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From Analog to Digital Television; Strategies to Promote Rapid Adaptation and Awareness

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Abstract: Europe is currently transitioning to digital terrestrial television and is aimed to replace all analog infrastructures by 2012. Besides replacing all broadcasting networks in Europe, the transition requires updating household televisions and antennas. As with any major change, public administrations must keep citizens informed and provide support, especially when dealing with a communication medium expected to support a new portfolio of services and information. State-of-the-art technologies enable universal coverage in locations where television services are currently unavailable. This paper evaluates the transition to digital television in several European regions and analyzes novel approaches and solutions to achieving universal access to digital television and citizen awarenes.

Key Words: DTT, migration, change managing, citizen support
Category: A.1, C.2.m, H.3.5, J.1

1 Introduction

Programs and processes executed by public administrations are currently undergoing a rapid expansion. For instance, services are becoming more mature, support for operations is improving, and distribution channels for services are increasing. Thus, digital terrestrial television[Cave and Nakamura 2006] (hereafter, DTT) will play a paramount role in public policy.

DTT will likely become the preferred method of communication and can be used to engage citizens in government services (cf. Section 2). DTT has emerged as one of the most ubiquitous telecommunication services. Similar to broadband access and telephone usage, DTT is likely to become a universal multimedia (audio-visual and data) support service to which citizens may claim access rights.

Regretfully, the deployment of DTT may not be straightforward[Farrugia 2006]. This paper focuses on the methods used by public administrations of Europe to provide information on the status of DTT deployment and to guarantee universal coverage. In general, keeping citizens informed about the status of technology deployment is essential to keeping them engaged in government processes and to increasing the level of participation in public life. In particular, providing high quality information about the status of a major technological event, such as converting analog television into a high quality audiovisual medium and a digital service platform, is a once in a lifetime opportunity to reduce the digital divide. Moreover, for DTT to serve as a universal communication channel, methods must be adopted to guarantee universal access.

Despite potential difficulties in the transition to DTT, strict deadlines for DTT deployment have been established in specific European regions. Most difficulties are related to demographic and geographical issues. Indeed, the tool presented in Sect. 3.12 is focused on a particular European region where these difficulties are especially relevant.

In this paper, the methods adopted in several European countries for guaranteeing awareness and coordination, reducing deployment and penetration times, and achieving universal availability were evaluated. The difficulties and drawbacks encountered in each approach and solutions to common problems are discussed. These solutions provide new tools to ease the transition to DTT. General conclusions and detailed solutions are provided in Section 5.

2 Digital terrestrial television

Terrestrial television broadcasting is one of the most ubiquitous and relevant mass communications tools for delivering free-of-charge information and entertainment in Europe. In 1997, there were more than 830 million people and 220 million television sets in the EU27[UNESCO Institute for Statistics 2009]. Analog broadcasts reach more than 90% of households in practically all EU27 countries.

A fundamental transformation is currently under way in Europe, where television broadcasting systems are being converted from analog to digital by 2012. The transition to DTT is a major technical endeavor that will dramatically affect the future of terrestrial television all around the world. Apart from a more efficient use of the transmission spectrum and an improvement in sound and image quality, DTT makes it possible to provide an entire portfolio of new services by substantially increasing the number and diversity of programs available.

The conversion to digital television represents a substantial improvement in the technical quality of television and in the quantity and variety of television content available. However, this transition requires a complete overhaul of broadcasting infrastructure. This process is driven by governments, which grant the licenses necessary to operate broadcasting stations. Indeed, because DTT uses the electromagnetic spectrum more efficiently than analog TV, governments will be able to recapture and reallocate significant amounts of the spectrum to support additional wireless services[Mouyal 2006].

