STRATEGIC WHITE PAPER

Mobile Broadcasting:
Extending The Mobile Experience With Efficient Content Delivery

Mobile broadcast is more than the simple extension of broadcasting television to mobile terminals. It ranges from the delivery of live video content to customized information services in push and store mode and ease of interactivity. Thanks to their technical expertise and their cellular user experience, mobile operators are ideally placed to cooperate with media companies and make the most of the potential of this new market.

Several technology choices are competing for a place on the market. Technologies derived from terrestrial digital television and satellite broadcast television are extending their capabilities to mobility conditions, while cellular systems are enhancing their service with multicast operation. A combination of these technologies, when they are driven by an efficient Service Delivery Platform (SDP), is seen as the most appropriate model to successfully introduce mobile broadcast services.

This paper explains the business and technical intricacies of the different solutions, including those offered by Alcatel, by taking into account their technical capabilities, their scope of application, their maturity, and the regulatory situations.

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Introduction

Mobile broadcast is more than the simple extension of broadcasting television to mobile terminals. It ranges from the delivery of live video content to customized information services using push and store mechanisms, for example. This takes advantage of cellular interactivity and should benefit from the availability of content adapted and formatted to fit the specifics of mobile usage (small screens, time of the day, location, viewing duration, etc.). The value chain comprises four major roles:

- content provisioning,
- content aggregation and packaging,
- distribution and service provisioning,
- usage and content consumption.

Content developers focus on content provisioning. Broadcasters and possibly mobile operators concentrate on content aggregation and packaging. Mobile operators play a key role in service provisioning, the marketing, and customer management (sales, billing, and customer care - terminal delivery, single bill, preferences management, interactivity).

Several technology choices are competing for a place on the market for these services. They can be categorized into two main trends:

- Optimization of digital TV broadcast technologies to make them perform better in a mobile environment,
- Leveraging the complementary nature of cellular and broadcast technologies to benefit from their respective strengths.

Terrestrial (Digital Video Broadcasting Handheld - DVB-H) and satellite (Satellite Digital Multimedia Broadcast - S-DMB) television broadcasting networks will evolve by adapting their capabilities to the mobile environment, with the aim of achieving indoor coverage. In the meantime, mobile service providers can start to deliver streaming video on 2G/3G (2nd Generation/3rd Generation) networks with the objective of migrating towards more efficient multicasting capabilities.

A combination of these technologies is seen as the optimum model to successfully introduce mobile broadcast services by delivering content efficiently, together with interactivity and personalization. The key element in this approach is the Service Delivery Platform, which combines the pure content delivery tasks with services and end-user management.

This paper describes the different mobile broadcasting business models, technologies, and envisaged applications, as well as the players involved and how they can benefit from working together.

Mobile broadcast: the missing link in mobile networks

Mobile video streaming and downloading is a reality today on 2.5G and 3G mobile services. However, the delivery cost, based on unicast communication (communication with a single receiver), is delaying mass-market deployment.

High-capacity mobile broadcasting networks are the most likely candidates to distribute video to mobile terminals. However, for that to happen, some technical and business issues need to be solved. While this will take time, several factors are already helping to shape the promising mobile broadcasting market. On the technology side, high capacity broadcasting networks based on satellite (S-DMB) or terrestrial infrastructure (DVB-H) should provide the cost effective downlink channels necessary to efficiently deliver bandwidth-consuming applications. On the business side, the advent of new services with the capacity to reach millions of mobile subscribers will open up new opportunities for different players to enter the value chain of a dynamic market. Ovum [1] expects the number of mobile broadcast subscribers to increase from 4 million in 2005 to 87 million in 2008, with a parallel rise in service revenues from 0.3 billion to 8 billion Euros for the same period.

End-user demand

Broadcast services are of a “one-to-all” nature, delivering information to groups of users, with possibly some degree of personalization. Once the mobile terminal supports broadcasting capabilities, a large range of customer services becomes available:

- Free mobile “live” TV programs;
- Pay mobile “live” TV programs;
- Interactive mobile TV: gambling, subscription and feed-back during a “live” mobile TV program;
- Snapshot TV: short mobile videos specifically created for mobile consumption.
- Carrousel audio, video, and data:
  - Push and store: content is broadcast to all subscribers (pushed), stored on the terminals, and then played/run on demand, providing the illusion of instant transmission; examples of this kind of service are: downloading software updates, video and music content download for playing after payment (pay per view).
  - Local broadcast: museum information, shopping mall news.
  - Group messages: fleet management.

