Strategy White Paper

Unlimited Mobile TV for the Mass Market

Mobile TV is already booming on existing cellular infrastructures in unicast mode. But unicast is not optimized to deliver the same content to many users at the same time, and this prevents mass-market deployment. Overlay broadcast networks are necessary for mass access to mainstream TV channels through mobile devices.

For the broadcast part of the solution, Alcatel proposes to combine satellite and terrestrial infrastructure, enabling indoor, nationwide coverage while operating in a readily available frequency band. The unicast part of the solution will use the existing 3G networks to increase the number of available TV channels.

This paper explains the technical intricacies of the different aspects of this solution, describing their capabilities, scope of application, maturity, and the regulatory situations.

ALCATEL

Introduction

Recent studies show that there is substantial interest in mobile TV. For example, the study conducted by Louis Harris and IDATE for the CNES in May 2005 (face-to-face meetings with 1000 persons in the Toulouse area) came up with the following results:

- 1/3 of the respondents were "very interested" or "interested" in the concept, with some spontaneous responses showing that it is a good way to optimize one's spare time, to be better informed, to not miss anything on TV wherever one is, etc.
- Regarding contents, people are asking to be able to watch the traditional TV channels, complemented by some thematic channels with contents such as music, news, sports, etc. Respondents are also asking for more specific contents adapted to the mobility context, such as short video clips,
- People are ready to subscribe to such services if they are easy to use, available everywhere, and offering excellent image and sound quality,
- Most respondents want to consume video on their mobile devices with a flat fee (only 21% are ready to pay per consumption). On average, people are ready to pay 16 Euros for an offering that will include the traditional TV channels plus 10 thematic channels. Despite being high, this figure is corroborated by other studies.

Based on the Louis Harris/IDATE study figures, it can be calculated that mobile TV could generate annual revenue of more than one billion Euros for a country such as France. This is assuming that one out of four mobile users subscribe to a TV broadcast service, with various service levels ranging from 5 Euros for a basic service up to 15 Euros for a premium service plus VoD.

This appetite for mobile TV implies evolution of current networks. This paper describes the different technologies that can be used to effectively deliver mobile TV to the mass-market, describing their capabilities, scope of application, maturity, the regulatory situations and how they complement each other.

Definition of a mobile TV service

Based on the studies mentioned in section 1, it appears that a mobile TV service should include the traditional TV channels plus thematic channels. A mobile TV service will require significant content development and formatting to adapt offerings to the specifics of the mobile broadcast environment and market demand.

Mobile TV should be available in every location the consumers might expect to receive it (e.g., in a waiting room, in the teenager's bedroom, in a second home in the countryside, outside in parks, on public transport, etc.). This implies nationwide coverage and an indoor penetration equivalent to what is offered by mobile phones today.

Mobile TV should be received on specialized handheld devices with formats similar to existing portable DVD or MP3/Video players. The obvious device is the mobile handset that the consumer is always carrying. With growing competition between handset manufacturers, as observed with color displays and camera handset features, mobile TV will soon become a mandatory feature in handsets.

Furthermore, it is assumed that the mobile service provider will play a significant role in this new market and will be able to exploit a certain number of its assets to help position itself:

- Interactivity associated with the return channel (content selection, transaction, broadcast selection mode, etc.),
- The service portal, which may be accessed via the cellular network,
- Control of the terminal specifications and distribution (subsidization policy, pre-configuration, functionality selection, etc.),
- End-user knowledge and technical expertise in network service provisioning (single authentication and billing, customer profiles, m-payment, Digital Rights Management, decryption key delivery, location and positioning mechanisms, etc.),
- The ability to assemble an integrated offering using its own mobile network transmission capabilities along with overlay broadcast network content delivery.

The challenge of effectively delivering mobile TV

Mobile video is already a reality on existing 2.5G and 3G infrastructures, in streaming and downloading modes. However, if 3G enables the uptake of mobile TV, an overlay access network

Broadcast
Using a common radio bearer for all users in the coverage area allows a limited number of TV channels to be offered to an unlimited number of users.

Unicast
Using a dedicated radio bearer per user allows an unlimited number of TV channels to be offered to a limited number of users.