For this process to succeed, the upgrade of broadcasting and receiving infrastructures should be deployed at the same time. To upgrade receivers, household televisions and antennas must be replaced with digital ones, or convenient adaptation equipment must be distributed. When broadcasters terminate analog signals, digital terrestrial television is expected to be widely adopted. Thereafter, DTT is expected to grow by 12% each year. In 2007, there were 158 million households using digital television services in Western Europe and the US. By 2012, 274 million households are predicted to have digital TV [European Commission 2007].

In most national markets, the most significant increase in digital television services will occur 12 to 24 months prior to analog signal termination. Driven by campaigns from national regulatory authorities and public service broadcasters, there will be a massive push to migrate consumers to digital platforms.

Strong leadership and an effective communication strategy are essential for the transition to succeed[DigiTAG 2006]. Viewers must have access to accurate and up-to-date information on the launch of DTT services, coverage, adaptation methods and the date when analogue terrestrial television will end. Methods for communicating with viewers include advertisements, television banners, letters, web portals and brochures. Furthermore, consumer electronic resellers can also provide guidance to viewers.

In spite of being one of the most ubiquitous telecommunication services, analog television access is not universal. In most European countries, coverage ranges from 90% to 98% of the total population. Deployment costs grow exponentially in coverage areas above 90%. Thus, approximately 15 million people who live in rural areas and remote regions of Europe have never had access to terrestrial television. In areas without access to analog television, the only solutions are pay or free-to-air satellite services, due to existing audiovisual rights management policies or diverging programming grids.

One of the consequences of the digital deployment drive and the associated communication campaigns is that citizens living in terrestrial TV black-out areas can access the digital television. To respond to these claims, public administrations and broadcasters are studying cost-effective solutions to convert television into a universal service. Due to the fact that technical foundations representing digital television, the DVB family of standards [DVB Consortium 2009], are independent of (radio) communication channels and user devices, solutions based on a variety of technologies are possible.

3 Initiatives to facilitate the transition to DTT

Transition to DTT and the associated analog switch-off (ASO) are major issues for most developed countries. Many countries such as Andorra, Finland, Germany, Luxembourg, the Netherlands, Sweden and Switzerland have already completed the transformation process, Others initiated the transition to DTT a long time ago and are currently striving to meet deadlines and standards agreed upon for DTT availability (see Table 3) [Makki and Sangtani 2008].

Country	Launch date	Completion of ASO
Austria	2006	2010
Croatia	2009	2011
Czech Republic	2005	2011
Denmark	2006	2009
Estonia	2006	2010
France	2005	2011
Greece	2008	2010
Hungary	2008	2011
Ireland	2009	2012
Italy	2004	2012
Lithuania	2008	2012
Norway	2007	2009
Poland	2009	2013
Portugal	2009	2012
Russia	TBC	2015
Slovakia	2009	2012
Slovenia	2006	2011
Spain	2000/2005	2010
UK	1998	2012
Ukraine	2008	2014

Table 1: Plans to deploy DTT

All countries in the transition process offer information regarding the current status of deployment and many countries are implementing or studying alternate distribution channels for DTT programs. The most common method of providing information is through web-based applications. The most common methods for extending terrestrial TV distribution toward universal coverage are satellite-based solutions.

Currently, European countries transitioning to DTT are in various stages of the conversion process. For instance, Denmark has already completed the ASO, while many countries are only beginning the transition process. Thus, the capacity and availability of tools to support the transition to DTT also varies. We conducted a brief survey to gain insight into available approaches and solutions to common problems encountered in the transition to DTT. This review focuses on cases studies and provides information for countries converting to DTT. Due to the unique orography and demography, as well as the use of advanced web tools to track the ASO, the transition in Galicia, a region in northwest Spain, is discussed in detail.

3.1 Ireland

Currently, the ASO in Ireland has not been fully addressed[Broadcasting Commision of Ireland 2009]. Although the Irish government, through the Broadcasting Authority of Ireland (BAI), assigned the responsibility of digital migration to the One Vision consortium, which includes Eircom TV3, Arqiva and Stanta, very little has been accomplished. Indeed, this consortium has not been established as a legal entity and governmental funds to support this change have yet to be approved. Therefore, tools to guide citizens along the ASO are not available at this time.

