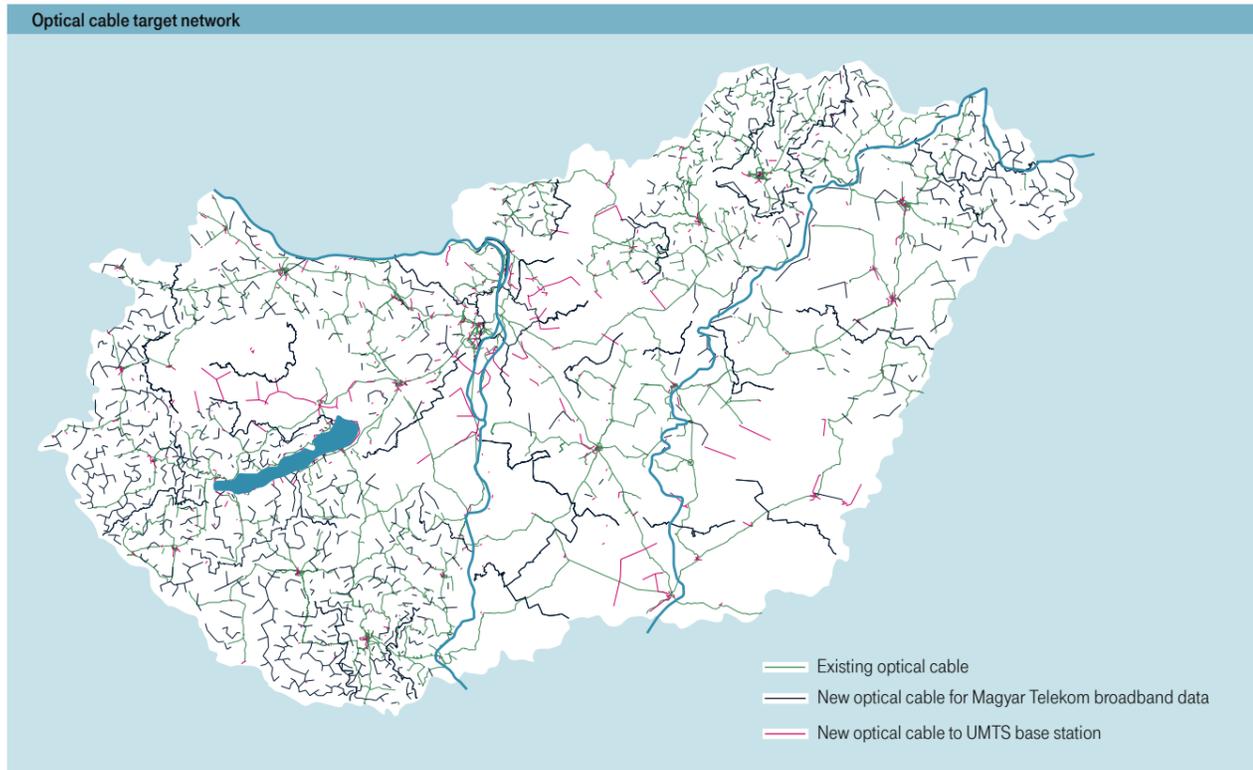
The planning and optimization of the network was carried out with the Xplanet planning system used at Magyar Telekom, based on the jointly identified transmission demands. This was followed by the analysis of system technology alternatives.



Results of the analysis:

- In the regional network the development of optical cable network can be harmonized to a great extent, taking into account the demands of Magyar Telekom and T-Mobile. Common construction is possible along a route of approximately 680 km.
- In Budapest and in large cities the optical cables can be built up to the Node-B points, taking into consideration the existing optical network of Magyar Telekom.
- In Budapest the existing ATM infrastructure of Magyar Telekom can be used for UMTS.
- We have not found any sharp price difference between various system technology solutions, therefore the solution which is the most cost-effective in the given area shall always be applied.

The automatically produced result of computer aided design is the presentation on the map, showing the topology of the optimized network:



#### Multimedia – the Digital Home concept

The application of the Internet on a global scale makes possible for us to rapidly access various up-to-date information with a computer linked to the world wide web. Up to now the Internet was used mainly at workplaces and schools, but recently the browsing on the web at home has also become a frequent activity. A new term, the so-called home networking in the frame of which the service providers aim at offering a wider range of services than Internet browsing, has also emerged. With a home networking system a number of services can become available without leaving the flat.

The purpose of research and development cooperation between BME (Budapest University of Technology and Economics) and Magyar Telekom was to produce a study and prototype suitable for presenting the range of services that can be provided in home environment.

A home multimedia environment can basically comprise the following services:

- multimedia entertainment – for example Video on Demand; TV and radio transmission forwarded via the Internet,
- distance learning,

- teleworking,
- electronic purchasing,
- home automation and safety engineering – for example systems signaling break-in and danger, control of electric devices.

Apart from the description of these services the study deals with individual user groups and their habits as well as with the types of network solutions that can be applied in the homes. In the frame of a current market survey the so-called enduser devices required for the provision of services are also outlined.

From the services a prototype has been produced for the multimedia services (Video on Demand), home automation and safety engineering themes.

The study makes possible for Magyar Telekom to obtain useful information about devices on the market as well as about services implemented by other service providers. With the development of the pilot system we can harmonize separate systems and establish unified control environment.



#### Methodology for detecting and localizing bottlenecks of IP network

To know whether the possibly degraded service quality is caused by a bottleneck occurred in the IP network of Magyar Telekom or it is the consequence of the saturation of the external IP network becomes more and more important due to the growth of IP traffic. A methodology based on the packet level measuring of IP network traffic had to be worked out for the localization of the bottleneck. With passive measurement the traffic of the network is not increased, as opposed to the active method where test packets are input to the system in the course of measuring. By analyzing the micro-structure of the traffic the upgrading of our methods used for the traffic calculation of IP network also becomes possible.

The objective of research and development efforts was to elaborate a methodology which enables us to obtain information – even by processing traffic data measured on a single link of the IP network – about indicators that indirectly show the presence of bottleneck and the degradation of service quality. When a bottleneck is detected the identification of the location (Magyar Telekom's IP network, external IP network) is essential. Using the worked out methodology we are able to estimate service quality features with measurements carried out in the IP network, quantifying thereby the extent of user satisfaction or dissatisfaction.

For the elaboration of the methodology we performed measurements on several links of Magyar Telekom's IP network (in both overload and non-overload cases) during which the packet level data of traffic transferred over the link were recorded. We have developed procedures suitable for the processing of measurements, enabling us to obtain traffic statistics that indicate the presence of a bottleneck. The data processing was extended to determine further statistical indicators as well that are characteristic of packet level traffic. In the course of these efforts we received data that can be utilized in traffic calculation to identify the distribution of the size of packets, to classify the traffic in terms of protocols and to describe user behavior. The packet level traffic was analyzed also from further two aspects to be taken into account during calculation. These aspects were the fluctuation (burst like character) of the traffic and its presentation on several time scales (self-similarity).

#### Analysis and planning of NGN architectures

It is difficult to give a precise (closed) technical definition for the Next Generation Network (NGN) since this is a very complex concept, flexible in terms of technology. NGN is the convergent network of the future where efforts to work out and develop it are still far from being terminated.

The NGN can be described with its main objectives, technical characteristics, capabilities and architecture:

#### Main objectives

- A) Multi-service integrated network – a single network for all kinds of services, promising the reduction of development and operating expenses.
- B) Make services and applications independent of the technology – New Generation Service (NGS) concept, offering the flexible implementation and operation of services and applications, and making also possible the separation of network operator and service provider roles.
- C) Personalized and everywhere available services – users can assemble service elements (components) according to their demand, and the same set of services is available at different locations, via various access tools. With this approach the concept of mobility is extended, the so-called nomadic use appears at the borders of the fixed network as well.

#### Technical characteristics and capabilities

A network that meets the above-mentioned targets must have several capabilities. To mention only the most important ones: packet based transfer, separation of control functions from the media, end-to-end broadband capabilities with the management of the Quality of Service (QoS), several types of name- and addressing system allowing conversion to IP addresses, general mobility, fixedmobile convergence capability, compliance with regulatory requirements.

#### Architecture and protocols

NGN brought about a reform in architecture. Instead of monolithic exchanges separated functional elements are used, and the control functions – hidden previously in the inside of switches – now appear between the devices. On the one hand this approach promises flexibility and economic efficiency, but on the other hand it represents a serious challenge in terms of standardization.

