Final Report

Austrian DVB-T Trial
Graz 2004

!TV4GRAZ

Vienna, December 14, 2004

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Preface

The era of digital television has arrived. The time to convert is now.

In this publication, the Austrian Regulatory Authority for Broadcasting and Telecommunications (RTR), as the operative arm of the Austrian Communications Authority (KommAustria) and a leading partner in the project, presents a comprehensive report on the regional trial of digital terrestrial television and interactive MHP applications in Graz, Austria, in 2004.

The trial, which was intended to provide technical insight for the introduction of digital terrestrial television (DVB-T) as well as knowledge regarding viewer acceptance, was among the earliest objectives defined by the Digital Platform Austria working group set up by Austria's Federal Chancellor in 2002.

2004: A decisive year for DVB-T

2004 was a decisive year for the establishment of digital broadcasting, in particular DVB-T, which means that the timing of the trial in Graz was perfect. Several EU member states have initiated important measures which have brought DVB-T out of the sphere of research and development and made it a daily reality for millions of viewers, especially in Great Britain, Spain, Sweden, Finland and Italy. In Germany, the successful transition in Berlin was followed by regular DVB-T operation in several significant coverage areas; by the end of 2004, approximately 1.4 million German households will have DVB-T reception devices. In addition, mobile digital TV is also showing promise as the next major development.

Therefore, it appears that the time has come to promote the introduction of digital television in Austria as well: 76% of Austrian households have PCs, and DVD players as well as digital cameras have each reached penetration levels of 55%. Moreover, large parts of the population are aware of digital television: 23% of consumers intend to switch to digital TV within the next five years, and 34% say they might do so in the next five years.

Digital TV trial in Graz yields worthwhile results

The preparations for the trial in Graz were wide-ranging and intensive, and the technical and organizational challenges were considerable for all partners involved in the project, as was the financial expenditure.

In retrospect, however, there is no doubt that the joint efforts of the project partners have paid off in a number of ways:

- The Graz trial underscored the future potential of Austria as a media location. Not only did the trial attract the attention of the relevant public in Austria, it was also followed with a surprisingly high level of interest by experts far beyond Austria's borders, especially with regard to the development of interactive additional services based on the MHP standard.

- For KommAustria and RTR, the trial yielded substantial technical insight and strategic approaches for the continued implementation of the Austrian Digitization Plan.

- The project also gave television stations, including ORF, ATVplus and five other private television broadcasters, an initial opportunity to test the practical handling of

these services and applications, which will become a major competitive factor in the world of digital TV.

- In addition to television broadcasters, IT companies and other service providers were able to generate know-how which will benefit the companies themselves as well as the digitization of all broadcasting transmission platforms (cable, satellite and terrestrial).

- Numerous communication activities accompanied the project and began to raise public awareness of the upcoming digitization of terrestrial television beyond the expert circles immediately affected by these advances.

In addition to the hard facts which came to light in this trial and from which Austria will benefit as a media location in general, I would also like to mention another special facet of the experience: The highly team-oriented and professional way in which representatives of companies which generally compete with one another were able to cooperate and realize an ambitious project together.

I would like to extend my sincere gratitude to all of the companies and institutions involved in this exciting and challenging project, and especially to their dedicated employees.

The time has come for Austria to introduce digital TV on all broadcasting platforms. The time to convert is now.

Alfred Grinschgl
Managing Director, Broadcasting Division
Austrian Regulatory Authority for Broadcasting and Telecommunications (RTR)

1.   Introduction

1.1.   Digital technology takes hold

Digital technology has already made its way into vast areas of the information and communications landscape. In all areas of application, the conversion of information into strings of zeroes and ones allows data to be compressed on modern storage media without sacrificing its quality. As the production industry in the media field entered the digital age long ago and the penetration of digital storage media (such as DVDs) is increasing rapidly in the consumer sector, the time has also come for broadcasting to upgrade to digital technology in order to meet the challenges of the future.

In Europe and many other regions (Africa, Asia), Digital Video Broadcasting (DVB) has successfully established itself as the technical standard for the industry. This technical standard has been adapted to accommodate the characteristics of specific broadcasting platforms, including cable (DVB-C), satellite (DVB-S) and terrestrial (DVB-T).

The speed of market penetration and the specifics of digitization on these three broadcasting platforms (cable, satellite and terrestrial) show significant differences and vary widely in different media markets. In any case, however, it is clear that none of the three platforms and no company in these markets can ignore the process of digitization, as otherwise they will be in danger of losing their competitive edge in the digital world.

The current status and outlook for each transmission platform are discussed in the sections below.

1.1.1.   Satellite broadcasting

Approximately 45% of Austrian households are equipped with satellite receiver systems. When used with analog technology, these systems only support the reception of foreign television channels. Households with analog satellite reception systems still have to rely on terrestrial reception in order to receive Austrian television channels (ORF and the private stations). In this respect, Austria is in a peculiar situation which is closely linked to the media policy role of such a small country adjacent to the German media market, which is ten times the size of Austria's and offers programming in the same language: For cost reasons (expensive channel rights), and especially because German television stations have claimed the unencrypted satellite broadcasting rights for themselves, Austrian broadcasters generally only own the rights to broadcast their channels in Austria. When broadcasting via satellite, Austrian stations have to ensure that their channels can only be received in Austria, which is only feasible by broadcasting an encrypted digital signal.

However, the number of digital satellite receivers in Austria is increasing rapidly. 25% of Austria's satellite television households (approximately 1.4 million) already have digital receivers. The reasons for this are as follows: The already large range of channels (several hundred) is increasing constantly; the one-time investment costs for digital devices are dropping rapidly; and analog satellite receivers (mostly purchased in the 1990s) are slowly becoming outdated. Another reason is that satellite users are already accustomed to using their television sets in conjunction with a set-top box requiring a separate remote control. Moreover, consumers with digital satellite receiver systems and the required decryption technology can receive all channels (including the Austrian ones) on a single platform (i.e., satellite). Thus ORF's channels are already being received and decrypted using Smart Cards by more than 400,000 Austrian satellite television households.

With its increasing market penetration, Premiere Austria, a package offered in Austria by the German pay TV provider Premiere, is also making a contribution to the digitization of satellite households: After purchasing the broadcasting rights to soccer games in the Austrian national league (*Bundesliga*), Premiere Austria was able to increase its number of subscriptions in Austria to over 200,000 (as of the end of Q3 2004). The channel aims to have 250,000 subscribers by June 2005.

Thus the digitization of satellite receiver systems is already progressing rapidly, driven by the market and in line with international developments. This reception mode is also being digitized quickly in the wake of international developments without specific efforts in Austria, especially as these systems are operated exclusively by foreign satellite providers (e.g., Astra). Almost 25% of all Austrian satellite television households are now using digital systems, and Christmas business is likely to raise this percentage to 30% by the end of 2004. In July and August 2004, more than 45,000 DVB-S receivers were sold, almost double the number sold in the same period in 2003 (approximately 26,000 units) and even five times the corresponding figure for 2002 (approximately 9,000 units; source: Fessel-GfK Consumer Scan 2002 – 2004).

1.1.2. Cable broadcasting

The level of cable penetration in Austria is approximately 40%. In contrast to satellite television, this field exhibits a constant penetration level, especially as those areas where installing cable networks is commercially attractive and reasonable have already been covered. Due to its profit orientation, the cable television broadcasting platform largely focuses on urban areas in Austria, and this situation is not likely to change. Cable reception mainly distinguishes itself by the variety of channels available and a high level of convenience, but also by regular costs. Cable television reception does not require the installation of a satellite dish, nor does it involve an extra set-top box, and Austrian as well as additional international channels are easy to receive using a conventional television set. The variety offered by analog cable television (30 to 40 channels) is not nearly as broad as in the case of satellite, but most consumers consider this sufficient because the basic (analog) package includes all channels which have broad-based attraction.

Whereas digitization is progressing rapidly in satellite reception, the number of digital cable television viewers has seen considerably slower growth. Cable network operators have only succeeded in making digital technology attractive to their subscribers to a limited extent, mainly by offering additional services (additional television channels plus services such as e-mail, games, etc.). For the consumers, a digital cable connection may be more expensive, especially if set-top boxes are provided without a one-time payment but made available to the subscriber for a monthly fee, as is the case with the provider UPC Telekabel. The trend toward packages and pay TV offers is highly conspicuous. In addition, digital cable television requires the installation of an additional set-top box. However, cable networks have a crucial feature which is a prerequisite for implementing interactive television: A return channel. While satellite and terrestrial technologies generally require the return channel to be realized by other means (e.g., a telephone line) for full interactivity, cable networks already have a built-in bi-directional connection.

Digital penetration in Austrian cable networks is currently 5%, and the largest Austrian cable network operator, UPC Telekabel, shows a current total of 27,000 digitized households on its networks in Vienna, Graz and Klagenfurt.

1.1.3.   Terrestrial broadcasting

In the range of broadcasting transmission platforms, terrestrial broadcasting – that is, reception by antenna – represents a unique situation in Austria. Austria's infrastructure was built up to broadcast ORF's television signals in the 1950s and 1960s using funds collected in the form of broadcasting fees in order to enable ORF to fulfill its legal obligation to provide (full) coverage (i.e., programming fees for the fulfillment of the coverage requirement under § 3 of the ORF Act, among other purposes).

Terrestrial transmission remained the only means of receiving television signals until the late 1970s, when Telekabel Wien began constructing its cable network in Vienna (1979). With the advent of cable and satellite television and the transmission of foreign (German-language) television channels in the 1980s, terrestrial broadcasting began to lose significance. Today, only about 15% of television households receive television content exclusively via antenna. However, there are also households which use analog satellite receiver systems and thus depend on terrestrial broadcasting to receive Austrian channels. Accordingly, terrestrial broadcasting is still the most important broadcasting platform for ORF and Austria's private channels.

In addition, many households with cable connections or satellite systems also have additional television sets which rely on terrestrial signals. In total, terrestrial broadcasting is used both exclusively and in conjunction with satellite or cable in more than 50% of Austrian households (as of late 2004).

In this respect, terrestrial broadcasting enjoys its own specific importance in media policy without reducing the significance of the other platforms for consumers.

1.2.   Capabilities of digital television

Even if we must assume that (despite digitization) the medium of television will not deliver the same level of interactivity as the Internet, for example, and that television will thus largely remain a passive medium, digitization still promises a large number of new possible uses within today's information society.

Digitization will not spark a revolution in television, it is far more an evolutionary development which will allow the user to receive a greater variety of channels with clearly superior picture and sound quality (depending on the television set), as well as transporting large quantities of additional information and thus enabling various forms of interaction.

1.2.1.   Variety of channels and efficiency of spectrum usage

Digital signal processing enables substantial reductions in the bandwidth required to broadcast a television channel and makes it possible to combine this signal with data from other channels in a single data stream for transmission; this process is referred to as multiplexing. The data stream is then split into the individual channels by digital receivers (i.e., set-top boxes or digital-ready television sets). This procedure allows a far more efficient use of the frequency spectrum, thus allowing a larger number of channels to be broadcast than in the case of analog technology. For television broadcasters, digital transmission will reduce broadcasting costs compared to analog networks.

In digital terrestrial broadcasting, this more efficient use of the frequency spectrum not only arises due to the ability to use one channel to broadcast content from several television stations, but also due to the possibility of using single frequency network (SFN)

infrastructure, which would cause massive reception problems in the analog world. This network structure makes it possible to supply an entire mountain valley or urban area using only one television frequency.

1.2.2. Interactive additional services

Digital transmission technology also makes it possible to enrich television shows with additional information or to add interactive elements to television broadcasts. This is achieved by means of middleware (an application program interface, or API) which is integrated into the set-top box and makes it possible to display additional content and applications on a conventional television set. In Europe and many other parts of the world, the Multimedia Home Platform (MHP) has established itself as the open standard for applications and additional services. The development of this software interface between the set-top box (or television set) and the broadcast program is being pushed forward by a consortium of 730 members from 51 countries and five continents. MHP serves as an "operating system" for additional applications such as electronic program guides (EPGs), digital videotext, e-government applications and other services of the information age.

In this way, it is possible to offer show-specific information (additional information about the show currently on the air) as well as stand-alone services (data services, digital videotext, electronic program guides, local information, etc.). Viewers can access and use these data services using the remote control for the set-top box.

In principle, this form of interactivity – also known as "enhanced TV" – can be regarded as a digital enhancement of conventional teletext, especially with regard to its functionality, the large quantity of information offered, the quality of graphics as well as the data transfer speed.

In such enhancement services, the viewer interacts with the set-top box, which loads the additional services. Up to that point, there is no need for a return channel connection to the broadcaster, as no individual content is retrieved and no information is exchanged. In such cases, we also speak of "local interactivity" without a return channel.

However, the return channel – which provides the television viewer with the ability to transfer information to the broadcaster (or an 'intermediary' IT center) – is a prerequisite for full interactivity in which the television set can also be used to satisfy individual information needs and to involve viewers in determining program content. It is this return channel connection which enables numerous applications such as voting and opinion polls, betting applications, games, merchandise orders, individual information requests, etc.

Especially in light of the future business models in digital television, it is important to test such applications thoroughly. However, testing these interactive services and researching audience acceptance should mainly help to identify the added value which most aptly demonstrates the benefits of this new technology to consumers in the early stages of introducing digital terrestrial television.

The benefits of digitization which are common to all transmission platforms (satellite, cable and terrestrial) are its increased variety and interactive additional services. Cable networks are especially well equipped for this purpose, especially with regard to full interactivity. While cable networks have a return channel practically built in, terrestrial and satellite broadcasting require other types of return channel connections (e.g., telephone lines). These can be based on analog or digital (ISDN) technology as well as broadband Internet (e.g., ADSL) or mobile technology (e.g., GSM, GPRS or UMTS).

From the very outset of the project in Graz, full interactivity was considered a fundamental requirement. This was the special challenge involved in this project and at the same time the key feature which made the Graz trial especially progressive compared to other activities in the international arena.

1.2.3. Mobility and portability

Terrestrial broadcasting is the only platform which exhibits an additional performance feature in digitization: The possibility of mobile, portable reception. With sufficient field strength, the DVB-T signal can also be received by mobile television sets with small rod antennas or flat antennas with flawless picture quality. The television sets of the future, which will already come equipped to process digital signals, will thus be able to receive television signals without being wired to the nearest antenna socket.

The full (or widespread) penetration of mobile telephones and the technological leaps they have made justify the expectation that mobile television reception on handheld computers and "smart phones," or the transfer of data via broadcasting channels (datacasting) will become reality in the near future. This development is also being encouraged heavily by the mobile communications industry; a new DVB standard suited for mobile reception devices (low energy consumption, smaller screens) is being developed under the heading of DVB-H (H = handheld) and will be published in the near future.

For infrastructure operators, DVB-H provides an inexpensive means of transmitting content to a large number of subscribers simultaneously. Television operators expect DVB-T and DVB-H to give rise to new forms of usage among consumers, thus enabling television content to remain attractive to younger viewers in particular. Even if television reception on mobile phones is still a long way off, this development needs to be taken into account in frequency planning now.

1.3. General conditions in Europe and legal issues

The *e*Europe 2005 action plan launched at the Seville European Council of Seville in 2002 addressed the "objective of making the European Union the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion" by 2010. One special characteristic of this objective lies in the continued development of a knowledge-based information society with open access for all consumers and non-discriminatory access to data transmission services on the providers' side. The problem of a digital divide, which reserves the benefits of the networked information society for a so-called "info elite" and cuts off large parts of society from such developments, can be avoided by creating infrastructure which provides all consumers with access to services and content in the communications landscape.

In this context, the digitization of broadcasting transmission plays an especially important role as a means of transporting content and data services in the information society. The migration from analog to digital technology also provides far more transmission capacity on all platforms (terrestrial, satellite and cable) and enables a more efficient use of the frequency spectrum, which is especially relevant in terrestrial broadcasting. This will have positive effects on providers as well as consumers. For content and service providers, dissemination will become easier and less expensive in the digital age due to the larger data capacities available. After the migration to digital data transmission, consumers can expect far more channels as well as new types of content and services.

Cooperating actively in the pursuit of this common European goal is especially important to a relatively small economy such as Austria's. Accordingly, the digitization of broadcasting is a major objective of the media policy pursued in the broadcasting laws passed in Austria in 2001 and is addressed in Part 6 of the Austrian Private Television Act (PrTV-G).

The digitization of broadcasting platforms is meant to make a contribution to greater media diversity in Austria, as well as strengthening both current and future Austrian television broadcasters by providing independent infrastructure, which will also increase Austria's attractiveness as a location for media and communications.

Future-proof infrastructure which provides a stable basis for the dissemination of regional content also makes a huge contribution to preserving a country's cultural and economic identity. In this context, the terrestrial transmission of broadcasting services plays an especially important role in the combination of various platforms.

1.4.   Digital Platform Austria

In light of the special situation with regard to media policy and the complexity of the migration process, the Austrian Private Television Act (PrTV-G) also provides for the digitization of terrestrial broadcasting as a high-priority objective in the work of the KommAustria regulatory authority and the Digital Platform Austria, which was set up by the Austrian Federal Chancellor in 2002 to support the regulatory authority in this process. The introduction and continued development of digital broadcasting is to be enabled and supported on all platforms. Therefore, the legal mandate to create a Digitization Plan covers all broadcasting transmission platforms (for radio as well as television).

With the support of the working group, which includes some 300 experts representing broadcasters, service providers, network operators, the industry, retailers, research organizations and consumers, the regulatory authority is to "facilitate the beginning of the introduction of digital terrestrial television by 2003" (§ 21 Par. 1 PrTV-G).

The regulatory authority met this deadline by publishing the Austrian Digitization Plan (in compliance with § 21 Par. 5 PrTV-G) as a strategic basis for the introduction of digital terrestrial television, and by preparing for an initial DVB-T trial in early 2004 under the auspices of RTR, the operative arm of KommAustria.

In December 2003, KommAustria published the first version of the Digitization Plan for the introduction of DVB-T; this document contains the strategy presented by the regulatory authority for the introduction of digital terrestrial television (DVB-T) throughout Austria as well as a schedule for the realization of this strategy by the year 2010.

The content-related work of the Digital Platform Austria working group is divided into three expert panels covering the fields of technology, law and market/content. Since their inception nearly two years ago, these expert panels have discussed numerous professional aspects of the complex and multi-layered problem of digitization, sometimes calling in international experts. The regulatory authority's technical considerations in drawing up the Digitization Plan are based on the work done by these expert panels as well as close observation of developments on other markets.

The members of the working group took part in the final deliberations on the Digitization Plan in a plenary meeting at the Austrian Federal Economic Chamber on November 28, 2003. Before the meeting, a position paper on the subject was delivered to the members via the working group's Internet platform along with an invitation to present criticism, remarks and

additional points at the meeting. The main points of the Digitization Plan were presented by Franz Prull, Deputy Head of KommAustria, prior to the plenary discussion.

1.5.　　Austrian Digitization Fund

One political measure which was crucial to the DVB-T trial in Graz was the establishment of the Austrian Digitization Fund on the initiative of the Digital Platform Austria working group.

In an amendment to the KommAustria Act, the fund was set up as of January 1, 2004, with an endowment of EUR 7.5 million per year.

The funds for this purpose stem from that part of broadcasting fees which was previously allocated to the federal budget without a specific dedication. The fund is administered by RTR, and KommAustria is able to submit comments and opinions before grant decisions are made.

Under § 9b of the KommAustria Act, the Digitization Fund can be used for the following purposes, among others:

1. Academic studies and analyses
2. Promotion of pilot projects and research projects
3. Development of programs and additional services
4. Public information measures
5. Planning and construction of infrastructure in order to attain a reasonable level of coverage
6. Promotion and acquisition of digital-ready terminal devices
7. Grants for broadcasting organizations in order to facilitate the transition
8. Measures to create financial incentives for consumers
9. Financing of KommAustria and RTR's expenses for the creation and implementation of the Digitization Plan

Grants are to be awarded according to technology-neutral criteria with due attention to all transmission means and platforms for digital broadcasting.

1.6.　　!TV4GRAZ: A Digital Platform Austria project

The initial plenary assembly of the Digital Platform Austria working group took place on January 29, 2002, in the Ares Tower in Vienna.

For the initial stage of its activities, the group defined the strategic objectives of preparing and executing a trial for digital terrestrial television. This was handled by the regulatory authority KommAustria and RTR, which were assigned the responsibility for managing the working group under the Private Television Act.

From the regulatory authority's standpoint (and especially in light of the fact that the Digitization Plan called for the creation of a road map for the introduction of digital terrestrial television throughout Austria), one very significant objective was to gather independent experience with regard to the technical propagation characteristics of DVB-T.

In order to define an introduction strategy tailored to the specific circumstances in Austria (difficult topography, few available frequencies, small number of broadcasters, etc.), it appeared crucial to accumulate internal know-how in addition to observing international experience.

From the very outset, this was planned in close coordination with the Austrian Broadcasting Corporation (ORF). In several respects, ORF can be regarded as the main party affected by the digitization of terrestrial broadcasting.

First, it owns and operates the current analog broadcasting network. Second, ORF is subject to a legal coverage obligation which requires the company to broadcast its channels by terrestrial means. In addition, ORF competes with foreign channels, especially the large German public and private television stations, in more than 80% of Austrian television households. A number of those channels have been using their digital satellite broadcasting capabilities to test additional MHP applications for some time now.

We can assume that features such as electronic program guides, enhanced TV (additional information on the show currently being aired), digital videotext (with improved graphics and the ability to have a scaled-down television image displayed in split-screen mode), and interactive services will become a factor in competition among television stations in the near future.

Especially in light of the fast-increasing number of digital satellite receivers, an area in which ORF and the Austrian private stations are in direct competition with large German broadcasters, it is crucial to ensure that Austrian broadcasters remain competitive in this new field.

In response to this initial situation, the working group developed a planning scenario for an extended trial involving KommAustria/RTR, ORF and other sources of know-how in the Digital Platform Austria (e.g., Siemens and BearingPoint [previously known as Infonova]) in its early preparation meetings. In addition to testing the technical transmission of DVB-T signals, the trial was also designed to support research on the functionality and audience acceptance of interactive additional services and MHP-based applications.
The idea of the project was to complete the entire technical cycle of interactive television for the first time in Austria using DVB-T in the forward channel and the MHP standard for interactive additional services.

A test panel consisting of a limited number of households was selected (on the basis of demoscopic criteria) to test and evaluate these services and applications.

The objective of this market research was to derive insights regarding future business models for all broadcasters and all transmission platforms as well as the future operators of DVB-T platforms in the course of implementing the Digitization Plan.

As the Styrian provincial government had shown interest in carrying out such a forward-looking project in its province and was thus also willing to support the project with funds from the Styrian Business Promotion Agency (SFG), the capital of Styria (Graz) was chosen as the location for the trial. Graz was also especially suited for such a trial due to is topographic and socio-demographic characteristics.

As a technical prerequisite for conducting the trial, the initial task of KommAustria and RTR was to find available television frequencies for the Graz coverage area and to coordinate these frequencies with neighboring countries.

After lengthy negotiations with the frequency administrators in Hungary, Slovenia and Croatia, it became clear that only one frequency with sufficient signal strength would be available: Channel 62, with two low-lying broadcast locations in the city of Graz. It was thus possible to ensure that a small single-frequency network could be constructed and tested within the frequency limitations in the Graz area.

The core partners: In September 2002, RTR conducted a written survey of all members of the Digital Platform Austria. The objective of this survey was to sound out the willingness of individual companies and institutions to contribute resources and know-how to the trial.

A total of 16 organizations submitted opinions; some of the services and products were not necessary (or not yet necessary at that point). However, this allowed RTR to gather a great deal of information on potential contributions and contacts which would prove valuable in the realization of the trial.

In the ensuing planning meetings, the trial was expanded to include another facet: Telekom Austria also showed interest in testing its ADSL technology for the forward television broadcasting channel in an additional group of households (see also Section 3.10.).

Subsequently, the following companies turned out to be willing to invest substantial resources in such a joint project according to the principles of a public-private partnership:

- Austrian Broadcasting Corporation (ORF):
  Construction and operation of broadcasting facilities and multiplexing technology
  Development of MHP-based applications
  Suitable programming

- Siemens Austria:
  Setup and operation of an IT center for processing data received via the return channel
  Design and programming of MHP applications

- Telekom Austria:
  Signal transport in the forward channel
  Provision of line infrastructure for the return channel (analog and ADSL)
  Operation of a forward TV channel using ADSL in 50 additional households

- RTR:
  Project management
  Market research
  Communication
  Frequency and coverage planning

On November 3, 2003, these four core partners entered into a cooperation agreement in the presence of Franz Morak, the Austrian State Secretary for the Arts and Media. The agreement defined the distribution of tasks among the core partners as well as their common objectives.

In addition to the core partners, a large number of negotiations were held with other companies and institutions, especially with private television broadcasters.

Additional project partners: Given the modulation type used in Graz, Channel 62 provided sufficient bandwidth to broadcast four television channels including additional digital services. In addition to ORF 1, ORF 2 Styria and ATVplus (which can also be received by analog terrestrial means), an additional combined channel was planned under the working title of "Channel 4" (later: !TV4GRAZ). This channel was used to broadcast shows enhanced with additional digital services and interactive MHP applications developed by ORF and the participating private television stations. The interactive channel was the main focus of concurrent market research and thus an essential part of the trial (see also Section 3.6.).

In order to carry out a research and development project of this complexity with four large and independent organizations, it was necessary to set up a central project management unit.

After a hearing with three applicants, the core partners nominated Bruno Josseck, a member of the technical staff at Joanneum Research and the Institute for Communication Technology and Wave Propagation (now the Institute of Communication Networks and Satellite Communications) at the Graz University of Technology, as project manager.

The overall project management structure is shown in the organizational chart below.

Figure 1: Project management organizational chart
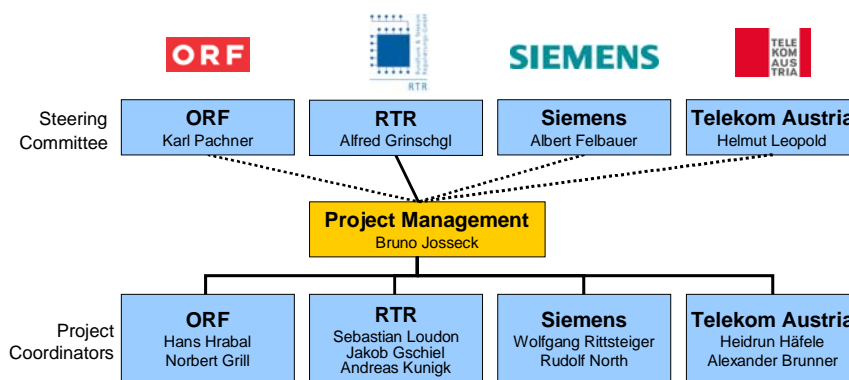
2. Description of the project

2.1. Overview

From June 1 to August 31, 2004, the full technical cycle of interaction in digital terrestrial television broadcasting was completed for the first time ever in Austria. The television signal broadcast in the project was based on the DVB-T (Digital Video Broadcasting – Terrestrial) standard. Interactive additional services were programmed and broadcast on the basis of the European Multimedia Home Platform (MHP) operating system standard.

With a total budget of some EUR 11.1 million, the project was funded by the participating companies themselves as well as the Digitization Fund set up at RTR in early 2004. The trial was also supported by the Styrian Business Promotion Agency (SFG). Although the trial involved terrestrial broadcasting as the platform for the forward channel, investments in this infrastructure accounted for less than 10% of the project expenses.

The majority of investments involved developing MHP-based interactive applications and establishing a complete cycle of interaction in digital television. In this way, the experience gained by the broadcasting organizations and application developers involved in the Graz trial will benefit digitization on all transmission platforms (cable, satellite and terrestrial), as well as promoting Austria as a media location in general.

In addition to the key partners ORF, RTR, Siemens Austria and Telekom Austria, numerous other companies also participated in the project. Project management was handled by the Institute of Communication Networks and Satellite Communications at the Graz University of Technology / Joanneum Research.

In Graz, two broadcasting facilities were used to set up a single-frequency network which enabled DVB-T reception covering most of the city.

150 test households in Graz were equipped for reception with set-top boxes manufactured by Humax, Nokia, Philips und Fujitsu Siemens and designed to support return channel connections as well as MHP-based applications. The use of the boxes as well as opinions on the additional interactive content offered were documented by the market research organization Fessel-GfK and the evolaris foundation in Graz.

By means of multiplexing, ORF broadcast four digitized television channels using the bandwidth required for one conventional channel: ORF 1, ORF 2, ATVplus and the interactive channel !TV4GRAZ, which was created specifically for the pilot tests.
!TV4GRAZ's schedule consisted of ORF shows and content from six private television broadcasters (ATVplus, gotv, ProSieben Austria, Sat.1 Austria, Steiermark 1 and Atv Aichfeld).

In this part of the project, special emphasis was placed on the digital interactive additional services broadcast along with !TV4GRAZ's television programs. Each show was accompanied by an MHP portal in the individual design of the television station responsible for the program.

An electronic program guide (EPG) was developed as an independent MHP product and provided viewers with an overview of the shows broadcast on the four channels at all times. These MHP applications were conceived by the television broadcasters and mainly programmed in the development departments at Siemens Austria, BearingPoint, Sony NetServices and PLOT.

