DTT AND WIMAX: WIRELESS INTEGRATED TECHNOLOGIES FOR DIGITAL DIVIDE ISSUE

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INTRODUCTION

This paper briefly discusses the benefits provided by the convergence and integration of heterogeneous technologies, such as WiMAX and digital television broadcasting.

As described in more details in the following paragraphs, the technologies defined by the DVB consortium provide an effective means for addressing three different classes of services:

- multimedia (audio/video) content distribution
- application distribution
- datacast (both to fixed and mobile user terminals).

WiMAX technologies might easily provide means for wireless broadband return channel connection. From a different point of view, the vertical integration of IP datacast techniques in DVB with the wireless networking technologies might foster the development of a new generation of services.

DIGITAL TELEVISION OVERVIEW

Digital Terrestrial Television is about to become the new frontier for entertainment and access to services for million of people. A revolution that is leading to the multiplication of the free-to-air TV offer with high audio-visual quality and interactive services.

More in general, DTT is a technology that allows to use TV frequencies for the realization of new telematic networks typologies, broadcast oriented, with pervasive and broadband territorial coverage. In fact DTT enables to regionalize the transmissions offering local structures, such as PAs (Public Administrations), the unique possibility to grant the access to their services through a practical mean that is accessible to all.

Integration between new DTT networks and “traditional” ones is a process with potentially enormous fallbacks in the way of living the television experience togheter to the access to informatic and telematic services.

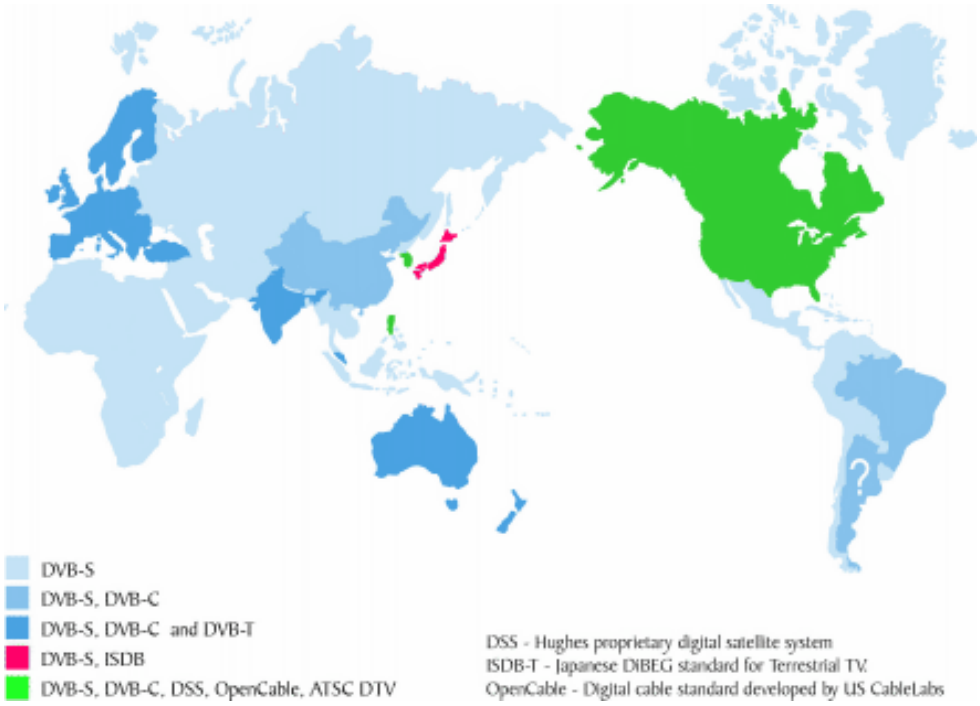
DTV STANDARDS

The migration from analog TV transmission to digital TV transmission is a process widely on the way. This appears especially clear in satellite broadcasting, where the majority of TV content is broadcast following the Digital Video Broadcasting (DVB-Satellite) standards. The DVB consortium is committed to designing global standards for the delivery of digital television and data ser-

vices. DVB-S, DVB-T, DVB-C, DVB-RCS and DVB-RCT are the main standards that cover all types of possible digital transmission issues, starting from satellite broadcasting, through terrestrial and cable and ending with the specification for a return channel via satellite or terrestrial frequencies. Digital broadcasting, other than a reliable and high-quality diffusion of video and audio contents, enables an easy way to distribute any kind of information through the same channel (data broadcasting).