The main objective of initial implementations was to realize telephony on IP bearer network. For this purpose manufacturers grouped the necessary functions into their devices according to their own concepts: soft-switch, signaling- and media gateways, servers, etc. Moreover, the applied interfaces and protocols are not fully mature either therefore today the devices are not compatible yet.

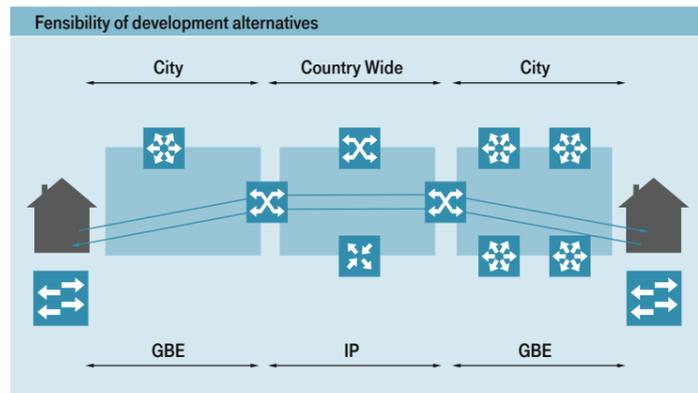
In the analysis and planning of architectures the most important element was to recognize that the previous telephony centered concepts were going to be replaced by a more comprehensive elaboration of NGN architecture which is based on and integrates the IP Multimedia Subsystem (IMS) described in third generation mobile specifications. The activity of ITU NGN Focus Group and ETSI TISPAN Working Group represents a remarkable main trend of these efforts. The principal attractive features of the NGN architecture being elaborated by ITU will be the interoperation with access networks of different realization, the implementation of mobility in a wide range including interworking between networks of various service providers, the handling of multimedia services and applications with adequate security and differentiating in quality (QoS) which makes also possible a charging structure adapted to the given services.

We have worked out the framework and system engineering plan for the implementation of NGN based on the analysis of the explored NGN concept and of the possible architectures.

**Development of Layer 2 VPN technologies**

With the gaining ground of IP networks, technologies allowing the development of "transparent" data communication over IP also emerged as an alternative solution to traditional data transmission technologies (ATM, MLLN).

In the course of development we have examined the development alternatives as well as the dominant and spreading technologies. These are as follows: - EoMPLS (Ethernet over MPLS) - VPLS (Virtual Private LAN Service) - VPWS (Virtual Pseudo Wire Service) The figure below sketches out an implementation possibility:



The special feature of the development was that tests other than singlemanufacturer ones have also been carried out. As a result of developments concrete proposals on the modification and upgrading of products were made. The achievements have been and are implemented during the development of Magyar Telekom's MetroNet2 product.

**Development of 3play system technology**

The Triple-play (hereinafter referred to as 3play) is an integrated service based on non-traditional PSTN/ISDN technology, offering voice- (telephone), data- (Internet) and program type content services (TV and radio programs, video, teletext, etc.) over the IP network and ensures simultaneous access to these three service elements.

The ultimate purpose of 3play service is to make available this integrated facility to users connected via any kind of access network (xDSL, Ethernet, CATV, GSM, Wireless LAN, etc.).

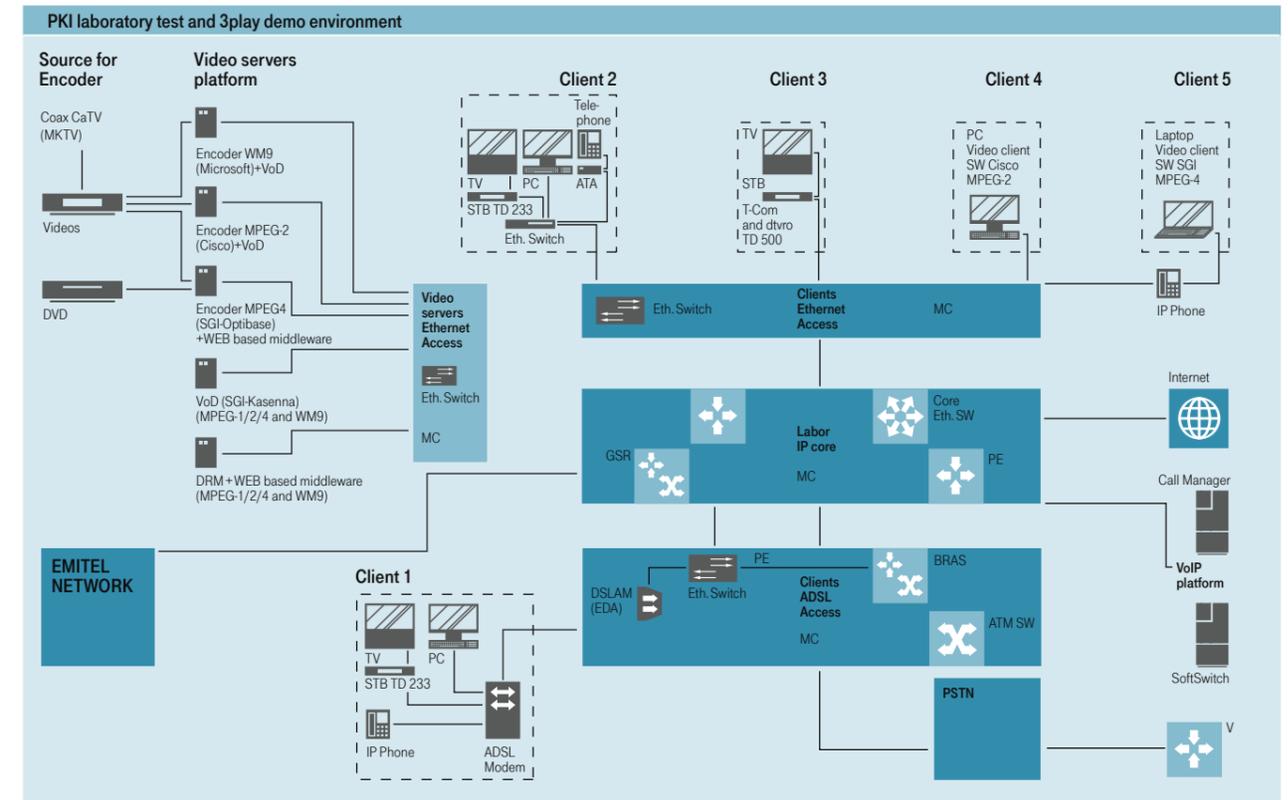
Applying traditional telephone set/mobile phone/IP telephone, television and/or computer the services can be used mainly via such access network that can provide a bandwidth necessary for enjoying the service elements as well as the required service quality.

The aim of our work was to prepare ourselves professionally for the provision of 3play service operating in service provider environment and for the identification of special boundary conditions. The testing of protocols and devices as well as the analysis of advantages and drawbacks was also essential for the optimum implementation in Magyar Telekom specific environment.

The following tasks have been performed in connection with 3play:

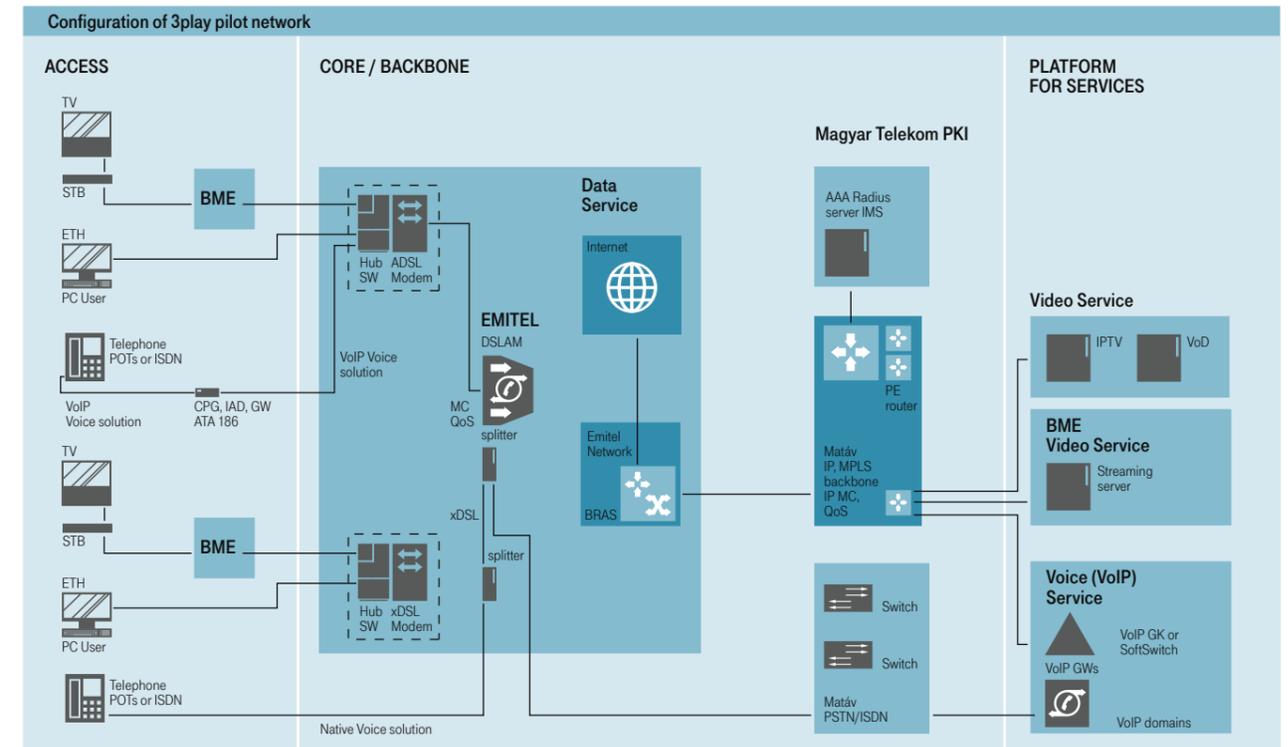
- development of 3play systems technology,
- testing of multimedia services in Ethernet environment,
- testing of DRM (Digital Rights Management) systems needed for the implementation of 3play service.

The following figure shows the laboratory test and demo environment of PKI where access to the service was implemented via both ADSL and Ethernet facilities.



Utilizing the previously mentioned laboratory network set up at PKI we have carried out – in cooperation with Emitel – laboratory tests and friendly subscriber tests as well, in the frame of which the basic functions of 3play service

have been realized. This task is closely connected with the activities described in Chapter 3.2. The next figure shows the schematic structure of the 3play pilot network created together with Emitel.



During the elaboration of the subject several applicable 3play devices forming a complete system (STB, video-encoder, IP TV middleware, VoD-server, DRMserver, DSL-modem units, VoIP GW, IP DSLAM, Ethernet SW, etc.); protocols (MC-PIM, IGMP, etc.); and encoding procedures (MPEG-2/4, WM9) as well as the interoperation thereof were tested in laboratory environment.

We are planning to carry on the theme with further tests.

**Development of multimedia services**

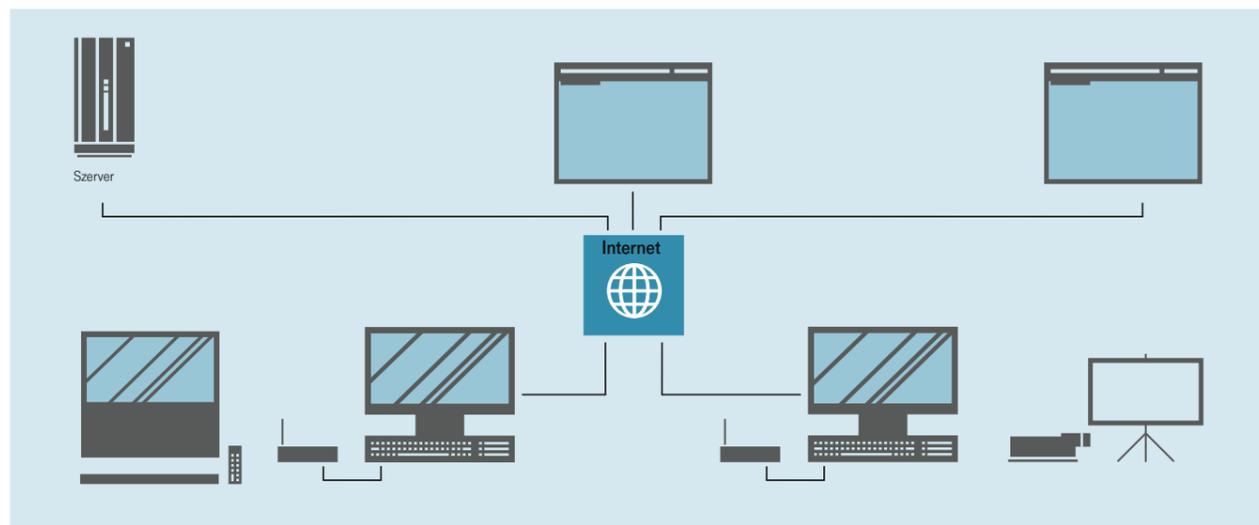
The dynamic evolution of information technologies and the intensive gaining ground of new technical solutions compels companies in a number of industries to think over the tried and tested business models in order to be able to maintain their market position and to compete successfully with new players emerging on the market. Trends necessitating such actions are for example the fast spreading of broadband networks, the integration of data- and telecommunications networks and lately the appearance of video traffic on the data networks (triple-play).

The market becomes saturated in the area of telecommunications services as well, forcing service providers to extend their portfolio and to increase efficiency. Apart from traditional telephone usage the necessity of developing various supplementary services can more and more be experienced. These new services differ fundamentally from the previous ones, moreover require the upgrading of networks, the automation of processes and the reconsideration of methods used for measuring and billing the usage.

In the frame of a research and development (R+D) project Magyar Telekom launched, with the contribution of several external organizations, the testing of future multimedia services and the elaboration of technical possibilities.

The study on the "Possibilities of utilizing for advertising purposes broadband digital content service solutions transmitted over the IP network (Multimedia streaming publicity)" was completed in cooperation with the Regional Innovation and Research Center of T-Systems. The document describes an innovative service, the broadcasting of up-to-date broadband digital advertising, outlining also the environment of the solution, and touching upon the requirements of advertising using outdoor and indoor projection, the solutions available on the market, the technical parameters of traffic and its feasibility in the network of Magyar Telekom. Emphasis is laid on the identification of requirements raised in connection with the service as well as on detailing individual developments necessary for the provision of the service such as the elaboration of customized advertising order form, administration application and web interfaces corresponding to customer demands. In addition, the requirements of customer friendly use and the technical infrastructure needed for the provision of the service are also specified.

A prototype has also been produced on the basis of the study.



**Telecommunications services developed to aid impaired users**

The telecommunications and infocommunication technologies of the future represent a new opportunity for those with some kind of impairment to improve their quality of life. The utilization of these technologies is assisted by the VoxAid software engineered at the Department of Telecommunications and Media Informatics within Budapest University of Technology and Economics (BME TMIT), entrusted with this work by Magyar Telekom PKI. This facility makes possible with a text displayed on the screen of the computer the use of the telephone for hard of hearing and/or speech impaired people.

People living with decomposition of movement and speech defects can often communicate only slowly. The e-mail and computer based conference open up a new channel for them where speed is no more a handicap. The computerized speech synthesis and voice gateways offer useful help to both the visually impaired and the handicapped by speech disorders. As we have previously mentioned, disabled people often communicate more slowly, thus they prefer the messaging systems. The conversion of various message types is important for them. This task is realized by the so-called Unified Messaging System (UMS). The table below shows the possibility of changing over between the systems.

The PKI application called VoxAid is a communication tool that has been worked out for hard of hearing and/or speech impaired people. Using this facility even those who do not hear at all and are unable to speak can make calls.

The upgrading of VoxAid software aimed at the expansion of the applied dictionary on the one hand and at the replacement of the fixed dictionary solution on the other hand. In free text operating mode any text can be typed in, requesting the application to read it out. In fixed text operating

mode the user can select from phrases stored in advance and arranged into categories. Choosing the adequate category the phrases belonging to it appear on the lower half of the screen. By clicking on the phrase (or on the "Reading out" icon) the application reads out the selected text.

Using the developed software the hit rate of text recognition is about 60 %. In our opinion this result is insufficient for general introduction in practice therefore we are planning the improvement of the software.

**Methodology for the analysis of copper access network**

In the plan for 2004 the connection of 100,000 new ADSL customers was scheduled where the access section between the DSLAM unit and the customer's flat is realized with copper cables in the majority of cases. The planned amount of new connections can be achieved – in addition to increasing the penetration rate in settlements already provided with ADSL capability – only through the involvement of new settlements.

Due to mass provisioning efforts the pre-qualification of the access network was given a key role, strengthened further by network analysis tasks connected with the increase of ADSL speed (ADSL Speed-Up) envisaged in the course of the year.