The Irish Government is not planning to adopt MHP as an interactive support for DTT but is planning on implementing MHEG5[MHEG 2009].

3.2 Denmark

Denmark has successfully completed the ASO. According to official reports, the entire population of Denmark can access digital terrestrial television; thus, tools for monitoring service availability are not necessary. Nevertheless, citizens have access to a call center in case technical problems arise. However, this resource is underused due to the lack of significant issues.

3.3 Norway

Norway also completed the ASO on the expected date. On December 1st, 2009, the last analogue TV transmitter was turned off, completing the transition process. Currently, the entire population of Norway can access DTT. 430 transmitters are deployed across the country, supporting 25 TV programs and 16 radio stations.

3.4 Italy

Italy has initiated the transition process; however, coverage for this technology is not complete. Lazio and Rome have completed the digital transition, which was facilitated by the Italian government by subsidizing the purchase of DTT receivers. Efforts to provide support DVB-H-based mobile TV, which is not available in other countries, is gaining momentum in Italy. Nevertheless, information on DTT coverage cannot be monitored online.

3.5 Poland

The transition to DTT in Poland has been delayed due to legal problems that have made ASO impossible. Indeed, regulatory inconsistencies have only recently been solved and have reduced the number of multiplexes available for DTT from 5 to 3. The reduction in licenses made it possible to enable mobile TV and allocate part of the digital spectrum for broadband connections. Currently, tools to monitor DTT coverage or guide users along the migration process are not available.

3.6 Slovakia

Plans for the deployment of DTT in Slovakia are behind schedule. Issues with the DTT platform operator have caused delays in the agenda, which was outlined in 2009. Furthermore, tools for guidance and monitoring are not yet available.

As can be inferred from the large number of countries in the early stages of transition, Slovakia is not an exception. In most cases, the ASO is a large-scale project that requires the interaction of many parties, including technological and legal entities.

3.7 Greece

Digea, an *ad-hoc* company, was established by national broadcast companies to deploy the new network and manage the transition. Digea is expected to complete the process by the end of 2010. To provide information on DTT coverage, a web page based on Google Maps was developed. Coverage is represented as static layers on a background map displaying the area currently covered by DTT. Although the location of broadcasting facilities associated with coverage areas are provided, further information to assist the citizen in configuring home DTT equipment is not available (e.g., proper antenna orientation, signal levels within coverage areas, methods to monitor future coverage, etc.).

3.8 Spain

In Spain, transitioning to DTT is not a simple task. Due to Spain's political organization, migration to digital technology has to be coordinated with different Spanish autonomous regions because each region contributes to regional mass media and communication services. To complete the digitalization process, the entire country was divided into 90 areas with a distinct agenda. Nevertheless, all regions should have completed the transition by April of 2010.

To assist in the conversion to DTT, the national government of Spain developed a tool for digital technology users. A web portal that provides users

Figure 1: Information support for DTT coverage from the Spanish Ministry

with information based on postal code was established by the Ministry of Industry, Tourism and Commerce[Ministerio de Industria, Turismo y Comercio 2009]. The website provides information regarding reception of DTT channels; however, support for graphical information or areas with DTT coverage is not provided (Fig. 1).

Spain also launched a satellite solution to achieving universal coverage. TDT-SAT[Abertis Telecom 2009] includes all free-to-air Spanish DTT services and is intended to provide access to households lacking terrestrial coverage. Due to divisions within the Spanish government and public DTT services and programs targeted to regional audiences, the protocol to grant access to DTT was delegated to Spanish autonomous regions. This process involves the satellite operator, specialist retail dealers and receptor manufacturers, as well as national and regional governments (cf. Fig. 2).