The MHP portals allowed viewers to access current news, weather forecasts, additional information on the show currently being aired, and other information. The set-top boxes, which were equipped with conventional modems or ADSL connections, also made it possible to try out return channel-based functions. For example, viewers could use their remote controls to vote on controversial topics discussed in the television shows, submit their film request of the week, or even order merchandise. An application developed by Österreichische Sportwetten GmbH – tipp3 live! – also enabled the test households to bet on soccer matches. Current voting results and betting odds were broadcast to the viewers via the MHP portals.

Precise coverage levels, in particular with regard to the various reception modes (stationary, portable indoor, portable outdoor and mobile), were measured in numerous sub-projects carried out on behalf of RTR by the Institute of Communication Networks and Satellite Communications at the Graz University of Technology and by Joanneum Research. For the measurement of mobile reception, two automobiles with DVB-T reception systems were used: One measurement vehicle provided by the European Space Agency (ESA) as well as a standard passenger vehicle which was provided by BMW Austria for the duration of the project and equipped with built-in audio/video entertainment systems capable of receiving digital terrestrial television signals.

On August 1, 2004, the !TV4GRAZ channel was shut down as scheduled. However, the three television channels – ORF 1, ORF 2 Styria and ATVplus – were still broadcast in Graz by digital terrestrial means and continued offering MHP portals along with their television programs until the end of August. This enabled the broadcasters to simulate the real operation of three channels enhanced by additional services, as a multiplex operator will be able to realize using one frequency in the future.

The process of multiplexing is essential to digital broadcasting, as multiplexing involves merging, digitizing (if necessary) and finally compressing video, audio and application data. Multiplexer operation and data playout (i.e., data transmission) were handled centrally by ORF due to the need for dynamic and flexible operations and in order to leverage potential synergies. In addition to a trained professional staff, this facility also provided infrastructure for measurements and monitoring.

At the ORF facility in Vienna, the signals of the four television channels as well as the interactive additional services were multiplexed, that is, merged into one digital data stream for broadcasting on a single channel. The equipment necessary for this purpose was acquired and operated by ORF. Using the analog technology which has prevailed up to now, this channel could only support broadcasts of one television station's picture, sound and (if available) teletext. The data stream was transported to the two DVB-T broadcasting facilities in Graz by means of Telekom Austria's fiber optic lines and radio systems.

Telekom Austria's core competence in this project was the development of suitable network plans. On the whole, the digital line network developed in cooperation with ORF as well as the adaptations carried out in order to connect the two broadcasting locations in the DVB-T trial provided the high-performance transport network required to transfer the signal to Graz. In the implementation process, the greatest emphasis was placed on ensuring reliability, thus a fully redundant connection was set up for the fiber optics as well as radio signals.

The data stream from the multiplexer output in Vienna to ORF's regional studio in Graz was carried by ORF's digital line network. The signals were transmitted from the regional studio to Telekom Austria by way of an ATM switch in Graz, after which they were transported to the broadcast locations in Graz via Telekom Austria's multi-service broadband network. The Telekom Austria broadcasting facility was fed by a fiber optics-based ATM connection, while the other location was supplied by means of an SDH radio link between the facilities.

Transmission functions were monitored actively by operations personnel at Telekom Austria and ORF. Finally, the signal for ORF 1, ORF 2 Styria, ATVplus and !TV4GRAZ was broadcast digitally from the two facilities. The 150+ households equipped with DVB-T and MHP-compatible set-top boxes were able to receive those channels along with additional MHP-based services. The set-top boxes decoded the digital signal and enabled viewers to access the interactive portals.

2.2. DVB-T single frequency network

For the digital terrestrial transmission of the four channels ORF 1, ORF 2 Styria, ATVplus and the test channel !TV4GRAZ with its additional MHP services, it was necessary to acquire, install and operate two DVB-T broadcasting systems. The systems were set up at two locations in Graz: One in the center (belonging to Telekom Austria) and one at the eastern edge of town (belonging to Connect Austria). At Telekom Austria's facility, the broadcasting antennas were mounted on the existing mobile network mast and the broadcasting devices were installed in the Telekom Austria building. At the Connect Austria location, the antennas were also mounted on the existing mast, and the devices were housed in a container placed there for that purpose.

Figure 2: Coverage calculations for the DVB-T single frequency network in the Graz area

■ Portable-indoor-Empfang
■ Stationärer Empfang
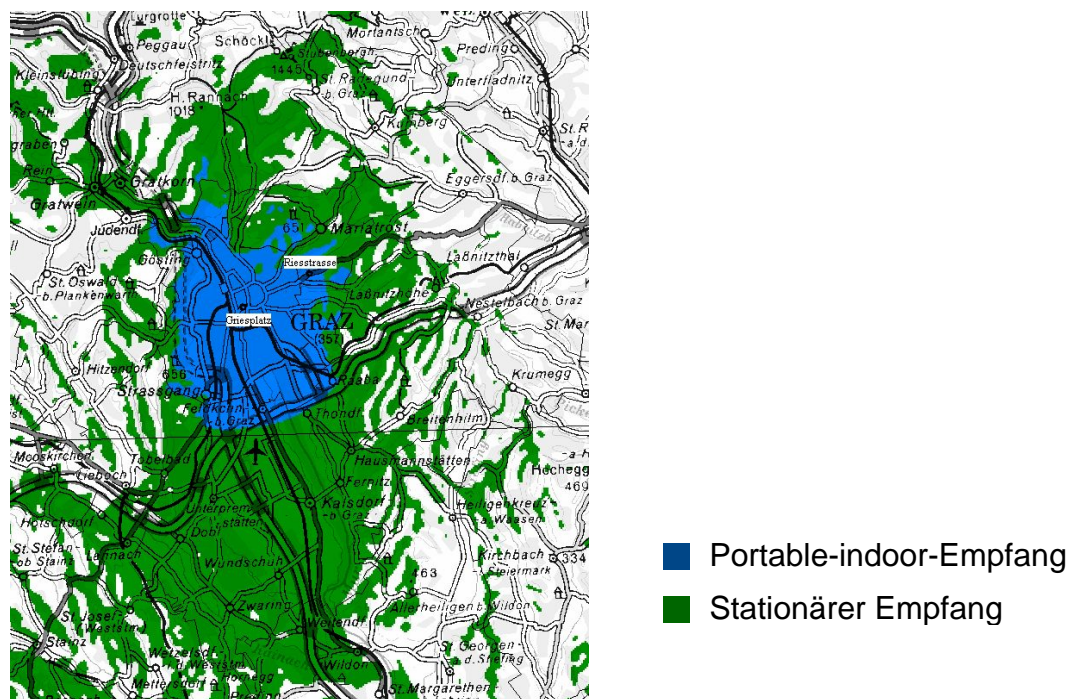
The transmitters were operated in single frequency network (SFN) mode, that is, they broadcast synchronously on the same frequency (Channel 62) with an output power of approximately 750 watts each after filtering. The data stream was broadcast terrestrially from the two antenna masts using the 16QAM 3/4 modulation procedure on Channel 62 (802 MHz) with an output of 750 watts each. This modulation procedure enabled a bit rate of 16.59 Mbit/s, which was used to transmit four television channels as well as additional (partly interactive) data services. The usage and distribution of the available bandwidth were defined in a bit rate plan created jointly by the core partners.

2.3.   Set-top boxes

In order to receive the digital television signals, viewers require special set-top boxes which are connected between the television antenna and the television set itself. The set-top box converts the digital signal in such a way that it can be read and displayed by conventional analog television sets. In general, each broadcasting platform – cable, satellite and terrestrial – currently requires a set-top box specifically adapted to the wave propagation characteristics of that platform. The technical requirements which the set-top boxes had to fulfill for the DVB-T trial in Graz were defined by the project management and the core partners. The most important criteria were as follows: MHP compatibility, return channel support and, of course, DVB-T reception.

From the very outset, the core partners and project managers considered it important to use set-top boxes made by multiple manufacturers in order to simulate real market conditions with various devices. The manufacturers and importers in question were contacted via the respective trade association within the Austrian Federal Economic Chamber and asked to submit offers regarding set-top boxes which fulfill the defined requirements. However, the search for suitable devices was still extremely difficult. In particular, this was due to the fact that the high demands of the DVB-T trial in Graz were far more advanced than current developments in existing DVB-T markets. For example, additional MHP services have not been implemented in the greater Berlin/Brandenburg area, which was the first region in Germany to migrate completely to DVB-T. The set-top boxes available on the market there were only designed to allow the reception of the audio and video signals and to allow the viewer to change channels.

In the end, four manufacturers were able to supply set-top boxes in sufficient quantities: Fujitsu Siemens and Philips (50 units each), Humax (80 units) and Nokia (20 units; for further information, please refer to the Project Management's Technical Report, Sections 5.1. and 5.2.) These devices were largely prototypes or boxes used in other markets.

However, it was soon discovered that the operating system programming in the set-top boxes varied when it came to the activation and functioning of the internal modems. All of the modems were designed to accept MHP commands, but the manufacturers of the set-top boxes had based their systems on differing MHP command chains. Therefore, it was a special challenge for the participating application developers to design the interactive applications in the MHP portals (in direct cooperation with the middleware developers) in such a way that a connection to the Telekom Austria network could be established from all MHP applications with each set-top box.

2.4.   Return channel technology

The interaction cycle is mainly dependent on the return channel, which enabled the test viewers to take part in votes or to use interactive ordering functions. For the purposes of the trial, Telekom Austria made two types of return channel available: Dial-in access using POTS (for the set-top boxes equipped with modems) and ADSL.

Of the 150 test households which formed the market research panel, 100 households were equipped with set-top boxes connected to Telekom Austria's analog telephone lines. In these cases, the return channel connection was established by means of a V.90 modem built into the set-top box. The modem was activated and dialed in to the IT center whenever the viewer triggered interactive functions (e.g., voting functions) using the remote control.

In the other 50 households, the return channel was supported by an ADSL connection to Telekom Austria. These households were the ones equipped with a set-top box

manufactured by Fujitsu Siemens, as this was the only device type in use which had an Ethernet connection. The main advantage of this return channel technology is the considerably higher speed of the dial-in process compared to analog connections and the far higher data rate ADSL provides in the return channel.

With its "always on" functionality, ADSL proved to be the preferred option in the Graz trial, as the connection did not have to be established again and again by user actions and the users' return channel activities were handled very rapidly. In the DVB-T trial, broadband thus proved to be a driver of new technologies, innovative interactive networks and new business models. The final consumer can use various forms of communication – from interactive services to conventional telephony – flexibly and efficiently with the same broadband connection.

The efforts of the project management to include set-top boxes which do not have to be connected to the homes' fixed-link telephone lines but use a mobile return channel (such as a GPRS or UMTS module) were frustrated by the fact that the availability of such models was limited to just a few prototypes.
Nevertheless, an additional project made it possible to gain experience with "hybrid" networks in Graz. Hybrid network technologies were tested and their functional characteristics researched in a separate project carried out by the Institute of Communication Networks and Satellite Communications at the Graz University of Technology, Joanneum Research and T-Mobile Austria. This research largely focused on the combination of DVB-T for the forward channel with the established mobile technologies GPRS and UMTS as return channel connections. Both the media and telecommunications industries currently see great potential in this particular combination of DVB-T as a relatively inexpensive forward channel and UMTS for return channel technology and point-to-point connections.
Especially with regard to future business models, experience in this field plays a crucial role in the overall digitization strategy.

2.5. Siemens Interactive Application Center (IAC)

The information which was transmitted from the set-top boxes in the test households to the Internet via the return channel finally reached Siemens Austria's Interactive Application Center, where the data was analyzed and processed further. The IAC formed the hub of the interaction cycle and enabled the use of a wide variety of applications.

Figure 3: The IAC in the interaction cycle
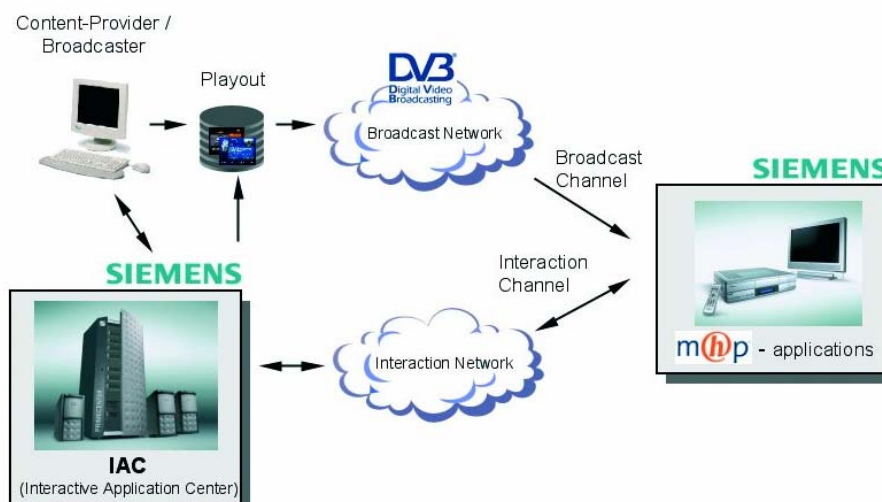
For example, this enabled voting results to be transmitted to the broadcaster and then to the playout center at ORF, where the data could be broadcast along with the relevant television shows. In this way, it was possible to chart the results of polls in which viewers submitted their votes during discussion shows nearly in real time in the shows' MHP-based data services, for example.

The data transmitted from the households to the Siemens Interactive Application Center was encrypted for data protection purposes. Viewers were also able to place live bets on soccer matches in the !TV4GRAZ trial (in the trial, this application was not commercially oriented but allowed viewers to bet using points only). Bets and current odds were provided by Österreichische Sportwetten GmbH, an Austrian sports betting company, and updated constantly via the IAC before and during live soccer matches. If users were not sure how their previous bets had turned out, they could retrieve their betting records from the Siemens IAC.

In order to enable merchandise orders and bets, it was necessary to identify individual viewers. For this purpose, the corresponding applications required the viewer to enter his/her user ID number and password when using such services. Siemens' IAC passed these anonymized orders (e.g., for a television station's merchandising items) on to the market research organization Fessel-GfK for fulfillment. Only Fessel-GfK knew the true identity of the viewers and was able to match user IDs and passwords to viewers.

Moreover, during the music shows broadcast by gotv, viewers were able to select current music videos from a list of some 200 titles in the MHP portal and thus influence the show in a way which was visible to all other viewers. Music video requests were forwarded by the IAC to a server on which all of the available videos were stored and which inserted the selected title in the ongoing show automatically. The IAC's controls also made it possible to display the user's nickname to all viewers on the television screen during the requested video.

Not only the households themselves were stored in the comprehensive database, the various television broadcasters were also able to set up and configure their services individually and to retrieve data evaluations for the households.

The IAC transferred updated information, betting odds and new voting options to the ORF playout via a specially developed interface which passed the data on for transmission. In order not to overload the playout with excessively large quantities of information, the transferred data was collected and compressed at the IAC before being passed on; this was done, for example, before news reports from the Austrian Press Agency (APA) were made available to viewers on ATVplus' MHP portal.

Figure 4: The IAC
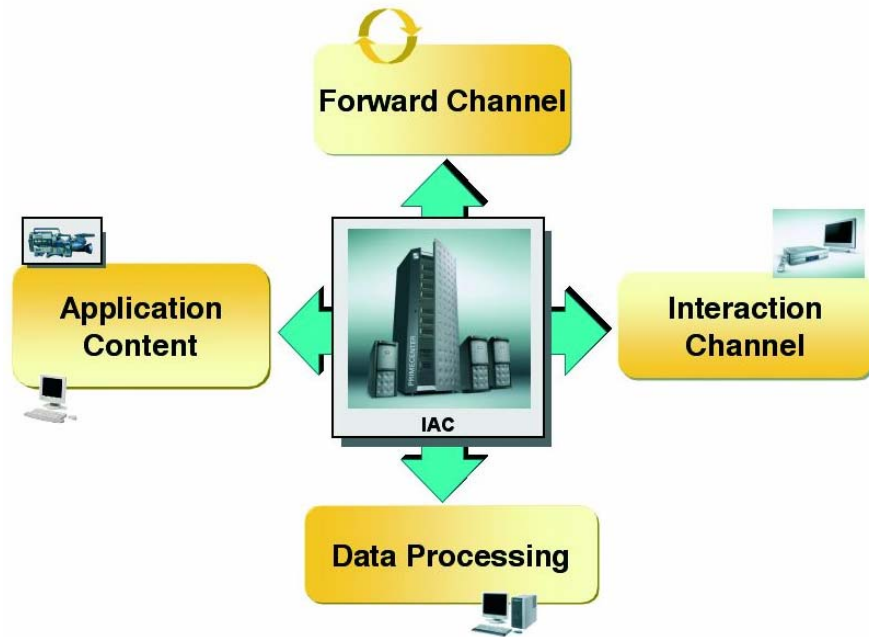
The Siemens Interactive Application Center provided a flexible platform for !TV4GRAZ and played an important role in the playout of MHP-based interactive content for most of the private television broadcasters, as well as handling the interactions on the return channel for all of the television stations.

2.6.   !TV4GRAZ schedule

RTR and the key partners in this project did not want to carry out the Graz pilot test as a pure "technical trial" but to involve the consumers in the process and thus receive their feedback on digital television and its interactive possibilities.

Therefore, the interactive television channel !TV4GRAZ was developed for the Graz trial and broadcast in addition to ORF 1, ORF 2 Styria and ATVplus. In combination with the MHP applications broadcast simultaneously and the accompanying market research activities, this channel formed the actual core of the DVB-T trial in Graz.

Even during the initial discussions of this project in 2002, RTR determined that !TV4GRAZ (originally referred to as Channel 4) should be made available to all Austrian television broadcasters – both private and public – as an open platform on which they could test their own MHP services. At the end of 2003, RTR put Mr. Andreas Kunigk in charge of surveying and coordinating the interests of the private television stations as well as planning a broadcast schedule together with Gerhard Frühling, the employee responsible for program scheduling at ORF.

One of the great successes of the project was the fact that it inspired several relevant private television broadcasters – including two local television stations – to participate. !TV4GRAZ presented the test households with a widely varied mix of television shows from ORF and the private television stations ATVplus, gotv, ProSieben Austria, Sat.1 Austria, Steiermark 1 and Atv Aichfeld.
One of the main objectives for all of the parties involved was to develop and offer interactive, MHP-based digital content to accompany their shows.

!TV4GRAZ was on the air 24 hours per day for three months. During its core broadcasting time (10:00 am to 12:00 midnight), the broadcasters offered 1,260 hours of interactive programming. This included approximately 40 different shows in the genres of information, culture, science, sports, music, series, films, services and documentaries – in short, the content a viewer would expect from a fully developed television channel today. However, this content was also expanded to include MHP-based services which enabled viewers to take part in surveys on the show currently being aired, to order merchandise or to retrieve a wide variety of information on current shows, world news and many other topics. These functions could be accessed easily and at any time with the remote control.

!TV4GRAZ's schedule consisted of shows selected by the television stations participating in the trial. In this context, the main challenge for !TV4GRAZ was to create an attractive schedule with due attention to various age groups, times of day and viewing habits.

Through this project, !TV4GRAZ also established itself as a broadcasting brand for this interactive television station. This brand was easy to communicate to the test households by displaying the !TV4GRAZ logo on screen at all times. The attractive and familiar television content helped to allay any reservations viewers may have had regarding the new technologies, thus enabling viewers to familiarize themselves with state-of-the-art MHP-based additional services based on popular programming content.

During the breaks between shows, short films placed the !TV4GRAZ project in the context of television history or provided information on the province of Styria as a business location. Students in the Information Design program at the Joanneum specialized college in Graz also created artistic videos dealing with concepts from the world of communication.

In the !TV4GRAZ schedule shown below, additional incentives to test MHP services were offered in the form of special shows (e.g. live soccer broadcasts) during the three-month broadcasting period. Shows from the core time (10:00 am to 12:00 midnight) were repeated in the period from midnight to 10:00 am.

Figure 5: !TV4GRAZ programming schedule (10:00 am to 12:00 midnight)

	MON	TUE	WED	THU	FRI	SAT	SUN
10.00	ORF	ORF	ORF	ORF	ORF	ORF	ORF
30	TW1: Panorama cam	TW1: Panorama cam	TW1: Panorama cam	TW1: Panorama cam	TW1: Panorama cam	TW1: Panorama cam	TW1: Panorama cam
11.00	ATV+	ATV+	ATV+	ATV+	ATV+	ATV+	ATV+
30	Psychologist Tanja Guserl	Psychologist Tanja Guserl	Psychologist Tanja Guserl	Psychologist Tanja Guserl	Psychologist Tanja Guserl	Psychologist Tanja Guserl	Psychologist Tanja Guserl
12.00	ATV+	ATV+	ATV+	ATV+	ATV+	ATV+	ATV+
30	Talk drama: Dr. Ehrenberger	Talk drama: Dr. Ehrenberger	Talk drama: Dr. Ehrenberger	Talk drama: Dr. Ehrenberger	Talk drama: Dr. Ehrenberger	Talk drama: Dr. Ehrenberger	Talk drama: Dr. Ehrenberger
13.00	gotv	gotv	gotv	gotv	gotv	Pro7	gotv
30	Music videos	Music videos	Music videos	Music videos	Music videos	Galileo	Music videos
						ORF	
						Modern Times	
14.00						ATV+	
30						Xpress.TV	
						ORF	
15.00						Play Music	
30						ATV+	
						Popcorn	
						gotv	
16.00	ORF	ORF	ORF	ORF	ORF	Music videos	
30	Barbara Karlich Show	Barbara Karlich Show	Barbara Karlich Show	Barbara Karlich Show	Barbara Karlich Show	Steiermark 1	ORF
						Journal	Live soccer match
17.00	ORF	ORF	ORF	ORF	ORF	ORF	
30	Cooking show	Cooking show	Cooking show	Cooking show	Cooking show	Styrian docu.	
	SAT1	SAT1	SAT1	SAT1	SAT1	Atv Aichfeld	
	Automotive show	Health show	Automotive show	Health show	Automotive show	Journal	
18.00	ORF	ORF	ORF	ORF	ORF	ORF	
30	Play Music	Willkommen Österreich	25 magazine	Willkommen Österreich	25 magazine	Science/Rsrch	
	ORF		ORF		ORF	ORF	ORF for Kids
	Willkommen Ö.		Willkommen Ö.		Willkommen Ö.	Styrian docu.	Science/Rsrch
19.00	ORF	ORF	ORF	ORF	ORF	ORF	ORF
30	Styria Today	Styria Today	Styria Today	Styria Today	Styria Today	Styria Today	Styria Today
	ORF	ORF	ORF	ORF	ORF	ORF	ORF
	News + culture	News + culture	News + culture	News + culture	News + culture	News + culture	News + culture
20.00	Pro7 Austria Top News					Pro7 2night tv	Pro7 A. Top Talk
30	ATV+	ORF	ORF	ATV+	ORF	ATV+	ORF
	Docu Soap: Building a home	Documentary: Universum	Series: Schloss-hotel Orth	Docu Soap: Exchanging families	Feature film: Gladiator	Show: The Chair	Modern Times
21.00	:05 ORF	:05 ATV+	:05 ORF				ATV+
	Special topic report	Xpress.TV	Documentary	:10 ATV+			Letzte d. Woche
30			:35 ORF	The Lugner family (reality)		:10 gotv	ATV+
		ORF	€co			Music videos	Aha! Science journal
22.00	Pro7	25 magazine	:10 ORF	:05 ATV+	ATV+		21:55 Pro7
	Galileo	ORF	Willkommen Ö.	Phettberg talk show / comedy	Popcorn		Galileo
30	ORF	Styrian docu.	ORF		ATV+		:25 ORF
	Culture	ORF	World journal		ünkürrekt		Documentary
23.00		Report		ATV+	Pro7		:10 ORF
			:20 ORF	Docu Soap: Building a home	Galileo		Documentary
30			Modern Times		SAT1		:40 gotv
		:40 gotv			Automotive show		
00:00	NIGHTTIME: RERUNS						

2.7.   MHP Applications

The MHP applications and portals developed specifically for the shows on the !TV4GRAZ channel can be regarded as an interactive extension of conventional teletext with a far greater variety of potential content and applications.

The products developed by ORF and the private television broadcasters followed different philosophies in terms of content and design. What all applications had in common, however, was that they offered complementary news and service information for specific shows and used the return channel in order to enable true interaction for the viewers in the form of ordering and voting functions.

These applications, which were programmed on the basis of MHP Standard 1.0.2., were the main focus of market research in the 150 test households.

2.7.1. Developing the ORF OK family of MHP products

Even as preparations for the !TV4GRAZ project began, ORF decided to develop ITV products which were as market-driven and sustainable as possible instead of a mere ITV portal. Therefore, instead of integrating all conceivable functions one might expect from multimedia TV products into a single portal, ORF divided its applications into three different ITV portals which differed in terms of functions and content. This accounted for the differing media usage expectations of television viewers.

First, these considerations gave rise to INFOTEXT, a comprehensive information portal with full news services provided from the data pool used for ORF's teletext.

The second portal, called TV-JETZT (TV NOW) in the Graz project, offered additional, in-depth information about the show currently on the air. The content for this portal was created by a newly established ITV editorial staff in cooperation with the editorial staff for ORF television.

The third portal ORF developed was the electronic program guide EPG4GRAZ (see Section 3.7.3.).

The plan of offering three portals soon led to a number of highly complex questions in software planning and programming which would not have arisen in the case of a single portal:

- How will the individual portals be related in terms of design and navigation?
- How will their functions be coordinated?
- Will each application be programmed separately, or can the three portals – despite their differences – use a common software basis?
- How will the users be made aware of the fact that there are multiple portals, and how will they be able to access specific portals directly from the show they are watching?
- How can three simultaneous applications be technically coordinated, monitored and controlled in order to ensure optimum performance?

Together with the Styrian-American consulting company BearingPoint, ORF's ITV development team compiled a detailed catalog of specifications in response to all of the questions above. This ITV architecture formed a basis which enabled the individual services to be designed in such a way that they could all function together and separately.

One important component in the simultaneous operation of multiple portals is a background application which as such is not visible to the user: The starter-controller software, which controlled the interaction of the various ORF OK portals. This ITV controller was developed and implemented for ORF by Sony NetServices. The controller ensured that the various ITV services functioned with nearly identical quality on the different set-top boxes.

Providing the ITV applications with journalistic content required a tool with which the editors could enter content such as text and images rapidly, easily, frequently and in a technically stable environment, and which would prepare this content for dispatch and import into the ITV products.

For this purpose, a content management system (CMS) was developed. This application formed the heart of the entire ITV production cycle. In cooperation with in-house engineers, ORF's ITV team programmed this system specifically for content provision and production in MHP services.

In parallel to the ongoing development of the ORF OK portals, the base module of the ITV CMS was programmed in just a few months, and the application was continuously adapted and expanded during test operations. The CMS is a combination of an editorial production tool and an automated "packaging" software. The editorial staff had access to numerous other content sources at ORF and could use them to extract content suitable for the ITV products. At the same time, the staff was also able to edit texts and photos in the CMS. The CMS also allowed the editors to define any necessary return channel features in the interactive application. Once a page or a new report had been configured and approved by the editor responsible, the new data record was programmed by the system and then exported or "written" to the portal application.

Constant fine-tuning of the applications to the different set-top box's characteristics and to the specific digital playout servers turned the CMS into a reliable production tool and an important building block for all of ORF's future ITV projects. A trial spanning several months under highly realistic conditions was crucial to the success of this application's development.

2.7.2. Portals developed by the private television broadcasters

In the DVB-T trial in Graz, Siemens Austria and Sony NetServices mainly provided support for the television stations ATVplus, Steiermark1, gotv, SAT.1 Austria and ProSieben Austria in developing their MHP applications for !TV4GRAZ.

Together with ATVplus, Sony NetServices first developed a basic design for an MHP portal which included the definition and structure of the information to be offered as well as special features such as ordering and voting functions using the remote control. The resulting menu items in the MHP portal as well as the navigation between main menus and sub-menus were then optimized in cooperation with Siemens in order to ensure that operation was as intuitive and user-friendly as possible.

One of the greatest challenges in designing the user interface was the cost-cutting decision to design the portal so flexibly that its general framework could be used by all private television stations in the trial and its design could be adapted to each station's corporate identity. Therefore, once the spaces for menu items, the miniature television image and advertising banners were defined, it was also necessary to ensure that design elements which contained the station's individual colors, logos and designs could be exchanged easily. In this way, Siemens and Sony NetServices cooperated in the production of five MHP portals which had different, unmistakable looks but were still based on the same architecture.

The viewers' navigation through the portals was enabled by the colored buttons and arrows on the remote control, as well as defined shortcuts which allowed the viewer to select menu items and other options directly using the number buttons on the remote control. In yet another option for increased flexibility, the portal architecture also made it possible to open a page deeper in the menu hierarchy instead of opening the start page when the viewer

opened the portal. For example, this provided viewers with direct access to a voting page related to the show on the air without requiring them to go through the respective menus.

Siemens carried out all of the programming for the portals and their functions (including the return channel connection) on the basis of MHP Standard 1.0.2.

The MHP and DVB-T-compatible set-top boxes installed in the households did exhibit some differences in terms of processing power and operating systems. In order to ensure that the MHP portals could still be displayed on the television screen by all of the chosen set-top boxes without problems, Siemens set up a test laboratory which simulated the entire broadcasting cycle. This made it possible to test the portals developed on the basis of MHP Reference Version 1.0.2.