Figure 1a: Broadcast approach

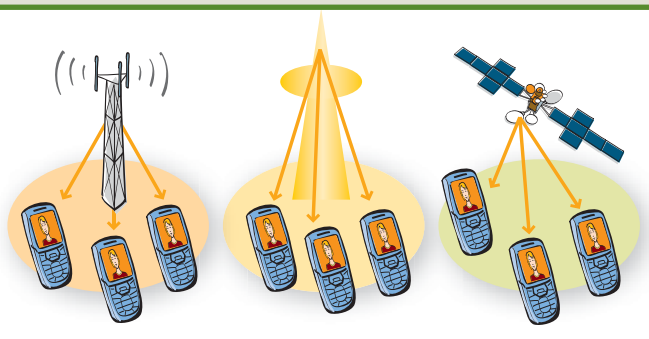
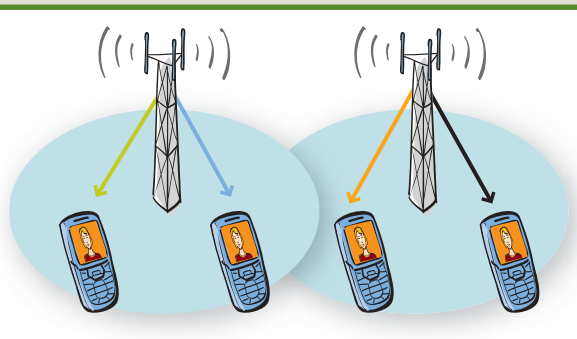


Figure 1b: Unicast approach



to address mass-market is needed. 3G cellular networks are currently not optimized to deliver large amounts of data to a multiplicity of receivers, from both a cost and a technical viewpoint.

For instance, a single UMTS cell supports only a small number of simultaneous, high bit-rate unicast multimedia sessions, typically four 256 kbit/s streams. This capacity will be somewhat improved with the planned evolution of UMTS, namely HSDPA (High Speed Downlink Packet Access) and later, with the arrival of 3GPP "Long Term Evolution" (3G LTE) technologies.

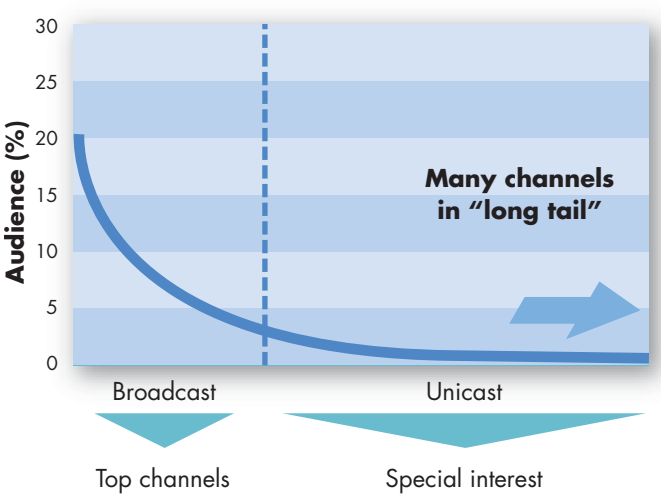
An alternative approach is to use a broadcast network to offer mobile TV services. See Figure 1. There are three main radio technology families for delivering broadcast content to mobile terminals:

- In-band cellular broadcast techniques such as the MBMS (Multimedia Broadcast/ Multicast Service) extension to UMTS,
- Terrestrial digital broadcast networks and their extensions, such as DVB-H (Digital Video Broadcast transmission to Handheld terminals, based on DVB-T standards), T-DMB (Terrestrial Digital Multimedia Broadcasting, based on T-DAB standards), MediaFLO (Media Forward Link Only, a Qualcomm proprietary solution improving DVB-H), and ISDB-T (Japanese digital television allowing HDTV as well as reception on handsets),
- Hybrid satellite/terrestrial systems, such as S-DMB from SKT in Korea, MobaHO! from MBCO in Japan (both projects using the same MBSAT satellite), and the recent DVB-H adapted for S-band and the hybrid operation concept, which Alcatel is proposing to the DVB Forum as an extension of DVB-H.