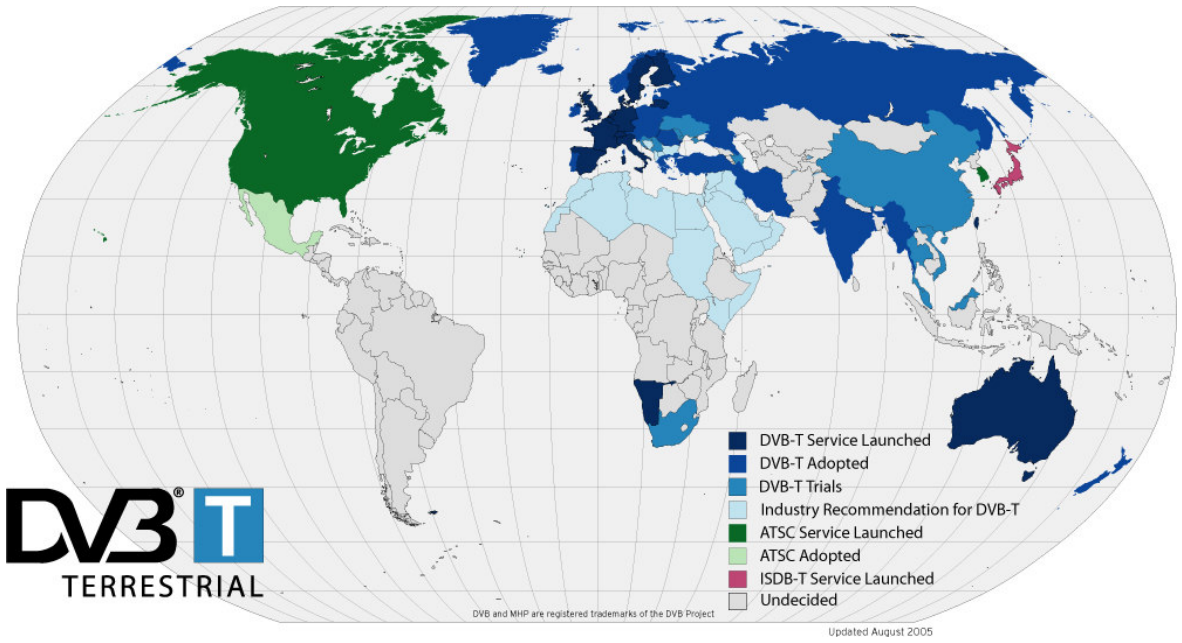
The two main areas of data broadcasting for satellite, cable or terrestrial are the delivery of interactive applications in a television home environment and IP delivery in a more generic networking logic. Two standards covering all the technological aspects of these two issues have been issued by DVB. These are DVB-MHP and IP over DVB that are portable in every broadcast environment.

The following picture illustrates DVB worldwide adoption.



DVB-T

DVB-T is the standard on which are based digital terrestrial transmissions (DTT). It shares with the other main DVB standards (DVB-satellite and DVB-cable) the same mechanisms for assembling and transporting TV streams but it differs for the physical layer specifications that are designed to suit the peculiarities of digital broadcasting over terrestrial frequencies.



ADVANTAGES OF DVB-T

IMPROVEMENT OF THE TELEVISION SERVICE IN TERMS OF QUANTITY AND QUALITY

With DTT the number of TV channels that can be broadcast can be four or fives greater than using analog modulations. Digital television offers a better image and sound quality allowing the usage of wide screen TVs (also high definition TV – HDTV) and digital audio surround systems. Besides the TV broadcaster can use its transmission resources with great flexibility: for instance, he can manage its bandwidth according to the revenue of each single service.

OFFER OF TV INTERACTIVE SERVICES

The digital TV receiver (STB - Set Top Box) can handle MHP interactive applications extracting them from the digital TV signal that comes from the antenna. It elaborates and presents the application and its data allowing the user to interact with the TV remote control. For advanced services the user may need to connect the STB to the return channel in order to establish private connections with dedicated data centers from which retrieving more specific information and performing personalized transactions. This will bring a wide range of informatics services to users that are not able for some reason to access internet thus contributing to eliminate the digital divide.