In order to allow the editorial staff at the television stations to update texts and other content in their MHP portals quickly and easily at all times, Siemens and Sony NetServices planned a central CES (Content Entry System) which the editorial staff could supply with new content via the Internet. This idea was implemented in its entirety by Sony NetServices. The application allowed the text and image content of the portals to be entered by the editors in a special screen on their own computers via an Internet connection and then sent to the CES along with broadcast times and other information. The CES then controlled the substitution of portal content either immediately or at later scheduled times, which in some cases depended on the broadcast times of individual shows for which the additional content was developed. The CES computer then passed this content on to the Siemens Interactive Application Center, which required especially close technical cooperation between Siemens and Sony NetServices. In this context, Siemens supplied the necessary interface description in order to enable the two computer systems to communicate properly, while Sony NetServices handled the task of programming in accordance with the interface specifications. At the Siemens Interactive Application Center, the content received from the CES was merged with the static frame data of each portal (i.e., the individual design and navigation structure of each television station's portal). This information was then passed on as a bundled data package to the private portal framework (also developed by Siemens) at ORF's broadcasting center via the Internet, after which it was finally broadcast on the !TV4GRAZ channel as a constantly updated product accompanying the television shows of ATVplus, Steiermark 1, gotv, SAT.1 Austria and ProSieben Austria.

2.7.3.   EPG4GRAZ

Electronic program guides play an especially important role in the range of products offered for multimedia TV-based data services. Be it in the form of DVB-T, DVB-S or DVB-C, the digitization of television is making an ever-increasing number of channels available to the viewer, thus making it more and more difficult for viewers to keep track of the channels on offer. Like printed television guides, a program guide which can be accessed directly on the television should support the individual viewer in selecting and navigating channels as well as providing additional, more detailed information on specific shows.
In order to attain this objective in an MHP-based application, the project partners decided to develop a comprehensive electronic program guide portal under the leadership of ORF. This portal included schedule information for all four channels broadcast via DVB-T in the Graz trial. The schedule information necessary for this guide was supplied by each station and imported into the EPG portal by ORF. ATVplus generated its own schedule data which was imported into EPG4GRAZ by ORF.

The EPG4GRAZ guide was created on the basis of the ITV architecture, design and navigation of the ORF OK portals. The technical system partners BearingPoint, Sony NetServices and ISD were involved in programming and technical implementation.

2.8.   Testing business models

One business model which suggests itself for the future is that television broadcasters will offer advertising space (e.g., in the form of banners or menu items in the main menu bar) on their stations' MHP portals for a fee. However, a more attractive option is to allow advertisers to place links to their own MHP portals on the television broadcasters' MHP portals. Another option is to supplement advertising spots in conventional television commercial blocks with the advertiser's own MHP content; these portals can be opened while the commercial itself is aired. All of these options were tested in the !TV4GRAZ project.

2.8.1.   The tipp3 live! portal

After comprehensive planning in cooperation with Österreichische Sportwetten GmbH (an Austrian sports betting company), Siemens implemented the tipp3 live! application specifically for the !TV4GRAZ project. This MHP portal allowed viewers in the test households to use their remote controls to place bets on soccer matches, which were also included in !TV4GRAZ programming schedule. The stakes were not real in this application; the betting system allowed viewers to bet, win and lose points instead of real money. In addition to enabling viewers to place bets directly through the portal, the return channel allowed viewers to track changes in betting odds during the soccer matches and to retrieve their personal betting account balances or betting records. The tipp3 live! betting portal was accessible via links from the ORF and ATVplus portals.

2.8.2.   The Siemens ITV advertising portal

Siemens also deployed its own MHP application, which was the first interactive television commercial and the first MHP advertising portal in Austria.

During the broadcast of a 50-second commercial for a new mobile telephone, the viewer was allowed to access Siemens' MHP advertising portal with comprehensive additional information on the product advertised. The portal provided technical information, special features and views of the device from all sides. Viewers were also able to take part in a contest and an opinion poll on the product via the return channel.

Siemens' MHP advertising application was developed in cooperation with the company's in-house agency (Corporate Communications) and Siemens' in-house software developer, Program and System Engineering (PSE). The application was designed and implemented expressly for the field tests in Graz.

2.8.3.   Content delivery for MHP portals

In addition to the possibility of accommodating classic advertising messages similar to newspaper advertisements (e.g., banners) on the broadcasters' MHP portals, a special business model was developed by allowing content to be placed at menu-item level in the portals.

In this context, we can distinguish between purchasing content for a portal and selling space in a portal. Both possibilities were demonstrated in the trial in Graz.

In ATVplus' MHP portal, the "News" menu item offered up-to-date reports in a wide variety of subject areas. The reports found in that section stemmed directly from the online editorial staff at the Austrian Press Agency (APA), which constantly updated the news directly on the ATVplus portal via an Internet connection to the Siemens IT center – without going through ATVplus' editorial offices. As the project offered an opportunity to gain experience in this field, APA offered this service free of charge in the Graz trial.

Like APA, Mowis GmbH (a weather information provider based in Attnang-Puchheim, Austria) also had direct access to the MHP portals of ProSieben Austria and Sat.1 Austria. The company supplied Austrian weather information under the corresponding menu items.
Both examples illustrate the business model which involves purchasing portal content.

The integration of the City of Graz authorities into the trial served as an example of selling space on MHP portals.
The GRAZ Tourism/Graz Online editorial staff in the City of Graz was also linked to the Siemens IAC via the Internet and provided content for the ATVplus portal under the menu item Graz4you, which included a great deal of service information on cultural and tourism offers in the greater Graz area.
In this case, advertising activities were included in the services offered on ATVplus' MHP portal. Under real conditions, we can assume that ATVplus would have charged Graz Online for the space provided on the MHP portal.

2.9. ORF'S MHP testing facility

In the !TV4GRAZ project, ORF assumed technical responsibility for broadcasting the three channels ORF 1, ORF 2 Styria and ATVplus (received by ORF in linear form) as well as the interactive channel !TV4GRAZ and its MHP applications. In order to test playout stability as regards compatibility with individual applications, an MHP testing facility was set up at the ORF headquarters in Vienna. This installation was not only able to test the four set-top box types for compatibility, it also made it possible to review the advantages and disadvantages of the playout infrastructure used. In order to test the applications for proper programming, color display and performance, each project partner was allowed to rent the ORF MHP test installation along with its staff.

The MHP applications were displayed on eight different types of television set using a crossbar switch. In this way, the graphic design could be adapted to the various characteristics of the television sets, thus allowing the portals to be adapted to the broad range of sets found in the households.

The core partner Telekom Austria set up an ADSL and conventional analog modem connection in order to allow return channel functions to be tested in this installation.

The applications developed for !TV4GRAZ were checked for playout and set-top box stability before receiving ORF's approval for initial broadcasting. This was followed by scheduling for the parallel broadcast of applications for each television show and the activation of the necessary data delivery interfaces.

ORF's MHP testing facility will also provide valuable services in future projects.

Figure 6: ORF's MHP testing facility

2.10.   Telekom Austria sub-project: i-active broadband TV

In addition to DVB-T, Telekom Austria's ADSL network was also used as the forward channel in an accompanying trial. In this project, the channels broadcast by DVB-T were fed into the ADSL network and delivered to an additional 50 households as broadband TV along with Internet and e-mail services. As in the case of DVB-T, the households were able to view the channels using the corresponding set-top boxes on their television sets. In this trial, pure television content was complemented with interactive services such as video on demand and infotainment pages.

During the project's preparation stage, there was no defined standard for the transmission of MHP services using the Internet Protocol (IP), and therefore no IP-based set-top boxes which could also display MHP applications were available. For this reason, the 50 households involved in the Telekom Austria project were not able to receive the MHP applications developed in the Graz trial.

Instead, Telekom Austria offered its 50 test households two different access portals (not based on the MHP standard) for the use of various broadband services.

Figure 7: Telekom Austria's two broadband TV portals

Via the interface in these portals, users were able to choose whether they would like to view linear television channels or retrieve content from a "Video Shop" (i.e., video on demand). Another option provided access to pages (similar to those on the web) with entertaining and informative content. In the future, the product will be expanded to include an EPG providing an overview of linear television content.

This trial also focused on evaluating the various encoding algorithms with a view to ensuring high picture quality at low bit rates. Low bandwidth usage combined with high picture quality is a requirement affecting more and more transmission technologies. In light of the need to fulfill the consumers' demands by offering a wide variety of channels, trends in encoder development are a significant topic for the future.

2.11. Concurrent market research

One of the main objectives of the Graz trial was to investigate the audience's acceptance of digital television in conjunction with additional MHP-based services. In the course of a broad-based market research project which accompanied the trial, the usage behavior of more than 150 test households as well as their interaction with the new services were observed.

The market research project was put out to public tender by RTR.

The objectives of this project were as follows:

- Assembly of a representative test panel consisting of 150 households
- Installation of set-top boxes in the test households by trained interviewers
- Creation of a weekly questionnaire
- Monitoring of usage behavior
- Additional surveys by telephone
- Execution of advanced usability and utibility tests
- Evaluation and presentation of results

The contract was awarded to Fessel-GfK, a market research organization with experience in media usage research. The company had presented a proposal for cooperation with evolaris, a private foundation based in Graz.

The selection, support and observation of test households were handled by Fessel-GfK. Information on the test households was only known to the market research organization. The purpose of this arrangement was to ensure that all data privacy regulations were observed and to prevent individual broadcasters from sending information or advertising material to the test households, which might have skewed the test results.

The evolaris foundation was responsible for the initial technical evaluation of the set-top boxes supplied by the manufacturers and for advanced usability and utibility tests. For this purpose, evolaris set up a testing laboratory in which the actual use of applications and additional services by subjects from the test households was observed and evaluated.

2.11.1.   Fessel-GfK

Fessel-GfK selected 150 test households in the Graz area. These households were then supported and observed from June 1, 2004, to August 31, 2004. The market researchers' main interest was how the households interacted with the set-top boxes, the test subjects' average evaluation of DVB-T reception quality, as well as their acceptance, use and evaluation of the additional digital services in the context of normal television programming.

The overall sample consisted of private households with at least one television set and one fixed-link telephone line. In addition, the households also had to be located within the digital terrestrial coverage area. Panel members were required to be at least 12 years old.

Fessel-GfK also made efforts to ensure diversity in the households' previous reception modes. One third of the households selected had previously relied on analog cable, one third on analog satellite, and one third on analog terrestrial reception.
For the trial, those households in which digital reception was not possible using their existing antennas were equipped with digital flat indoor antennas in order to enable them to receive DVB-T (terrestrially broadcast digital television) signals. Households with digital satellite or cable reception were excluded from the sample.

Initial contact to potential test households was established by means of a telephone screening interview. In this interview, the project was introduced briefly and candidates were asked about their general willingness to participate and about specific characteristics which were relevant to the final recruiting stage. From the body of households which remained after the screening process, the test households were finally recruited through personal interviews. In the recruiting interviews, all of the necessary sociodemographic information on the persons and households was gathered.

Over the entire period of the study, a toll-free telephone hotline was available to the households daily from 8:00 am to 11:00 pm. The inquiries and problems reported by the households were immediately passed on to the departments responsible (broadcasters, technicians, editors). In this way, response time was kept to a minimum in the case of broadcasting outages, poor reception quality or performance problems in the digital interactive services.

During the trial, each household maintained a diary designed by Fessel-GfK in order to document the viewers' experiences and impressions while using this new technology. The diary required test households to indicate the channels viewed, the reception quality and the performance of the interactive additional services. Moreover, the test subjects were also asked to note their evaluations and experiences. Once the observation period had ended, a final interview was conducted in which the households were asked for a concluding evaluation of the new television products with regard to technology, user friendliness and information content. The households were also asked about their future willingness to use

and purchase additional digital services as well as the peripheral devices required for that purpose.

The data collected was evaluated statistically and analyzed in terms of content, and the results were presented to RTR in a report with a management summary, conclusions and recommendations (see Fessel-GfK's market research report, Section 6).

2.11.2. evolaris foundation

The evolaris foundation supports companies in the design of IT applications and strives to contribute to closing the gap between innovations in information technology and the needs of the user.

In order to support and enrich the market research performed in this project, the evolaris research laboratory was hired to perform comprehensive usability tests in evolaris' customer experience lab. Usability tests are detailed user surveys based on open and closed questions. For the !TV4GRAZ project, these tests provided important detailed information on how selected test subjects dealt with these new television products.

evolaris carried out comprehensive usability tests in two waves with 30 subjects. The evolaris customer experience lab in Graz was designed as a test lab with the atmosphere of a living room in order to simulate as authentic a television viewing environment as possible for the subjects. The objectives of these tests were to investigate the specific usability of each MHP portal and to identify any use constraints. In the lab tests, special attention was paid to the following four dimensions: Usability, functionality (services offered), experience and aesthetics. The individual lab tests were scheduled according to the broadcasting windows of each broadcaster on the !TV4GRAZ channel in order to obtain evaluations for all of the additional MHP services offered.

For each test, the subject was invited to the laboratories and asked to perform various tasks in the portals offered. These tasks consisted of user surveys as well as laboratory observation in connection with task analyses.

In addition to the usability tests, evolaris also performed heuristic evaluations of the interactive portals offered by the broadcasters participating in the project; in this process, experts on usability and user interfaces assessed the additional digital services according to various criteria.

The qualitative and quantitative data collected in the course of the laboratory tests and heuristic evaluations (the latter being performed by experts, not test subjects) were evaluated statistically and analytically. The results of the usability tests and the heuristic evaluations should serve to advance the design of ITV applications and reception devices with attention to the overall use process (pre-use, use, after-use) and thus to increase and reinforce the acceptance of ITV.

2.12. Accompanying communication measures

The external impact of the Graz trial was supported by a large number of accompanying communication measures. Aside from numerous press conferences and press releases at various stages in the project (which served to inform specialists as well as a more general audience), a number of specific measures deserve special mention in this context.

An information stand with an atmosphere similar to that of a living room was set up at the Graz City Hall for a period of two months (June and July). This stand allowed people in Graz

to experience the new MHP applications first-hand. Students at the Graz University of Technology were on hand to provide answers to the visitors' questions about the trial and about the digitization of broadcasting. Of the several thousand queries, approximately half were related to technical aspects, and almost one third of the inquiries related to the advantages of digital television.

Surprisingly, the older generation (average age: 35+ years) was also very interested in this new technology. The visitors pointed out the excellent sound and picture quality as an outstanding feature of digital terrestrial television compared to analog broadcasting. They were also particularly interested in Dolby sound and HDTV. In addition, consumers indicated that a combination of at least two standards (e.g., DVB-S and DVB-T or DVB-C and DVB-T) in a single terminal device as well as a wireless connection to the return channel outlet in the household would be desirable. Visitors also asked about the possibility of receiving radio channels via DVB-T.

As a supplementary information measure, a compact and easy-to-understand information folder on the Graz trial was produced (10,000 copies) and distributed to the interested public.

Figure 8: Information stand at Graz City Hall

For the official start of the trial, a gala symposium was held in Graz and attended by a number of prominent figures; this symposium also served as a plenary meeting of the Digital Platform Austria working group. Leading representatives of the four main partner companies gave presentations of the trial with Austrian State Secretary for Media Franz Morak, Federal Council Member Herwig Hösele, and Graz Mayor Siegfried Nagl in attendance.

In addition, a number of expert discussions were held on various topics related to the digitization of broadcasting. The technical high point of the event was a talk given by one of the leading researchers on the development of digital television in Europe: Ulrich Reimers from the Institute for Communications Technology at Braunschweig Technical University in Germany.

During the gala symposium, the trial's project managers were presented with an item which would rouse the local population's curiosity about the future of television in a very special

way. For the duration of the trial, the BMW Group of Austria provided a new BMW vehicle equipped with a DVB-T receiver and the appropriate entertainment electronics in order to enable mobile reception tests. This allowed the people of Graz to take test rides and experience the outstanding mobile reception quality of digital broadcasting first-hand.

Figure 9: BMW 530d DVB-T test vehicle

Once the trial was completed, the core partners also decided to present the services provided and the results of the trial at various international industry fairs. For this purpose, four information boards for exhibitions were produced with details on the trial and the various services performed by the project partners; these boards could be integrated as modules into existing exhibition stands.

Moreover, a brochure of some 100 pages was produced to provide complete information on all aspects of the trial in German as well as English. As a complement, a DVD was produced with short, informative films on the project and all of the MHP applications developed for the Graz trial as well as explanations in German and English.

The brochure was also published on the web and can be accessed from the RTR home page (http://www.rtr.at).

This communication package – consisting of an exhibition stand, brochure and DVD – was first presented at the Munich Media Days in late October 2004.

Figure 10: Exhibition stand at the Munich Media Days

Mobile playout devices allowed stand visitors to sample the interactive applications developed by ORF and the private television stations. International specialists showed very keen interest in the !TV4GRAZ project.

2.13.   Project costs

This section gives a more detailed breakdown of the funds required in order to realize the Graz trial. In general, we can begin by commenting that the project required a highly significant allocation of financial and human resources from all partners due to the trial's defined objective, which was not only to test the digital terrestrial broadcasting of television signals but also to research the technical feasibility of additional MHP services and their acceptance on the consumer side.

Without this dedication of resources, it would have been impossible to obtain these results, which are of decisive importance to KommAustria's digitization strategy as well as all companies and institutions in broadcasting and related areas. The value of the insights provided by the trial goes well beyond the spatial and temporal limitations of this "local" project and represent a significant gain for the regulatory authority with regard to future regulatory measures governing the introduction of digital broadcasting in Austria.

The insights and experience gained in the Graz trial were by no means confined to the digitization of terrestrial broadcasting; they will benefit the digitization of the other broadcasting platforms (cable and satellite) as well.

The total expenses of this project came to approximately EUR 11.1 million, of which EUR 9.7 can be attributed to the core partners RTR, ORF, Siemens Austria and Telekom Austria. The remaining amount (approximately EUR 1.4 million) was distributed among the other project participants: ATV Privatfernseh GmbH (ATVplus), Österreichische Sportwetten GmbH, Sat 1 Privatrundfunk und Programm Gesellschaft mbH (Sat 1 Österreich), Seven One Media Austria GmbH (ProSieben), Styria Medien AG (Steiermark 1), TIV Kabelfernsehgesellschaft mbH (gotv), Tourismusfernsehen Gesellschaft mit beschränkter Haftung (TW1), and ATV Aichfeld Film- und Videoproduktion GmbH (AiTiVi). Approximately ten percent of the project costs were incurred for the construction of the required digital terrestrial broadcasting infrastructure.

Under the guidelines for the financing of regional pilot projects by the Austrian Digitization Fund, up to 50% of the project costs could be funded from this pool. The Styrian Business Promotion Agency (SFG) decided to support the project with funding of up to EUR 1.5 million. According to the relevant provision in the Digitization Fund guidelines, the maximum grant amount was limited to 60% of the total net costs to each project partner. The companies which received grants, the title of the project sponsored, and the respective grant amounts have been published on RTR's web site.

One reason behind the Styrian Business Promotion Agency's grant was the added value created within the province of Styria: A large number of companies and institutions based in Styria (Joanneum Research, BearingPoint, i-Punkt advertising agency, evolaris foundation, Graz University of Technology, ORF's provincial studio and others) had sustainable involvement in the project. The contracts awarded by RTR alone accounted for revenues of EUR 600,000 in Styria. A considerable portion of ORF's expenses went to Styrian companies, and the other project partners also hired Styrian companies as subcontractors or cooperation partners. In addition, two media companies from this province participated in the project: ATV Aichfeld Film- und Videoproduktion GmbH and Styria Medien AG.

As a core partner, RTR incurred EUR 1.1 million in costs for the overall project; these costs were covered entirely by the Austrian Digitization Fund. These expenses were reimbursed in line with § 9b No. 9 of the KommAustria Act, according to which the expenses of KommAustria and RTR for the creation and implementation of the Austrian Digitization Plan are to be covered directly by the Austrian Digitization Fund. Contracts were awarded to third parties in accordance with the public procurement regulations to be observed by RTR.

RTR's costs largely consisted of expenses for the accompanying market research conducted by Fessel-GfK/evolaris, the DVB-T boxes installed in the test households, the project management services provided by the Graz University of Technology, the coordination of project partners, the accompanying study on mobile reception and DVB-T interactivity conducted by Joanneum Research, as well as the accompanying public information measures (press conferences, brochures and public information events).

The other core partners' costs (ORF, Siemens Austria, Telekom Austria) consisted of expenses for the development and testing of interactive MHP-based applications, the return channel and the setup of the Interactive Application Center, as well as expenses for the provision and operation of digital television broadcasting infrastructure.

A majority of the other project partners' costs can be attributed to developing and testing interactive MHP-based applications, the provision of a return channel and the Interactive Application Center as well as personnel costs for editorial staff in the creation and preparation of interactive content. The interactive application costs also include the expense of developing an EPG (handled by ORF in cooperation with ATVplus) through which all participating television stations could be accessed directly. Infrastructure costs included expenses for renting antenna masts, for the multiplexer, for the provision of space, for signal delivery, etc. Moreover, the project partners all incurred additional costs for project coordination and informing the public about the project.

The total net project costs incurred by each project partner are as follows:

Project partner	Costs
RTR	EUR 1,100,000.00
Austrian Broadcasting Corporation (ORF)	EUR 4,591,266.00
Siemens Austria	EUR 2,107,768.00
Telekom Austria	EUR 1,914,201.00
ATV Privatfernseh-GmbH	EUR 431,825.00
Österreichische Sportwetten GmbH	EUR 300,796.00
Sat 1 Privatrundfunk und Programm Gesellschaft mbH	EUR 71,292.00
Seven One Media Austria GmbH	EUR 88,107.00
Styria Medien AG	EUR 49,077.00
TIV Kabelgesellschaft mbH	EUR 150,082.00
Tourismusfernsehen GmbH	EUR 108,399.00
ATV Aichfeld Film- und VideoproduktionsgmbH	EUR 208,852.00
TOTAL	**EUR 11,121,665.00**

2.14.   Project monitoring

At the beginning of the trial, the consulting company Ramsauer & Stürmer Consulting was hired by RTR for the purpose of management control during the project. These management control activities served to ensure that the grant funds were used in accordance with the

guidelines during the project and to monitor the project partners' fulfillment of grant requirements on an ongoing basis.

The essential aspects to be reviewed by Ramsauer & Stürmer were defined in cooperation with RTR and included the following:

- Definition of objectives for individual sub-projects and their contribution to the overall project
- Evaluation of project partners' attainment of those objectives upon completion of the project
- Review of economy, thrift and expedience in the use of grant funds
- Review of project cost reports and transparency in the use of funds
- Review of the use of fixed assets acquired in the course of the trial in accordance with relevant guidelines

Under their grant contracts, all of the project partners were required to present an interim report and a final report on their respective sub-projects. The reports were to be drawn up according to questions defined by RTR and Ramsauer & Stürmer on the basis of the review criteria listed above.

The interim report to be submitted by sponsored project participants after the first third of the project period included the following questions:

- Preview of essential expected results at the end of the project and comparison of these results with the objectives stated in the project application (in terms of content and extent), including reasons for any deviations
- Presentation of attainment level for objectives
- Information on the extent to which funds had been used as of the reporting date and projections of total project costs (forecast budget)
- Comparison of forecast budget with the original project budget, including an explanation of how any additional project costs would be covered (financing secured)
- Presentation of current and expected project development, including explanations of any deviations and descriptions of measures taken
- Information on changes in other important project characteristics on the grant recipient's part

The final report to be submitted by sponsored project participants upon completion of the technical part of the trial included the following points:

- Description of the results attained by the sponsored project (i.e., project benefits) in terms of content and extent, in particular with regard to each project's contribution to the fulfillment of objectives in superordinate (overall) projects
- Description of factors crucial to the success of the (sub-)project
- Final description of the development of the sponsored project over time
- Final description of project costs incurred with reference to the individual project stages, including indications of how the necessary funds were raised or covered with due attention to any budget overruns/underruns
- Explanations of substantial deviations from the plans submitted in the project application in terms of scheduling, funding and content
- Explanations of how the participant ensured that the grant requested for fixed assets was confined to the duration of the project only
- Description of measures taken by the grant recipient to inform the public about the project

Hearings were held on the final reports submitted by the core partners ORF, Siemens Austria and Telekom Austria; these were attended by the core partners' employees assigned to the project, Ramsauer & Stürmer's experts in the fields of auditing and project management control, and RTR employees. During these hearings, the final reports were analyzed specifically in terms of the costs reported. In addition, any unanswered questions were resolved and the core partners were asked to submit additional explanations and documentation. RTR decided on the final grant amount to be paid out on the basis of Ramsauer & Stürmer's final report, which contained an evaluation of all final project reports on the basis of the review criteria listed above.

The final report is expected at the end of 2004. At the time this report was created, all of the project participants had submitted their final reports, although in many cases additional information and submissions were still forthcoming.

3. Designing the MHP applications

At a very early stage, the project partners decided to integrate comprehensive MHP services in the !TV4GRAZ project. With RTR's support, ORF and a number of private television stations developed their own MHP applications in cooperation with additional project partners in the Graz trial. The resulting diversity of MHP experience, especially among television broadcasters and application developers, can only be found in very few countries. The sections that follow give an overview of the specific MHP-based services developed in the course of the project.

3.1. ORF's MHP portals

Whenever additional information was provided for an ORF television show, the ORF OK logo appeared above the station's usual logo in the top right-hand corner of the screen. The viewer was able to display this content on the television screen using the remote control for the set-top box. Essentially, the remote's OK, arrow, and colored buttons were used for this purpose. The viewer pressed the OK button to display ORF's interactive content on screen, initially in the form of a small menu which made it possible to open the desired ORF portal (INFOTEXT, EPG4GRAZ, TV-JETZT) by pressing one of the colored buttons. Unlike conventional teletext in analog television services, these additional digital TV services did not replace the television image on screen when one of the portals was opened; instead, the television image was displayed in a smaller window.

3.1.1. ORF OK – INFOTEXT

INFOTEXT was ORF's up-to-date information service, offering general headlines and the latest news in the areas of domestic and international news, sports, culture, weather, people, etc. On average, INFOTEXT offered approximately 350 pages of text information and 80 photos throughout the !TV4GRAZ project. The text reports were predominantly taken from the data used in ORF teletext. Depending on how current the content was, these reports were updated and substituted regularly (even several times a day).

The portal could be opened by pressing the red button on the remote control. The television image was then displayed in miniature format in the upper right-hand corner of the screen, and the INFOTEXT portal appeared in the remaining space. A three-level navigation bar (controlled using the arrow buttons on the remote) allowed viewers to choose among the categories mentioned above and to retrieve the desired information.
The orange navigator display tracked the navigation commands entered and thus ensured that the user always knew his/her current location within the portal. When the OK button was pressed, the content highlighted in orange was opened on the screen.

Figure 11: The ORF OK INFOTEXT portal

One special feature of all the ORF portals was the fact that that the navigator always moved the selected menu item to the center of the navigation bar, thus moving the desired information to the center of the user's attention. If a report spanned several pages, the paginator at the bottom edge of the text box showed the page number. The viewers were able to use the arrow keys to scroll through the pages offered. The picture (and sound) for the show on the air remained visible (and audible) at all times. The viewer simply pressed the blue button on the remote to exit the application and return to the full-screen display of the show on the air.

For quick information, there was also the option of using shortcuts: Within the portal, the colored buttons were assigned directly to specific pages, which expedited the process of accessing the desired information. This also shortened the usual navigation paths required in the bars at the top of the screen.

The ability to take part in surveys or quizzes reinforces the interactive elements of ITV portals. In cases where a return channel is set up, these functions can be used quickly and easily using the remote control. Every day, ORF INFOTEXT offered a voting function for the "Question of the Day," thus allowing viewers to express their opinions on relevant issues related to sports, information or culture. The results were then published in the portal. These interactive elements could be accessed via the navigation bar (using the arrow keys on the remote control), and the viewer simply had to press the OK button in order to confirm his/her selection. The data was transmitted via the return channel to the Siemens Interactive Application Center, where the results were analyzed. In the case of quizzes, it was also possible to retrieve the correct answer directly in the portal.

In addition to this and other voting functions, the ITV viewers themselves could also influence the actual content of television shows. Under the menu item "Film Request of the Week," ORF INFOTEXT made it possible to vote for one of three films. The film which received the largest number of votes was then aired on ORF on one of the following days.

The ORF OK INFOTEXT portal was developed by ORF's in-house ITV development team in cooperation with BearingPoint, a Styrian IT company.
The MHP application was programmed flexibly so that it could be offered in various colors and versions with a minimum of effort. The portal's MHP basis could also be used to develop entirely new portals. For example, an additional portal was developed for the cable provider Atv Aichfeld simply by adapting the ORF INFOTEXT portal.

3.1.2. ORF OK – TV-JETZT

Unlike INFOTEXT, TV-JETZT (TV NOW) was exclusively dedicated to offering detailed information on the show currently being aired. The portal therefore differed substantially from a program guide, which is meant to offer relatively general schedule information on many shows and channels over a longer period of time.

Figure 12: ORF OK TV-JETZT information on "Churchill"

In the production of a special data service such as TV-JETZT, the main priority was to offer additional information specific to each television show's content. For this purpose, it was crucial to fine-tune the content regularly in cooperation with the relevant television editorial staff at ORF. Coordination with MHP application scheduling for each show also had to be far more precise for the fast-changing TV-JETZT content than in the case of portal content which was independent of the shows on the air. At the end of each show, the information in TV-JETZT had to be changed as quickly as possible for the next program, which usually began almost immediately. This was only possible in the !TV4GRAZ project thanks to extremely careful coordination between the ITV editorial staff, the Content Entry System, application development, set-top box software and the digital playout. Considering the complexity of these interactions, the development of the TV-JETZT portal – and especially the establishment of a stable editorial workflow – can be considered one of the most outstanding achievements in the trial.