Unicast vs. broadcast

Comparing these unicast and broadcast approaches, it can be seen that, while solutions based on unicast radio can easily support a wide range of services, they are not suited to supporting mass user demand – especially once unlimited view time is offered by the service providers. On the other hand, solutions based on broadcast systems can easily support the demand for an unlimited number of users; however these systems are not adapted to supporting a very high number of channels nor non-broadcast services (Video on Demand, etc.).

Figure 2: Optimal balance between broadcast and unicast radio bearers



The solution to this dilemma is to combine the two approaches into a unified approach such that the limitations of each are overcome by the primary advantage of the other. The most popular channels can be broadcast and then the remaining channels selectively sent to particular users via unicast channels. In such a combined system, radio resources are not wasted broadcasting channels that only few people watch, and yet all users can receive the programming they want to watch.

Based on terrestrial TV viewing patterns and system simulations, it appears that a broadcast system supporting between 10 and 20 channels is sufficient to reduce the corresponding unicast load by 60% to 80%. See Figure 2.

In addition to the live-to-air mobile TV service offered by a mixture of broadcast and unicast radio bearers, a complete mobile TV solution should offer a range of interactive services such Video-on-Demand (VoD), podcast support and Personal Video Recoding (PVR) along with related e-commerce, Electronic Service Guides (ESG), etc. Most of these services are best supported using the unicast radio bearers.

Broadcast networks

The key component of mixed unicast/broadcast delivery of mobile TV services is a broadcast network designed to work as a complement, and not a competitor, to mobile networks. It offloads the most popular channels while maintaining access to the attractive interactive features and wide choice of a unicast-only solution.

An ideal complementary broadcast network would offer:

- Both national and indoor coverage at least matching that offered by the mobile network,
- Adequate, but not over-dimensioned, broadcast capacity,
- Simplified integration of broadcast and unicast components within an overall solution. Of particular importance is the integration at base station sites (equipment, towers, feeders, antenna, etc.) and within terminals.

The DVB-H proposal from Alcatel adapted for S-band has been developed with these specific requirements in mind.

The Alcatel proposal: a hybrid satellite/terrestrial broadcast network

For the broadcast component of an overall mobile TV solution, Alcatel proposes an evolution of the DVB-H standard. This evolution, thanks to the use of turbo codes, modified interleaving, S-band operation, and other improvements, allows DVB-H-like flexibility to be offered using a hybrid satellite/terrestrial transmission system.

Description of the solution

The Alcatel hybrid satellite/terrestrial solution employs a high-power geo-stationary satellite for cost-effective nationwide coverage and a network of medium and low-power repeaters, co-located with mobile base stations, to provide urban and indoor coverage. Several hybrid mobile satellite broadcast systems already in operation have demonstrated the efficiency of such hybrid solutions (Sirius and XM-radio systems in the USA for radio programs only), MobaHO! in Japan, and S-DMB in Korea (radio and TV programs).

Transmitter vs. repeater
A transmitter modulates and amplifies a broadcast signal. A repeater reshapes (or receives/modulates) and amplifies a broadcast signal. The signal is broadcast in the same frequency as the signal coming from a terrestrial transmitter or from a satellite.

It is proposed that key technologies such as OFDM modulation, time slicing, and IP datacasting from the terrestrial DVB-H system be maintained, while an improved link budget is achieved by employing turbo-codes (a new family of error-correction codes) and deeper interleaving. Furthermore, since the system is planned to operate at 2.2 GHz, it is expected that significant improvements can be made within the terminals, which should be able to offer higher antenna gains and reception diversity.

Satellite ensures nationwide direct reception of nine channels at 256 kbits/s. Suitable spatial technologies (large antennas, high-power platforms, etc.) are used to provide a net capacity of 2.3 Mbits/s for each carrier.

Repeaters in urban areas, mostly for indoor coverage, support satellite coverage. These repeaters re-transmit at the frequency of the satellite carrier and will therefore offer indoor coverage identical to a co-located UMTS system.

To increase the system capacity in urban areas, adjacent carrier transmitters can complement the satellite signal, allowing an additional 18 channels at 256 kbits/s. See Figure 3.

A dedicated frequency band

The hybrid satellite/terrestrial system uses the S-band at 2.2 GHz that was allocated to Mobile Satellite Service (MSS) in 1992 and is adjacent to the core terrestrial IMT-2000 bands. The main advantages of this frequency band are its worldwide availability, its proximity to the terrestrial UMTS bands, which favors low-cost integration in the 3G network and terminals, and the virtually worldwide harmonization of these frequencies, which favors economies of scale.