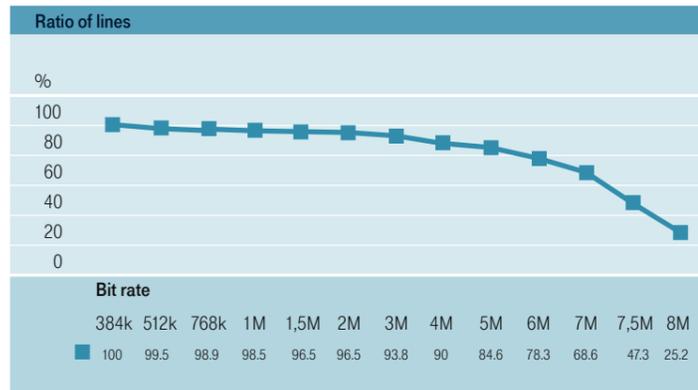
Although the ADSL pre-qualification system built on the data of the technical inventory system was already realized in 2003, the newer and higher level user demands make necessary ongoing upgrading. For the satisfaction of such demands the support system was supplemented in 2004 – with the efficient contribution of PKI – by the following main parts:

- As a result of developments and successful tests the pre-qualification system was integrated into Magyar Telekom's processes used for the support of ADSL provisioning.

	Phone call	Voice mail message	SMS	MMS	E-mail	Facsimile	Chat via Internet
Phone call	+	+	+	+	+	+	+
Voice mail message	+	+	+	+	+	+	+
SMS	+	+	+	+	+	+	+
MMS	-	-	-	-	-	-	-
E-mail	-	-	-	-	-	-	-
Facsimile	-	-	-	-	-	-	-
Chat via Internet	+	+	+	+	+	+	+

+ Solvable  
- Solvable with loss

- Following the analyses the results of measurements carried out by the technical area (PairQ) were directly used in the algorithm applied for the calculation of final result.
- Due to the specifications made after the comparison of inventory and prequalification data, the system is already able to differentiate whether physical copper cable or PCM pair gain equipment is used to link the



tested line to the telecommunications exchange. If the line is operated on PCM facility then the outcome of the pre-qualification is as follows: "ADSL cannot be installed – cutover is necessary".

A completely new procedure had to be worked out for compiling the expert opinion on the access network, requested for the planned speed increase. The procedure had to be completed in a short time, taking into account the following:

- search for the possible information source,
- specify the collection of data stored in the ANMS management system,
- process the line parameters of ADSL units being in operation /108 thousand/ (data cleaning, grouping and correction),
- generate the final result in table and graphical format.

Figure shows the ratio in percentage of Magyar Telekom subscriber lines that are able to implement transmission at given bit rates.

## R&D consortiums

### MUPBED project

The "Multi-Partner European Test Beds for Research Networking" (MUPBED) project is by the European Union supported IST (Information Society Technologies) project, running with the participation of Deutsche Telekom T-Systems, Telefónica, (Spain) Telekom Italia, Marconi, Juniper and seven foreign research institutes.

The main purpose of MUPBED project is to test and introduce those state-of-the art network technologies and solutions that help to build up the future's ultra-wide research networks and fundamentally ensure the competitiveness of the European research networks.

To achieve this target, MUPBED gives priority to the studying of the requirements of the raising multi-media applications and relevant interworking systems – such as, for instance, the GRID-s – in order to create the appropriate network architectures with consideration of the latest technological developments.

In addition, MUPBED puts to analysis the aspects and new solutions of the optimised interworking of the broadband applications and the dynamic communication networks. The research going on in MUPBED opens new horizons by implementing and testing the new type network concepts in a large-scaled Pan-European testing environment.

The work in the MUPBED project is divided into five Work Packages (for further details on project organisation, please visit to: [www.ist-mupbed.org](http://www.ist-mupbed.org)). Magyar Telekom is involved only in the work of the WP1 Work Group, which has the task of specification and continuous refining of the test bed reference architecture being developed in the project.

In lack of physical assets, the research is ongoing on a theoretical plane, but in a close working contact with the foreign partners.

The R&D activity launched in 2004 at PKI under the title "Participation in MUPBED project" covered first of all the making of studies necessary for the fulfilment of "Deliverable1.1 – Preliminary definition of reference architecture for an intelligent optical network supporting advanced application in research environments" by the date of May 2005. The prepared study paper of almost 20 pages forms an integrated part of Chapter "3. Application scenarios and network requirements" of the above performance, that will be published on the home page of the project.

The work performed in 2004 forms the basis for the completion in 2005 of Chapter "5. Network layer interworking", which is being entirely edited and co-ordinated by Magyar Telekom.

### National Research and Development Program (NKFP) project: adaptive media stream service architecture for the latest mobile telecommunications systems

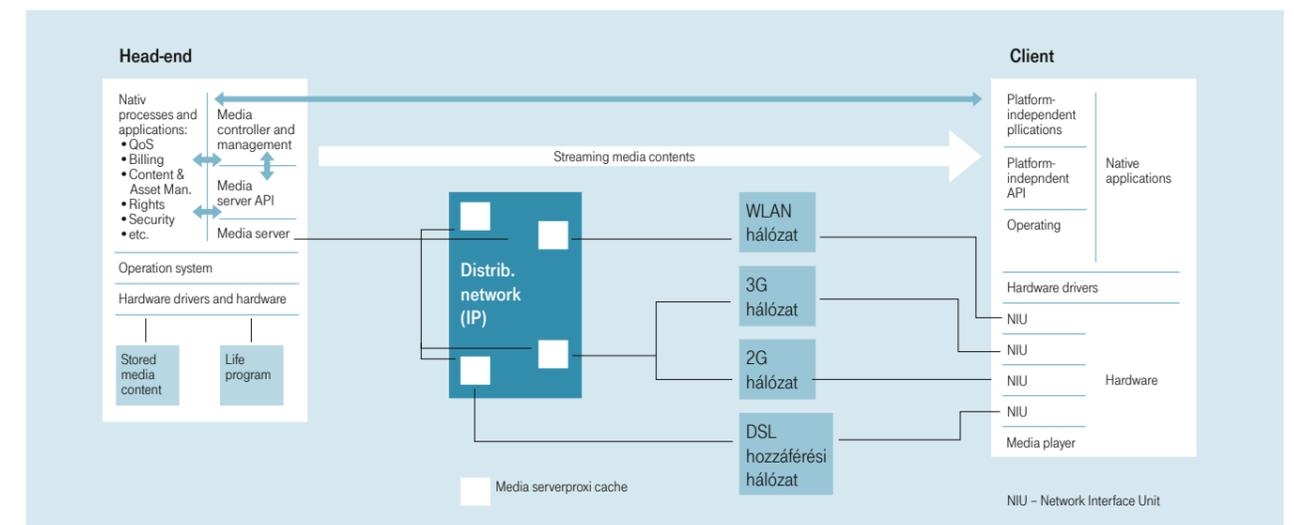
The main purpose of the project launched in 2004 is to develop a media stream service architecture for the next generations of fixed and wireless systems, with the help of which scalable and quality media stream (streaming audio and video) services and applications can be provided for the subscribers in a flexible manner, tailoring them to the actual customer needs and the changes in the status of the network.

The basic research-like tasks are aiming at the modelling of transmission of media streams in dynamically changing wireless communications networks and at the testing of the relevant wireless streaming protocols.

The applied research tasks have set the following main objectives:

- elaboration of solutions for the assurance of the quality of the mobile media streaming service,
- transparent transmission of multi media information through heterogeneous access networks,
- analysis of dynamic client-server feature compatibility methods,
- creation and optimising of adaptive Service Delivery Network (SDN) supporting value-added mobile services and applications,
- in addition, solving of data and service security tasks with the application of Digital Right Management technology in the next generation networks.

In the experimental development phase, which is a substantial part of the project there will be the adaptive media stream service architecture developed and its experimental system (test bed) implemented for the performing media stream transmission tests. Evaluating the test results and based on them by optimising the system we can prepare ourselves for the real service situations. We implement the mobile DRM (Digital Right Management) technology. The streaming tests are extended also to WLAN hotspots and Home Network environments.



## National and international relations

To strengthen our professional abilities and innovative thinking we put great emphasis on obtaining experience from national and international partners. In the course of it we have the opportunity of being involved in the scientific activity of institutions of higher education and getting familiar with the working culture and methods of other providers and manufacturers/suppliers for further development of our professional and business relations.