In order to meet the complex production requirements of ITV applications and content as effectively as possible, a separate ITV editorial staff was trained and deployed as part of the ORF !TV4GRAZ team in order to provide useful additional content for all of the shows ORF contributed to the !TV4GRAZ test channel.
The additional information provided here not only included text but also photos and graphics.

TV-JETZT proved to be especially well suited for documentaries, television journals as well as current information and news broadcasts. Additional information which could not be

included in the show (e.g., due to time constraints) was included in the additional content offered and could be retrieved by interested viewers throughout the show. This included background information as well as individual graphics, timelines, tables, illustrated biographies and related book recommendations to complement the content presented in each show.

Entertainment shows on ORF were also supplemented with numerous additional content features which varied widely according to the specific show: If, for example, a feature film was being aired, the viewers could use the portal to retrieve information on the plot, biographies of the actors, background information on the production or on the sociopolitical circumstances in which the film was set, as well as additional tips for fans. For various talk shows, viewers were able to get background information on each show's guests or hosts and interact with the show directly using voting or quiz functions via the return channel. Instead of remaining a passive observer, the viewer thus became an active participant in the television show. For soccer matches and other sporting events, TV-JETZT also offered background information on the relevant athletes and teams. During the Euro 2004 championships in Portugal, the ORF OK team enhanced each of the matches aired with additional information and interactive features such as betting, voting functions and a quiz on the European championships.

Figure 13: ORF OK – TV-JETZT – Euro 2004 championships

Like the INFOTEXT portal, the TV-JETZT portal could be opened by pressing the OK button. However, the TV-JETZT portal was mainly designed in yellow and was therefore accessed using the yellow button on the remote control. The television image was still displayed in miniature format (as in INFOTEXT), but it took up more of the screen in the TV-JETZT portal (quarter-screen view); this made it easier to create a connection between the show on the air and the additional information, plus the viewer could follow the show more easily.

The portal's navigation bars enabled viewers to open a voting page and to participate in polls related to the show currently on the air. Once the user pressed the OK button, his/her vote was sent to the Interactive Application Center (IAC). The voting results from all households

were merged at the IAC, after which it was possible to include them in the current show. This technically sophisticated and highly convenient method offered an attractive alternative to (or a replacement for) the current SMS-based and telephone voting processes used in successful viewer-participation shows such as ORF's "Starmania."

ORF was only able to meet the challenges encountered in the development, production and regular testing of TV-JETZT content with the support of Austrian IT experts. In close cooperation with ORF, the Styrian MHP developers at BearingPoint and the software experts at PLOT assisted in the development and ongoing improvement of TV-JETZT over the course of the !TV4GRAZ project. All return channel tests were performed and optimized in close cooperation with Siemens.

3.1.3.   ORF OK – OLYMPICS PORTAL

The fact that the interactive MHP portals developed in the Graz trial are not only suited for terrestrial broadcasting was clearly demonstrated by the success of a sports portal developed by ORF specifically for the 2004 Olympic Games in Athens and broadcast digitally via the Astra satellite system. This service was thus the first operational MHP content offered via satellite by an Austrian television broadcaster based on the experience gained in the Graz trial.

Figure 14: ORF's Olympics portal

In its Olympics portal, ORF offered up-to-date results and information on all Olympic disciplines from August 13 to 29, 2004. The content ranged from team rosters to athlete biographies, from sailing to military riding and Tae Kwon Do, as well as a historical overview of all summer Olympic Games held in modern times. A breakdown of medals won by country and discipline was also provided, as was a category containing comprehensive information on all Austrian athletes taking part in the 2004 Olympic Games.

The software architecture for the INFOTEXT and TV-JETZT portals was optimized and merged on the basis of insight gained in the initial tests in Graz. These improvements, which were essential to the performance of ORF OK products, were carried out by the ORF ITV team together with the developers at BearingPoint. Due to the large amount of Olympics-related content which had be presented in a clear and understandable format, the ORF OK navigation bar was expanded to include a fourth category. The Olympics portal was filled with some 500 pages of text and updated several times per day using the ORF OK CMS. In addition, this service included approximately 260 photos, including a slide show with the best

moments in the games. Although development and testing for this ORF OK product coincided with the !TV4GRAZ trial, the terrestrial test households in Graz were not able to receive the Olympia portal. The portal was deliberately filled with more content and data than DVB-T could support without disturbances in reception. Accordingly, the objective of this specific product development was to test ORF's digital playout as well as the CMS developed especially for the !TV4GRAZ project under very high data transfer requirements.

3.1.4. SteirerQuickText

In cooperation with ORF, TW1 supplied !TV4GRAZ with one hour of weather panorama images from Styria every morning. A total of 10 locations were chosen for these regional weather panoramas.

In order to add an interactive element to this weather show, a quick info service called "SteirerQuickText" (Styrian Quick Text) was developed. In this feature, a navigation bar with color-coded categories was opened automatically at the top edge of the screen. The categories were NEWS (red), TRAFFIC/TRANSPORT (green), EVENTS (yellow) and WEATHER (blue). By pressing the corresponding colored button, the viewer could display a line of text on screen showing the latest report from that category. Interested viewers could press the OK button to open the full text of the report. This "text basket" was then superimposed over the screen. After pressing the OK button again, the viewer could close the text and read the next report in that genre, open another category in the top navigation bar, or continue watching the weather panorama in full-screen mode.

Figure 15: SteirerQuickText

The ORF provincial studios in Styria cooperated closely with TW1's weather service in maintaining the content of this product and prepared in-depth information for the News, Traffic & Transport and Events categories. This data was sent to TW1, where the weather information was inserted, and the entire package was passed on as an XML file to ORF's headquarters in Vienna. From there, the finished application was broadcast along with the television signal.

3.2. MHP portals developed by private television stations

For the DVB-T trial in Graz, ATVplus and Sony NetServices developed the basic design of an MHP portal which was optimized further in cooperation with Siemens and pursued the

cost-effective strategy of being so flexible that its basic structure could be used by all the private television stations in the trial and adapted to each station's individual corporate identity. Therefore, once the spaces for menu items, the miniature television image and advertising banners were defined, it was also necessary to ensure that the design elements and colors which conveyed each station's individual design could be exchanged easily. In this way, Siemens and Sony NetServices cooperated in the production of five MHP portals which had different, unmistakable looks but were still based on the same architecture.

3.2.1.   ATVplus

The ATVplus portal consisted of 5 categories: ATVplus, News, i-aktiv, Graz4you and Shopping. In addition to show-specific additional information and various interactive functions, these categories also offered useful service tips as well as regional and national news. In this context, special attention was paid to clarity and user-friendly navigation within the portal.
Specially developed shortcuts served to shorten navigation paths; for example, viewers could press the numbers 1 to 5 to access the 5 main menu items directly.

Figure 16: Main menus of ATVplus' MHP portal
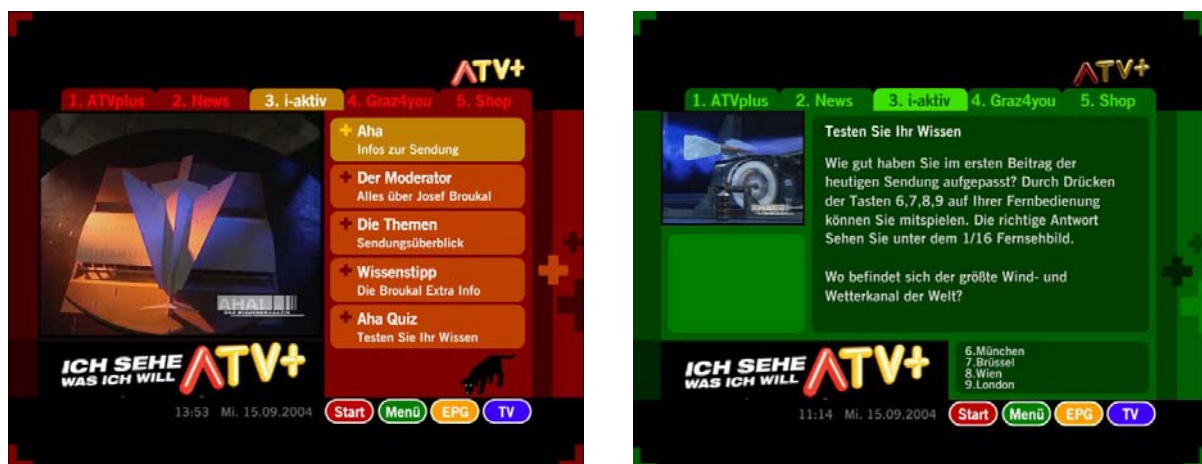
The **i-aktiv** category, which provided show-specific content, was defined as the portal's start page. In this way, viewers could immediately retrieve background information on the show currently being aired or on a specific host or protagonist, as well as accessing useful service tips related to the show. Quizzes, contests and voting functions were also offered. In order to participate, viewers had to choose between two to four possible selections and submit their answers to the IAC via the return channel. The voting results and quiz answers were published in the portal once this feedback was received.

Figure 17: Local interactivity in ATVplus' MHP portal

The **ATVplus** category provided information on the history and penetration of the television station, as well as providing information on upcoming events and contact information. One special interactive feature in ATVplus' portal was its "personalization" functions, which made it possible for viewers to change the portal's layout according to their individual preferences. Similar to adapting the desktop of a computer, viewers were allowed to change the color scheme and other elements of the portal's appearance. Viewers who enjoyed experimentation were able set the portal's color to red, blue or green, make the ATVplus mascot ("Barker" the dog) stand, run or sniff around, and choose from three versions of Barker, which was also the screen symbol indicating the availability of interactive additional services.

A special service was provided in the **News** category, where current national and international reports from APA (Austrian Press Agency) could be retrieved in real time. In order to realize this function, APA accessed the CES (Content Entry System) itself and updated the content in the portal directly.

The **Graz4you** category contained regional information, event tips and cultural highlights for the greater Graz area. This information was entered in the CES directly by the City of Graz's Department of Public Relations and Information. This feature was developed in such a way that it can be adapted to suit any region of Austria in the future.

ATVplus provided another means of interaction between the viewer and the broadcaster in the **Shopping** category. In the virtual shop, portal users could order the ATVplus mascot as a stuffed animal, T-shirts, key rings and other marketing merchandise, as well as previous broadcasts on VHS. The ordering process was likewise carried out using the remote control, and viewers only needed to enter their data in an order form and submit the order. Soon thereafter, the items ordered were delivered to their homes. The idea of interactive shopping can be expanded in a number of ways, for example by offering show-specific merchandise as well as general shopping portals in the future.

Figure 18: Ordering function in ATVplus' MHP portal

In the course of the DVB-T project, ATVplus deliberately implemented forward-looking business models in its portal. This included the possibility of outsourcing certain portal areas (as in the case of APA) as well as integrating potential advertising customers, possibly with their own portals (as in the tipp3 live! trial).

ATVplus submitted its MHP portal for the Austrian State Prize for Multimedia, and the portal received an award in the "Innovation" category.

3.2.2.   gotv

The MHP portal set up by gotv, a music channel for young people, worked like a jukebox. During gotv's broadcasting times on the !TV4GRAZ channel, the test subjects were able to request songs from a pool of 240 videos; the songs were then automatically inserted in the show and broadcast to all viewers shortly thereafter. Therefore, viewers who used their remote control to choose a song were able to influence the content of gotv's shows interactively.

Figure 19: gotv's MHP jukebox
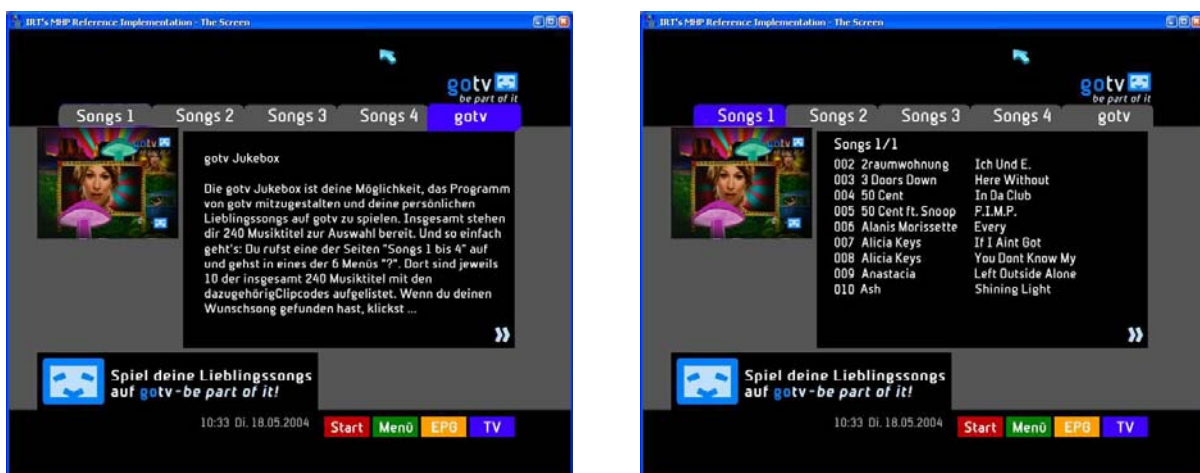
The gotv jukebox was implemented in cooperation with the partners Publitronic, Siemens PSE and Sony NetServices. For this purpose, a music video server was linked to the !TV4GRAZ broadcasting system at ORF's headquarters. On the server, the Netherlands-based company Publitronic installed a new version of gotv's playout program and stored videos from gotv's current rotation. Siemens PSE developed and provided an MHP application which allowed ITV viewers to request the videos on the music server via the return channel and to have them shown on !TV4GRAZ. Sony NetServices assumed responsibility for supporting the interactive MHP application, including content entry. In addition, Sony NetServices handled design activities, which included the colors, background images, logo, typography and graphics used in the application.

The gotv portal included five main menu items for navigation. Each of these items could have as many as six sub-menus, which could be assigned up to three detailed pages. The viewer was able to navigate through the portal using the numbers, arrows, the OK button and the four colored buttons on the remote control. In order to request videos, participants had to register with the Siemens Interactive Application Center directly in order to receive their own user IDs and PINs. This made it possible for multiple members of the same household to submit individual music requests. Registered users were also assigned nicknames which were displayed on the television screen while their requests were being broadcast.

3.2.3. ProSieben Austria

On weekdays, ProSieben Austria aired its "Austria TopNews and 2night.tv" live at 8:00 pm on !TV4GRAZ, as well as "2night.tv weekend" and "Austria TopTalk" on weekends. ProSieben Austria complemented these broadcasts with an interactive MHP portal which provided viewers with in-depth additional information in five categories: Austria TopNews, 2night.tv, Galileo, Digital and Inside.

Every day, three current topics presented in Austria TopNews were explained in greater detail in ProSieben Austria's interactive portal. The events and nightlife journal 2night.tv was also regularly accompanied by service-oriented background information and supplementary reports. For example, the MHP portal offered interested viewers nightlife tips, celebrity gossip and an event calendar for concerts and clubs in and around Graz.

Figure 20: ProSieben Austria's MHP portal

For Austria TopTalk, the ProSieben Austria application offered useful information on each talk show guest and the discussion topics of each show. Voting and quizzes provided interactive elements.

ProSieben Austria tackled the greatest challenge in this project – motivating the viewer to participate actively while watching television – by inviting them to vote in various surveys via the return channel. Galileo, a science and knowledge show, provided a solid basis for testing truly interactive applications. Before each show, a question specific to the topic of the day was asked, and ITV viewers were able to submit their answers using their remote controls. The answer was then explained directly in the show. In addition, the "Galilexikon" – an interactive quiz game – also encouraged viewers to participate.
In other voting functions, the viewers were able to submit their opinions on shows, hosts and the topics discussed.

In the "Digital" category, ProSieben Austria explained the most important terms related to digital television and described the station's role in the Graz trial.

The category "Inside" presented ProSieben's Austrian broadcasting station and provided additional information on Austria TopNews, the hosts and the ProSieben Austria team. Viewers could also take a look behind the scenes and see a presentation of the studio.

3.2.4.   Sat.1 Austria

Sat.1 Austria participated in the DVB-T project in Graz by providing two of its own television productions made in Austria: An automotive show for car enthusiasts (*Go! Das Motormagazin*) and a health journal (*Welt der Medizin*) were broadcast on !TV4GRAZ. However, Sat.1 Austria not only provided digital broadcasting content, it also offered fully interactive applications with viewer voting functions in order to make use of the television interaction cycle and the return channel connection to the Interactive Application Center.

The focus of these additional functions was on show-specific services, up-to-date schedule information, notes on programming topics and current weather information, all of which could be retrieved using the MHP portal.

Figure 21: Sat.1 Austria's MHP portal

As a complement to its automotive show, Sat.1 provided background information on all topics in the current show with additional links and related information. In addition, ITV viewers were able to access monthly service features related to automobiles. Information on car dealers in the Graz area as well as *Go!* surveys were also included in Sat. 1's digital interactive content.

In parallel to its show on health and medicine, the Sat.1 portal provided useful information such as contact data for services and doctors mentioned during the show. Sat.1 Austria plans to continue pursuing the possible applications of digital television and their use in the development of interactive business models.

3.2.5. Steiermark 1

In its MHP portal, Steiermark 1 focused on show-specific additional information for its talk show "Pro & Contra." Viewers of this show were able to retrieve biographies and photos of each studio guest as well as further information on the arguments presented by participants. In addition to providing a collection of related web links, the Steiermark 1 portal also asked viewers for their personal opinions on each show's topic, thus enabling them to make their voices heard via the return channel.

Figure 22: Steiermark 1's MHP portal

A cooperation arrangement with a regional weekly newspaper enabled ITV viewers to read the most important reports from the city of Graz on Steiermark 1's portal one day before the paper reached the newsstands.

3.2.6. Atv Aichfeld

Each week, ATV Aichfeld, a cable network operator and regional television station in the vicinity of Graz, produced its own television journal (*Das Magazin*) along with an interactive portal for !TV4GRAZ. The show presented current regional news from the areas of culture, politics, tourism, the environment, food and drink, business, etc.

The MHP application provided in-depth information on the topics presented.

Figure 23: Atv Aichfeld's MHP portal

By means of a radio link, the !TV4GRAZ signal was also fed into the regional cable network in Aichfeld.

3.3.   EPG4GRAZ

EPG4GRAZ was based on the architecture, design and navigation of the ORF OK portals and offered the viewers in the trial a full overview of the shows on all four channels.

The objective was to develop a program guide which enabled users to search for their favorite shows by channel, time or genre and to find these shows in the ORF 1, ORF 2, Steiermark 1, ATVplus and !TV4GRAZ schedules as quickly as possible. The main challenge in the process was generating the considerable quantity of schedule information, which was updated several times per day, as well as importing this information into the application in a reliable, usable form. The format which has been used for additional channel data since the very beginning of television digitization is the international standard EIT (Event Information Table). The guide data for all of the channels involved first had to be prepared in text format and then converted to EIT format. The MHP application was programmed in such a way that the newest data record supplied along with the digital TV signal was detected and included in the portal automatically.

Figure 24: EPG4GRAZ – 6-day preview by channel and genre

The EPG version used in Graz is part of a multi-stage EPG project and can be regarded as a base module for further development. In future digital TV projects, the MHP program guide will be expanded to include a number of useful functions. ORF's ITV development department is currently working on EPG Module II, which includes photos and extended text descriptions of shows; Module III calls for the integration of short on-demand video clips, meaning that viewers will even be able to retrieve various trailers for shows (e.g., feature films) as desired.

3.4. tipp3 live!

In the !TV4GRAZ project, Österreichische Sportwetten GmbH broadcast Austria's first interactive betting application for digital television in connection with the Euro 2004 soccer championships in Portugal. The application was programmed in cooperation with Siemens Austria.

In the tipp3 live! portal, ITV viewers were able to choose among the following options: Submit bets, Query account, Retrieve betting record and View terms and conditions of participation. Viewers were able to navigate through the portal using the number buttons or the OK button.

Figure 25: Menu in the tipp3live! betting portal

Starting several days before a match (and continuing right up to the end of the match itself), viewers were allowed to submit one or more bets on the final result using their remote controls (red, green, or yellow button). In the Graz DVB-T trial, bets were placed for points only. During each match, the odds were updated regularly by tipp3 live's betting management according to the usual rules for calculating betting odds.

Figure 26: Bet submission in the tipp3live! betting portal
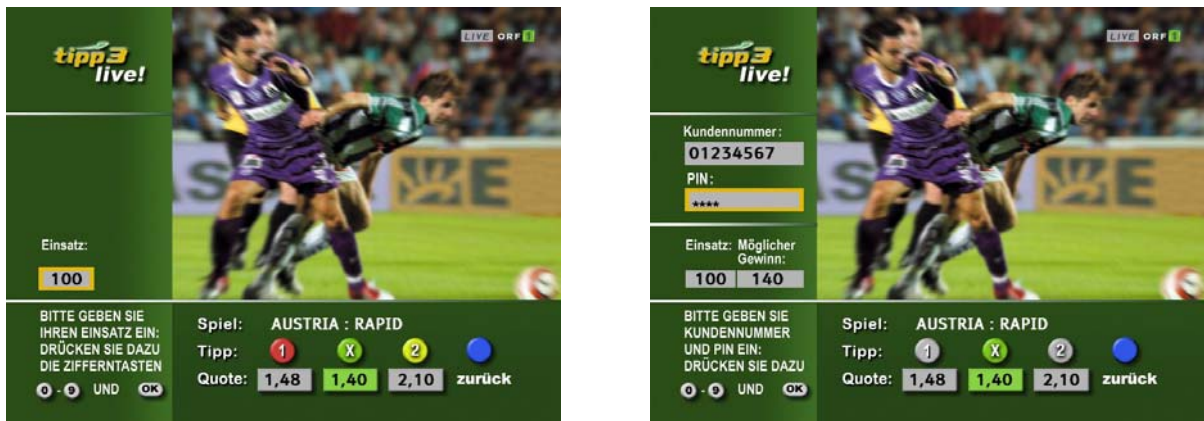
tipp3 live! was a separate portal and could be accessed from ORF's interactive content (INFOTEXT or TV-JETZT) or through the ATVplus portal.

In order to use the betting functions, viewers were required to submit their user IDs and a security PIN via the return channel. In this way, the developers were able to meet the security requirements which will later be crucial when such applications are deployed under real conditions.

The objective of this contribution to the !TV4GRAZ trial was to gain insight as to the technical connection of third-party applications with television broadcasters' MHP portals and to gain experience with the back-end processes necessary for this purpose as well as any related restrictions.

With its tipp3 live! application, Österreichische Sportwetten GmbH succeeded in creating a fully developed business model in the field of digital interactive television.

3.5.   Siemens' ITV advertising portal

With its own advertising portal in the Graz DVB-T trial, Siemens pointed out new advertising possibilities in the combined use of digital television and MHP-based additional content.

Viewers were able to open an MHP portal with information on one of Siemens' new mobile phones – not during a television show, but during a classic television commercial. Accordingly, this mobile phone commercial can be regarded as the first interactive television commercial for digital television in Austria.

During the 50-second commercial, the viewer could use the remote control to retrieve additional information on the product advertised. The underlying MHP portal offered technical data, special features and various views of the mobile phone as well as a contest.

Figure 27: ITV advertising portal for the Siemens SX1 mobile telephone

The contest was introduced as a means of measuring the final consumer's acceptance of this new medium. Specific, anonymized questions made it possible to generate valuable data on customer satisfaction with the medium, the product as well as the design of the advertisement, and then to use this information in an analysis of the future market for such applications. Three of the mobile phones were raffled off to participants in the interactive survey.

The possibility of actually ordering products via television is thus approaching quickly.

The advertising application for the SX1 was created in cooperation with Siemens' in-house agency (Corporate Communications) and its in-house software developer, Program and System Engineering (PSE). The application was designed and implemented expressly for the field tests in Graz.

4. Project Management's Technical Report

4.1. Selection of set-top boxes

The crucial function of set-top boxes in the interaction cycle of digital television – that is, decoding the digitized television signals and MHP content and displaying them on today's common television sets – made it necessary to make careful selections from the range of products available (which was still fairly small during the preparation stage) using stringent criteria.

As early as summer 2003, therefore, the project managers carried out an initial study of the market as well as intensive research on the availability of MHP-compatible set-top boxes, television sets and PC components in cooperation with the Institute of Communication Networks and Satellite Communication (IKS) at the Graz University of Technology. The result was that many of the devices previously announced by manufacturers were not yet available on the market and would not be available in the foreseeable future.

The project management's contact with the Broadcasting Technology Institute (IRT) in Munich, Germany, which had carried out a market study on MHP-compatible DVB receivers in October 2003, indicated that the only DVB-T receivers expected to be available for the German market in early 2004 were those manufactured by ADB and Panasonic; Nokia had also announced the launch of a set-top box.

In conjunction with the Association of the Austrian Electrical and Electronics Industries (FEEI), which had offered its support in the search for manufacturers and suppliers of MHP-compatible set-top boxes, an invitation for bids was sent out to the association's members in mid-November. This invitation included the general conditions for inclusion in the project (especially with regard to delivery dates) as well as the Guidelines for the DVB-T Platform Austria drawn up by the core partner ORF and the system partner BearingPoint. These guidelines described the technical requirements for suitable set-top boxes.

However, even with the support of FEEI, this search for manufacturers of suitable receivers hardly brought about new results beyond the existing contacts of ORF's project employees and the trial's project management. This was also due to the fact that the high demands of the project in Graz were far more advanced than current developments in existing DVB-T markets.

Philips promised to submit an offer by the end of December 2003 as well as a sample test box in advance. Panasonic and Nokia also showed interest in participating in the trial and made devices available for the ORF testing facility and the testing lab at the Graz University of Technology in December 2003 and January 2004.

Upon Siemens' initiative, the project management passed the requirements and specifications of the Graz trial on to Fujitsu Siemens, which was preparing a DVB-T version of its Activy Media Center for the German market.

The core partners agreed that Fujitsu Siemens' Activy box should be included in the Graz trial, especially because at the time it was the only deliverable set-top box on the market which had an Ethernet interface for a broadband return channel connection, while all of the other set-top boxes were equipped with a V.90 dialup modem. Moreover, the core partners and project management considered it important to simulate real market conditions by using set-top boxes from multiple manufacturers.

The ultimate results and agreements with the manufacturers/suppliers of the brands Philips, Nokia, Panasonic and Sony can all be attributed to the personal contacts and initiatives of ORF's project employees and the trial's project management. Due to many years of cooperation in the satellite sector, the suppliers' representatives made extraordinary efforts

within their companies to initiate the production of small lots (and in some cases prototypes) of their receivers for the Austrian trial.

As a result, by mid-January 2004 the four manufacturers/suppliers listed below had agreed to supply small lots of MHP-compatible DVB-T boxes (with delivery scheduled for late February / early March 2004). These manufacturers made test devices – which were not 100% identical to the limited-lot models in terms of hardware and software – available to the ORF testing facility and the Graz University of Technology lab from mid-January onward. The models which were to be used in the trial (and their planned quantities) are indicated below:

Figure 28: Set-top boxes to be used in Graz test households

Fujitsu Siemens Activy 350 (50 units)

2 x CI, single tuner / double tuner, UHF only, digital audio out: cinch, 20 to 120 GB HD
Modem: analog, ISDN, DSL (Ethernet)
MHP middleware: IRT reference implementation
Equipped with digital video recorder and DVD burner. E-mail and Internet access included. The Activy Media Center runs MHP and the accompanying Embedded XP.

Nokia MediaMaster 310-T (50 units)

V.90 modem connection, 1 CI slot, Dolby Digital out
Return channel: PSTN
MHP middleware: Alticast AlticaptorTM MHP

Panasonic TU-MTF 100T (35 units)

Connection type: V.90 modem, Dolby Digital out
Return channel: PSTN
MHP middleware: OpenTV Version EN23m02
MHP Version 1.0.2 compliant, 52 MByte

Philips DTR 4600 (50 units)

Connection type: V.90 modem
Return channel: PSTN
MHP middleware: Osmosys

At that point, the manufacturers (or suppliers for) Nokia, Philips and Panasonic specifically emphasized that the receivers were prototypes and that it would thus be necessary to over-order and ensure that a sufficient number of extra devices were available in case they needed to be exchanged in the households.

Finally, Sony also provided a television set with both an analog and integrated MHP-compatible DVB-T tuner for testing in the labs in Vienna and Graz.

Figure 29: Sony television set with integrated DVB-T and MHP receiver

Sony KD-32NX200E

MHP-compatible iTV with DVB-T receiver. 76cm visible FD Trinitron WEGA screen (32" tube), Memory Stick, digital & analog tuners, Electronic Program Guide, Virtual Dolby Surround + BBE, SmartLink, digital & analog text, Fastext, auto tuning/auto start-up, auto labeling/auto sorting, smart/zoom/4:3/wide mode, vertical picture stabilizer, DRC-MF, Dynamic Picture Control, digital/auto noise reduction, audio output 2x10 (L&R) + 15 (Ctr) watts RMS, analogue text page memory, 4x SCART (1x RGB), PCMCIA slot, open stand supplied.