A single carrier in this band will be used to serve a given country from satellite (e.g., in Figure 4, using frequency F2 in France). The signal is repeated in cities for indoor coverage using the same frequency (e.g., frequency F2 in France). Neighboring countries will use a different frequency served from the satellite (e.g., frequency F1 in Germany and Spain).

To increase the number of programs, terrestrial transmitters can locally reuse frequencies used by the satellite in neighboring countries (e.g., frequency F1 and F3 in France).

The 2.2 GHz MSS allocation in S-band is currently allocated, as a priority, to mobile communications by satellite. A use of this band for hybrid satellite/terrestrial applications requires some adjustment of the regulatory framework. This adjustment is currently being studied in Europe (CEPT).

Other supported solutions

The hybrid satellite/terrestrial solution can complement, or be complemented by, other broadcast technologies, depending on operator choice and spectrum availability.

Figure 3: Overview of the hybrid satellite solution

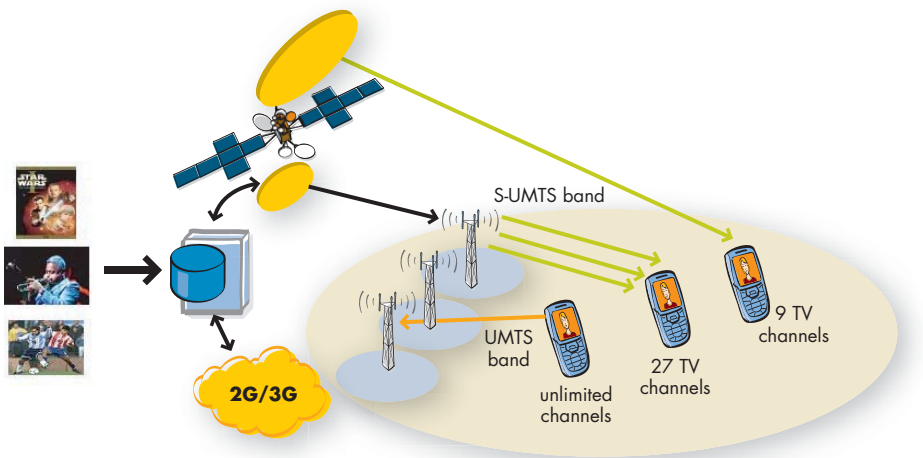
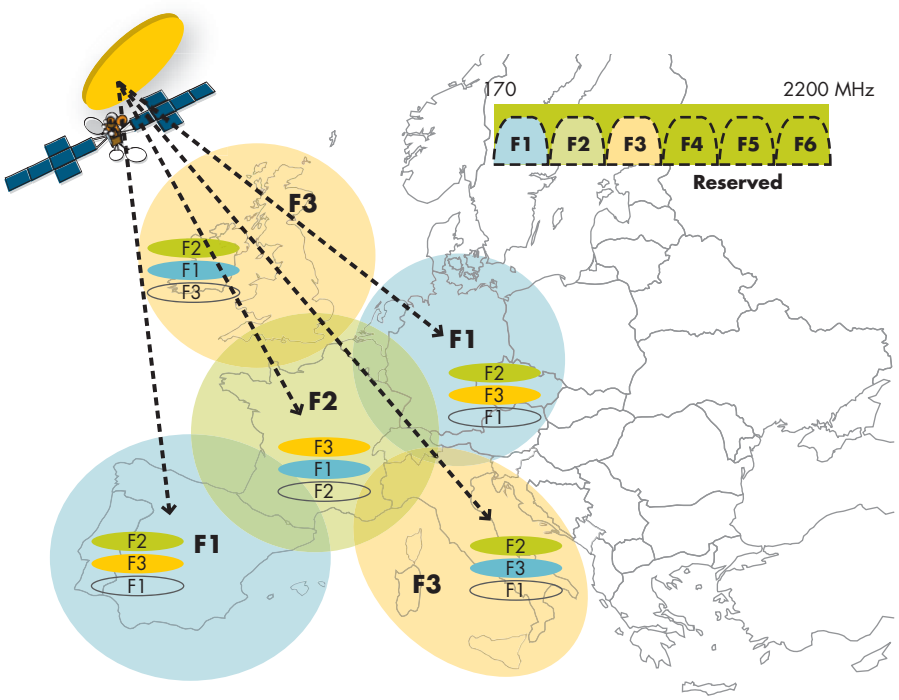