Satellite DTT programs are encrypted according to a conditional access model. A complex procedure is facilitated by a dedicated management portal hosted by the satellite operator. The TDT-SAT management platform is a virtual environment that supports the enrollment and programming of custom-manufactured satellite receivers. Access to the system is provided once registered installers indicate a complete installation in a specific home. Next, household designation is validated by the regional government under the supervision of the Spanish telecommunication authority, once it has been demonstrated that the target household will not have convenient terrestrial DTT coverage after the analog switch-off. This process guarantees compliance with audiovisual content rights for DTT, which were negotiated under a territorial model (regional, na-

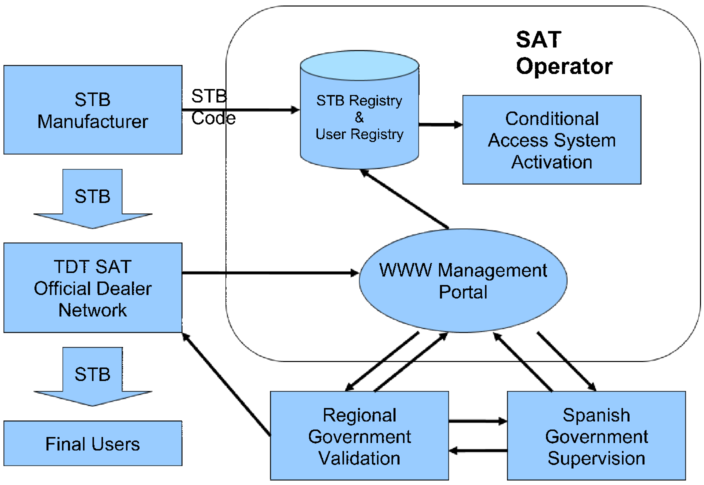

Figure 2: TDT-SAT management model

tional). Thus, only households that cannot access terrestrial coverage may receive satellite DTT. Furthermore, these households can only access programs aired in the specific region. Conditional program-based and territory-based access is implemented by decryption keys programmed into custom-designed receivers. The technical specifications of these receivers are public and any manufacturer may develop compliant receivers if desired.

3.9 United Kingdom

Currently, the United Kingdom is scheduled for a late switch-off date. To guide citizens along the transition process, a large amount of data has been published on the web[Digital TV Consumer Test Reports 2009].

The actual tool to track the conversion to digital technology can be found on this website and its features are similar to those described previously[Digital UK 2009]. As shown in Fig. 3, the site requires the full postal address and indicates the availability of digital reception or provides the expected date.

The BBC and ITV, the two main public service broadcasters in the UK, have made their services available digitally through a free-to-air satellite platform (Freesat) to complement their digital terrestrial platform (Freeview). To provide greater coverage and a larger number of channels, a digital satellite alternative was necessary. Freeview is currently available to only 73% of the population. However, after analog signal termination, coverage will increase to 98.5% for public service channels and 90% for Freeview service.

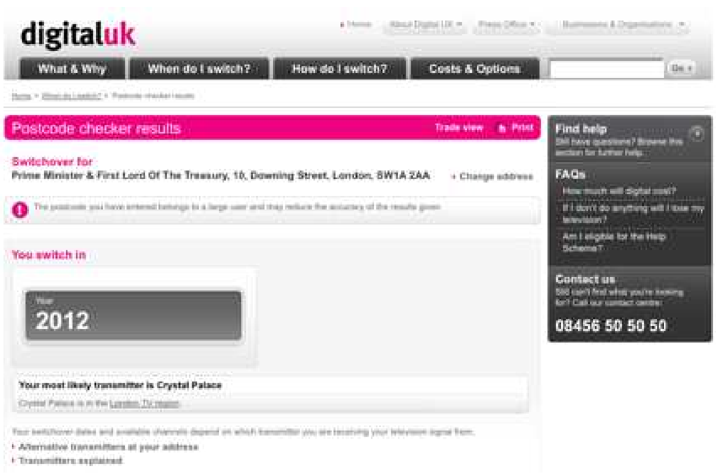

Figure 3: Monitoring DTT in the UK

In May of 2003, the BBC moved all of their channels onto the Astra 2D satellite, which focuses directly on the UK. This allowed the BBC to stop encrypting their broadcasts while continuing to meet license and copyright obligations. Free-to-air channels can be received using any standard digital satellite (DVB-S) receiver. However, the Freesat project aims to provide a more managed service with an electronic program guide (EPG), interactive features and approved receivers, similar to the solutions adopted in France and Spain.