MOBILITY OF THE SERVICE

Differing from DVB-S for which a fixed antenna is needed in reception, DVB-T allows to receive programs and services with a mobile antenna (at speeds of over 300 Km/h) without the need of connections points to any kind of network, in every spot that is covered by a TV transmitter.

COVERAGE OF MARGINAL AREAS

DVB-T signal will have in the near future the same coverage as the current analog TV signals. This means that the majority of marginal areas in terms of network connectivity will be reached in downlink by the DVB-T infrastructure and annexed services. In these areas we can group mountain and insular communities, and in general all the communities that are far from the metropolitan areas and badly served by land communication lines. For the return channel it is necessary to pass through the land or cellular networks but it will soon be possible to establish a return link over terrestrial frequencies (DVB-RCT).

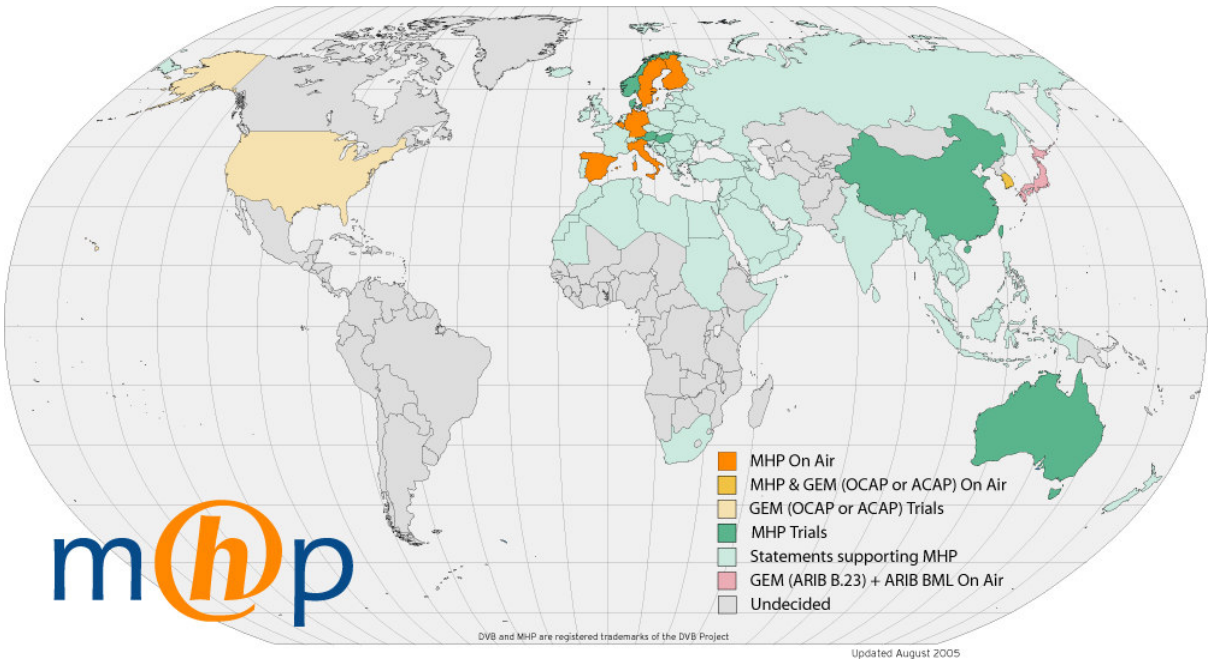
Regionality

Where satellite has a wide geographic coverage on a national or continental scale, it is instead useful to have regionalized transmissions targeting precise areas in order to select and distribute localized contents for each single territorial spot. For instance, in the case of Regional Public Administration it is unnecessary to distribute its local services outside its regional territory.

DVB-MHP

DVB-MHP (Multimedia Home Platform) is the new open standard that defines the specifications for realizing applications to be delivered along with TV programs. These applications will run on dedicated devices, ranging from high-end set top boxes to normal PCs, but also on a series of consumer electronics (CE) devices such as cellular phones, PDAs, car mounted devices etc. MHP also specifies the coding and distribution issues of these applications and the architecture of the receiving devices.