4.2. Testing the set-top boxes

In the course of initial tests with these set-top boxes at the ORF testing facility, it quickly became clear that the standards allowed some latitude which led to varying interpretations in middleware programming as well as MHP application development. The resulting failures prompted intense research as to the causes of the various compatibility problems encountered. The Austrian representatives of the manufacturers were urged to submit feedback on the functionality of the test devices supplied, and the ORF ITV development team requested a manufacturer's confirmation indicating the extent to which they fulfilled (or diverged from) the project partners' Guidelines for the DVB-T Platform Austria. In particular, this concerned the activation of the return channel. As time was a critical factor and it was thus necessary to resolve these problems as quickly as possible, the project management located the relevant contacts directly in the engineering departments of the box manufacturers' hardware and middleware developers and made these contacts available to the application developers for inquiries.

The first comprehensive tests at the ORF testing facility showed that the set-top box supplied by Panasonic for the trial did not comply with the project partners' Guidelines for the DVB-T Platform Austria. In particular, the television image could not be displayed in 1/8 screen mode due to hardware issues. As this was an absolute prerequisite for displaying the show on screen when the planned interactive applications were being used, the set-top box supplied by Panasonic could not be used in the DVB-T trial.

As the project management had constantly monitored the developing market for set-top boxes, a Humax MHP box used on the Italian market also came to their attention. Tests performed on an individual device acquired from Humax yielded very positive results. Humax's Austrian distributor, a company called Estro in Salzburg, offered at short notice to divert 50 units from a consignment intended for Italy. In coordination with the core partners' Steering Committee, the project management ordered 50 Humax DTT 4000s (see Figure 30), and the supplier promised to deliver by mid-March 2004, in time for use in the test households.

Figure 30: Humax DVB-T set-top box

Humax DTT 4000

Return channel: PSTN
Connection type: V.90 modem
MHP middleware: Alticast AlticaptorTM MHP

Tests performed on the Nokia Mediamaster 310 T showed that the box exhibited extremely long response and loading times. As this problem appeared to be related to the hardware used in the box, it was doubtful that the new software version 1.0.5 announced by Nokia would bring about improvements in this respect. In order to derive information on the acceptance of longer loading times in the trial as well, a reduced number of these Nokia boxes were still included in the test sample (20 instead of 50 units). The core partners' Steering Committee decided to offset the resulting deficit with 30 additional Humax boxes, which had shown outstanding test results and were available at short notice. Therefore, the total number of Humax DTT 4000 boxes was increased to 80 in the Graz trial.

As of early April 2004, the availability of MHP-compatible terrestrial set-top boxes for deployment in the 150+ test households in the DVB-T trial was thus as follows:

Humax DTT -4000   80 units, delivered on March 11, 2004
Philips DTR 4600   50 units, delivered on March 8, 2004
Nokia Mediamaster 310T   20 units, delivered on March 22, 2004
Fujitsu Siemens Activy 350 50 units, delivered on March 9, 2004

The total of 200 set-top boxes accounted for the fact that the boxes were prototypes and small-lot models which experience had shown to have a higher risk of failure. It was thus prudent to keep potential replacements on hand. As the boxes delivered were different from the initial test devices in terms of the hardware and the software versions installed, it was also necessary to make devices from these production runs available to the labs at ORF, Siemens, the Graz University of Technology, and evolaris for additional testing.

In late March / early April 2004, ORF and Siemens began performing return channel tests with the set-top boxes.

The Fujitsu Siemens Activy 350 (ADSL) and the Philips DTR 4600 (POTS) passed this return channel test without problems.

When activating the return channel, the Nokia Mediamaster 310 T and the Humax DTT-4000 both showed the same problem: The modem would dial in, but the connection would terminate immediately. It was soon discovered that the operating system programming in the set-top boxes varied when it came to the activation and functioning of the internal modems. The modems were designed to accept MHP commands, but it turned out that the developers of the Nokia and Humax middleware had based their systems on differing MHP command sequences. It was only after intensive and open cooperation between the application developers and the middleware programmers on the manufacturers' side that the experts were able to sequence the commands in such a way that the connection to the Telekom Austria telephone network could be established from all MHP applications with each brand of set-top box. This breakthrough came just in time for the start of the trial on June 1, 2004; as of that time, 156 households had already been equipped with set-top boxes.

In some cases, the required software upgrades could only be generated, tested in the ORF testing facility, and approved for transfer to the set-top boxes once these highly varied problems with the set-top boxes had been resolved. As these upgrades were not yet OTA-enabled (i.e., updates which can be received via the broadcast signal), the new software had to be loaded onto the boxes via the serial interface, which was a time-consuming process. For this purpose, the set-top boxes had to be unpacked and connected to a television set, a return channel and a laptop, after which the upgrade was transferred and a functional test was performed and logged. This firmware update procedure was carried out at the evolaris foundation by employees of evolaris and the Graz University of Technology between May 4 and 25, 2004, on the 50 Philips devices and subsequently on the 80 Humax and 20 Nokia boxes.

The official start of the incremental trial operation was on May 3, 2004, at 4:00 pm. An unofficial launch with an ATVplus MHP television show and portal took place on April 20, 2004, followed by ORF's INFOTEXT on April 27, 2004. This made it possible to carry out the final tests under real broadcasting conditions at the university and evolaris labs in Graz.

4.3.   Use of indoor antennas

In order to ensure ideal signal propagation, both DVB-T broadcasting facilities in Graz were set up at locations where no analog television broadcasting masts had been installed before. For this reason, the existing home antennas in Graz were generally not oriented properly to receive signals from the new masts, and DVB-T signal quality in the test households was expected to be fairly low using their antennas. In order to prepare for such a case and in order not to have to rule out previously selected test households due to a lack of signal reception, the project management ordered active indoor/outdoor antennas which had already yielded excellent results (also in terms of value for money) at the TU Graz / Joanneum Research testing facility.

Figure 31: Indoor/outdoor antennas for Graz test households: Antares DTA 3000 by Schwaiger (left) and BZD 30 Kathrein
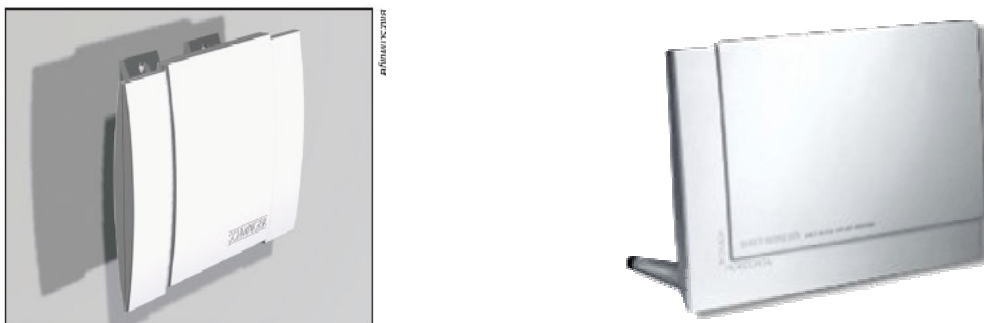
In addition, the devices also had an attractive design and could be used outdoors under certain circumstances. The on-site signal tests carried out by Fessel-GfK using set-top boxes in the selected test households showed that approximately 60% of these households (104 of 175) did not have sufficient signal reception using their rod, wire or house-mounted antennas, thus those households required this additional reception technology.

4.4. Technical problems and solutions

The field tests demonstrated the critical role of set-top boxes in the success of this closed-end project concept and in live operation in the future. Likewise, the trial also revealed the manufacturers' adherence to standards and specifications, which has been insufficient to date.

A number of problems immediately related to the devices used in the test households are described below for illustration purposes:

In comparative tests performed at the TU Graz video laboratory using the various set-top boxes and the same TV studio monitor, clear differences were identified in each box's display of MHP applications on screen. These differences included window size as well as font colors and quality in particular. When boxes were subsequently used in combination with television sets from various manufacturers and with computer monitors, the individual boxes again exhibited an entirely different display behavior. Even the use of different box output connections, plug connections or cable types had a noticeable effect on the quality and on-screen display. An inordinately high level of variance was recorded, which made it difficult to evaluate the boxes objectively and impossible to perform statistical evaluations, in particular due to the fast-changing formats used by the seven television broadcasters participating in the project as well as capacity restrictions.

Another effect which arose repeatedly was the problem of asynchronous audio and video signals on all channels, which was largely due to the terminal devices and their combinations (i.e., set-top boxes and television receivers) as well as the type of connection chosen. In particular, the Humax DTT-4000 used in the trial was not able to ensure synchronized sound and images. Depending on the device's state, there was a delay of up to one second. According to Humax, this function was not a requirement for the Italian DVB-T market, for which the series had been produced.

The performance of the tuners was also meant to be a criterion. Therefore, signal reception problems arose in some of the households at the beginning of the trial because signal availability had been tested there with the Humax boxes (the first to become available). However, the trial showed that the tuners in the Humax boxes showed substantially better input sensitivity compared to the other set-top boxes.

The "personalization" of MHP applications by the user (individual color settings, as offered on the ATVplus MHP portal) was not supported by the Humax and Nokia devices. The activated security functions did not allow these settings to be changed.

Tests with the Fujitsu Siemens Activy 350 in Graz showed that content changes in the MHP portals were not displayed by this box until the portal was closed and re-opened.

As the warmer season began, the households with indoor antennas also saw a decrease in the quality of the digital terrestrial signal. As comparative measurements showed, this was especially the case in households with already weak signal strength. This was due to seasonal changes in the weather (frequent rainfall) as well as foliage growth. The increased use of sun protection (e.g., heavy window blinds) in the test households also led to a reduction in reception quality.

In the further course of the trial, another substantial decrease in signal quality in the households and at the laboratory locations was observed as the number and data volume of some MHP applications increased considerably. In addition to signal interference, there were also disturbances in the process of loading the MHP applications on the set-top boxes. Aside from a technical malfunction at one of the broadcasting locations, another cause of the problems described was that the processors in the set-top boxes could no longer keep pace with the increased data volumes resulting from larger MHP applications in the reception signal, which then overloaded the boxes.

In the course of performance tests conducted by ORF, a total of three portals broadcast on the !TV4GRAZ channel (TV-JETZT, INFOTEXT and the EPG) were filled with more and more text, images, etc., which once again showed (and in some cases exceeded) the limitations of the set-top boxes used. This lengthened the application loading times on the boxes, as well as extending the time until the individual ORF applications were displayed on screen to a duration which was no longer acceptable in real operation (between 50 seconds and 3 minutes, depending on the type of set-top box). In many cases, the boxes failed to display part or all of the MHP portals.

In order to test the effects of the broadcast data volume on the duration of loading and display processes, the appropriate tests were performed and repeated. These tests involved turning off channels 1 to 3 on an alternating basis, or omitting one of the ORF portals or linked sub-portals (such as the Siemens SX1 contest application). The performance of the set-top boxes improved substantially as a result. These findings should be included in the general specifications of the invitation to tender for multiplexer operation, which is scheduled for 2005.

Once the entire technical cycle of digital broadcasting and terrestrial reception had been put into operation for the interactive television content, a number of unforeseeable problems and challenges arose which can largely be attributed to the dynamic development of several MHP portals. Until mid-July, trial operation was dominated by technical problems such as signal quality, return channel connections, specific characteristics of set-top boxes or the digital data playout, which was controlled by the newly developed Synapse and Coral Servers, and therefore the test households were not able to use all of the interactive MHP content offered for certain periods of time. This meant that the test households were not able to learn to use the interactive applications until later in the trial. These circumstances also compromised one of the original objectives of the market research project, which was to allow viewers to approach the MHP applications without previous influence and to allow them to evaluate the applications independently. Instead, the households were introduced to the available applications by means of specific assigned tasks in their diaries and by means of help pages in the portals in order to ensure that sufficient experience reports could be collected from the test subjects in the time remaining in the trial.

The essential technical problems which limited the availability or usability of the interactive applications are listed below.

The Synapse program (developed by Thales) was used at ORF's broadcasting center for the purpose of controlling, automating and broadcasting the interactive MHP services. This elementary part of MHP broadcasting is a relatively new software development and includes a number of specific functions which have to be adapted to the existing broadcasting infrastructure. As a result, the stability of this software component frequently did not meet the requirements of the project in the first few weeks; the component also malfunctioned repeatedly, in some cases due to overloads. The developer worked to remedy these problems with exceptional commitment. However, the improvements necessary in this very complex system were highly time-consuming. Therefore, the first step taken was to reduce the input to Synapse (which was sometimes received every minute), for example by supplying the MHP portals' content updates at greater intervals and in zipped files. Supplying MHP portals with content just one minute before the portals were launched was demonstrated successfully using the ATVplus portal as an example, after which this practice was maintained.

Another problem was the lack of stability in establishing the return channel connection between the set-top box and the Siemens IAC; the cause of this problem could not be traced for some time. All of the devices used were affected by this problem. The fact that the same

set-top boxes would work in one attempt and then fail in the next made evaluation especially difficult. As it turned out in the course of the trial, the reasons behind this problem were varied, which made it even more difficult to isolate specific errors. Through the intensive cooperation of all parties involved, however, it was possible to identify the sources of these errors and remedy them successively.

For example, the small quantity of results recorded at the IAC for the use of interactive applications (voting, ordering functions) aroused certain suspicions. A large number of interactions should have been recorded just from the MHP tests carried out at the ORF testing facility, evolaris, the information stand at Graz's City Hall and the University of Technology.

The use of MHP services is heavily dependent on the return channel, which enables viewers to participate in voting / opinion polls and to order merchandise. For the purposes of the trial, Telekom Austria made two types of return channel available: POTS and ADSL dial-in access. ADSL turned out to be the preferred option among the Graz test households because of its constant ("always on") connection.

Even in June, the tests carried out regularly at the TU Graz and evolaris using the interactive applications repeatedly pointed to return channel problems with the Humax, Philips und Nokia set-top boxes. Test households also reported dial-in problems to the Fessel-GfK hotline again and again. In the end, it seemed highly probable that these problems were caused by location-related (over)loads in the telephone network. In contrast to the other locations in Graz, for example, not a single dial-in error was encountered over two weeks at the city hall information stand, where a Humax set-top box was used in connection with a trunk line from Telekom Austria's main distribution frame in the cellar of the building. Subsequently, return channel tests were carried out in the first half of July in cooperation with an expert from Telekom Austria using a PC modem from various locations (TU Graz, city hall information stand, etc.). Telekom Austria monitored the dial-in attempts in parallel in order to rule out or pinpoint specific dial-in and line problems. In the course of these repeated tests, the Telekom Austria experts confirmed the failure of components in the distribution network which were responsible for the dynamic forward routing of the Aon Flash dial-in connection to the Telekom Austria server. It turned out that immediately after the elimination of defective components (or the repeated re-booting of failed components) a substantially higher success rate could be observed at the Siemens IAC for voting and ordering functions from all locations and for all set-top boxes equipped with V.90 modems. The functioning interactive services were then used actively by approximately two thirds of the test households.

4.5.   Test Stage 2: Simulation of live DVB-T operation

At midnight on August 1, 2004, broadcasting of the !TV4GRAZ channel was discontinued as scheduled, and the channel was removed from the Graz DVB-T multiplex.
In another step toward a realistic scenario with three television channels on one frequency, the project partners agreed to continue the Graz trial into the month of August.
Starting on August 2, 2004, regular DVB-T operation was simulated on Channel 62 by broadcasting ORF 1, ORF 2 and ATVplus 24 hours per day and by including each broadcaster's interactive MHP portals as well as the EPG. 80 test households which had agreed to participate were researched by Fessel-GfK during this stage.
The reduced data quantity on Channel 62, the constant assignment of only one MHP portal to each station (instead of the alternating portals on !TV4GRAZ), and the previous resolution of technical problems then ensured the technical stability of the cycle. This also increased the willingness of the test subjects to use the new interactive content more frequently. The trial ended on August 31, 2004.

4.6.   IKS measurements of DVB-T reception quality

DVB-T enables the transmission of television signals and data to mobile users, even allowing high-quality reception in moving vehicles.

Joanneum Research developed a special measurement vehicle for the European Space Agency (ESA), which in turn made the vehicle available for the Graz trial. The "measurement bus" was equipped with a special DVB-T measurement system and linked to existing GPS (Global Positioning System) infrastructure. One essential activity was the creation of an automatic measurement and recording system. The necessary analysis programs were also developed in order to allow the measurement results to be displayed in graphical, geocoded form.

Figure 32: Measurement vehicle and built-in measurement equipment

4.6.1.   Survey of measurement data for mobile reception quality

Over a period of approximately three months, the ESA measurement vehicle was used to drive through the coverage area systematically in order to compile a highly detailed map with the respective reception quality measurements.
The mobile reception of DVB-T services was recorded on the map (Figure 33) using GPS navigation data.

The underlying map, which was created by RTR's department for broadcasting frequency management, shows the theoretical coverage area for mobile outdoor reception

The map also shows superimposed routes on which the actual reception of DVB-T content from the SFN multiplex in Graz is shown using color codes. The color green means excellent reception, blue stands for good reception, orange lines signify poor reception with brief interruptions, and red means no reception at all.

Figure 33: Comparison of mobile reception measurement with RTR's theoretical model for mobile outdoor reception
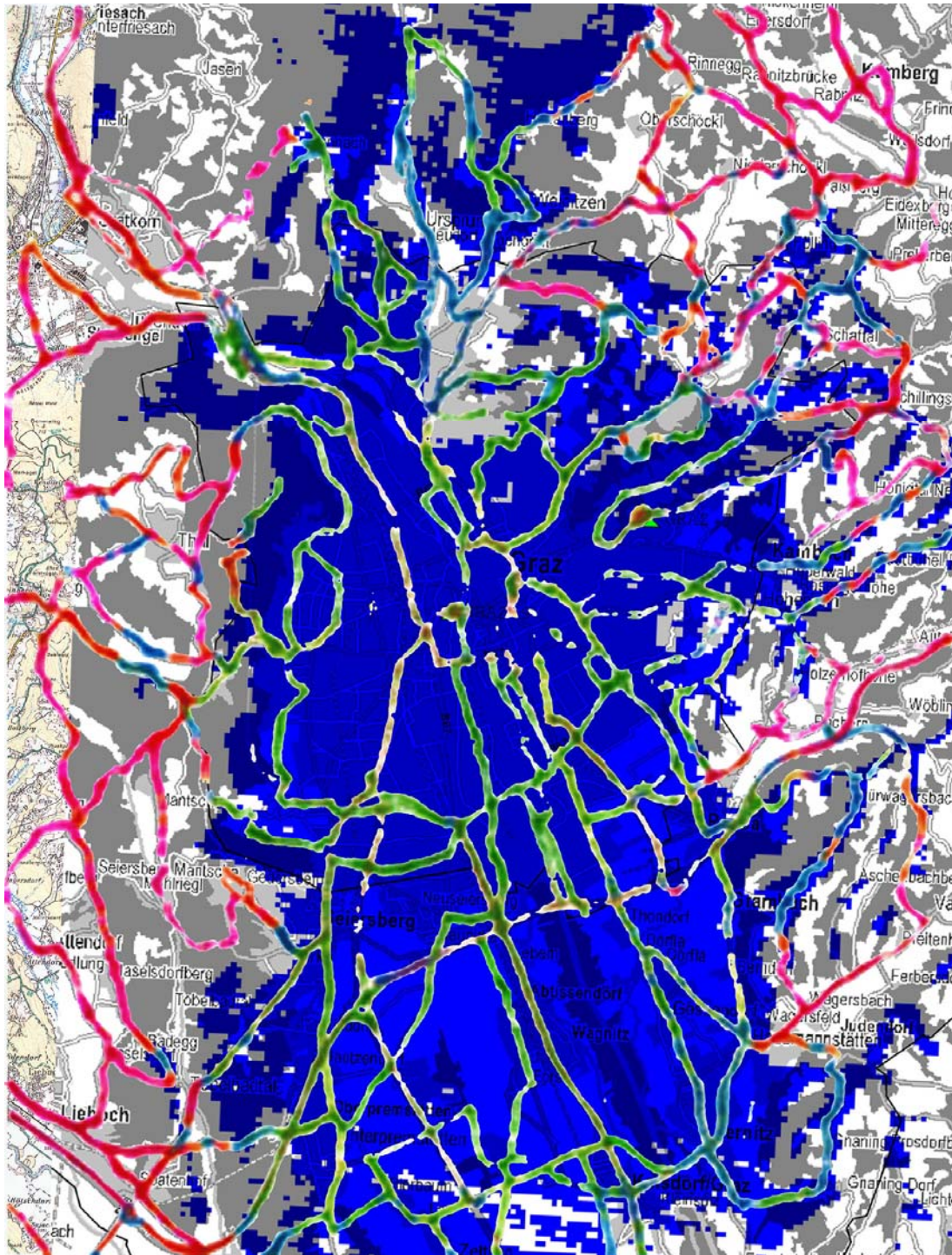
4.6.2. Comparison of analog and digital TV signals in mobile reception

In addition to the measurements taken, the mobile reception of analog and digitally broadcast terrestrial content was reviewed, compared in quarter-screen format and recorded. The quarter-screen display (Figure 34) shows the video signal received by the digital and analog receivers as well as a front-camera image of the measurement vehicle's surroundings and the corresponding measurement values. The front camera image gave a good impression of

the vegetation and buildings along the routes traveled; this was helpful in making conclusions about fluctuations in reception along measurement routes.

Figure 34: Comparison of analog and digital picture quality in mobile use

These recordings were used to generate DVD videos which quite impressively show the advantages of digital broadcasting compared to conventional analog technology in mobile outdoor reception.

4.6.3.   Portable indoor / outdoor measurements

Measurements were also taken inside and outside buildings in projects conducted at the Institute of Communication Networks and Satellite Communications (IKS). Four different building types were examined: wood construction, old reinforced concrete, modern glass/reinforced concrete, and brick/block buildings.

The Institute of Applied Systems Technology (IAS) at Joanneum Research and the Institute of Communication Networks and Satellite Communication at the Graz University of Technology will produce a separate report detailing the results of these measurements.

Figure 35: Portable indoor measurements: Modern glass/reinforced concrete building

1 block = 5 m

SZ03
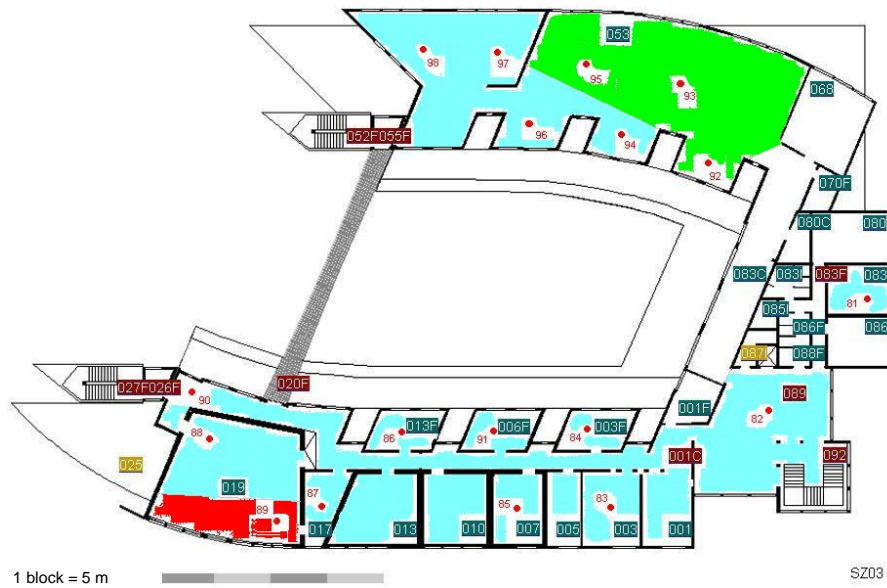
4.7. Conclusions and outlook

Overall, the features and performance of the set-top boxes can be considered rather disappointing from a technical standpoint. The loading times for MHP applications as well as the response time for interactive services, which is in part heavily influenced by the memory modules used, are rated by consumers as a primary criterion for using MHP content. For this reason, the industry would certainly be well advised to manufacture boxes with improved technical components and to coordinate closely with broadcasters and MHP portal developers with regard to the requirements these devices will have to meet. In particular, greater attention should be paid to the quality and performance of the components responsible for graphics, processing and storage.

However, in this context it is also necessary to mention the special challenges faced by the set-top boxes used in the Graz trial. User errors in the test households as well as the dynamic development processes which the applications underwent also have to mentioned as probable reasons for the performance of the set-top boxes, which was rated as poor on multiple occasions.

The latitude for interpretation in MHP standards, which is still excessive in some areas, shows that the set-top box manufacturers, the relevant middleware developers and television broadcasters (along with their MHP application developers) have to agree on essential architectural fundamentals as soon as possible in order to ensure functional reliability and compatibility with the developments of future partners in this field and to devote sufficient attention to usability from the viewer's perspective. Only stable technology will be able to ensure a high level of viewer acceptance. For this reason, a certification system for these devices (similar to the one used in Italy) should certainly be taken into consideration in Austria.

In summary, we can state that the trial has yielded valuable results with regard to the specifications required in the future invitation to tender for multiplexer operation and with regard to the time frame in which DVB-T-based MHP portals can be expected to mature. In particular, the performance tests performed during the trial with regard to data rate management within a multiplexer clearly showed that (for the modulation process used in

Graz) the optimum capacity utilization for one conventional television channel is the transmission of three digital channels along with comprehensive additional digital services.

4.8.   Special project: Mobile Internet services

Digital television infrastructure provides new possibilities beyond the medium of television, especially as any form of digital data can be transmitted. Therefore, DVB-T also provides an ideal medium for the simultaneous dissemination of Internet-based content to a large number of fixed-location and mobile users.

In conjunction with a return channel for interactive applications, this will provide high-performance, low-cost infrastructure for a large number of new applications. The combination of DVB-T for disseminating information and UMTS for the interactive return channel offers an extremely attractive solution. For example, this new communications infrastructure can be used to deliver electronic newspapers along with additional services to fixed-location and mobile users. This will appear not as a competitor but as a complement to UMTS, as it will enable services and applications which UMTS can not support due to bandwidth and cost limitations. In order to test these possibilities, the Institute of Applied Systems Technology (IAS) at Joanneum Research and the Institute of Communication Networks and Satellite Communication (IKS) at the Graz University of Technology set up separate DVB-T broadcasting infrastructure on which Internet-based data services were transmitted on their own frequency channel independently of the !TV4GRAZ main project.

4.8.1.   Independent DVB-T broadcasting infrastructure

In order to perform tests independently of the trial operation, a 200 W DVB-T transmitter was acquired from the company Harris-Hirschmann and installed at the Institute of Communication Networks and Satellite Communications in Graz. A Kathrein sector antenna (borrowed from ORF) was used as the broadcast antenna. The transmitter was put into operation at the end of April 2003 once a test license had been issued for Channel 62. When ORF's two transmitters were set up in 2004, the tests were switched to Channel 60.

Figure 36: DVB-T transmitter and antenna at the Institute of Communication Networks and Satellite Communications

The transmitter was supplied with the transport data stream by a Tandberg MX-5210 DVB remultiplexer via an ASI high-speed interface.

Various sources were used for the test broadcasts, including channels received by satellite as well as locally generated content. The channels were broadcast in unencrypted form (FTA, or free to air) and could be displayed with DVB-T receivers commonly used on the market.

A simple, functional test studio was set up for the purpose of demonstrating live broadcasts. DVD players, video and audio editing stations, studio cameras and control monitors were available, and it was also possible to integrate other signal sources in parallel.

The channels broadcast were received by stationary receivers (set-top boxes and integrated digital television sets) as well as portable and mobile devices. The portable devices included laptop computers with DVB-T receiver cards (PCMCIA card by Satelco and active antenna by Kathrein) and set-top boxes built into vehicles (e.g., HiTop's Diversity receiver).

4.8.2. Connection to the Internet

In this project, special server infrastructure was set up with a connection to the DVB multiplexer and to the mobile communications infrastructure (see Figure 37). A cooperation agreement was concluded with T-Mobile for the return channel connection. T-Mobile made its mobile network as well as GSM/GPRS and UMTS handsets available for the tests. One essential part of the work at the Institute of Communication Networks and Satellite Communications was the implementation of the required protocols, especially the broadcast/multicast protocols and their applications.

Figure 37: Overview of the interactive system's architecture
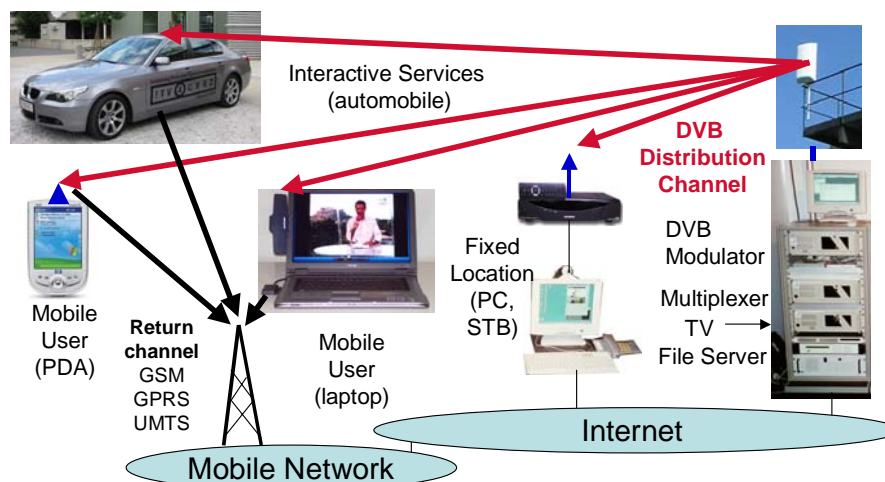
In order to demonstrate broadband data transmission to mobile terminal devices via a DVB-T service, a vehicle was equipped with the necessary equipment: A miniature PC served as the Internet gateway for data requested by a notebook or PDA, and the computers were connected using a WLAN.