3.10 France

Currently, France is considering a delay in the transition to DTT. Nevertheless, their citizens are supported by web accessible information. In particular, French DTT coverage can be monitored on Le Site de la TNT[TVNT.net 2009] (cf. Fig. 4). By providing the postal code, it is possible to determine DTT accessible areas. However, the possibilities of this tool are limited.

In June 2009, France launched FRANSAT[Eutelsat. FRANSAT 2009],], a satellite solution for homes unable to receive DTT terrestrially. Satellite reception of France's free DTT channels via FRANSAT is subscription-free and is based on the same model as terrestrial DTT. To receive these channels, households must have access to a pack composed of a decoder and a conditional-access smart card. Packs are already available at satellite dealers, antenna installers, specialist retail warehouses and hypermarkets. Although the pack is available in all of France, communication campaigns stress its availability in zones without terrestrial coverage. According to the French government, the new service is ad-

Figure 4: Web page providing information on DTT coverage in France

dressing 10-15% of TV-enabled households that will be unable to conveniently receive terrestrial DTT after analog signal termination scheduled on November 30, 2011.

FRANSAT supports all free-to-air DTT channels, including HDTV channels TF 1HD, France 2 HD, M6 HD and ARTE HD. Furthermore, this service requires no satellite antenna replacement for the 1.5 million French homes equipped with analog reception of France's national satellite channels.

However, a specific procedure has not been deployed to guarantee that only households lacking terrestrial coverage will be granted access to satellite DTT. Access packs are distributed only in metropolitan France and export restrictions are in place. However, any customer may acquire a pack and can install it in any place with satellite coverage. Thus, users in neighboring countries have acquired packs to receive French DTT services at their homes abroad.

3.11 Portugal

The Portuguese government has also established their own tools to assist their citizens in the transition to DTT. As shown in Fig. 5, by providing the postal code, DTT coverage can be monitored.

Currently, the Portuguese transition to DTT is a success. According to Portugal Telecom, the company responsible for supporting this service, up to 60% of the population (about 6 million) can access this new technology. Digital content broadcasting in high definition is expected to begin in a short period of time. Therefore, Portugal is clearly ahead of the deadlines for ASO.

3.12 Galicia

Dispersion and orography control infrastructure deployment, especially in telecommunication infrastructures. For example, the public broadcaster, Televisión de

Figure 5: Monitoring DTT in Portugal

Galicia, deployed over 1000 broadcasting facilities, most of them low-power UHF micro-relays, to guarantee coverage for analogue television to approximately 93% of the Galician population. Alternatively, 70% coverage is achieved with approximately 30 facilities covering the largest villages where most of the population resides.

Galicia is hilly and relatively uniform in elevation, with more than half of its 29,574 Km2 located between elevations of 400 and 600 m. The interior of Galicia is dominated by mountains that make radio-electrical planning difficult. Villages are typically small and isolated, and the parish is the common division among widely dispersed inhabited settlements. Galicia, with a population of around 2.7 million people, is organized into four provinces, 315 councils, 3,729 parishes and approximately 29,100 settlements, where more than 50% of all settlements in Spain are located in Galicia. From these settlements, approximately 28,800 have less than 500 inhabitants. Around 70% of all inhabited settlements in Galicia have less than 10 buildings or 50 inhabitants.

Due to the demographic dispersion and terrain of Galicia, the deployment of digital broadcasting requires increased coordination and management.