In the following picture we illustrate DVB-MHP worldwide adoption.



Examples of interactive applications that can be developed include: interactive advertising, advanced electronic program guides, video on demand applications, interactive games, interactive TV programs (e.g.: quizzes), interactive news/interactive sport programs, interactive educational programs, t-commerce services.

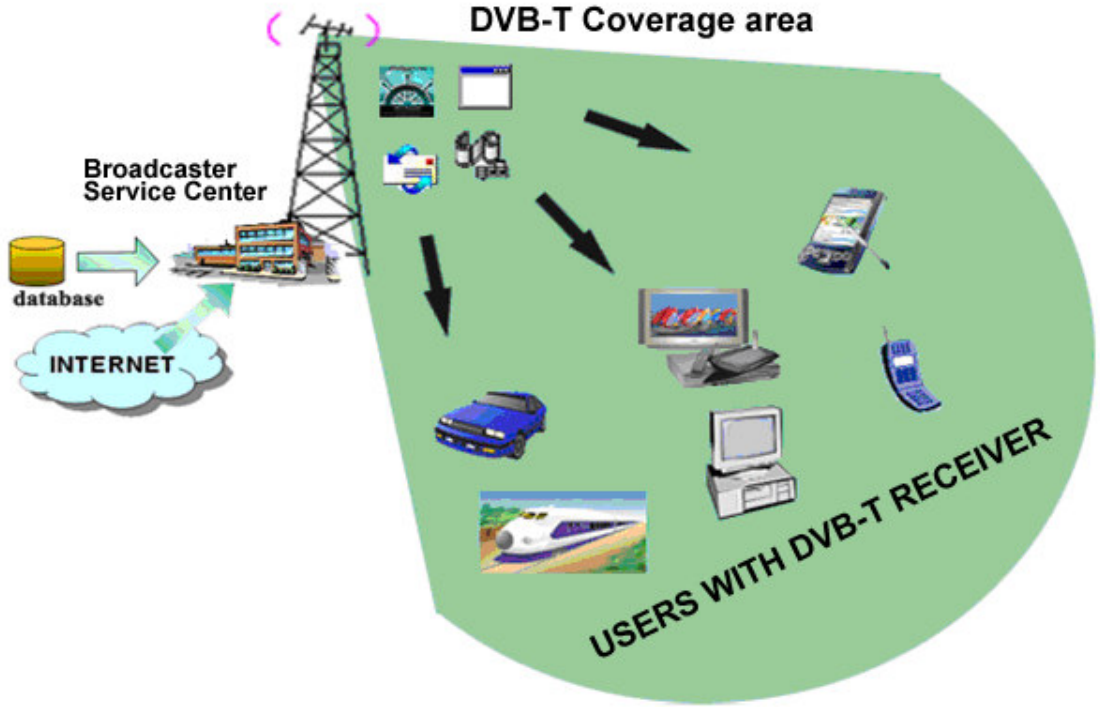
Fig.1 Examples of MHP applications broadcast in ITALY over DVB-T

1. **Civic TV JOB Portal for consulting and replying to job announcements**
2. **Civic TV CINEMA Portal for consulting daily movie schedule and placing reservation**
3. **Integrated Messaging Client on TV for sending/receiving mails, SMS, MMS**

IP OVER DVB

Beyond the transmission of TV channels with related TV applications, DVB (S-T-C) can be employed to transport IP packets in a more “infrastructural” usage of digital broadcasting, aimed at the realization of new types of IP networks with many peculiarities.

The transmission of high bitrate IP flows (unicast/multicast) over geographical areas allows the simultaneous transfer of large amounts of data from a source/datacenter to fixed or mobile users provided with a DVB-T receiver. It is therefore possible to realize services for the transparent distribution - that is without the need for the user of establishing network connections - of files of any kind including web pages, mails, newsgroup messages, multimedia contents etc.



IP over DVB-T SERVICES

Web pushing

It’s a service for the distribution of web pages and related multimedia contents that allows to navigate off-line through the pages that are delivered through DVB-T to user devices. In the realization of this kind of services it is important to individuate the most useful web contents to present to users for a comfortable and transparent off-line browsing after an automatic download on terminals.