4.8.3. Construction of multimedia vehicles

In the first step, the Institute's automobile (a VW Passat, see Figure 38) was equipped as a multimedia test vehicle. This included the following:

- Installation of a DVB Diversity receiver with two external magnetic antennas
- Integration of the GPRS/UMTS system
- Setup and installation of the router PC with a WLAN access point
- Connection tests with external laptops using WLAN technology

Figure 38: DVB-T equipment in the test vehicle

Return Channel:
GPRS /UMTS

WLAN
Access Point/
Gateway

WLAN

Forward Channel:
~16 Mbit/s
via DVB-T
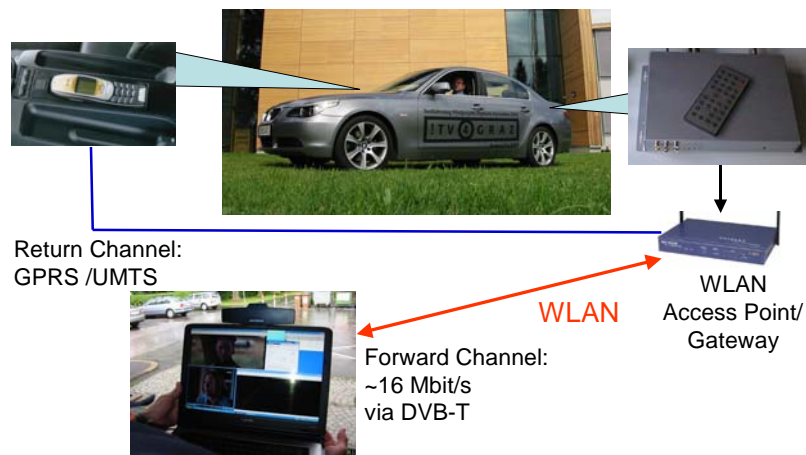
In addition, BMW Austria made a BMW 530 TD sedan available as a demonstration vehicle for the duration of the 2004 Graz DVB-T trial.
Aside from its standard features, this vehicle also had the technical equipment listed below.

In addition to a navigation system and an analog television receiver, the vehicle also had a DVB-T tuner made by FUBA (available ex works) and a fold-down TFT monitor with an integrated DVD player built into the headliner. This made it possible for passengers sitting in the rear seats to enjoy DVB-T and DVD content.

Joanneum Research and the Graz University of Technology also realized a system which enabled an interactive data connection via IP.

4.8.4. Internet applications

One of the core elements of the research was the testing and demonstration of new applications based on Internet technology. Examples of these applications include:

- Dissemination of electronic newspapers (e.g., Styria Online, ORF Online)
- Access to the Internet for traffic and tourist information
- Tests for the dissemination of short videos, etc.

Figure 39: Demonstration of Internet-based mobile services

This project mainly focused on user evaluations. Based on the results, additional applications were implemented and the transmission protocols were optimized.

The streaming services turned out to be extremely functional and efficient applications using this broadband terrestrial distribution medium. Access to the web portals of newspapers and media organizations (Styria Online, ORF Online, ATVplus portal) also turned out to be exceptionally fast. In this context, the relatively narrow bandwidth of the return channel was completely sufficient to request the desired services and to confirm the data packets received. These services will be available via DVB-H in the future.

5. Fessel-GfK market research report

5.1. Overview

Fessel-GfK accompanied the tests households in the !TV4GRAZ project with broad-based market research in cooperation with the evolaris foundation (see Section 2.11.2). The market researchers were responsible for recruiting test households, carrying out technical inspections prior to the trial, conducting regular surveys and maintaining communication with the test households.

Within the DVB-T coverage area in Graz, households with fixed-link telephone connections and at least one television set were recruited at random by means of telephone screening. In this screening interview, the project was introduced briefly and candidates were asked about their general willingness to participate and about specific characteristics which were relevant to the final recruiting stage. The resulting pool comprised 825 addresses. The final recruiting stage involved personal interviews and technical inspections.

In each household, a digital receiver was connected to the television set which was used most often. The digital reception quality on the household's main television was checked at the very beginning of the recruiting interview. If the digital reception was insufficient using the existing antenna (ORF1, ORF2 and ATVplus without pixellation or interruptions), the reception signal was checked again using a digital indoor flat antenna. In addition, the technical means of connecting the set-top box to the television set was recorded, and the required length of the telephone cord for the return channel connection (and whether the cord could be connected to the existing socket) was checked. In cases where the main criteria – digital reception and the return channel connection – were fulfilled, the recruiting interview was completed.

From the pool of 825 interested households, 244 addresses were visited in person. In the end, 178 households fulfilled the recruiting criteria and could be included in the trial. In order to obtain valid results with regard to the previous reception types in households, it was important to ensure an even balance of households which had used analog cable, satellite and terrestrial reception to date (one third each). Households with digital satellite or cable reception were excluded.

Over the entire period of the survey, a toll-free telephone hotline was available to the households daily from 8:00 am to 11:00 pm. The inquiries and problems submitted by the households were immediately passed on to the responsible departments (broadcasters, technicians, editors). In this way, response time was kept to a minimum in cases of broadcasting outages, poor reception quality or problems with digital interactive services.

During the trial, the households maintained diaries (in 12 waves) documenting their experiences and impressions while using this new technology. In this diary, Fessel-GfK asked about the channels watched, the reception quality, and the use and display quality of the additional interactive services. Moreover, the test subjects were also asked to note their evaluations and experiences.

The main results from the various parts of the study are explained below. These results are based on the experiences of test subjects during the trial.

In order to extend and enrich the market research performed in this project, the evolaris research laboratory cooperated with Fessel-GfK by performing comprehensive lab tests for usability in evolaris' customer experience labs. Usability tests are detailed user surveys based on open and closed questions. For the !TV4GRAZ project, these tests provided important detailed information on how selected test subjects dealt with these new television products.

evolaris carried out comprehensive usability tests in two waves with 30 subjects. The dates of individual laboratory tests were based on the broadcasting times of each television station on the !TV4GRAZ channel. For each test, the subject was invited to the laboratories and asked to perform various tasks in the portals offered. These tasks consisted of user surveys as well as laboratory observation in connection with task analyses. The evolaris customer experience lab in Graz, where the usability tests were carried out, was designed as a test lab with the atmosphere of a living room in order to simulate as authentic a television viewing environment as possible for the subjects.

The objective of the usability tests was to investigate the specific usability of each MHP portal and to identify any use constraints. In the lab tests, special attention was paid to the following four dimensions: usability, functionality (services offered), experience and aesthetics.

In addition to the usability tests, evolaris also performed heuristic evaluations of the interactive portals offered by the broadcasters participating in the project; in this process, experts on usability and user interfaces assessed the additional digital services according to various criteria.

The qualitative and quantitative data collected in the course of the laboratory tests and heuristic evaluations are to be evaluated statistically and analytically. The results will be presented to RTR and the broadcasters in a detailed report.

The results of the usability tests and the heuristic evaluations should serve to advance the design of ITV applications and reception devices with attention to the overall use process (pre-use, use, after-use) and thus to increase and reinforce the acceptance of ITV.

5.2.   General attitude toward digital terrestrial television

The digital terrestrial content broadcast during the trial showed considerable advantages compared to analog television and served to convince consumers of this new technology. At the end of the trial period, the test subjects generally showed positive attitudes toward the new television technology and would largely welcome the introduction of digital terrestrial television.

On the basis of a five-point scale, the subjects were asked to indicate whether they would welcome or reject the introduction of digital terrestrial television in Austria. Approximately three quarters of the respondents showed "positive" or "fairly positive" attitudes about the transition to digital television. At that time, 21% could not make a statement for or against digital television, and only 6% were decidedly against the transition. Those test subjects who had only received Austrian television channels by analog terrestrial means tended to favor the introduction more than test subjects with cable television.

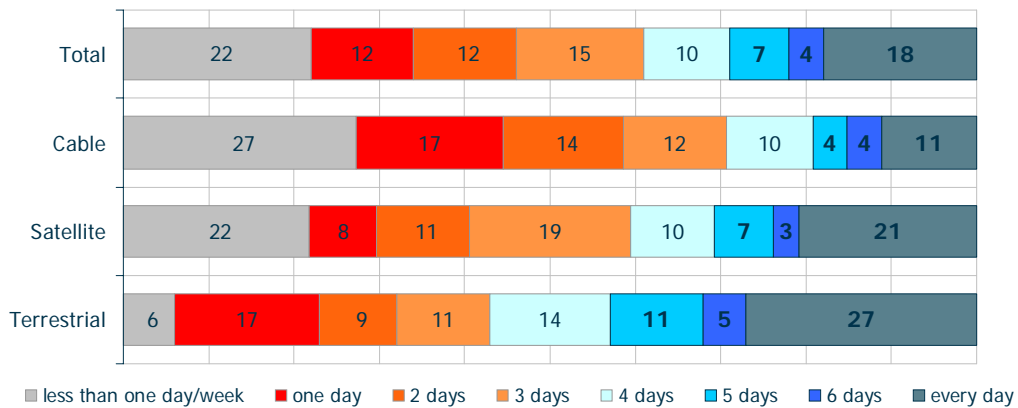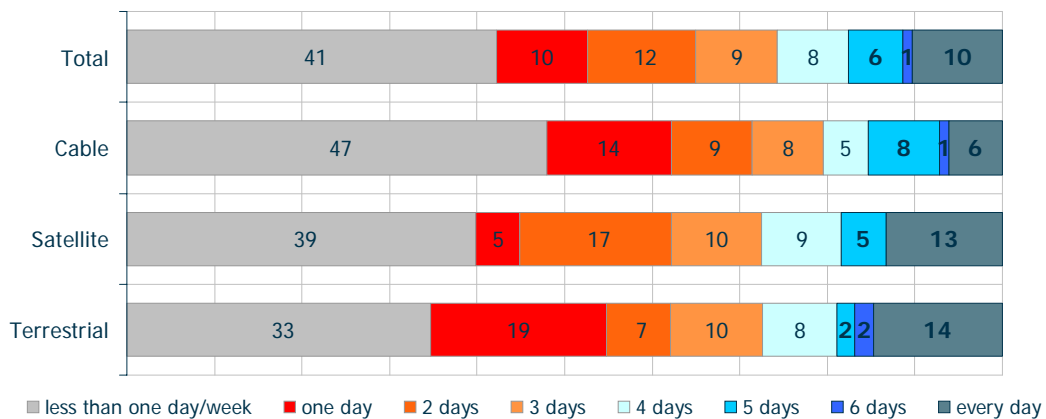**Figure 40: Attitude toward introduction of digital terrestrial television (respondents 12 years and up)**
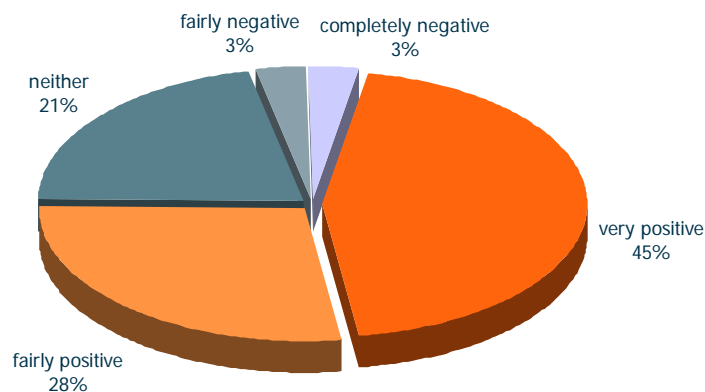
Source: Core results of DVB-T trial, reporting based on respondents 12 years and older, Fessel-GfK (on behalf of RTR)

In order to identify the main factors influencing these attitudes, the subjects were also asked to explain their responses. Most justifications focused on improvements in reception quality, followed by a general acceptance of technological advances, the added value of additional digital services and the interactivity offered. Critical statements were far more seldom, referring to additional costs due to new equipment purchases and the technology used in the trial, which those test subjects believed had not yet fully matured.

5.3. Reception quality of digital terrestrial television

The target group rated digital terrestrial television reception to be very good, with a majority observing a significant improvement in reception compared to analog television.

In the trial, the channels ORF1, ORF2, ATVplus and !TV4GRAZ could be received with additional digital services. The test subjects were asked to rate the reception quality of the channels on a five-point scale. Compared to the other three channels, !TV4GRAZ tended to receive lower ratings.

In terms of the technical process, !TV4GRAZ was a very complex channel combining content from eight different channels (ORF 1, ORF 2 Styria, ATVplus, ProSieben Austria, Sat.1 Austria, gotv, Steiermark 1 and Atv Aichfeld) and their additional digital services. However, the actual reception quality of that channel did not differ from that of the other channels. While the digital services were being loaded on the set-top boxes, there were brief interruptions in the televisions' on-screen display for technical reasons; these interruptions were perceived subjectively as lower-quality reception.

Subjects in households which had only received terrestrial television in the past tended to give higher ratings to digital reception quality. In such cases, the analog signal was substituted most strongly by DVB-T compared to their previous television platform. The subjects were then asked for a direct comparison of analog and digital television: 55% of the test subjects indicated that digital reception was "better" or "much better" than analog reception. Among the terrestrial-only households, 62% of the test subjects rated digital reception better.

Figure 41: Ratings of reception quality

Average	Total	Cable	Satellite	Terr.
ORF1	1.5	1.5	1.6	1.4
ORF2	1.6	1.7	1.6	1.4
ATV+	1.6	1.7	1.6	1.4
!TV4Graz	1.7	1.8	1.6	1.5
Improvement compared to analog reception	2.3	2.5	2.2	2.1
Additional digital services	2.3	2.4	2.3	2.1

Source: Core results of DVB-T trial, reporting based on respondents 12 years and older, Fessel-GfK (on behalf of RTR)

5.4. !TV4GRAZ: Frequency of use

The content offered on the test channel !TV4GRAZ was used very intensively, which enabled the channel to fulfill its function as a vehicle for digital services very well.

In order to use additional digital content, the test subjects had to switch to the !TV4GRAZ channel. Therefore, the frequency with which the subjects had viewed !TV4GRAZ was among the introductory questions. Approximately three quarters of the test subjects indicated that they had watched !TV4GRAZ at least once per week during the trial. 29% could be considered intensive users, indicating that they had viewed !TV4GRAZ five to seven days per week. If this result is subdivided according to the original reception types in the households, the channel's level of penetration tended to be lower in cable television households, with only 19% using the channel intensively. In contrast, 43% of the terrestrial-only test subjects viewed the channel five to seven days per week. In satellite and terrestrial households, the digital signal was a far stronger substitute for the analog signal. The reason for this lies in the better reception quality of digital television. Overall, the channel !TV4GRAZ showed a respectable weekly level of penetration, which indicates that the panel members were heavily involved in the project.

Figure 42: !TV4GRAZ: Frequency of use (percentage of respondents 12 years and up)

|	less than one day/week	one day	2 days	3 days	4 days	5 days	6 days	every day
Total	22	12	12	15	10	7	4	18
Cable	27	17	14	12	10	4	4	11
Satellite	22	8	11	19	10	7	3	21
Terrestrial	6	17	9	11	14	11	5	27

Source: Core results of DVB-T trial, reporting based on respondents 12 years and older, Fessel-GfK (on behalf of RTR)

5.5. Use of additional digital services

Approximately half (56%) of the respondents used at least one of the additional digital services offered once or more each week. Within that group, 17% were intensive users (five to seven times per week). 41% used the digital services less than once a week.

The usage intensity of additional digital services was lower compared to that of the !TV4GRAZ channel. However, this intensity of use, which appears lower at first glance, is an average which includes the technical problems and challenges encountered in the initial stage of the trial (June 1 to early July 2004; longer loading times, interruptions in loading processes, return channel problems).

Figure 43: Frequency of use for additional digital services
(percentage of respondents 12 years and up)

|	less than one day/week	one day	2 days	3 days	4 days	5 days	6 days	every day
Total	41	10	12	9	8	6	1	10
Cable	47	14	9	8	5	8	1	6
Satellite	39	5	17	10	9	5		13
Terrestrial	33	19	7	10	8	2	2	14

Source: Core results of DVB-T trial, reporting based on respondents 12 years and older, Fessel-GfK (on behalf of RTR)

5.5.1.   Recognition of digital portals

Once the test period was completed, the individual additional digital services showed very high recall/recognition scores depending on their availability on the air.

With the television broadcasters' MHP portals, the MHP content developed by Siemens Austria and Österreichische Sportwetten GmbH (tipp3 live!), and the EPG4GRAZ, the participants in the trial had access to a total of eleven differently designed additional digital services. The individual services were not available to the test subjects throughout the day because they were only broadcast on the !TV4GRAZ channel along with each broadcaster's show while it was being aired.

Therefore, the results indicating which portals the subjects recall without assistance or when presented with an image mainly reflect the frequency with which the broadcasters and their portals were represented in the !TV4GRAZ programming schedule.

The highest recall value (68%) was attained by the ORF portal, followed by the ATVplus portal (57%) and the gotv portal (50%). The tipp3 (38%), ProSieben (35%) and EPG (35%) portals were remembered by roughly one third each. The Sat.1 portal was on the air for approximately 30 minutes in the early evening and was remembered by 19% of the subjects. The portals broadcast on weekends were each remembered by approximately one tenth of viewers (Steiermark 1: 11%; Aichfeld TV: 9%). The recall value for Steirertext (Styrian Text), which was broadcast during ORF's TW1 feature, was 5%. The advertising portal for the Siemens mobile phone (accessible via a link from the ORF portal) was recognized by 11%.

Figure 44: Recognition of digital portals, unaided/aided recall
(percentage of respondents 12 years and up)
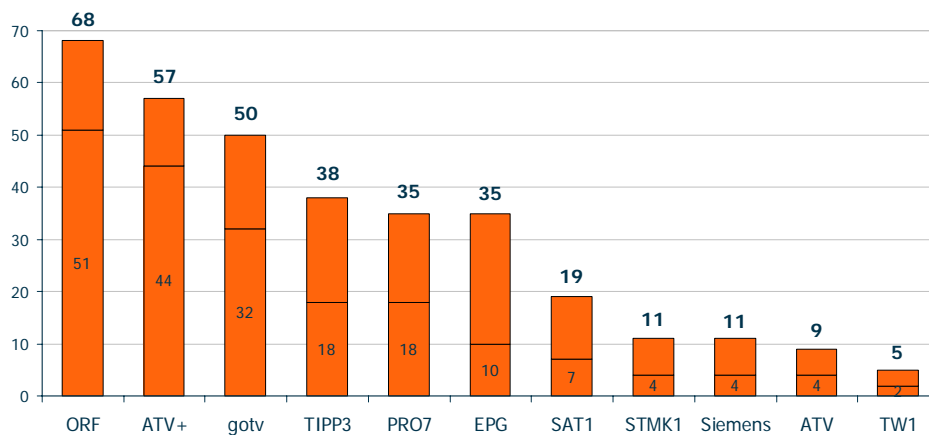
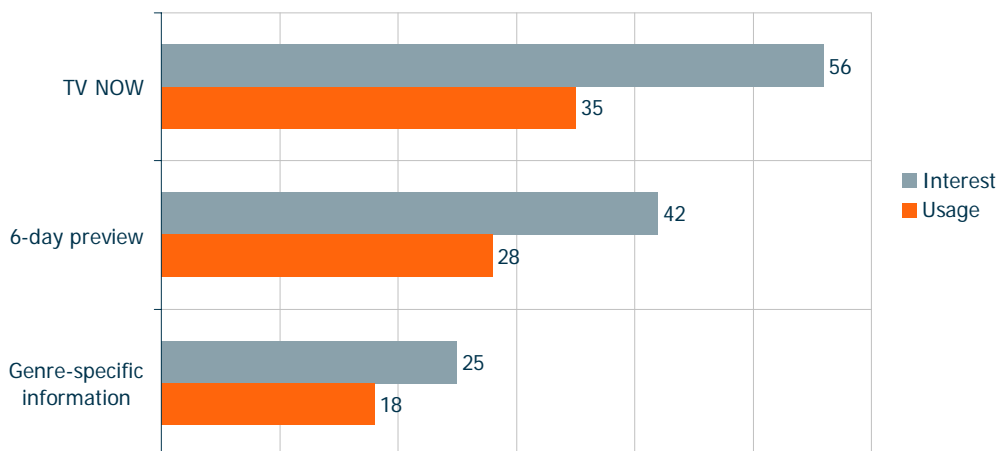
Source: Core results of DVB-T trial, reporting based on respondents 12 years and older, Fessel-GfK (on behalf of RTR)

5.5.2.   General interest in content offered

In general, we can state that interest in the content of the MHP portals was very broad-based and that the test subjects also sought out and used the content actively. The portal providers made a variety of information resources available to the audience in Graz. In order to measure general interest in the different topics offered, they were organized uniformly in a catalog for all portals. The test subjects were asked to indicate on a five-point scale how interested they were in the topics and whether they had accessed information on each topic

in at least one of the portals. The largest amount of content offered on all portals was in the form of current information resources.

These resources were categorized into the following subject areas:
Content which could be used passively: News from the areas of politics, business/economy, culture, chronicles and sports as well as weather information, programming information, show-specific content and internal information about the television stations.

Interactive return channel-based content: Ordering, voting, live betting.

Current information:
Subjects were very interested in weather information and forecasts for their immediate area of residence, for Austria, for the various provinces and for provincial capitals. The pages on each of these topics were used by approximately one half of the test subjects.

The second focus area in which the subjects showed great interest encompassed information on international, national and regional politics. The content pages in these subject areas were each retrieved from the digital services by approximately half of the panel participants as well.

The third focus area included sports reports. Just over half of the participants showed interest in current sports information, event results and reports on the Euro 2004 soccer championships, and the MHP portals offered in this field were used to approximately the same extent.

Figure 45: General interest / use: General news
(respondents 12 years and up / interest [top two boxes] / at least occasional use during the project / %)
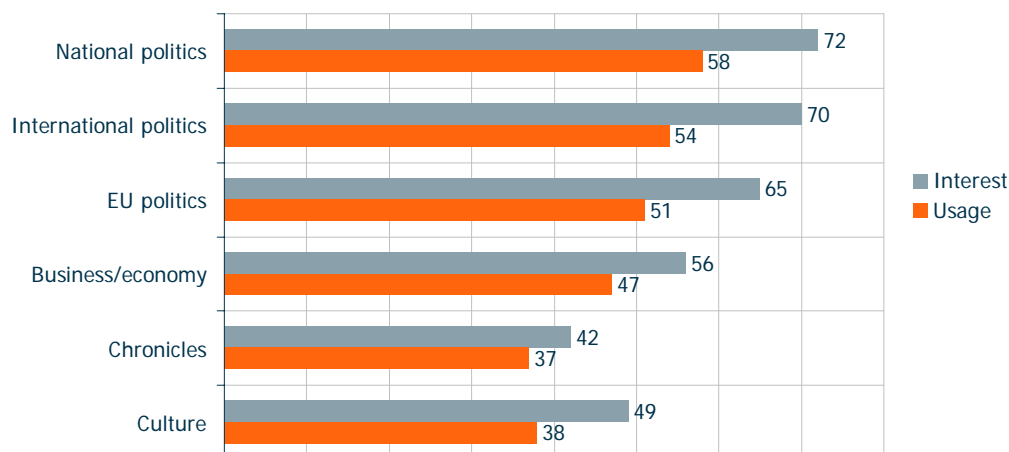
Source: Core results of DVB-T trial, reporting based on respondents 12 years and older, Fessel-GfK (on behalf of RTR)

**Figure 46: General interest / use: Regional news
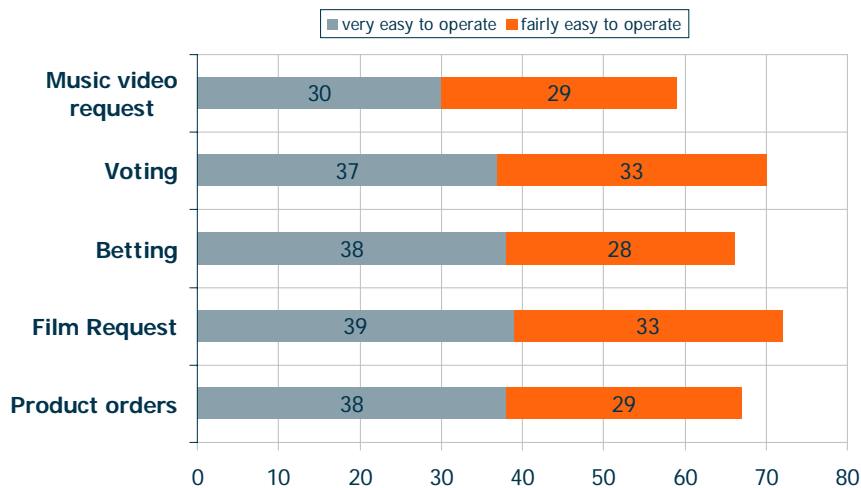(respondents 12 years and up / interest [top two boxes] / at least occasional use during the project / %)**
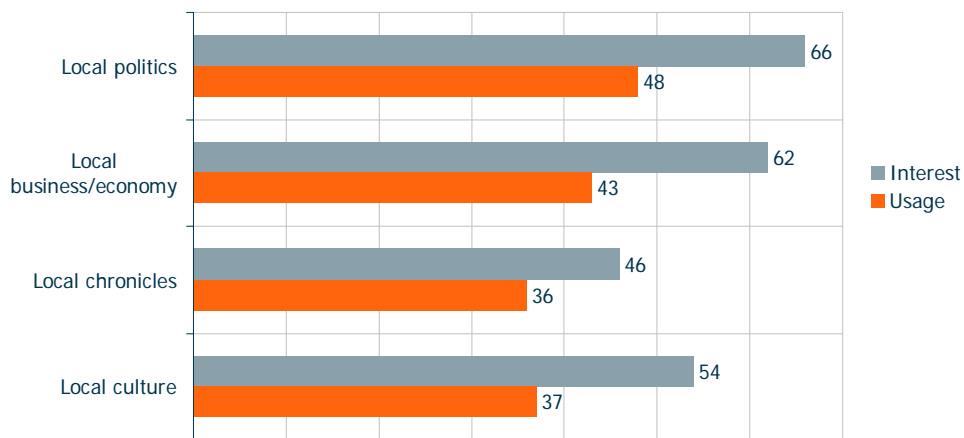
Source: Core results of DVB-T trial, reporting based on respondents 12 years and older, Fessel-GfK (on behalf of RTR)

**Figure 47: General interest / use: Weather
(respondents 12 years and up / interest [top two boxes] / at least occasional use during the project / %)**
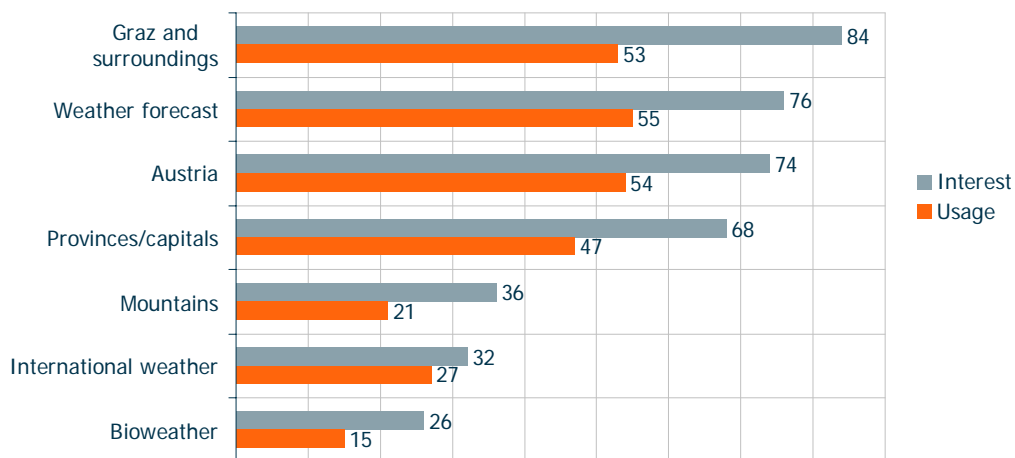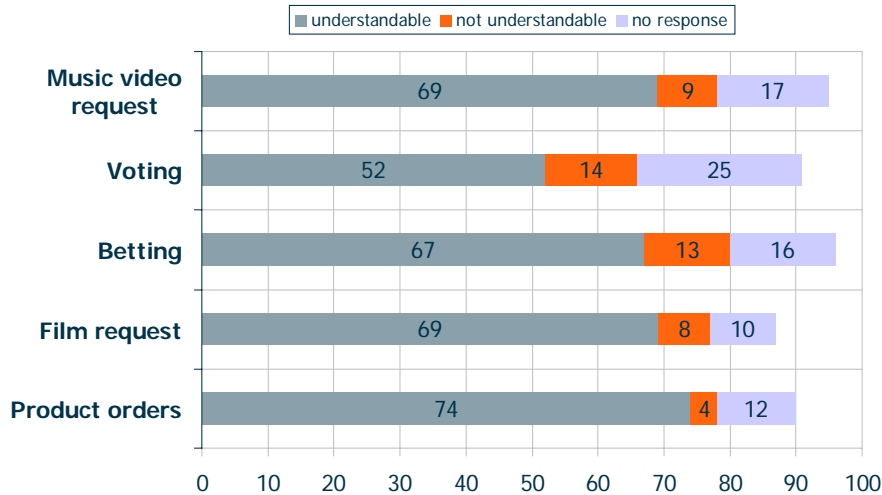

Source: Core results of DVB-T trial, reporting based on respondents 12 years and older, Fessel-GfK (on behalf of RTR)

**Figure 48: General interest / use: Sports
(respondents 12 years and up / interest [top two boxes] / at least occasional use during the project / %)**
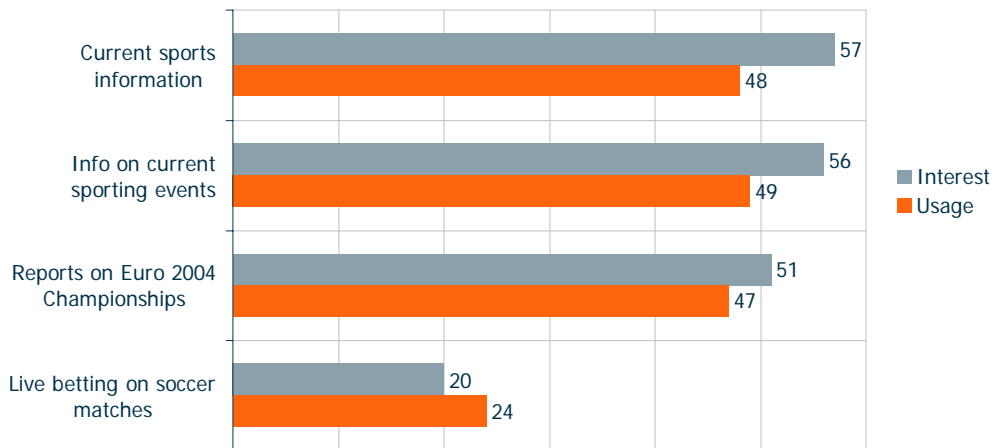
Source: Core results of DVB-T trial, reporting based on respondents 12 years and older, Fessel-GfK (on behalf of RTR)

**Figure 49: General interest / use: Broadcasters' internal information / other
(respondents 12 years and up / interest [top two boxes] / at least occasional use during the project / %)**
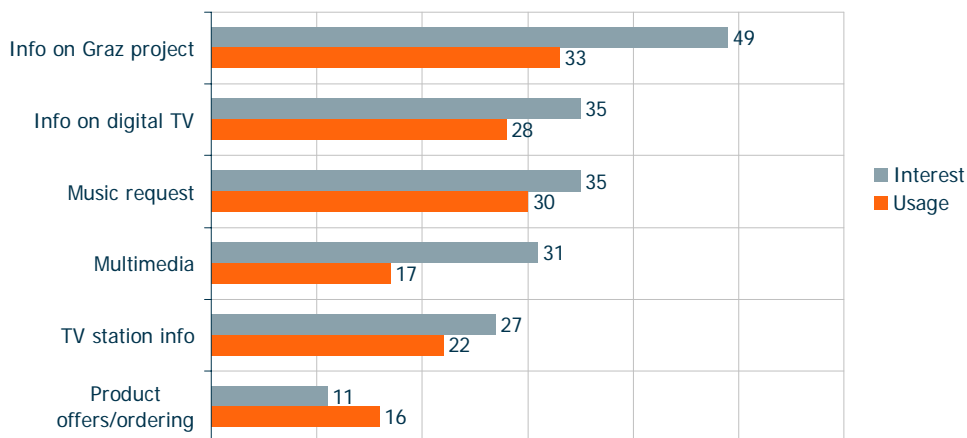
Source: Core results of DVB-T trial, reporting based on respondents 12 years and older, Fessel-GfK (on behalf of RTR)

5.5.3. Show-specific content

Most providers of additional digital services made show-specific content available. Approximately two thirds of the test users were interested in general show-specific content. 42% were interested in service information (tips, addresses, etc.), and one third were interested in actors and musicians. The lowest level of interest was in talk show guests, actors/contributors (19%) and show hosts (13%).