To guarantee the availability of DTT signal and to ensure the reception of digital signals, household equipment has been upgraded and new infrastructures have been deployed. Furthermore, an online service was developed to offer those in charge of infrastructure deployment, including government officials, telecom operators, equipment manufacturers, electronic equipment resellers and field technicians, up-to-date information on the exact location of analog and digital television infrastructures, facilities deployed to increase coverage, gaps in coverage and methods to optimize further deployments. Furthermore, the website offers citizens up-to-date information on signal availability, before and after the analog switch-off, and provides directions to upgrade their equipment at the lowest possible cost. The service provided at `www.tdtgalicia.es` offers an interactive geographical information service based on Autodesk geospatial solutions. This service includes information on broadcasting infrastructures, administrative geographical limits (province, council, parish and settlements), roads, inhabited nuclei and bathymetric data. Table 3.12 provides a detailed description of the information included on the site.

Layer	Source service
Orthophotographs	SITGA Wep Map Service (WMS)
Radio-electrical coverage	Telecom Planning Service. Government of Galicia
Broadcasting facilities	Telecom Planning Service. Government of Galicia
Administrative boundaries	Territorial planning. Government of Galicia
Roads	Territorial planning. Government of Galicia
Settlements	Territorial planning. Government of Galicia
Bathymetrics	Fishing and Maritime Affairs. Government of Galicia

Table 2: Information and service providers

Interactive access to GIS data is provided through Autodesk MapGuide Open Source [Autodesk 2008], a web-based platform that enables rapid deployment of geospatial web services. Thus, tools that feature selection, property inspection and map tips, and perform operations such as buffer, select within and measure are available. MapGuide includes an XML database for managing content and supports most popular geospatial file formats, databases and standards, which facilitate the seamless integration of geospatial data from different sources. MapGuide Open Source is licensed under the GNU lesser general public license (LGLP) [Free Software Foundation 2007]. Users may directly zoom and pan the map to access the area of their interest or may use an interactive menu to locate their specific settlement and access the current state of digital terrestrial television coverage. The menu offers top-down navigation beginning with one of four

Figure 6: Map of digital television in Galicia

Galician provinces, followed by council, parish and inhabited settlement. Once a settlement is selected, the tool locates the region and provides a map of the area. Furthermore, the website offers information about the percentage of coverage, distance to the nearest broadcasting facility and the direction the user should orientate the antennae, both graphically and in text.

The user may also obtain a map from Google maps service with the location of both the settlement of interest and the nearest broadcasting facility. This information is relevant for installers because they can access precise information regarding proper antennae orientation. As shown in Fig. 7, this information is provided graphically by indicating the direction of antenna orientation with a simple compass. In addition to this information, the software also offers general information about the days remaining until analog switch-off, average coverage, links to other relevant resources and a user manual. This tool is provided under a WAI-compliant web interface[W3C 1999]. Compliance to A and AA sections of WAI is a must in providing content from a public administration. Specifically, content must be offered to all citizens regardless of visual limitations or hardware availability.