Figure 4: Example of a frequency reuse scheme in Europe



Terrestrial broadcast systems

DVB-T was designed for TV reception and mainly targets stationary and possibly in-car receivers. Given the nature of the targeted receivers, the transmission network only needs a few high-power transmitters to cover vast areas. However, DVB-T is not adapted to reception by handheld terminals because of power consumption issues, the lack of processing power on such terminals, and poor indoor coverage (use of rooftop antenna).

To overcome these limitations, the DVB Forum has developed a new concept, DVB-H. This adds elements at the physical and link layers of DVB-T to reduce power consumption and improve performance in urban indoor environments. It makes use of IP technology for transport.

DVB-H can offer a capacity of 5 to 11 Mbits/s on an 8 MHz channel. Depending on the configuration, 20 to 30 channels at 256 kbits/s should be possible. Providing good urban indoor coverage requires a mix of around 100 high-power transmitters and up to 10,000 low-power repeaters to offer indoor coverage for a country like France. Additional high power transmitters will be required if all rural areas were to be covered for outdoor handheld reception.

DVB-H was initially designed to use the UHF band below 700/750 MHz. Unfortunately, analog and digital TV currently use these frequencies. Broad availability of frequencies cannot be envisaged before analog TV switch-off; this is planned in most European country beyond 2010, with some exceptions such as Finland, Italy, Switzerland or part of Germany.

Mobile cellular systems - UMTS/MBMS/3G LTE

MBMS is a unidirectional broadcast service over an enhanced UMTS network. MBMS offers limited capacity - approximately three channels at 256 kbits/s. The ratio between unicast and broadcast can, however, be dynamically adjusted on a cell-by-cell basis. While fully compliant MBMS infrastructure and terminals should be available by 2007, it is unlikely that MBMS will be economical for mass mobile TV. This is because its low capacity will not be able to overload sufficient unicast traffic to justify locking up significant UMTS spectrum resources. It should therefore be seen more as a complement for providing local information.

On the longer term, 3G Long Term Evolution (next generation radio technology beyond the UMTS/HSDPA) will permit content delivery over OFDM radio technology using any frequency belonging to the mobile operators. Alcatel proposes to study in 3GPP an optimized broadcast mechanism, fully integrated with 3G LTE, making the terminals and the infrastructure simpler and better integrated.

WiMAX

Mobile WiMAX (802.16e) permits the delivery of high broadband data and video services thanks to use of SOFDMA technology associated with smart antennas and an IP-based architecture.

Mobile WiMAX could be used as a stand-alone solution for urban areas but requires additional technology for full coverage capabilities. Alcatel proposes to implement the MBS (Multimedia Broadcast Service) feature to provide broadcast capability by 2007/2008.

Mobile WiMAX offers a higher number of mobile TV channels in unicast mode and is therefore an ideal complement to provide additional capacities. It should be noted that mobile WiMAX can be provided at 2.5 and 3.5 GHz and requires a license for spectrum.

Technology comparison

Table 1 below summarizes the main technologies and frequency bands that could be used to propose mobile TV:

Table 1: Comparison of the main technologies

Technology	Frequency band	Number of TV broadcast channels (@ 256 kbits/s)	Number of TV unicast channels (@ 256 kbits/s)	Remarks
DVB-H in UHF	UHF or L-band	20 to 30	-	Use of the L-band requires an evolution of the DVB-H standard
DVB-H in S-band	2.2 GHz MSS	9 (satellite only) 9 + 18 (satellite + repeaters)	-	Evolution of the DVB-H standard
MediaFLO	UHF	30 (source Qualcomm)	-	Proprietary end-to-end technology
T-DMB	VHF or L-band	12 (with 3 carriers)	-	
UMTS	2 GHz	6 (MBMS)	3 (Release 99) (2-3x capacity increase with HSDPA)	Adapted to broadcasting local contents
WiMAX	3.5 GHz 2.5 GHz	12 (MBS) 16 (MBS)	40 50	Currently unicast mode only. Evolution towards broadcast