Accordingly, we have various and diversified development relations, starting from the business co-operations with vendors and partner providers and relations maintained with domestic education institutes, scientific and interest representation organisations and continued with the common activities in international R&D and standardisation organisations.

Hungary's accession to the European Union has opened the way also for Magyar Telekom to join and participate in various national and international R&D programs. With the using of funds won via application submissions prepared either alone or in collaboration with manufacturers, research institutions or universities we can implement R&D programs promoting business growth. These themes have been detailed in the relevant professional chapters.

### Domestic relations

#### Educational institutions

PKI's relations are traditionally essential with the institutions of higher education (primarily with BME, the Budapest University of Technology and Economics), since these relations form us a basis for knowledge transfer and recruitment of young professionals. We have been allocating orders for years to BME in connection with platform/network or product development related R&D themes, involving the University, or its students in daily activities. Year by year we are sponsoring several scientific events organised by BME.

Additionally, PKI has been co-operating traditionally for several years with the Technical College of Budapest, Széchenyi István University of Győr, University of Pécs and

University of Miskolc, involving their graduating students in daily development activities, promoting in this way the scientific and practice-oriented education of the rising generation of Hungarian professionals.

#### Co-operative research centres

In 2004 the Company or the Group had more available financial means to fulfil the development tasks, since according to the Act of 2003 on Research and Technology Innovation Fund the business associations falling within the scope of the Act on Accountancy shall pay a contribution, from which the direct costs of research and development activities performed within the business association's own scope of activity as well as the expenses of research and development tasks ordered from certain organisations may be deducted.

Being encouraged by the Act, in 2004 our Company has launched major developments and established several consortiums with its research partners for the successful and more efficient realisation of these tasks outlined in details in the relevant professional chapters.

The Inter-University Centre for Telecommunications and Informatics (ETIK) was established in 1998 with the key objective to establish a research-development and innovation centre that promotes the mutually advantageous co-operation of universities and industry in the domain of telecommunications and IT research & development. Magyar Telekom is one of the founding industrial members.

The grants obtained in the frame of the Co-operative Research Centres Program (KKK) of the Ministry of Education enabled us to launch new projects. As of 2004, by submitting applications, further projects can be financed from the GVOP (Economic Competitiveness Operative Program). In the frame of KKK, the Inter-University Telecommunications and IT Centre deals with the following 12 research themes divided into 3 research programs:



#### I. Internet-based info-communication networks

- 1.) Analysis, modelling and engineering applications of IP traffic
- 2.) Communication protocols
- 3.) Traffic engineering in IP networks
- 4.) Algorithmic analysis of networks' routing and streaming problems with engineering methods
- 5.) Voice transmission over Internet Protocol (VoIP)
- 6.) Analysis of traffic (QoS) parameters of high speed networks and elaboration of call admission control algorithms.

#### II. Mobile communication technologies and systems

- 7.) Analysis of third generation (3G) mobile systems
- 8.) Analysis of IP mobility issues
- 9.) Analysis of wireless infrastructure and ad-hoc LAN-s
- 10.) Digital broadcasting and related new services

#### III. Mathematical methods in technical research

- 11.) Analysis of coding theory problems from the perspective of telecommunications applications
- 12.) Non-orthodox network tests

#### Scientific organisations

We actively contribute to the activities of the Scientific Association for Infocommunications (HTE). PKI is represented by two members in the Board and we take

part in the work of almost all sections. We also co-operate with HTE members in the organising committees of various events.

Magyar Telekom has been member of the Hungarian Innovation Association (MISZ) since 1996. From 1997 on the company has been regularly participating in the National Innovation Award Competition and till today it has been awarded three times with special Innovation Prize for its four submitted competition papers. The elaborators of these studies are usually PKI engineers.

To the 13th National Innovation Award Competition (2004) we have submitted a study paper titled: "Broadband for everyone with the utilisation of the advantages of Ethernet technology". The judgement committee has recognised this work with a certificate of merit. The successful participation enhances the recognition of Magyar Telekom's innovation capabilities. In addition, through MISZ we help young Hungarians to participate in the scientific and innovation activities.

Magyar Telekom is a founding member of the Hungarian Standards Institution (MSZT). The representative of Magyar Telekom is an elected member of the Standardisation Council, the management organ of MSZT. Our specialists lead several technical committees, prepare national stan-

dards and actively contribute to the work performed in the frame of national, program and technical committees. Approximately 10 % of national standards issued by the Hungarian Standardisation Body are used by Magyar Telekom.

#### International relations

PKI participates in various international organisations for telecommunications development and standardisation (EURESCOM, ETSI, ITU), whereby – in addition to obtaining information about the international trends of telecommunications development – we can also participate in the shaping and identification of these trends.

The standards and specifications elaborated by ETSI (European Telecommunications Standards Institute), the European Union's official standardisation body – where Magyar Telekom has full membership – are indispensable in the designing and operation of telecommunications networks and services as well as for ensuring the interoperation of new services. The recommendations worked out by ETSI take into consideration specific European conditions and requirements and supplement the relevant recommendations of ITU-T. In addition to the results directly used for network and product development, the interim working documents are applied in the domain of strategic planning.

PKI experts are involved in the work of TISPAN, or TM6 Work Groups dealing with the standardisation of ENUM and DSL technologies.

The results achieved in the Work Group of ENUM in the domain of IP-based voice transmission and protocol support of new telecommunications services are utilised in the development of the new voice services.

The TM6 Working Group has the task to create standards for xDSL technologies and related other subject-matters (e.g. spectrum management, splitter requirements, etc.). xDSL is a collective term, comprising specifically the following technologies: HDSL, SHDSL, ADSL, ADSL2, ADSL2+, VDSL, VDSL2. ETSI TM6 – in close collaboration with the SG15 Work Group of ITU – elaborates its recommendations with consideration to specific European conditions

and requirements. One of the most important issues in 2004 was the standardisation of ADSL2+ and VDSL2 technologies. These technologies are capable to provide higher bandwidth (over 20 Mbps) and therefore are suitable for the provisioning of new, especially video services.

The standards elaborated by ITU-T and ITU-R, the two professional branches of ITU (International Telecommunications Union), ensure world-wide compatibility of telecommunications networks and services. Like with ETSI, interim working documents are important input information for strategic issues. PKI experts contributed to the work performed by Study Group 15 dealing with the elaboration of recommendations for network signalling and protocols. This activity comprises the further development of the current recommendations (e.g. SS7, DSS1, etc.), the upgrading of IN (intelligent network towards convergent next generation network architectures (NGN).

EURESCOM (European Institute for Research and Strategic Studies in Telecommunications) was established by European network operators for conducting joint research and development activities and for the publication of results. Magyar Telekom has been a shareholder member of the organisation since 1992.

In 2004 PKI professionals participated in the elaboration of the following EURESCOM projects:

- P 1304 CENTS – Analysis of future optical access network technologies
- P 1401 OSIAN – Digital Home – development of multimedia services
- P1305 GENIE – Upgrading of MPLS/GMPLS based networks and elaboration of new services that can be provided on MPLS/GMPLS basis
- P1446 WiBan – WiMAX in connectivity/aggregation and access networks
- P1444 NGN signal transmission using ENUM
- P1445 OSS concepts of next generation networks

The international DSL Forum, as an international consortium, brings together 200 members, including leading service providers, equipment manufacturers and other interested parties (non-profit organisations). The objective of this Forum is to exploit the full broadband possibilities/potential of DSL technology for the satisfaction of mass

demands. Focusing on the 200 million subscribers planned for 2005 the DSL Forum endeavours to rationalise processes, elaborate specifications and identify the steps of the explosion like, global roll-out of DSL by sharing the best practices. The main goal of DSL Forum is to meet the demands of new generation multimedia services and on-line society by working out new standards and encouraging the launch of new applications.

#### Co-operations within Deutsche Telekom Group

The harmonization projects between DT and the DT Group members (MakTel, Slovak Telekom, Croatian Telekom) play an important role in our development cooperation relations. Their objective is to ensure cultural and infrastructure compatibility, to implement joint development projects and to establish DT Group level cost optimized networks (for example to create joint terminal equipment portfolio and uniformed ADSL and IP platform, to prepare the introduction of new technologies and to harmonise next generation network concepts). The development themes launched with common efforts offer the opportunity of utilisation Group-level synergies, while pursuing efficient financial and human resource management and involving common contractual partners.

#### The role of events organised by PKI in our relations

To present our achievements, to exchange experience and strengthen inter-personal relations traditionally we organise two conferences each year. One of these outstanding events is organised in spring, while the other is held traditionally around 20-22 November at the date of the foundation of the Institute.