In Spain, the approach to universal coverage is based on autonomous regions

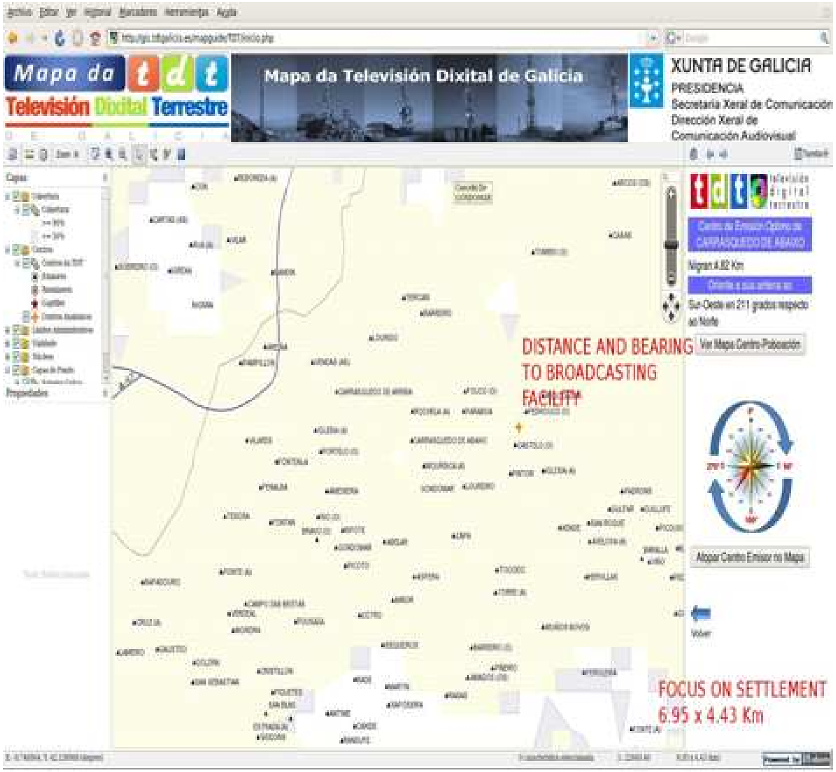

Figure 7: View upon navigating to a specific settlement

and the described solutions have already been adopted in Galicia.

4 Discussion

After reviewing the resources provided by different administrations, it is clear that most services include a map of actual coverage and provide an interactive tool to obtain the coverage in a given area. In general, information services are complemented with a portfolio of resources and links including technological descriptions, programs, broadcasters, statistics, a general outline of the transition process and established dates for analog termination in different areas. In most cases, signal availability in a given area is estimated by postal code.

However, a postal code-based approach to coverage assessment, the solution adopted in most countries, has a major drawback, which is more relevant in territories with a demographic structure based on scattered populations. Postal codes may lack the necessary resolution to obtain an accurate radio-electrical representation due to the size and propagation properties of digital signals. Furthermore, signal propagation [Collins 2000] depends on terrain, buildings, trees and other vertical structures, as well as the relative location of broadcasting centers, which is independent of postal delivery routes. In most cases, while general information regarding household adaptation is available in frequently asked questions (FAQ) compilations and how-to documents, most tools do not offer information specifically addressing situations where an actual user may require assistance or a local technician lacking expensive equipment may acquire a convenient understanding of digital signal quality assessment.

However, web-based tools provided in Galicia integrate geo-location services, demographics information, urban and regional planning data and radio-electrical measurements to provide DTT availability information. As a result, fine resolution, up-to-date information about actual coverage is available to citizens, consumer electronic resellers and field technicians in a way that is accurate and meaningful to their needs (e.g., antenna placement and orientation, signal quality, alternate stations covering the area, etc.)

Alternative solutions for providing digital television that were previously unavailable with analog technology are facilitated by digital technology. For example, cable, satellite and terrestrial television share formats of broadcasted programs, as defined by the DVB family of open standards for digital television. As a result, some countries are deploying or studying satellite-based solutions for simultaneously broadcasting terrestrial digital programs. In these cases, limitations due to differences in distribution rights of terrestrial and satellite broadcasts (in most cases, terrestrial programs are negotiated on a single-territory basis) are overcome by applying conditional access solutions such as conditional access modules and cards, satellite coverage within political borders or commercial devices distributed within a designated territory.

5 Conclusion

Introducing new communication channels to support interaction with citizens is currently an open issue in the domain of eGovernment[Layne and Lee 2001]. where current services are expected to be deployed as multi-channel services. For this reason, along with all the other advantages to the digital transition, administrations are compelled to promote DTT deployment and to support agents involved in this process. As this endeavor may require more time than expected, updated information regarding DTT availability and configuration is necessary.