Figure 1 shows how the trend of broadcast technologies and services toward the mobile world affects both traditional broadcast and mobile services. Broadcasters can take advantage of technology developments to reach a vast mobile subscriber base with generic content. Mobile operators see broadcasting technologies as a way to deliver a larger choice of personalized content using a “push and store” mode, if and when low-cost, high-capacity memory is embedded in terminals.

In the “push and store” mode, the content is sent (pushed) and stored on the receiver. The user can configure push services (e.g., receive news updates several times a day). The network could also trigger them based on personal profiles, (e.g., download a financial news bulletin whenever NASDAQ goes up or down by more than 5%). Push and store mode

benefits from the advanced high-capacity hard disks and memories embedded in mobile terminals.

Mobile broadcasting business models and players

This section answers the question: what value can be added to the content by the different players in the service delivery value chain?

Mobile broadcasting value chain and major players

There are four main stages in the mobile broadcast value chain:

- Content, which entails the creation and licensing of content;
- Packaging, which revolves around the aggregation and publishing of content;
- Distribution, which involves the transport and delivery of content;
- Usage, which has to do with the consumption of content by the end-user.

A participant can play one or more of the above roles. Equally, one role can be shared among several actors. In fact, it is expected that several players involved in the value chain will compete to occupy strategic terrain:

- ***Content providers***, including film studios, music labels, some broadcasters (e.g., BBC or Discovery Channel), etc.
- ***Content aggregators***, which reformat and perform a first aggregation of the content. TV channels, public broadcasters, pay TV operators can be found in this group.
- ***Service portals***, which build the service offering, brand it, and present it to the end customers. They may come from the Internet world (e.g., MSN, Yahoo), from the TV world (e.g., TPS), or from the mobile world (e.g., Vodafone Live).
- ***Broadcast infrastructure providers***, which operate terrestrial (e.g., TDF, Retevisión), satellite (e.g., Astra), and cellular infrastructure (e.g., Vodafone, Orange, etc.).
- ***Mobile operators***, which can play a role in service provisioning, sales, billing, and customer care (terminal delivery, single bill, preference management, interactivity) as well as service portals.

Mobile broadcasting business models

The roles of the different players depend on the business model envisaged for mobile broadcasting. Several models can be considered:

- ***Lead business model***: in this model, the mobile network operator is the driver. It acts as Service Provider and Interactivity Provider, too, since it has partial or total control over the content aggregator. It brands the service. In this model, broadcasters and other content aggregators may find themselves in a situation of losing control of the end user.
- ***Bypass business model***: in this case, the mobile operator is virtually left out of the value chain. Other parties control the content aggregation and service provisioning stages. The mobile operator may still provide a "transparent" point-to-point uplink connection for interactivity. In this model, the limited interactivity will reduce the service offering, which together with a more difficult access to the cellular customer base will diminish revenue potential. However, because of its simplicity, it could well be the first model to be implemented.
- ***Consortium business model***: the mobile operator offers the service in cooperation with a content aggregator (e.g., a TV broadcaster). It may or may not brand the services itself but in any case performs some customer management functions, such as charging, security key delivery, update of location information, etc.

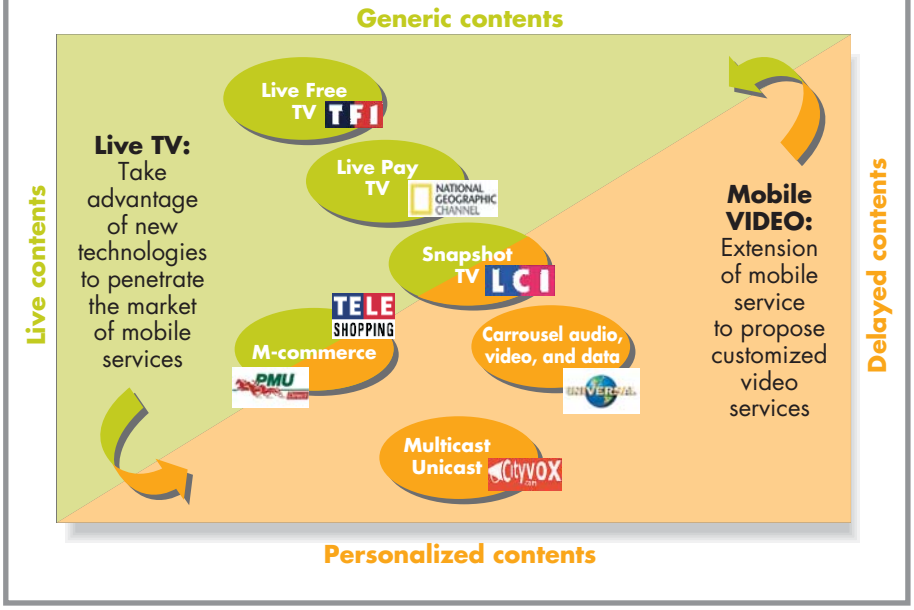
The consortium model takes advantage of the complementary nature of cellular and broadcast – mobile operators and broadcasters, along with other interested parties, partner to share the cost and operations of offering a wide range of services in a converged broadcast and cellular environment.