One of the outstanding events of 2004 was the "Conference on nanotechnology" held on 26 and 27 April 2004. The first day's programs were hosted at the Hungarian Academy of Sciences, while the second day's programs in the Conference Hall of Magyar Telekom Headquarters. The organisers of the event were PKI, the Hungarian Academy of Sciences and the National Council for Communications and Informatics (NHIT). It was the first time that – in addition to scientists – also telecommunications experts could have the chance to get to know the practical and theoretical results of outstanding Hungarian physicists, biologists, physicians and chemists/technologist and form a view on the possible impact of

nanotechnology on telecommunications. Last May the daily 'Napi Gazdaság' and Business Online each issued a briefing of the conference.

The conference event of PKI Scientific Days we held in Magyar Telekom Headquarters on 29-30 November 2004 at the date of the 113 th anniversary of the foundation of the Institute. This time the conference focused on the topic "Preparation for the application of new technologies". The conference attracted an intense attention and there were 390 participants in the event.

In 2004 innovation, development and applied research were put in the focus of attention countrywide, and the topics of the presentations of 'PKI Days' were selected according to it. Numerous IT applications and a wide choice of telecom services were introduced to the audience on the event. In Section 1 of the first day's program governmental representatives of telecommunications, IT and technical development outlined their ideas.

Further papers of the sections addressed – among others – the objectives, trends and directions of research, the possibilities of the extension of service portfolio and the implementation of broadband entertainment services, the possible orientation of NGN and the main aspects and principles of security and dimensioning.

From the slides presented and from the articles selected for the special issue of 'PKI Days' we have compiled a CD.

The fact that our events and conferences attract hundreds of experts indicates an intense interest in the technical results of PKI and of Magyar Telekom as well. Prominent personalities of the telecommunications sector take part in our events and several lectures are delivered also by invited recognized telecommunications, IT and economic experts.

In addition to the above mentioned events, PKI organises also regular short meetings, so called 'professional afternoons', inviting – besides presenters of its own – also university or other external partners to talk about a current research topic or present their actual results. These internal consultations with 20-30 participants in average give a forum for free professional discussions on the merit of issues for the preparation further development tasks.

# Research and development activity of member companies

## R&D activity of T-Mobile

According to the vision of T-Mobile Magyarország Rt. the company links - as the leading telecommunications and information service provider on the market - individuals of the society for a better future, trying to offer top quality, efficiency and innovative knowledge to its customers. For this purpose it participated last year in several research and development projects in cooperation with a number of organizations (universities, strategic investors and suppliers).

The continuous integration of IT and telecommunications systems is essential for the information society since at present the various information contents (speech, picture, video, etc.) can often be accessed only via different networks which requires expensive investments on the part of both service providers and users. Therefore T-Mobile and its R+D partners participate on the one hand in a project launched in the frame of the National Research and Development Program for creating such a man-machine voice connection in voice information systems (for example automated informing systems using interactive voice response units, call centers, voice portals, etc.) where the use is adapted better than previously to the human behavior. On the other hand we contribute to the development of a service framework - mainly for mobile environment - that assists us in providing quality media flow (voice and video) services and applications in a scaleable way, adapting flexibly to user demands and to the changes of network status.

The other direction of the support attempts to help disabled people. The deaf cope with a lot of difficulties when they have to communicate with their hearing fellows by way of speech. They are also mostly excluded from the use of mobile phones. Mobile phones as very intelligent and programmable devices that are always at hand and have network connection can be the basis of useful auxiliary tools for the deaf. Therefore the task is to develop - built on the latest results of voice technology - a device equipped with a suitable display unit that is able to understand speech signals as well as to transform the speech of deaf persons often difficult to understand into a more comprehensible one. The development of such equipment on business basis cannot be hoped. To provide auxiliary devices becomes an obligation specified in law. Results achieved in this area in Frame Program No. 5 of the European Union are also to be adapted.

The building of an on-line information database for improving automatically the traffic conditions of aboveground transport has begun with the contribution of Budapest University of Technology and Economics. The key element of the system developed as pilot during the project first for the area of Budapest is a database comprising information on transport lines that can be queried from mobile phones as well and is directly and rapidly available for anybody and from anywhere. A further possibility is to create a database on road breaking.



The running environments of today's mobile devices are diverse (Windows, Symbian, NOKIA, etc.). Applications downloaded to mobile devices run with different efficiency in various environments, therefore the purpose of research is to analyze JVM profiles, MS/CLR and the conditions of optimum platform selection on the one hand, and to choose the appropriate running environment for a more efficient development on the other hand.

The performance of embedded systems applied in 3G mobile networks varies according to the function to be implemented. The capacity constraint of the system as dedicated hardware requires the optimum implementation of the VoiceOverIP function wished to be integrated as well as the portability of a given solution. The purpose of research efforts is to perform algorithmic developments and work out software solutions that are adapted to the available bandwidth.

Applications running on mobile devices are brought into service in the user environment following a relatively short testing period. The development of the monitoring software that can be used for controlling, testing and analyzing the proper operation of solutions integrated into various environments is in process.

The evolution of today's web applications is steadily shifted towards implementations based on loosely

coupled components (SOA - Service Oriented Architecture). The system of XML web services ensuring the scalability of applications in a flexible way can be considered as state-of-the-art technology. On the other hand the selection of the appropriate service provider may result in lengthy search in a registration database due to the large number of web services. The purpose of the development is to examine how the selection of services can be made more efficient with the introduction of semantical metadata on the one hand, and to elaborate planning samples on the other hand.

The activity of T-Mobile is not restricted to Hungary; the company participates in projects of key importance at international level as well. We can mention for example the R+D and demonstration project financed by the European Union, launched with the purpose of working out and bringing into pilot operation at two sites a general mobile- and Internet payment solution.

According to the objective of the project called "Standardization of mobile service development applications" the operation of mobile terminals based on similar principles, and in compliance with standards that are unified in terms of the services also is essential for the evolution of 2G and 3G mobile telephone systems. Real mobility is possible only when services offered by carriers are standardized, do not depend on the given system or

terminal and can be accessed from any network. Representing the Company, T-Mobile Magyarország Rt. contributed to the standardization efforts of the PAG

## R&D activity of Emitel

The number of Emitel's ADSL customers showed a dynamic growth over the last two years. The company could satisfy demands with gradually increasing regional coverage; this indicator came close to 100 % by the end of 2004.

The service provider network is built on the EDA (Ethernet DSL Access) system of Ericsson. ADSL concentrators (Digital Subscriber Line Access Multiplexer /DSLAM/ units) located at settlements are interconnected via Ethernet backbone network.

The steadily growing ADSL and/or Ethernet backbone network provides broadband Internet connection for the time being. The main purpose of the project was to assess the capabilities of the access network in the area of multimedia services as well.

The three participants of the project were as follows:

- Emitel Rt. as the party having ordered the research and development project (customer),
- Department of Telecommunications and Media Informatics at Budapest University of Technology and Economics (BME) as contractor,
- PKI as the cooperating partner of the customer.

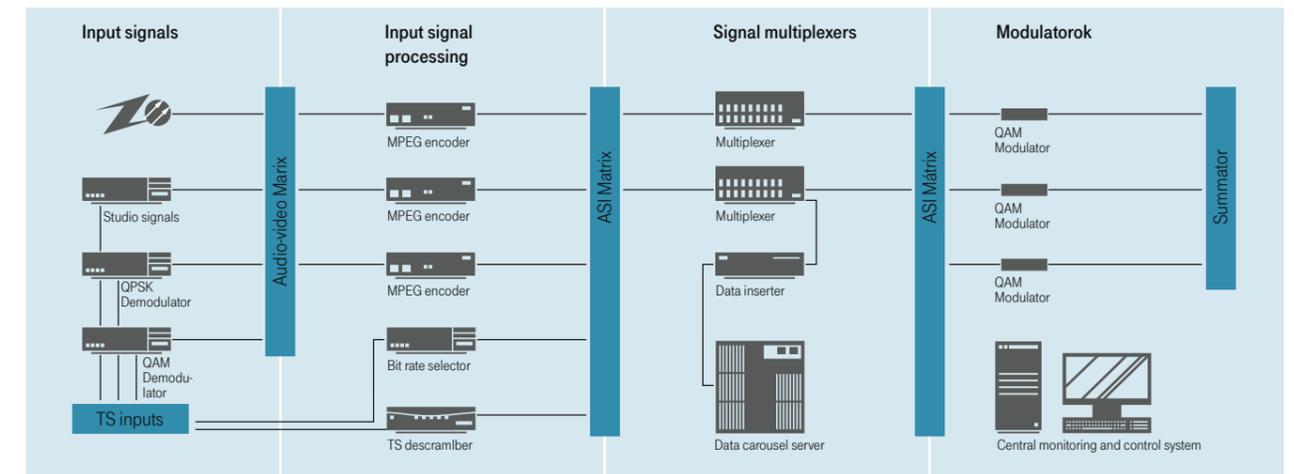
In the frame of elaborating the theme a study called "Multimedia services in Ethernet environment" was prepared by BME; the requirements included in the study were specified together by Emitel Rt. and PKI. The work examined the technical bases, the technologies, the schematic system engineering solution as well as the services that can be offered.