E-Mail and News pushing

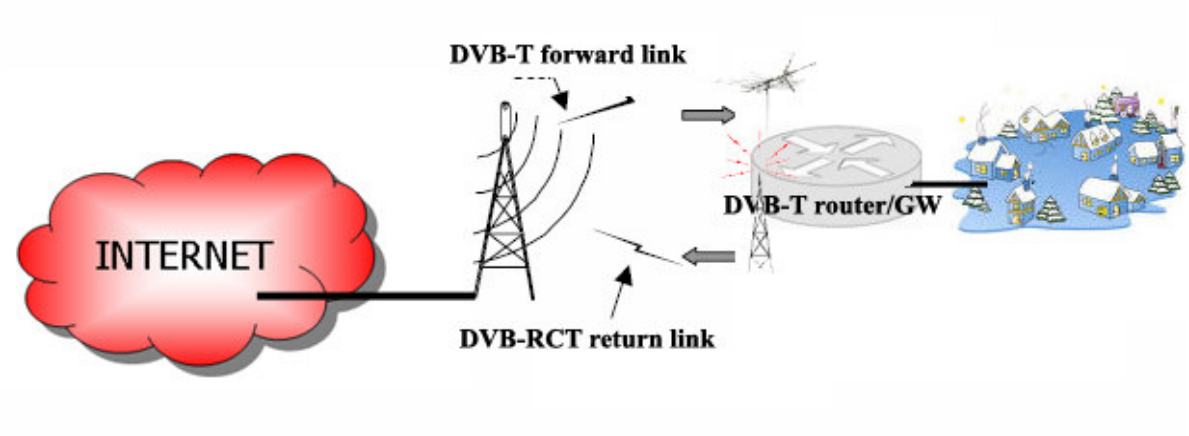
In the same way as for web page, it is possible to push to end-user terminals personal mails, mailing lists and newsgroup for their off-line access, including attached files of any size.

Database update

It is often necessary to update simultaneously the contents of a number of databases distributed over a territory, caring about consistency between them. The possibility of transmitting simultaneously large quantities of data at high speeds offered by DVB-T, finds an important application in the synchronized update of databases (for example those of a public administration deployed all over the territory).

Bidirectionality and terrestrial trunks

It was assumed until now to use DVB-T as an infrastructure for the unidirectional data broadcasting, considering that possible return channel communications would happen through a traditional return link (land or cellular lines), thus in an asymmetric way. However a return channel over terrestrial frequencies will soon be available thanks to the implementation of the standard DVB-RCT (return channel terrestrial). In this way it will possible to build, on the same DVB-T coverage scale, real bidirectional digital radio links for data transport, symmetric or not. DVB-T and DVB-RCT will allow to realize broadband network trunks for the access to communication backbones, indispensable for bringing connectivity to those areas that are badly served by network infrastructures.



WIMAX OVERVIEW

The core 802.16 specification was an air interface standard for broadband wireless access systems using point-to-multipoint infrastructure designs, with support for non-line-of-sight architectures (in 2GHz-11GHz range).

This standard will help and accelerate the deployment of broadband systems for last-mile both in urban and in rural areas, enabling service provider to increase performance and reliability while reducing their equipment costs.

However product certification is required to fulfil this scenario and IEEE doesn't provide certifications path; for the Broadband Wireless Access (BWA) market and 802.16 standard this role is played by *Worldwide Microwave Interoperability Forum* or WiMAX. This non-profit organization target is to insure interoperability between different vendor products through conformance test plans and a "WiMAX Certified ™" label.

General frequency ranges for 802.16 standard are very wide and takes from 2 to 66GHz but a number of PHY considerations were taken into account for the target environment. Higher frequencies are specified mainly for line-of-sight solutions while requirements for non-line-of-sight capability can be achieved sub 11 GHz. The original IEEE 802.16 MAC was enhanced to accommodate different PHYs and services, which addresses the needs of different environments. The standard is designed to accommodate either Time Division Duplexing (TDD) or Frequency Division Duplexing (FDD) deployments, allowing for both full and half-duplex terminals in the FDD case.

Moreover the MAC layer is designed to transport protocols such as ATM, Ethernet or IP and support several QoS traffic classes (UGS, rtPS, nrtPS, and Best Effort); to optimise the trade-off between capacity and robustness, the frame structure allows terminals to be dynamically assigned uplink and downlink burst profiles according to their link conditions

WIMAX AS DVB-T RETURN CHANNEL INTEGRATION

Technical characteristics make WiMAX the optimal solution to build return channel for DVB-T networks and to create a real interactive systems.