Roles for the mobile operator in the value chain

Although the mobile service provider does not have a single mandatory role, it has a certain number of assets on which it can capitalize to position itself in the value chain:

- Interactivity associated with the return channel (content selection, transaction, broadcast/multicast selection mode, etc.),

Fig. 1 Broadcast/multicast customer usage

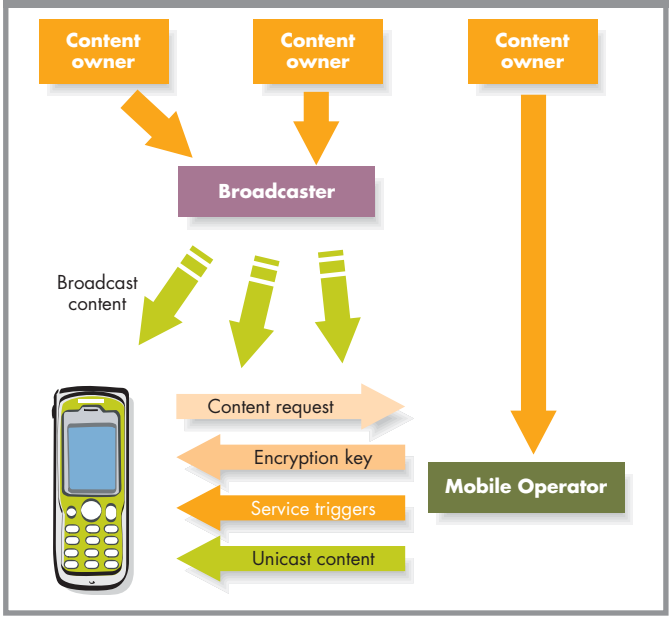


- Service portal, which may be accessed via the cellular network and/or through the Internet via broadband access,
- Control of the terminal specifications and distribution (subsidization policy, pre-configuration, functionality selection, etc.),
- End-user knowledge and technical expertise in network service provisioning (single authenticating and billing functionality, customer profiles, m-payment, Digital Rights management (DRM), decryption key delivery, location and positioning mechanisms, etc.).

In particular, the mobile operator has the real-time knowledge of actual usage. It can play a central role by managing subscriptions and billing. In addition to providing encryption keys in line with users' rights and profiles, it can, for example, drive the terminal to download background subscribed broadcast content for later viewing (push and store) through content download triggers.

This model can be extended relatively easily to combine broadcast and unicast content seamlessly, e.g., to complement broadcast networks' global programs by targeted and localized advertisements (as per Figure 2). In this model, part of the content is specific to the user status and location and will be delivered by the mobile operator through streaming.

Fig. 2 Scenario for cellular and broadcast services cooperation



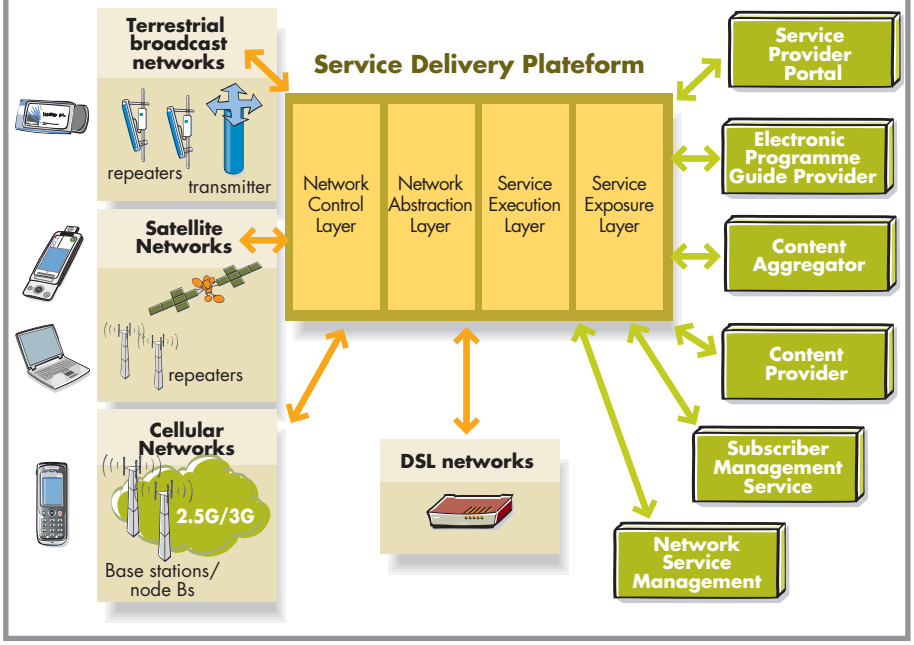
How to manage and deliver the broadcast services: the Alcatel Service Delivery Platform

To offer personalized mobile broadcast services, operators need an infrastructure platform that allows them to introduce new services quickly and deliver them in an efficient and reliable way.