Figure 50: General interest / use: Show-specific content
(respondents 12 years and up / interest [top two boxes] / at least occasional use during the project / %)
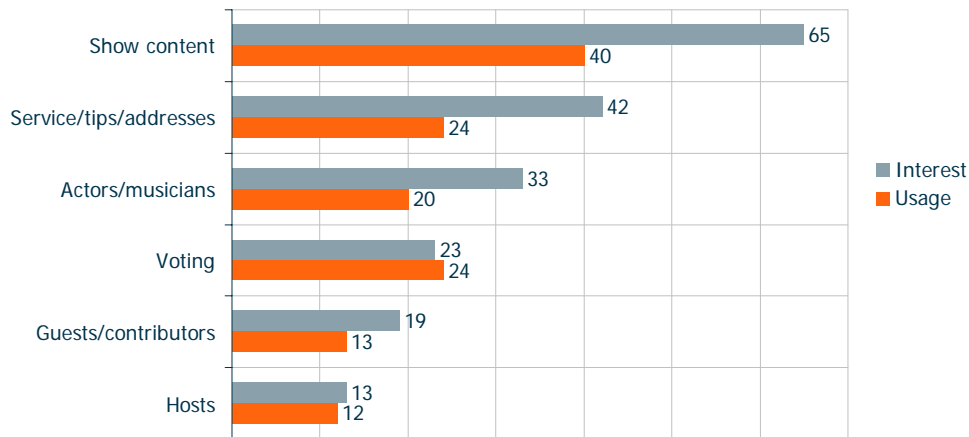
Source: Core results of DVB-T trial, reporting based on respondents 12 years and older, Fessel-GfK (on behalf of RTR)

5.5.4. Electronic Program Guide (EPG)

EPG4GRAZ, the electronic television guide offered during the trial, only became available during the second half of the test period. Therefore, the test viewers did not have the opportunity to familiarize themselves and to gain experience with this new service sufficiently. The frequency of use for this service also reflected these circumstances. Approximately half of the test subjects were interested in information on the current programming schedule. The 6-day preview was of interest to 42%, and one fourth of the users indicated an interest in genre-specific information.

Figure 51: General interest / use: Electronic program guide information (EPG)
(respondents 12 years and up / interest [top two boxes] / at least occasional use during the project / %)

Source: Core results of DVB-T trial, reporting based on respondents 12 years and older, Fessel-GfK (on behalf of RTR)

5.5.5. Interactive return channel-based content

62% of the test subjects used one or more interactive services such as song requests, voting or betting functions, while 38% did not test these services.

The use and acceptance of interactive applications were among the main components of the trial. Test subjects were offered various interactive applications which were available over the entire observation period or only for certain time periods during the trial.

Among the content offered was an application which allowed viewers to select and request videos, which were then shown during the show. The nickname of the viewer who requested the video was also displayed on screen during the video. 46% of the test subjects used this application.

The providers of additional digital services also included a number of questions for the test viewers in the portals (voting functions, opinion polls and the like). These interactive functions were used by 41% of the viewers.

Before and during soccer broadcasts, the test viewers were able to use virtual points to place bets on the outcome of each match. 40% of the test subjects took advantage of this option.

Viewers were given the opportunity to request films a total of three times.

Ordering functions for merchandise were also tested in the trial. This option was only made available by one portal provider, and viewers had a choice of two products. 26% of the test subjects used this ordering application.

The ordering and voting applications were considered easy to operate by the majority of users. The feedback (from Siemens' Interactive Application Center) was also assessed as clear and understandable. One exception was those voting functions which were deemed incomprehensible without further explanation.

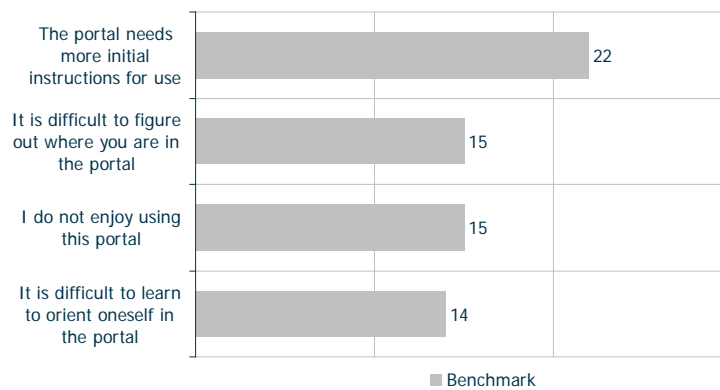**Figure 52: Use of interactive content (respondents 12 years and up)**
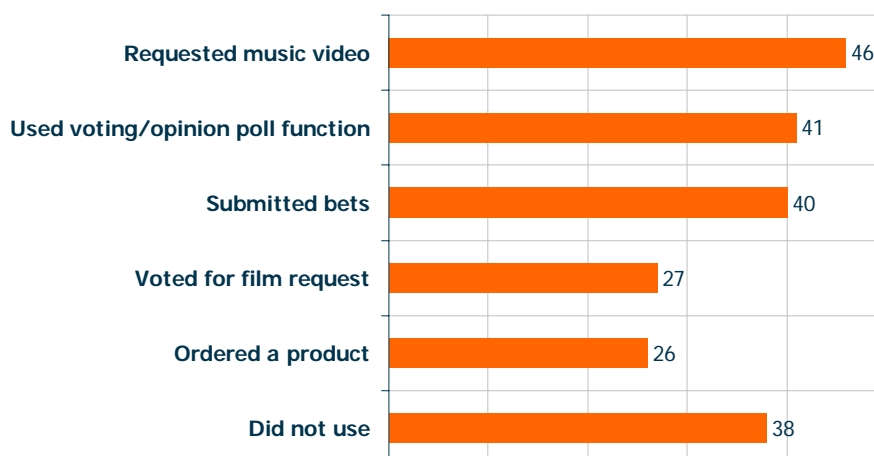
Source: Core results of DVB-T trial, reporting based on respondents 12 years and older, Fessel-GfK (on behalf of RTR)

Figure 53: Intensity of use for interactive services (users of each interactive service / %)
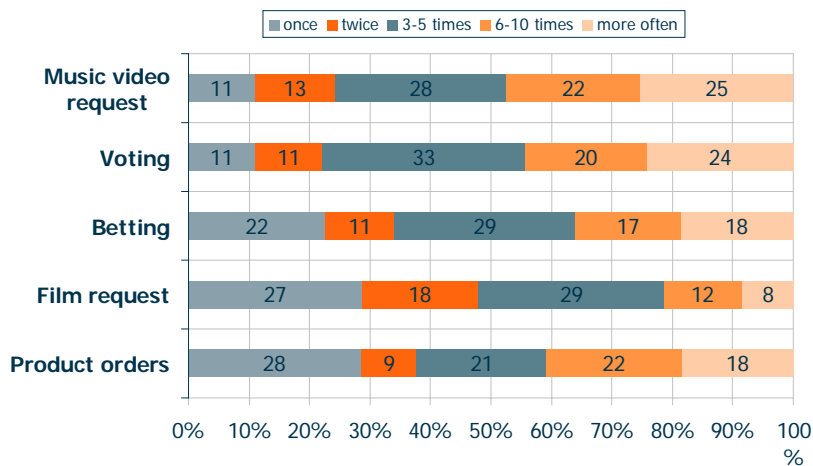
Legend: once | twice | 3-5 times | 6-10 times | more often

Service	once	twice	3-5 times	6-10 times	more often
Music video request	11	13	28	22	25
Voting	11	11	33	20	24
Betting	22	11	29	17	18
Film request	27	18	29	12	8
Product orders	28	9	21	22	18

Source: Core results of DVB-T trial, reporting based on respondents 12 years and older, Fessel-GfK (on behalf of RTR)

Figure 54: Functionality of interactive services (users of each interactive service / top two boxes: very/fairly easy to operate / %)

Legend: very easy to operate | fairly easy to operate

Service	very easy to operate	fairly easy to operate
Music video request	30	29
Voting	37	33
Betting	38	28
Film Request	39	33
Product orders	38	29

Source: Core results of DVB-T trial, reporting based on respondents 12 years and older, Fessel-GfK (on behalf of RTR)

**Figure 55: Functionality of interactive services – feedback
(users of each interactive service / %)**

Source: Core results of DVB-T trial, reporting based on respondents 12 years and older, Fessel-GfK (on behalf of RTR)

5.6. Usability of MHP portals and set-top boxes

The ease of use and comprehensibility of the MHP portals were assessed by the test subjects in very different ways. On average, the portals were given positive assessments in terms of navigation, comprehensibility and graphic presentation. Negative assessments were given to loading times, response times and the labeling of menu items.

To a certain extent, the test subjects' judgments have to be regarded in conjunction with the set-top boxes, as various factors influenced the functioning, clarity and handling of portals and devices. These factors included the size of each portal, ongoing updates, the performance and response time of the set-top boxes as well as the speed and quality of the display on screen.

The test subjects were presented with a number of statements to assess the usability of the portals they used and were able to express their agreement or disagreement with each statement on the basis of a five-point scale.
For competition reasons, Fessel-GfK can only make detailed evaluations of individual MHP portals available to the specific portal provider, thus the average values for all portals are used to reflect usability.

The test subjects often cited a lack of process transparency as a drawback.

Viewers did learn to open the portals using the colored buttons on the set-top box's remote control, but this was not self-explanatory for first-time users. Even the meaning of ATV's "Barker" symbol appearing on screen (signaling that additional digital services were available) was often not interpreted correctly. Uncertainty as to certain processes – such as loading times or connecting via the return channel – should be eliminated for the user by displaying progress indicators on screen. Viewers require a degree of certainty as to whether the desired and requested actions are actually being executed in order to prevent them from becoming impatient and ultimately aborting their requests for services.

The time period between pressing the button and the visible response on the screen was recognized as the upstream cause of numerous other usability problems, especially with regard to navigation, orientation and efficiency. Therefore, the response time for actions within individual portals was often considered too long, that is, when a button was pressed on the remote control it took too long to see the result on the screen. This delayed response time often led to users executing other actions prematurely, which then put the set-top box in danger of crashing.

 (Note: The reasons for the defects indicated by the test subjects in this context mainly lay in technical problems which could be detected and in most cases resolved during the trial. For further details, please refer to the Project Management's Technical Report, Section 5.4.)

Problems with the labeling of menu items played a particularly decisive role, especially in the portals' introduction stage. As the project progressed, learning processes began and the users became more accustomed to many categories and abbreviations.
As the initial use experience with a newly adopted technology is crucial to the viewer's future probability of use, the wording in the portal should be as simple as possible in order to ensure broad-based effectiveness.

Figure 56: User friendliness of digital portals (agreement in top two boxes / total users / %)
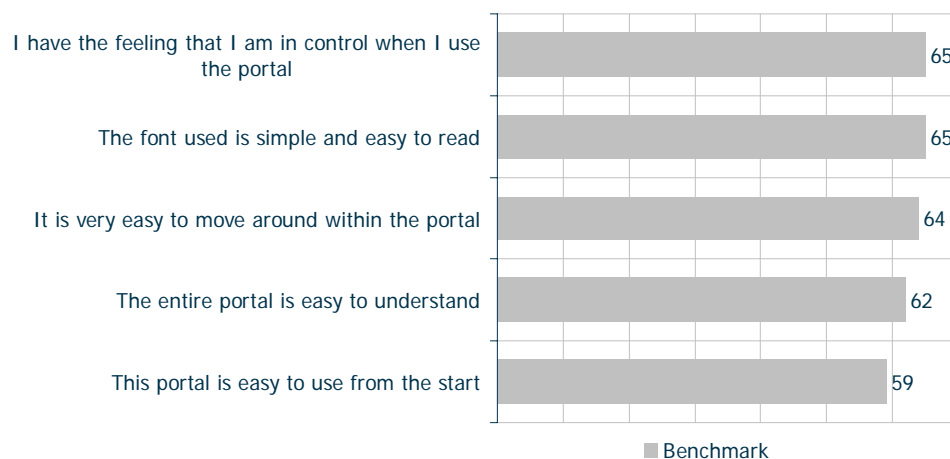
I have the feeling that I am in control when I use the portal	65
The font used is simple and easy to read	65
It is very easy to move around within the portal	64
The entire portal is easy to understand	62
This portal is easy to use from the start	59

■ Benchmark

Source: Core results of DVB-T trial, reporting based on respondents 12 years and older, Fessel-GfK (on behalf of RTR)

Figure 57: User friendliness of digital portals (total users / %)
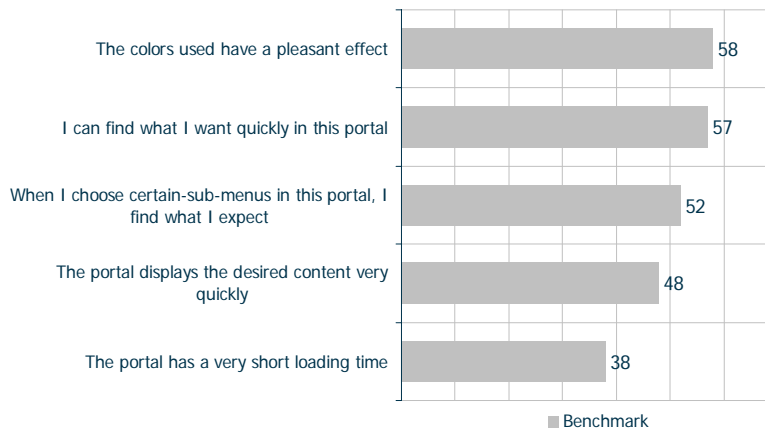
Source: Core results of DVB-T trial, reporting based on respondents 12 years and older, Fessel-GfK (on behalf of RTR)

Figure 58: User friendliness of digital portals (total users / %)

Source: Core results of DVB-T trial, reporting based on respondents 12 years and older, Fessel-GfK (on behalf of RTR)

5.7. Future use of digital terrestrial television

In addition to their attitudes regarding the introduction of digital terrestrial television in Austria, users were also asked about their specific future interest in using digital terrestrial television beyond the scope of the trial.

Two thirds of the test subjects in Graz would welcome the continued availability of a DVB-T signal.

5.7.1. Willingness to purchase a set-top box

35% of the test persons confirmed that they would purchase the necessary set-top box if DVB-T remained available in Graz. The highest willingness to purchase was among those people who currently rely on analog terrestrial reception alone (51%). 40% of those who have analog satellite reception indicated that they would purchase a set-top box.

In addition to their intentions to purchase a set-top box, the participants were also asked how much they would be willing to pay for such a device. The average willingness to pay was EUR 252.00. People with analog terrestrial reception indicated that they would be willing to pay an average of EUR 178.00.

Figure 59: Attitude toward continued availability of digital terrestrial television in Graz (ORF1, ORF2 and ATVplus with their respective digital services; percentage of respondents 12 years and up)
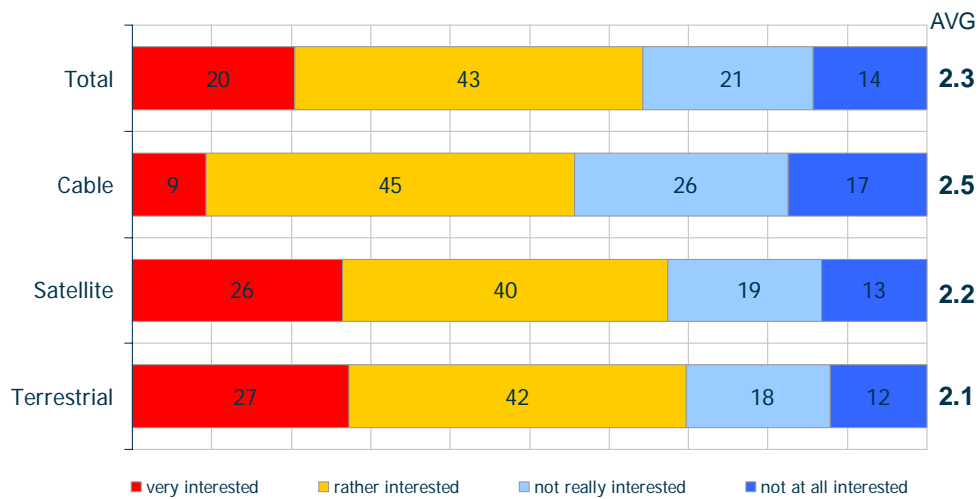
Source: Core results of DVB-T trial, reporting based on respondents 12 years and older, Fessel-GfK (on behalf of RTR)

Figure 60: Intention to purchase a DVB-T receiver if digital terrestrial broadcasting were continued (percentage of respondents 12 years and up)
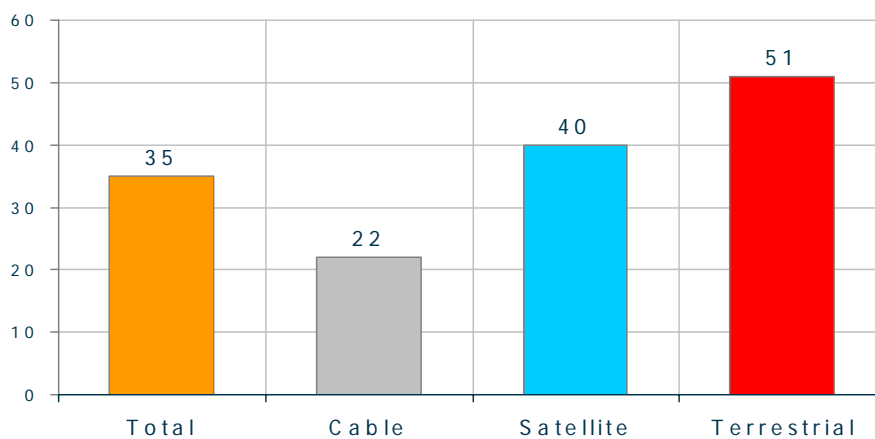
Source: Core results of DVB-T trial, reporting based on respondents 12 years and older, Fessel-GfK (on behalf of RTR)

Figure 61: Intention to purchase and willingness to pay for a DVB-T receiver if digital terrestrial broadcasting were continued (percentage of respondents 12 years and up)
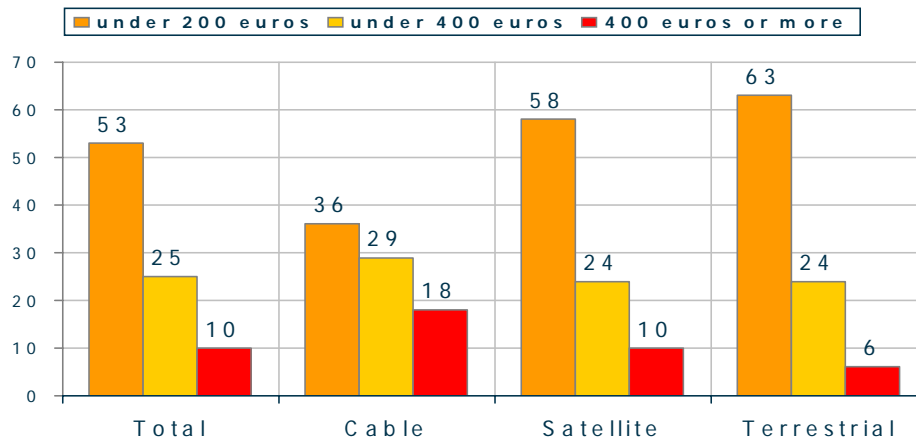
Source: Core results of DVB-T trial, reporting based on respondents 12 years and older, Fessel-GfK (on behalf of RTR)

5.7.2.   Use of mobility associated with DVB-T

At approximately 30%, the interest in mobile television is very high in the population and could, with the appropriate content, certainly take on a central role in the television medium.

Mobility is among the main benefits of digital terrestrial television. In order to estimate the probability that this mode of access will be used in the future, the test subjects were presented with a number of conceivable situations. Using a five-point scale, they were asked to rate the circumstances under which they would take advantage of the mobility involved in digital terrestrial television.

Aside from portability at home, which 72% considered relevant, the subjects' willingness to view mobile television outside their homes was approximately 30%. 13% would certainly purchase a small portable television in order to be able to watch television anywhere, and 16% indicated that they would probably do so. 23% would want television for passengers in their automobiles. 22% of respondents would also like to see selected news or other broadcasts on their mobile phones.

Figure 62: Probability of use for mobile television (percentage of respondents 12 years and up)
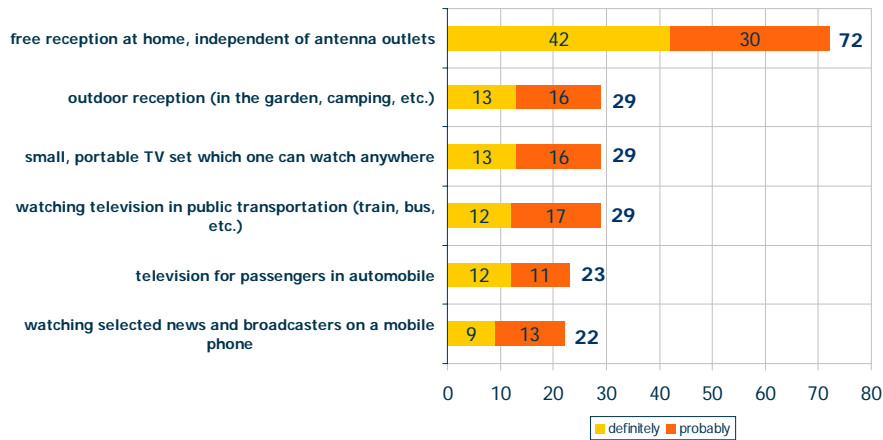
Source: Core results of DVB-T trial, reporting based on respondents 12 years and older, Fessel-GfK (on behalf of RTR)

5.8. Future use of additional digital services

Today's passive television consumers are interested in the possibility of using a single remote control to select channels, access digital services, request films, participate actively in shows by voting, switch to another platform (the Internet) and many more options.

During the trial, the test subjects gained comprehensive experience with additional digital services and interactive applications. In the final survey, they were asked to indicate which of the future applications they were likely to use using a five-point scale.

5.8.1. Retrieval of enhancement information

Overall, the retrieval of information will also take on an important role in the world of digital television (replacement of analog teletext by digital text with new graphics, etc.). Thus 67% of the test subjects indicated a desire to use digital teletext.

Only about a third of the test subjects would retrieve additional information on the content, hosts, actors, guests, etc. during a television show. Therefore, it may be worth considering making show-specific information available in the television station's MHP portal for a longer period than just during the relevant show.

Multimedia functions are becoming increasingly attractive to end users. Already one in four can imagine "Accessing the Internet using the remote control or an infrared keyboard." Internet users are equally interested in this option in digital television.

16% of respondents indicated that they would retrieve "additional information on a product during a commercial" in order to access more detailed information.

5.8.2. Interactive return channel-based applications

62% of the test subjects used one or more interactive services such as requests/orders, voting functions or betting, while 38% did not test these services.

Half of the test persons can imagine "Answering questions in quizzes directly using the remote control," 30% would take part in votes or opinion polls using their remotes, and 26% would take part in contests.

Approximately one third of the respondents indicated that they would use "Pay per view, that is, the film is loaded onto your set-top box for a fee and you can watch it at the time of your choice" (not tested in the Graz trial).

The test users also had the opportunity to test a betting application during the project. When asked about their probability of using such applications in the future, 17% indicated that they would want to place "bets using the remote control during sports broadcasts."

12% could imagine "Tele-shopping, that is, ordering products you are interested in using your remote control" (10% of the test subjects indicated that they had already purchased products via tele-shopping).

Figure 63: General probability of use for digital services (percentage of respondents 12 years and up)
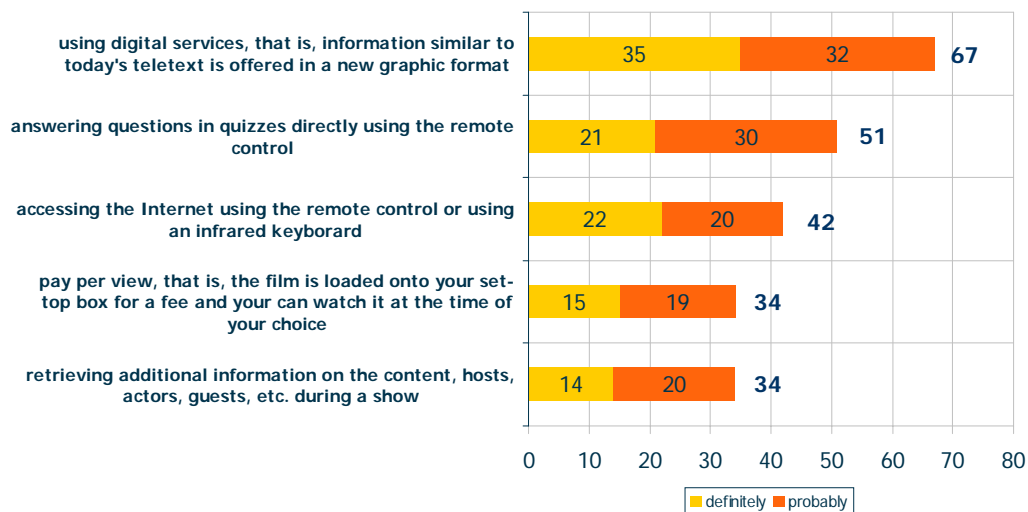
Source: Core results of DVB-T trial, reporting based on respondents 12 years and older, Fessel-GfK (on behalf of RTR)

**Figure 64: General probability of use for digital services
(percentage of respondents 12 years and up)**
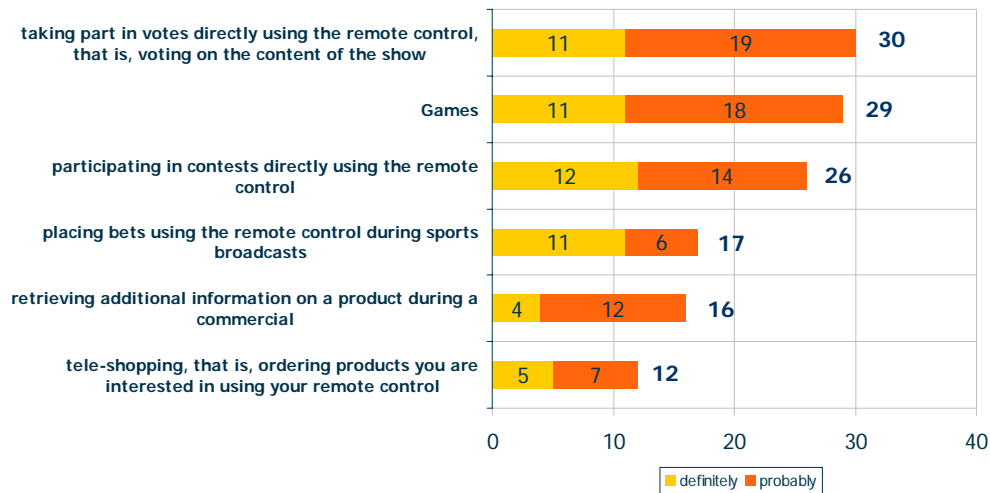
Source: Core results of DVB-T trial, reporting based on respondents 12 years and older, Fessel-GfK (on behalf of RTR)

5.9. Intentions to switch from analog to digital television reception

Approximately half of the households indicated that they plan to switch to digital television within the next five years and that they are willing to pay an average of EUR 252.00 for that purpose.