At the moment, DVB-T STB are using dialup modem to create the link for the return channel; this link is required by several applications, e.g. voting, answering to quiz questions, etc

STB based on dialup have two main problems: first of all, the delay required by the modem to setup the link forcing user to wait up to 20-30 seconds for a reply. The second problem is the bandwidth available: traditional modems offer at most 50kbit/s links that are unsuitable for multimedia applications, as audio and video streams.

WIMAX AS ALWAYS ON SYSTEM

WiMAX permits to overcome both problems: WiMAX Subscriber Station could be used as an "always on" device, ready to send data to the network when a user presses a key on his remote control. WiMAX offer also a second great opportunity to simplify the installation in home user environment: next generation of Subscriber Stations are designed as indoor-only equipment leading to a unique device that could be deployed everywhere in a home, interconnected to a PC or a STB and switched on, without any requirement for antenna setup**.**

WIMAX FOR BROADBAND COMMUNICATIONS

WiMAX systems compliant to 802.16-2004 IEEE Standards offer a broadband return channel as WiMAX cell capacity can achieve several Mbit/s shared between active users. Considering a real example, we could choice Italian WiMAX experimental deployment: cells will be based on one or two 1.75 MHz channels and the maximum available bandwidth in optimal condition is near 5 Mbit/s.

This value is very interesting because it enable video streaming applications: WiMAX could be integrated into a DVB-T system as "Unicast channel" to deliver to the end-user data but also other multimedia content chosen with a MHP application.

For example, a user watching a film can activate an MHP application which offers other multimedia contents tied with DVB-T transmission. The user can select a content, for example the trailer of the main actor latest film, and she can receive it as unicast transmission between WiMAX channel.

WiMAX Base Station can guarantee the required network parameters (bandwidth, delay, jitter and packet loss) to insure a good user experience with the stream based on unicast link.

NEXT GENERATION SCENARIOS

IEEE is actually working on the extension of the 802.16-2004 standard with the 802.16e amendment and the soon to be approved 802.16f and 802.16g task groups will revise the base specification to enable not just fixed, but also portable and mobile operation in frequency bands below 6GHz.

The first step will be a "nomadic service": user can move their equipment in different geographical areas and then switch them on to get linked to the Base Station; the other way could be the use of a WiMAX PDA enabled, but without real "always on" mobile links.

The second step is full mobility up to 120 km/h or higher, which requires roaming between different Base Station in the same IP subnet or in different IP networks.

Nomadic users require some mechanism to automatically manage IP connection persistence or automatic reestablishment; full mobility scenario is comparable with 3G networks: users will change Base Station during a multimedia (voice and video) connection without any interruption.

Full mobility requires low latency and low packet loss handovers between different Base Stations.

DVB-RCT AND WIMAX

The DVB set of standards includes the specification of the terrestrial return channel (DVB-RCT) for implementing the so called terrestrial wireless interactive system.

The availability of such a system would enable the construction of wireless set top boxes, allowing the user to experience interactive TV services without the need of awkward domestic cabling procedure for the connection of the set top box to the return channel.

The standard is designed to support interactive application such as voting, quizzes, etc… involving enormous numbers of interactions carrying small amounts of data in short time intervals. It is not designed, instead, to support Internet like connectivity for accessing services such as VoD (video on demand). Moreover, the proposed range of frequencies for the operation is the VHF/UHF spectrum, requiring the allocation of specific frequencies for the implementation of the return channel.

WiMAX standard build on the same baseline technologies but allow a grater flexibility in building a network connection.

The availability of on-chip support for the 802.16e standard will ease the implementation of all-wireless high performance devices with full connectivity capabilities.

From a different point of view, IP data encapsulation capabilities offered by DVB standard (IP-MPE) provide an interesting way for simultaneous distribution of high bit rate data fluxes to a plurality of users in alternative to establishing a plurality of unicast connections.

Vertical integration of DVB and WiMAX platform might enable, as an example, the announcement of multicast services on the IP infrastructure and the reception of the stream via the DVB infrastructure saving wireless bandwidth for further services.