(Presence and Availability Group) Working Group of Open Mobile Alliance (OMA).

After the completion of the study a pilot network was constructed (see Chapter 2.2.11) where practical tests could be carried out. The pilot network had a total of 12 termination points in Kiskunhalas, Baja, Szeged and Budapest. At the termination points broadband Internet, video transmission and voice transmission were operated simultaneously via Ethernet based ADSL access. In case of video transmission programs of both real-time (TV signal) and on-demand character could be received. The central elements of the system were installed at PKI's laboratory in Budapest, while the majority of termination points were located within the service area of Emitel Rt.

Based on the evaluation of the project the main features of the experience gained can be summed up as follows:

- The Ethernet based ADSL access network is suitable for the provision of multimedia services. The majority of subscriber termination points meet the requirements raised by video transmission.
- We have made a survey of correlations between the quality of video transmission and the capabilities of Ethernet based access network.
- The principles of priority management for various services have been identified on both the Ethernet backbone network and the ADSL access section.
- After further tests the multiple utilization of the access network and thereby the increase of revenues will be possible.



## R&D activity of T-Kábel

### Implementation alternatives of digital CATV systems

The purpose of the project was to compile an analyzing strategic study on the comprehensive structure of a current CATV network from Head-End systems to Customer Premises Equipment (CPE) as well as on the achievable topologies (star, serial, ring) and system technologies including the advantages and drawbacks thereof. The theme was elaborated by the working group set up in the organization of the Scientific Association for Infocommunication (HTE).

The study includes the worked out measuring method as well for testing the quality parameters of the transmission path, the digital head-end and the SetTop Box. The prototype implementing the measuring procedure was also completed for the tests.

The measuring instrument is able to reverse engineer in real time the transport stream connected to its input as well as to display programs and other data or signals included in the stream. The analyzer offers the following features:

- Data Analyzer
- PSI (Program Specific Information) Analyzer

- PMT (Program Map Table) Analyzer
- Speed Analyzer
- Visual Test
- Measuring Platform In this version the analyzer and the development system form the first, implemented building block of a larger complex equipment; this building block can be used as stand-alone facility as well. Upgrading is possible in terms of both hardware and software.

Due to its style and the tests shown at the end of the document the study can be used for training purposes as well.

## R&D activity of T-Online

In 2004 the Company worked on three R+D projects with the involvement of external partners. The results achieved are summed up as follows.

Efficient e-mail archiving is a problem for a lot of companies and individuals; today this issue is not dealt with yet according to its importance (weight). In the study prepared by the Department of Telecommunications and Media Informatics at BME the reasons are analyzed and proposals for solutions are made. The authors investigate also whether e-mail archiving service is worth offering for an Internet Service Provider and if so, what are the required functions. The benefits of archiving are also described and analyzed in general:

- on-line storage demand is decreased,
- the size of the mailbox is significantly increased,
- the recovery time is reduced in case of server disaster.

The study analyzes the features of the various archiving products, with especial regard to the supported mailing systems, to the method of storing and indexing, to the off-line and on-line retrievability of archived elements as well as to the possibilities of system operator, service provider and user.

The following archiving systems were discussed in the study: Enterprise Vault (KVS), Email Xcelerator (StorageTek), Assentor Enterprise (iLumin).

The intelligent upgrading of search functions used in Internet content service became nowadays one of the major issues in this area. The analysis given by the Department of Telecommunications and Media Informatics at BME describes possibilities for the keywording of Hungarian textual content units. Based on the results, the semantical knowledge technologies T-Online should take into account when deciding on the directions of development are also identified.

The authors of the completed study make preparations for creating a system where the content of selected Internet sites (i.e. whose content has been checked) – or later on the extract thereof - is assigned to the elements of a

category system. The development of the hierarchical category system and its populating with documents constitute one of the essential components of this task. Since the mapping of documents to categories – or in short their categorization – shall be implemented automatically, using only the required minimum human resources, we have to specify the keywords that are characteristic of the categories. This latter task can be realized most easily by creating a learning document collection and teaching a categorizing, classifying algorithm. The study deals also with the methods of indexing documents, based on which the index building module, one of the essential components of the system to be constructed can be realized.

The changes of attention and viewer interaction when using interactive, new visual media have a major impact on users accustomed to watching television. The study worked out by C3 Cultural and Communication Center Foundation deals with the correlation between eyeball movement and the reception as well as processing of multimedia interfaces appearing on the screen, describing the rate of glancing over and passing on. The possibilities of a multimedia interface, where customers used to watching television can also access easily and rapidly the contents but skilled computer users are not averse to it either, have been outlined as well.

In the frame of the subject two issues were investigated in detail:

- a) Correlations of visual perception and eyeball movement when viewing complex images (multimedia, web sites)

The research efforts proved that the overwhelming majority of eyeball movements and fixations were directed towards the central part of the pages. Particularly small number of fixations were found on the edge and at the very bottom of sites. It was surprising that surfaces and parts of site (for example advertising spaces) comprising striking stimuli/picture elements but irrelevant from the aspect of the specific tasks to be performed by those involved in the experiment could catch the eye only to the minimum extent.

The result of the research was presented to colleagues engaged in content development and market research. Coordination efforts on the applicability of the methodology in practice are conducted during research aiming at grounding adequate presentation.

b) Interaction with the monitor: differences between the monitor of the computer and the television screen from the aspect of the viewer

The general program elements are not shown on the navigation interface of the set top box, the remote

controller can be used for navigating on the current web site. According to the feedback of users the uniformly preferred site includes – if possible - less than ten branching points or options built on visual elements with short descriptions; allows navigation with digit buttons and the entering of text; and applies multimedia elements. The result of the research project is a prototype interface applied for modeling the téka interface of [origo] so that it can be used on the television screen with a remote controller. The solution has been presented on a test set top box.

## R&D activity of EPT

### Automating of billing of retail and wholesale VoIP in a closed billing system

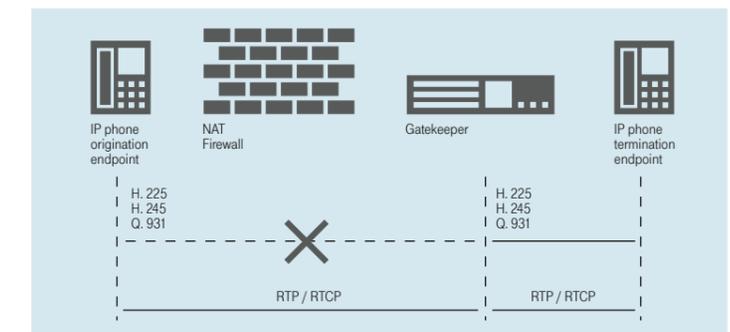
VoIP type traffic may consist of the following components:

- call signalling,
- call control/call setup,
- media communications.

In our days there are two standards rivalling with each other on the IP telephony market. One of them is the H.323 [H323] standard that has a relatively greater past and that is recommended by ITU-T, while the other is the SIP (Session Initiation Protocol) elaborated by the MMUSIC Work Group of IETF. The study paper written in this subject matter introduces both VoIP protocols, even compares them. It discusses the billing problems of PSTN-PSTN connections and that of the IPPSTN connections as well. The RADIUS protocol, which is necessary for the transmission of the basic billing information, is introduced in details. In addition, the problems of the application of private networks and firewalls are also addressed.

Depending on which type of VoIP protocol we are using, the communication can be implemented on two or several different channels. The channels are designated by the pairs of ports used either by the TCP (Transmission Control Protocol) that interconnects the two network elements or

by the UDP (User Datagram Protocol). Considering that most private IP network uses dynamic call signalling and local, dynamic IP address allocation, and also that for the users the handling of both of incoming and outgoing calls is inevitable, using of NAT and the firewall is an unavoidable problem for the administrators of VoIP



systems. The figure below introduces the call set up principle using NAT/Firewall.