When comparing the cost of these technologies, it is to be noted that:

- DVB-H in UHF is acceptable for city coverage with numerous repeaters. However, it becomes uneconomical for nationwide coverage, as it would require a very large number of transmitters and repeaters. In addition, frequency may not be available in many areas before analog TV switch-off. DVB-H in the L-band requires a higher number of transmitters and new spectrum planning,
- DVB-H in S-band using a hybrid solution offers city coverage with repeaters, nationwide coverage from day one with satellite, great savings in terms of installation due to high reuse of cellular site assets, and operation in a telecommunications frequency band that is available everywhere,
- T-DMB, like DVB-H, does not allow nationwide coverage at a reasonable cost, nor does it offer indoor coverage without repeaters. In addition, since the system operates with a 1.5 MHz bandwidth, several transmitters may be required on each site to provide reasonable capacity,
- MBMS reuses existing UMTS infrastructure. However, the UMTS frequencies would be used to the detriment of other lucrative services. In addition, it offers a very limited number of channels,
- WiMAX provides complementary and local content at a reasonable cost thanks to the available bandwidth and possibly the lower license price.

Deployment considerations

Timeline

Broadcast video on a handheld mobile device will be a reality in the next two or three years. What is still not clear is the way it will be delivered. The most likely scenario will use a combination of different technologies, with an evolution over time - starting from current unicast streaming using current 3G technologies to finally arrive at mass broadcast using DVB-H based overlay networks.

Rollout of commercial terrestrial DVB-H services is not expected before end 2006, since the regulatory environment and business model still need to be clarified. In most countries, the unavailability of UHF frequencies may prevent going beyond multi-city coverage before 2010/2012. In parallel, DVB-H in S-band systems are expected end 2007 for terrestrial urban use, extending in 2009 with the launch of dedicated satellites to offer nationwide coverage.

Migration

For a mobile operator, the likely migration path over the next five years will see their existing 3G unicast-based mobile TV systems initially boosted, in terms of capacity, with the deployment of HSDPA capability and the switch on of additional 3G carriers. Afterwards, adding a parallel broadcast capability to broadcast more popular channels will allow the operator to transparently migrate most of the urban and rural unicast mobile TV load and hence enable continued 3G growth without resorting to cell splitting.

Reuse of existing cellular sites for terrestrial repeaters

The proximity of the 2.2 GHz MSS band to the terrestrial UMTS bands allows an easy integration of DVB-H in S-band terrestrial repeaters in existing cellular sites. The feeder and antenna systems are reused with a simple upgrade. The repeaters are installed in most cases in the existing 3G cabinets.

Beyond the obvious cost reduction, this simple integration allows any expensive re-negotiation with the site owner to be avoided. The installation becomes a maintenance task, like adding transceivers to an existing site.

A service delivery platform common to unicast and broadcast

The current service platform will be upgraded to deliver all types of content (live TV, VoD, podcast, etc.), using unicast (2G, 3G, WiMAX, etc.) or broadcast (DVB-H based) modes, depending on the customer location and the requested service or channel.

A typical service delivery platform will implement the following features:

- Live and VoD streaming servers and video encoders,
- An Electronic Service Guide (ESG) to list the available channels and contents. ESG is common to broadcast and unicast modes,
- An interactive services and rich media service node (e.g., to allow the purchase of the MP3 file associated to a clip currently playing on a TV channel),
- A DRM & key management to authorize access to a specific channel or to specific contents,