Digital television is already offered on the cable and satellite platforms, and digital penetration in Austria is currently at 13%. One on four satellite TV households have digital reception, and the tendency here is clearly rising; by the end of 2004, this figure will have probably reached 30%. Only 4% of Austria's cable households have digital receivers. On average, 2% of Austrian television households switch from analog to digital technology each year.

The test households in Graz were surveyed as to their plans to switch to digital television in the next five years, and 42% indicated that they intended to do so.

47% of those with analog terrestrial or analog satellite reception expressed their desire to switch to digital technology. Among those with cable television, the willingness to switch is significantly lower at 33%.

Approximately half of those who expressed a willingness to switch intend to do so by the end of 2005.

When asked about their preferred digital reception platform, half of those willing to switch indicated that they intend to switch to digital satellite reception. Approximately 30% indicated that they would choose the digital terrestrial platform, and only about a tenth would consider digital cable reception.

Even before its introduction, the digital terrestrial platform is already showing greater potential than digital cable. The Graz test households are, of course, aware that the digital terrestrial option will be offered in the near future.

Figure 65: Intention to change over to digital television in the next five years (percentage of respondents 12 years and up)
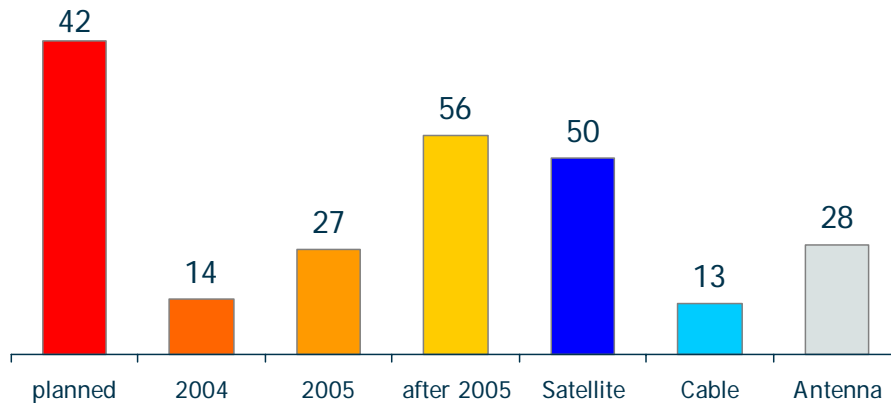
Source: Core results of DVB-T trial, reporting based on respondents 12 years and older, Fessel-GfK (on behalf of RTR)

5.10.   Channel variety as a factor in success

For a majority of the Graz test subjects, having a variety of channels plays a key role in access to television.

Platform selection is determined by the need for a variety of channels, the comparison of monthly fees versus one-time costs, and reception quality.

As shown in the course of the trial, the reception quality of digital terrestrial television is outstanding. One-time acquisition costs are incurred in the switch from analog to digital technology on any platform. Therefore, the competitive disadvantage of digital terrestrial television is the lower expected variety of channels.

The test subjects in Graz were asked whether digital terrestrial television should offer more variety (10 to 15 channels) or if it would be sufficient to receive three or four channels with additional digital services. 22% would be satisfied with three to four channels plus digital services, but the majority would want more variety.

Figure 66: Channel variety versus additional digital services; If you could receive digital television directly via antenna, which would you consider more important: Having a larger number of channels or just a few channels with additional digital services? (percentage of respondents 12 years and up)
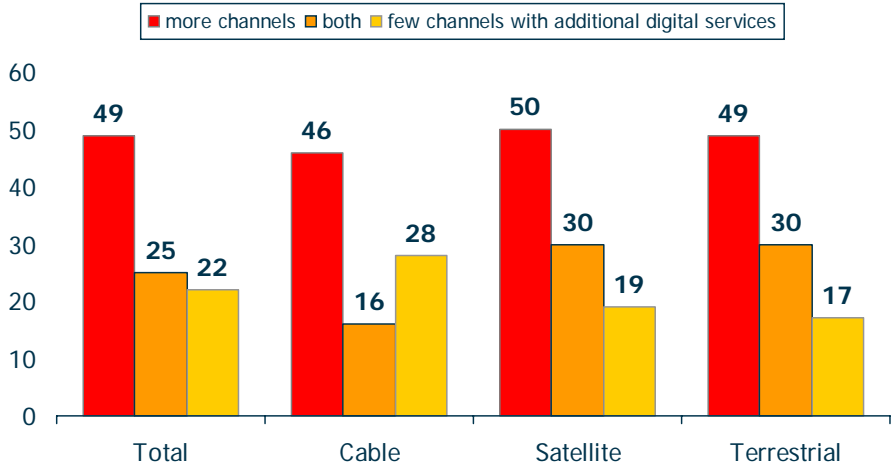
Source: Core results of DVB-T trial, reporting based on respondents 12 years and older, Fessel-GfK (on behalf of RTR)

Figure 67: Channel variety – Desired number of channels in digital terrestrial television (percentage of respondents 12 years and up)
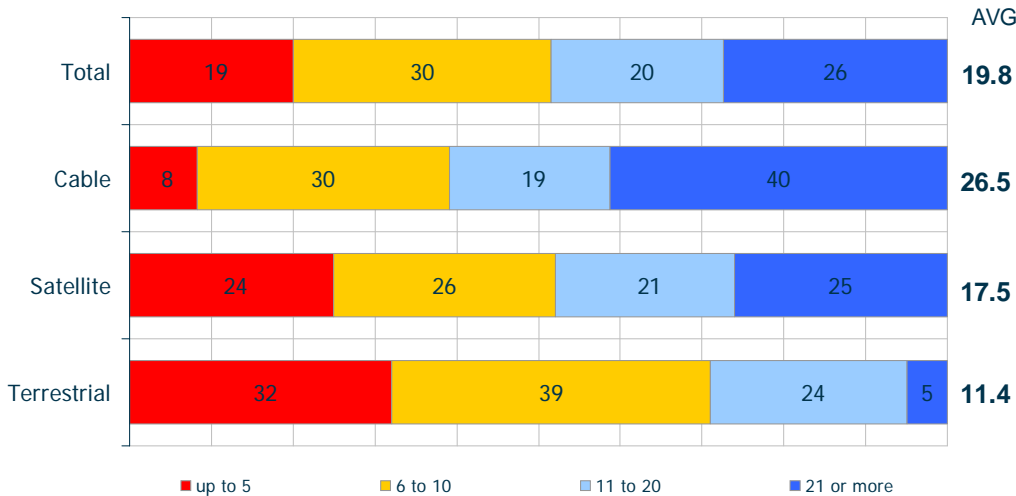
Source: Core results of DVB-T trial, reporting based on respondents 12 years and older, Fessel-GfK (on behalf of RTR)

5.11.   Effort involved in concurrent market research

The market research accompanying the DVB trial in Graz required the efforts of a relatively large team at Fessel-GfK and the evolaris foundation. In total, seven employees in the field of research and two employees in field organization were assigned to the project at Fessel-GfK. 20 telephone interviewers were employed for the screening stage. A total of 18 interviewers from Fessel-GfK's staff in Graz were employed for recruiting, initial inspections, installation, final interviews and in the removal of the reception equipment from the test

households. In order to remedy the technical problems in the households competently, Fessel-GfK also employed a trained television technician (132 assignments).

The surveys made use of state-of-the-art instruments such as CATI (computer-assisted telephone interviews) and CAPI (computer-assisted personal interviews). The study began on May 31, 2004, and ended on August 31, 2004. In this period of time, a total of 12 diaries were sent to each panel household (total: approximately 1,800 diaries). For questions on the project, the diaries and technical problems, the households had a hotline at their disposal from 8:00 am to 11:00 pm, 7 days a week. A total of 911 calls were registered and handled.

The team at evolaris consisted of five employees. A studio (the "X-Perience Lab") was set up for the usability tests and used for the initial evaluation of the digital receivers, as a monitoring area, and as a storage area for the digital equipment. Two freelancers were employed for monitoring, which involved checking the additional digital services and their content while they were on the air in order to provide competent answers to the tests households' inquiries about current offers and in order to assume technical review functions for the developers and providers of additional digital services.

5.12. Future prospects

As users became accustomed to the new technology and its technical stability and availability increased in the course of the trial, the test households reported an increasing number of successful experiences with the services offered. For example, in the course of the project the new technology developed an increasingly positive image in the eyes of the test subjects. This process warrants a positive perspective on the future of digital television – and especially its interactive capabilities – in Austria.

6.   Results, insights and outlook

This regional trial for digital terrestrial television and interactive additional television services based on the MHP standard can be seen as an integral part of Austria's overall strategy for the introduction of digital broadcasting.

The digitization of broadcasting will affect all broadcasting forms and platforms, including radio and television as well as satellite, cable and terrestrial transmission. The trial in Graz and the sustainable accumulation of specific know-how by all parties involved will serve as an indispensable aid in the process of digitization in general.

In particular, the future significance of the MHP-related activities carried out by the television stations and software companies involved in the Graz project is not just limited to the terrestrial platform. The experience gained with this new technology in Graz will certainly serve to benefit all broadcasting platforms.

For the Austrian Communications Authority (KommAustria) and its operative arm RTR, the trial has provided essential technical and strategic insights for the invitation to tender for a license to operate Austria's first multiplex platform (scheduled for the first half of 2005). In this context, the main question concerns the features of digital terrestrial broadcasting which should be emphasized in the introductory stage: Variety of channels, interactivity, picture and reception quality, or new modes of reception (portable indoor, mobile reception).
In KommAustria's Digitization Plan, which was created with the support of the Digital Platform Austria (a forum set up in 2002 and consisting of some 300 experts from all fields concerned with digitization), regular DVB-T broadcasting operations are scheduled to begin in 2006.

After the construction of DVB-T networks in areas of high population density, the Digitization Plan calls for the complete transition of each Austrian province from analog to digital transmission between 2007 and 2010. By 2010, terrestrial television should be completely digitized, and the coverage level should be very close to the full coverage offered in analog operation.

6.1.   Integration into an international network

6.1.1.   DICE project

The Graz trial led directly to Austria being invited to participate in an international information network consisting of comparable DVB-T trials under the name of DICE (Digital Innovation through Cooperation in Europe). Under the leadership of the Economic Senate of Berlin, Austria (i.e., RTR in cooperation with the Institute of Communication Networks and Satellite Communications at the Graz University of Technology) will be involved in the network along with the following EU member states: Sweden, Denmark, Great Britain, Hungary, Poland and Lithuania. The objective of this network, which is funded by the EU's Interreg IIIc program, is to find joint solutions to the challenges of digitization on the basis of experience gained in individual projects.

The DICE project is subdivided into five specific working groups focusing on the following subject areas: Social Acceptance, Business Models, Frequency Policy and Regulation, Platform, and Interactive Services. The goal of the project is to develop joint approaches to specific challenges in these areas on the basis of experience from specific regional projects.

The "Platform" working group, which has a number of international members, is headed by Otto Koudelka of the Institute of Communication Networks and Satellite Communications

(IKS) at the Graz University of Technology. Experts from all core partners in the Graz trial (ORF, Siemens Austria, Telekom Austria and RTR) also participate in the various DICE working groups.

6.1.2.   The European Commission's MHP Implementation Group

The MHP Implementation Group was set up in the fall of 2004 as part of the Radio Spectrum Policy Group (RSPG), which was established in 2003 as a strategic advisory body for the European Commission regarding the use of the frequency spectrum. This working group, which includes delegations from all 25 EU member states, discusses issues relevant to the successful introduction of MHP as a standard for interactive television. The delegations each consist of one representative of a country's relevant ministry or regulatory authority as well as one representative each from industry, broadcasting network operators and broadcasters. The Austrian delegation is composed of representatives of the !TV4GRAZ project partners (ORF, ATVplus and Siemens Austria).

6.2.   Raising public awareness

The broad range of participants in the trial and the accompanying communication measures attracted increasing attention to the upcoming developments of digital television in the business world, in politics, and in the public eye.

Thus the trial enjoyed considerable coverage in both specialized publications and the general media, especially after the event marking the official start of the project on May 13, 2004. More than 2,300 visitor inquiries on digital television were answered at an information stand set up at the Graz City Hall for the duration of the trial.

In a nationwide, representative survey conducted by Fessel-GfK, 43% of the population already indicated that they have a "fairly sound knowledge" of digital television (Lifestyle Online 2004 survey). Since the beginning of the Graz trial, RTR has seen a considerable increase in interest and inquiries regarding DVB-T from regional private television broadcasters.

In addition, the accompanying communication measures taken by the core partners in the project also strengthened the presence of this project within the relevant industries – even beyond Austria's borders. The achievements and insights associated with the Graz trial were communicated to the specialized public in Austria abroad by means of a trade fair exhibit (Munich Media Days), the publication of a color brochure describing the project in German and English over some 100 pages, as well as a DVD which gives users an overview of all the MHP applications realized in Graz.

6.3.   Know-how acquisition

Due to the considerable know-how they have gained through this project, the television stations and IT companies involved in the Graz trial as well as the media and other business enterprises involved in testing new business models are now better prepared for the challenges and interactive possibilities of the MHP standard.

The diversity of the participants in the trial (both public and private) made it possible to reach the crucial goal of creating the same know-how advantage for large nationwide broadcasters and regional television companies alike. Regional channels were integrated into the trial

specifically to demonstrate the relevance of these new technologies in the activities of this group of television broadcasters.

The processes required to broadcast, develop, create and support MHP-based information and service products and to link them to third-party MHP applications for advertising and commercial purposes became more transparent to the partners in the project. In this way, the digital future of television has become more comprehensible and calculable in both technical and commercial terms.

The companies involved are now in a position to meet the prerequisites for the digital broadcasting of television content and additional interactive content themselves – without needing to acquire fundamental knowledge and developments from companies abroad. Even companies which were not involved in the Graz trial also received significant input for their own processes of preparing for the future and will profit from the public availability of the trial's results and insights. Thus this regional trial has created added value for the digitization of broadcasting in general.

6.4.   The interaction cycle based on DVB-T and MHP

The complete technical cycle of interaction in a television channel broadcast by digital terrestrial means and supplemented with interactive services (including return channel connections for the test households) was set up for the first time in Austria using the DVB-T and MHP standards. In this context, MHP proved to be very suitable as an operating system standard for broadcasting complex text and image content in various designs and with different return channel-based interactive services using DVB, and for displaying this content on the viewers' screens using the set-top boxes of various manufacturers.

6.5.   Set-top boxes

The field tests demonstrated the critical role of set-top boxes in the success of such a closed-end project concept. Likewise, the manufacturers' adherence to standards and specifications – which has been insufficient to date – was also revealed. A free market for set-top boxes will only be able to develop if consumers can rely on the terminal devices to reliably display the MHP services developed by IT companies and television providers.

A certification system which labels especially suitable set-top boxes for consumers would be a viable solution to this problem. The box manufacturers could have their products undergo an independent technical review on the basis of defined criteria.
Such a certificate could also serve as the basis for a future digitization promotion program which would provide government subsidies for citizens purchasing such devices.

6.6.   Further development of MHP

The application of the MHP standard in the trial revealed both strengths and weaknesses. The resulting insights as to the requirements of MHP for the design and use of a wide variety of additional digital services will influence the development of future versions of the MHP standard. This means that the test operations in Austria will provide significant input for the future development and use of MHP throughout Europe.

Therefore, future versions of the MHP standard will either have to limit the room for interpretation in programming certain applications considerably, or eliminate this latitude by

way of clear process definitions in order to ensure that applications function on all MHP-compatible set-top boxes.

On the other hand, a version of the MHP standard which can be deployed on a broad basis will have to account for a wide variety of design possibilities in order to satisfy the various design needs of portal developers and operators with regard to fonts, font sizes and colors. This is especially important because the visual design possibilities offered by MHP represent an essential difference from conventional teletext and videotext displays.

6.7.   Compatibility of MHP products

In addition to the functional compatibility of MHP products with set-top boxes, the full compatibility of MHP products with one another also has to be considered a main objective. In the Graz trial, the possible applications of MHP (which are still very open in some areas) showed that software developers, set-top box manufacturers and television broadcasters will have to agree on essential architectural fundamentals for the design of MHP content in order to ensure reliable functioning and compatibility with the MHP developments of future business partners. This is an indispensable prerequisite for the ability to realize business models based on MHP products.

For example, advertisers and businesses will only develop their own MHP portals to advertise products or product lines if these portals can be linked to the portals of all television broadcasters (thus ensuring broad-based usability) and can be retrieved by the consumer by such means. The same applies to the operators of commercial portals such as the sports betting application developed in the Graz trial.

6.8.   Development of business models

During the trial, television broadcasters and content suppliers recognized and successfully tested future business models based on MHP applications using a return channel.
The simple insertion of banner advertisements (static advertisements) in the television broadcasters' MHP portals was only one part of a broad range of possible services.

For example, television broadcasters and various content suppliers started cooperation arrangements in which these service providers created up-to-date reports on world news, nationwide weather information and regional culture tips for the television broadcasters and sent the reports directly to the broadcasters' digital MHP portals via the Internet.

An independent MHP portal developed by Österreichische Sportwetten GmbH (tipp3 live!) which allowed viewers to place bets via their television sets was linked to two broadcasters' MHP portals.

Another independent MHP portal developed by Siemens Austria was designed as an interactive product advertisement for a mobile telephone. This portal was available to viewers during a television commercial for the product and displayed more detailed advertising content on the television screen.

Participating in votes and opinion polls or placing password-protected orders for goods and services via the return channel also indicate future sources of income for service providers. However, the resulting need to process and forward the data on the return channel also gives rise to new business models for multiplex operators and external IT centers. Of course, this will have to be carried out in compliance with general data protection regulations and be kept transparent to the consumer at all times.

The business models enabled by digital MHP-based data services have sensitized the parties involved as well as outside observers to the commercial scenarios associated with this new technology (both as examples and in concrete terms) and inspired further development.

6.9. EPG

Viewers expect an electronic program guide (EPG) in future content offerings, and this guide will have to be more than just an up-to-date program overview. For example, EPG features such as search functions by genre and – as offered in Graz – a six-day preview are considered critical to their success.

This result is also supported by the Lifestyle Online 2004 survey conducted by Fessel-GfK. According to the survey, 65% of respondents would like to use the EPG as a screen-based television guide, and the same proportion would like to use it to retrieve detailed information on television shows. A majority of respondents also expressed a desire for interactive services, including automatic references to shows dealing with similar content (53%), automatic tips regarding especially interesting shows which match the viewer's previously entered personal profile (52%), and the ability to view short trailers and excerpts from films (50%).

6.10. Viewer acceptance of MHP-based content

The results of the market research accompanying the project in over 150 test households show a high level of acceptance for the attractively designed features of MHP-based digital videotext or teletext. In this context, however, the test households expect the quality and quantity of content to match that of conventional videotext offerings.

Interactive, return-channel-based content is assessed critically for creativity and useful value. Such content certainly has a sound chance of success, but according to the principle of supply and demand it will only be profitable if the users consider it especially attractive or helpful. This will be even more the case once fees are charged for this content in regular operation.

Those interactive offers which are directly related to the television medium or the show currently on the air are likely to be successful with a minimum of effort. For example, the test households in Graz gave especially positive feedback on the possibility of choosing music videos from a list of suggestions in gotv's MHP portal using the return channel and having them played on the air, similar to a jukebox or an all-request show. This offer is considered especially creative, is immediately linked with the television channel's content, and is not available elsewhere in this form.

Voting functions related to the content of the show currently on the air are also considered attractive. In such cases, however, the attractiveness of the television show – not the MHP content itself – is most likely to determine the usage intensity of the accompanying MHP content.

Interactive MHP applications which are independent of specific shows will be successful to the extent that they prove to be innovative, unique or convenient.

The loading times for the MHP applications (i.e., the time between activation using the remote control and the actual response on the screen) are also rated by consumers as a primary criterion for using MHP portals. However, this speed depends mainly on the bandwidth available for broadcasting the DVB-T signal and has to be taken into account in frequency planning. It also depends on the features of the set-top boxes with regard to processing power and RAM.

In general, the successful market introduction of digital television – and especially additional interactive data services – will depend heavily on whether the parties involved are able to develop and use a vocabulary which is as simple and comprehensible as possible. Technical terms such as DVB-T or MHP trigger threshold anxieties and can lead to rejection among consumers. Only in rare cases is interactivity understood to be an advantage of this new television technology; in fact, it is more likely to be associated with unfriendly or useless applications. Viewers will certainly use attractive interactive content, but they will first have to become aware of its benefits through the portals themselves. Interactivity is therefore not entirely appropriate as a sales argument.

6.11.   Return channel and Interactive Application Center

The interactive return channel developed in the course of the !TV4GRAZ project enables true interaction between television viewers and broadcasters or MHP portals via the set-top box's remote control. This allows viewers to respond to the shows currently on the air, to participate in determining the content of programs, to express their opinions, to order goods and to use various services. As the main hub in the overall DVB-T interaction cycle, the Siemens Interactive Application Center (IAC) ensured the necessary exchange of data for interactive television by means of interfaces to service providers, television broadcasters and set-top boxes. In the Graz trial, this functionality was implemented successfully for seven broadcasters, two service providers and four set-top box types.

We can also expect such IT centers to play an essential role in the processing of interactions via the return channel in the future. It would be fairly simple to program interactive applications in such a way that the modem in the set-top box would dial in to the specific service provider's server when establishing the return channel connection, thus bypassing an independent IT center. However, in order to ensure the necessary transaction security for all parties involved, we can assume that most of these interactions will be protected by a user ID and a password. From today's perspective, it seems fairly impractical to expect every user to register and create an individual password with each MHP content provider in order to use its services. What is far more probable is a scenario in which the viewer registers with one IT center and is assigned a user ID and password only once (possibly even when purchasing the set-top box). This information could then be used for all further interactions.

It also seems highly probable that such IT centers will cooperate closely with multiplex operators in the future. Regardless of whether the multiplex operator itself handles these tasks or outsources them to third parties, this development will have to be monitored for compliance with regulatory and data protection standards.

6.12.   Picture quality and portability

Compared to analog television broadcasting, DVB-T's excellent reception and picture quality was pointed out as an outstanding feature by a majority of the test households. The resulting portability of devices for flexible use indoors at the same level of reception quality was also mentioned by consumers as an especially attractive feature. However, this also leads to the

insight that portability can only become an attractive argument for DVB-T if the return channel technology in DVB-T receivers sees further development.

In the future, it would be necessary to introduce wireless return channel connections using mobile modules or WLAN connections in order to ensure full portability within the households.

In the medium term, consumers are not likely to accept portability which involves moving a television and antenna as well as a separate set-top box. The integration of DVB-T receivers into television sets will have to be a high-priority technical objective and may also provide new sales impetus for retailers. In addition, however, consumers will also expect the tuner built into the television set to allow a free choice between DVB-T, DVB-S and DVB-C reception. Many of the visitors at the project information stand at the Graz City Hall voiced such preferences. Accordingly, it should at least be possible to choose between DVB-S and DVB-T reception in a single device.

6.13.   Mobility

In tests of television reception in vehicles, the project showed quite impressively that mobile reception is an essential performance feature of digital terrestrial television which will make a considerable contribution to its economic potential.

For mobile reception, the added value provided by DVB-T compared to analog broadcasting was clearly demonstrated with a vehicle provided by BMW and equipped with a DVB-T-compatible television entertainment system. Visitors to the information stand at the Graz City Hall responded to this demonstration with very positive feedback. The commitment of the automobile manufacturer also shows that industry's interest in the new technology.

Public interest in mobile television reception also warrants the conclusion that the further development and testing of broadcasting standards such as DVB-H would also make sense for very small mobile receivers.

6.14.   Frequency engineering experience

The dense usage of the frequency spectrum was confirmed in the process of searching for a suitable television frequency in the Graz coverage area. The ORF location originally chosen for the Graz-Schöckl area could not be coordinated successfully. In particular, the highly exposed location of the main transmitter and the resulting interference well across Austria's borders prompted the conclusion that the technical parameters necessary to cover the Graz area would have to be planned on the basis of alternative locations. Finally, a mobile communications location in the center of Graz and another such location at the eastern edge of the city could be coordinated successfully with the neighboring countries. These two locations provided a solid basis for a sufficient coverage level in the city. This also made it possible to decrease the resulting interference levels substantially. For future trials, the project yielded the insight that mobile network locations are exceptionally suitable for regional coverage areas due to their differing network typology.

This was another reason for the choice of Channel 62, which made it possible to test the adjacent channel situation with an analog location (Demmerkogel, Channel 61). Due to mutual interference, high-powered transmissions can not run on adjacent channels at different locations in "analog" frequency planning. This limitation was mitigated by digital transmission technology. The Graz trial showed that the adjacent channel situation did not limit the respective coverage areas with the parameters selected.

One substantial advantage of the new digital technology is the ability to construct single-frequency networks and thus ensure a more efficient use of frequencies. In addition, it is possible to improve the reception situation in certain areas by selecting locations appropriately. This improvement was verified specifically by means of indoor measurements taken by the Graz University of Technology.

With regard to data rate management within a multiplexer, the project yielded the conclusion that in the modulation process used in Graz (16 QAM ¾), the optimum capacity utilization for one conventional television channel is the transmission of three digital channels including their additional interactive services.

The series of measurements carried out for stationary, portable outdoor (mobile), and portable indoor reception matched the theoretical simulation results on the PC very closely. This will also ensure the requisite level of certainty in future planning. However, it was also discovered that different building compositions, in particular materials and wall thickness, had a considerable effect on portable indoor coverage.

6.15.   DVB-T's prospects of success

In Austrian households, especially on the main (living room) television, the market research indicates that digital terrestrial television will not become a serious competitor to satellite and cable. According to the results of our concurrent market research, the decline of the terrestrial platform can probably be stopped. However, it seems as though digitization will not be able to bring about substantial increases in the use of terrestrial broadcasting on the main television sets in Austrian households.

However, it is necessary to differentiate between various scenarios and original situations in this context. For households in multi-family buildings in those densely populated areas where the cable network is developed to a lesser extent and where the possibility of installing satellite reception systems is limited or involves various obstacles (e.g., shadowing effects from neighboring buildings), DVB-T will be welcomed as a means of improving the reception quality of television channels compared to the analog technology used to date.

In addition, DVB-T offers regional television stations – which have been broadcast predominantly on cable networks to date – a highly attractive opportunity to increase their technical range in addition to cable broadcasting.

The market research results indicate that consumers consider it important to have a wide variety of channels. From today's perspective, however, DVB-T in Austria will hardly be able to offer the range of channels to which satellite and cable viewers are accustomed. In particular, it is questionable whether German television stations will invest in this broadcasting platform in Austria. However, we can expect a substantially larger number of Austrian channels to be broadcast via DVB-T than in analog terrestrial broadcasting to date. In this respect, DVB-T is a highly attractive alternative for households which have relied on analog antennas up to now.

Due to its special characteristics (portable indoor reception and mobility coupled with high picture and sound quality), however, DVB-T is likely to enrich the market for additional television sets in households as well as mobile use (e.g., in vehicles). As DVB-T broadcasting systems can also be used to transmit television content using the DVB-H standard for small reception devices such as handheld computers and mobile telephones, the construction of a DVB-T network also creates potential for a completely new business area and for consumer-friendly usage.

In its own way, DVB-T will also turn out to be the broadcasting platform which underpins the broadcasting of free TV channels in Austria in the long term. From today's perspective, the creation of a digital terrestrial platform as a future-proof and independent broadcasting technology for Austrian television will make a substantial contribution to securing and promoting Austria as a media location. In addition, DVB-T will allow unhindered access to services in the information society, largely regardless of one's income or place of residence.

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