Besides replacing analog television with digital technology, the purpose of the transition is to convert television into a universal service that provides information and entertainment, and can serve as a platform to support additional non-broadcasting services[Jaaskelainen 2001].

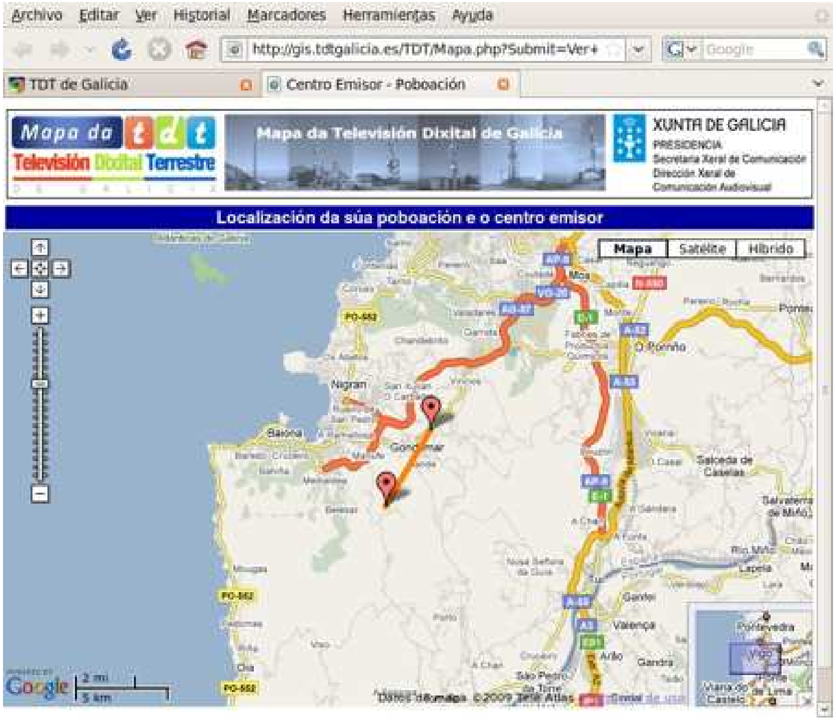

Figure 8: Location of settlements and broadcasting facilities

To meet these objectives, a significant effort from public administrations is required.

Indeed, termination of analog signals is a once-in-a-lifetime opportunity to eliminate the digital divide. In areas where population dispersion and difficult orography are the driving forces for telecommunication infrastructure deployment, the introduction of digital television may be used to provide broadband access to settlements where traditional options are too costly. Thus, the European Commission promotes the identification of a reserved harmonized sub-band of the UHF for bi-directional broadband communications and favors a flexible channel plan with different options[European Commission 2007]. This initiative has the support of the European Telecommunications Network Operators' Association[European Telecommunications Network Operators' Association 2008].

Citizen support is provided through a variety of different resources and web-based solutions are a significant information source. The web is simple to use and provides up-to-date information. This paper discusses several solutions ranging from simple information repositories to novel interactive applications based on

GIS technology and web 2.0 facilities. The most elaborate solutions offer up-to-date, high-quality graphical information to all parties involved in the DTT transition, fostering agent coordination, household adaptation and radio-electrical planning.

Postal codes are the standard criteria to identify coverage areas. However, as one case study demonstrates, solutions that offer better resolution than postal codes are available. Using inhabited settlements as a basis for coverage areas guarantees better accuracy when providing information to citizens and other agents. Besides, settlement boundaries are typically related to terrain characteristics (rivers, mountain ranges, valleys, etc.), while postal codes depend on city and road planning. Inhabited settlements map better to radio-electrical propagation than postal codes. Comprehensive solutions offer interactive information that is not limited to an estimation of coverage area but includes assistance in adapting household equipment by identifying the location of the most suitable broadcasting facility.

In conclusion, the solutions analyzed in this review provide citizens and agents information on the transition to DTT. Sophisticated tools provide information and services that ease the process of analog signal termination.

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