Figure 5: Mobile TV timeline

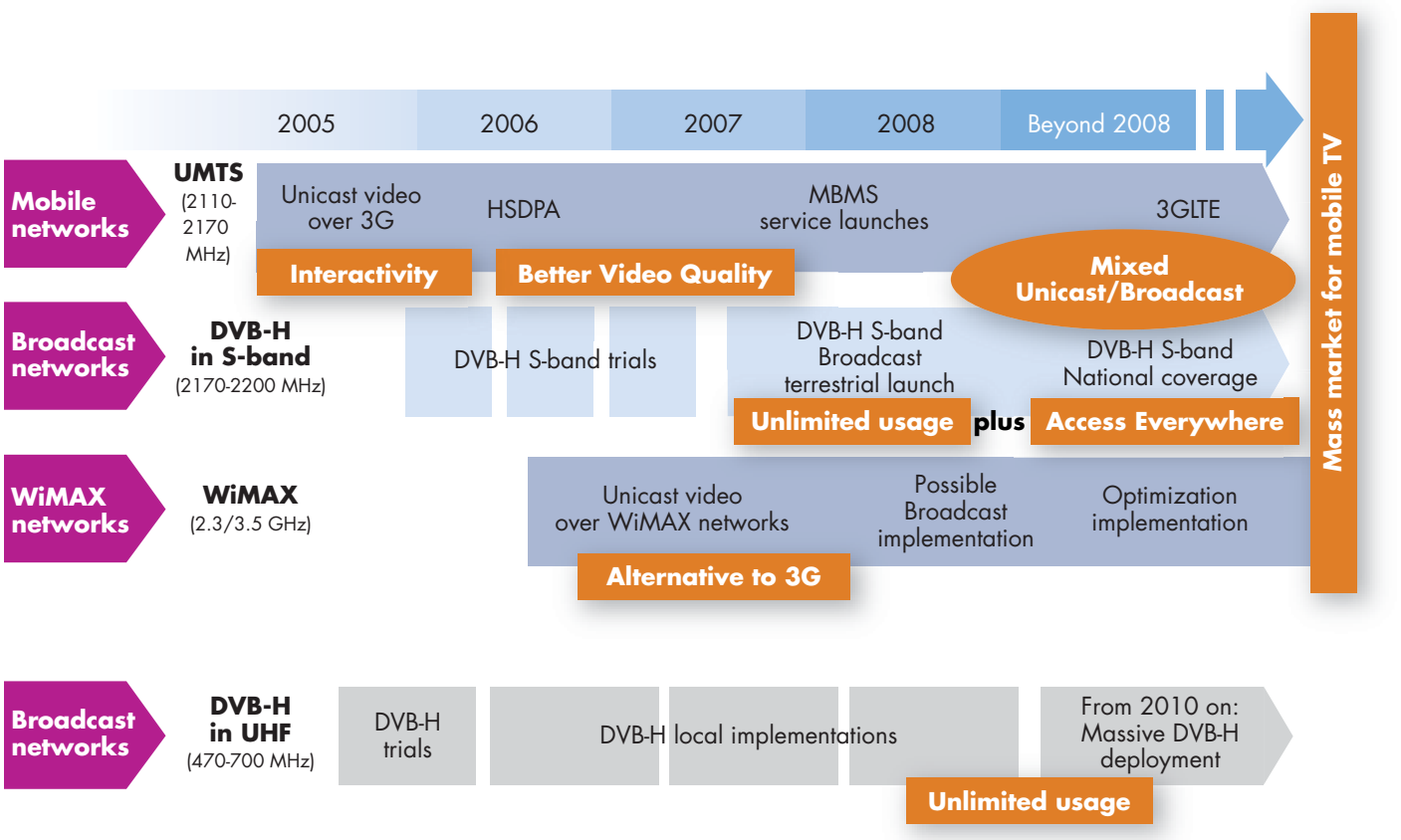
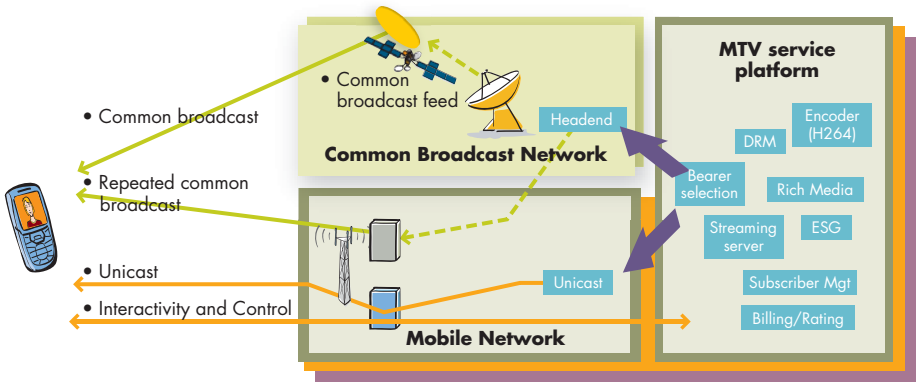


Figure 6: A single service platform for unicast and broadcast TV services



- Interactive and personalized advertising,
- An audience measurement engine,
- Content and subscriber management,
- A bearer selection function to send requested contents using either the broadcast or the unicast modes.