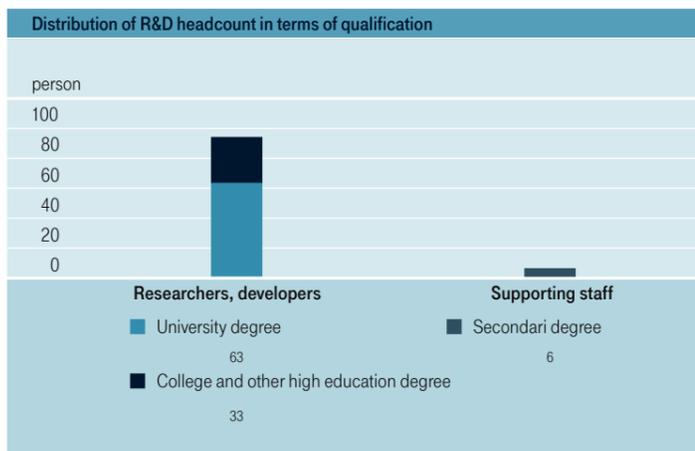
In connection with the study we can state that the control of the billing concept was successful for those call records that are included in both databases and for which the billing information is available from EPT side.

# Key financial indicators of R&D activity

## Indicators of Magyar Telekom Ltd.

In 2004 research and development activity was performed within Magyar Telekom exclusively by PKI. PKI is functioning within the Company not as a specialised research place, but as a unit in the activity of which the research and development functions are combined with innovation tasks. The headcount figures of the human resources available in 2004 are summarized in the Table.

Headcount	Year 2004
PKI full-time employees (person)	160
From the above employed in R&D themes (person)	102
Full time R&D headcount (person)	34



In 2004 PKI had 160 full-time employees. From this staff the headcount dealing with R&D project was 102; in relation to the full-time workers it means 34 people.

The Table shows the distribution of PKI employees engaged in research and development in terms of qualification:

64% of the Institute's headcount were engaged in research and development tasks and from this staff there are 96 professionals with university or college degree, and 6 employees administratively supporting research activities with secondary education degrees.

The staff of the Institute has the required skills to perform the technical development tasks and knows well the strategic objectives and is willing to work actively and efficiently to achieve them. 89% of the employees have graduated from a college or university, many have two



degrees. Most of the colleagues having college or university degree speak at least one foreign language – typically English. From the employees of PKI 6 hold university doctor's degree, whereas from those employed in part-time 1 is holder of a candidate's degree and 1 has Doctor's degree granted by the Hungarian Academy of Sciences.

We enhance the professional knowledge of our employees and the putting forth their managerial and interest representation abilities via appropriate internal and external training programs. Our employees have been regularly participating in professional further education programs and – according to our possibilities – in domestic and international conferences.

Publications of our experts appear in Hungarian and international technical journals, in conference reports and in books. In the series of scientific works written by our colleagues there have been one book in Hungarian, 10 professional journal articles, 2 CD-s, 1 conference publication or 1 book in foreign language and 1 press article published. Certificates and awards have been granted to several employees of the Institute for the innovative results achieved.

In 2004 PKI has handled 76 research-development

themes. The objectives and the volume of the individual projects have influenced the number of themes. Every launched research theme we could successfully accomplish, i.e. the achieved results are utilised in the Company's activity.

The Institute represents itself not only in domestic project but in outstanding international projects as well. Such a project of high importance is the EU-financed "Multi-Partner European Test Beds for Research Networking" MUPBED project in the frame of which we receive support in the period 2004 – 2007.

Our activities performed in the frames of EURESCOM are also remarkable. Beyond involving external financial resources it provides the possibility to utilise directly the R&D results and to extend professional knowledge basis.

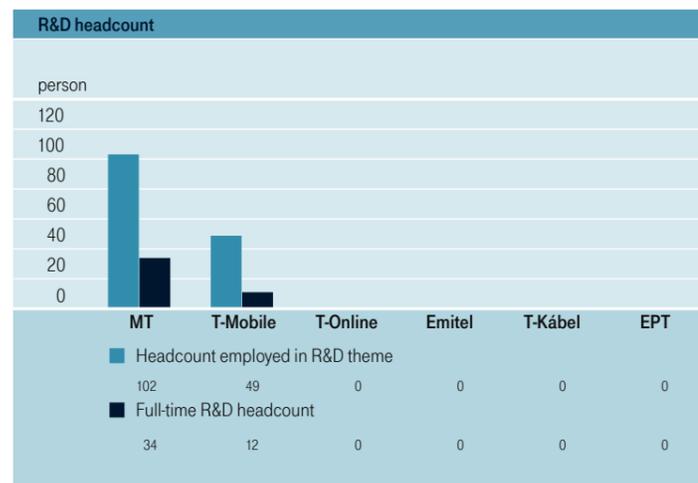
4 R&D project themes were elaborated in the frame of international co-operation.

49% of the technical development projects belonged to the category of applied research and 51% to experimental or pilot test tasks. No basic research activities are carried out by Magyar Telekom.

## Indicators of Magyar Telekom Group

In the recent years research and development activity was performed within Magyar Telekom Group at PKI only. The Act on the Innovation Fund has encouraged the Magyar Telekom Group member companies to intensify their research and development activities in 2004.

In the followings we present the relevant data of those Group member companies, where research and development activities were performed during 2004. The headcount figures are shown in the Table below:



As it can be seen from the diagram, in 2004 only Magyar Telekom and T-Mobile have pursued own R&D activity. From the employees of the two companies 151 people were involved in the elaboration of R&D themes. The corresponding figure related to full-time employees was 46. From employees engaged in R&D projects 142 have higher education degree, 9 employees working in the technical and administrative support fields to R&D have secondary degree.

The distribution of R&D themes is shown the Table on the bottom.

94% from the elaborated 114 R&D themes were completed successfully and the results we can utilise within Magyar Telekom Group. From the R&D themes 39% consisted of applied research, while 61% of experimental development tasks.

Denomination (pieces)	MT	T-Mobile	T-Online	Emitel	T-Kábel	EPT	Total
Number of R&D themes	76	32	3	1	1	1	114
From the above successfully completed	76	25	3	1	1	1	107
From R&D themes: Basic research	-	-	-	-	-	-	0
Applied research	37	4	2	-	-	1	44
Experimental development	39	28	1	1	1	-	70

## Outlook

Extrapolating the evolution experienced in the recent years, mobility and broadband transmission still seem to be the most prospective areas. We have remarkable experience in both. The popularity of the mobile systems has gone beyond all expectations and the number of more than 7 million users indicates that the customers still think that this line of telecommunications is worth to make even pecuniary sacrifice for such services. Broadband transmission is spreading rapidly, as well; the demand for higher transmission speeds is growing. Considerable improvement is to be expected in both fields, at the same time the extension of the frequency bands under the conditions of the given cellular systems has its limits, and it is not clear, whether the nomadic users (on the move) do require broadband access. Broadband transmission enables fast accessing to information on the Internet, but the transmission in good quality of entertainment programs will require even higher bandwidth.

On the basis of the above the upgrading and further development of optical fibre networks and bringing the endpoints as close as possible to the subscribers are tasks of primary importance. New technologies come up, with the help of which the information can be end-to-end forwarded to the people without electrical transformation. High capacity, fast operating and well manageable photo-electric switches will be needed, and it will require the intensification of R&D activities in the field of photonics.

In case of availability of the necessary facilities the tasks of all professional segments of IT can be met with adequate

centralization. The presentation and the ordering of goods in e-commerce, the centralization of public administration and then the enlargement of the scope of authority of the regional centres, as well as the continuous monitoring in public health and medical services can utilise the country-wide available fibre optical network. Accordingly, the IT network of this kind can be a network consisting of high capacity switches, sensors, data input devices and comfortable, distinctly visible displays. The way to such a network leads through the continuous implementation and development of Next Generation Network (NGN).

The ambition of service providers to attract customers and increase their market share leads to price competition, and we can see competing players in the area of bandwidth as well. The provision of new services that are capable of satisfying broadband demands may result in competitive edge.

Customer premises equipment become more and more intelligent, telephone sets are continuously upgraded with additional functions and equipment of new type are required for multimedia services. New services can be built on these products, and our technical knowledge plays an increasingly important role in the launch of such services.

In short, one of the major tasks to be performed by the Institute is to elaborate the concept of new platforms and to have our vision on the new network concept pointing towards NGN accepted.

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