Conclusion

Mobile video is already booming on existing cellular infrastructures in unicast mode. But this mode is not optimized to deliver the same content to many users, and this inhibits mass-market deployment. For mass use of video on mobile, overlay broadcast networks, distinct from cellular networks, are necessary.

To deliver the solution that best fits each operator's needs, Alcatel is developing complete mobile TV solutions, taking into account the capabilities of various technologies (unicast and broadcast, satellite and terrestrial, etc.), their scope of application (live TV, VoD, etc.), and the regulatory situations. Alcatel proposes end-to-end solutions that include:

- A satellite solution developed by Alcatel Alenia Space; this solution leverages its expertise in hybrid solution (XM radio and Sirius),
- A range of low power transmitters/repeaters for indoor coverage,
- Complementary WiMAX coverage for enhanced local or regional services,
- A service platform derived from existing unicast systems currently used by many operators worldwide,
- Partnerships with leading terminal and chipset vendors to offer terminals that support DVB-H in S-band in addition to DVB-H in UHF.

To make mobile TV a reality for the mass market in the next two or three years, all stakeholders (mobile operators, broadcasters, equipment vendors, contents providers, etc.) need to work together, starting immediately. Together they need to create the right combination: infrastructure to offer the service everywhere, affordable mobile phones, and attractive contents.

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Glossary of terms and abbreviations:

2G 2nd Generation mobile communications (GSM, cdmaOne, …)
3G 3rd Generation mobile communications (UMTS, CDMA2000, …)
3G LTE 3rd Generation – Long Term Evolution
CEPT European Conference of Postal and Telecommunications Administrations
CNES Centre National d'Etude Spatial (National Space Research Center)
DRM Digital Rights Management
DVB-H Digital Video Broadcast - Handheld
DVB-T Digital Video Broadcast Terrestrial
DVD Digital Versatile Disc
EDGE Enhanced Data rates for GSM Evolution
E-SDR European Satellite radio Broadcasting System
HDTV High Definition Television
HSDPA High Speed Downlink Packet Access
IMT-2000 International Mobile Communications 2000
IP Internet Protocol
ISDB-T Integrated Services Digital Broadcasting - Terrestrial
MBCO Mobile Broadcasting Corporation
MBMS Multimedia Broadcast and Multicast Services
MBS Multimedia Broadcast Services
MBSAT Mobile Broadcasting SATellite
MP3 Motion Picture expert group audio layer 3
MSS Mobile Satellite Service
OFDM Orthogonal Frequency Division Multiplexing
S-DAB Satellite - Digital Audio Broadcast
S-DMB Satellite - Digital Multimedia Broadcast
SKT South Korea Telecom
T-DAB Terrestrial - Digital Audio Broadcast
T-DMB Terrestrial - Digital Multimedia Broadcast
TV Television
UHF Ultra High Frequency
UMTS Universal Mobile Telecommunication System
VoD Video on Demand
WiMAX World-wide Interoperability for Microwave Access

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Alistair Urie is currently Mobile Strategy Director for Alcatel in the corporate CTO office. He has previously worked in Alcatel on standardization management, mobile systems product strategy, and international research programs (RACE) for GSM and UMTS systems. Prior to joining Alcatel in 1991 he had been involved in both line and radio transmission system research at the Telecom Australia Research Laboratories and had also worked at the Department of Science, Antarctic Division, in Australia. Mr. Urie is Vice-Chairman of the ETSI Board and Chairman of the ETSI "Operational Co-ordination Group" (OCG).

Philip Kelley has over 20 years of experience in Telecommunications and Information Systems, including positions in marketing and business management within Alcatel, Thomson, McDonnell Douglas, and Alstom. He is a member of the board of the French "Forum de la Télévision Mobile", and Secretary of the Advisory Board of ICIN (International Conference on Intelligence in service delivery Networks).
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