In response to this need, Alcatel has developed the Service Delivery Platform (SDP). The SDP plays a key role in the launch of mobile broadcast services as it allows operators to:

- easily define the logic by which subscribers can access interactive services from their mobile handsets (or any other device),
- rapidly introduce new services, mainly from 3rd parties thanks to an open interface,
- implement the right business model by preserving each partner's area of expertise: content providers focusing on content creation and interactivity value proposition, mobile operators on customer billing and personalization.

Fig. 3 The Service Delivery Platform in a converged cellular and broadcast environment



The Alcatel SDP combines interactive video content delivery with user management including security, billing, and DRM. The platform is modular, and it is access technology agnostic, and it can offer services from download (push and store) to unicast streaming or broadcast over any kind of network. The Alcatel SDP provides the necessary intelligence between the content, the network, and the business systems.

The Alcatel SDP is aligned with today's major standards. This allows the integration of best-of-breed solutions that are

outside of Alcatel's core expertise. Furthermore, the Alcatel SDP easily integrates with service delivery platform components already deployed at established network operators. Based on its leadership in broadband network infrastructure, Alcatel guides operators on the choice of the broadcast service provisioning option that best fits their objectives and situation.

Which technology for which services?

There are three main radio technology families (see Figure 4) for delivering broadcast content to mobile terminals:

- Hybrid satellite/terrestrial gap-fillers systems, e.g. S-DMB, MBSAT, S-DAB
- Terrestrial digital broadcast networks and their evolutions, e.g. DVB-T/H , ISDB-T, T-DAB, T-DMB
- Broadcast-enhanced mobile cellular networks, e.g. UMTS enhanced with Multimedia Broadcast and Multicast Service (MBMS), CDMA2000 enhanced with Broadcast and Multicast Service (BCMCS)

Fig. 4 Overview of the mobile broadcasting technologies

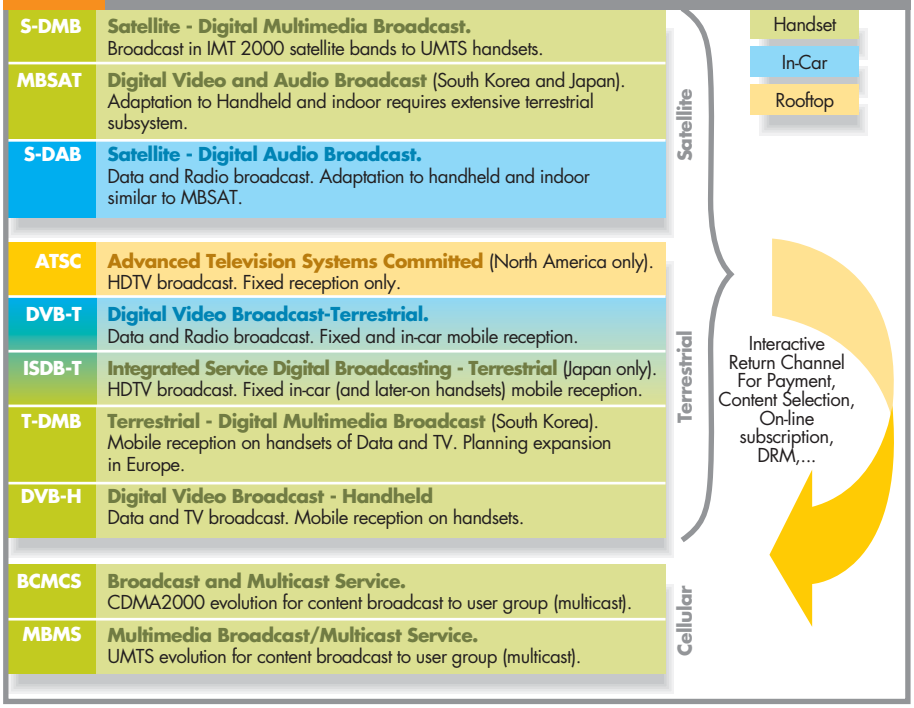
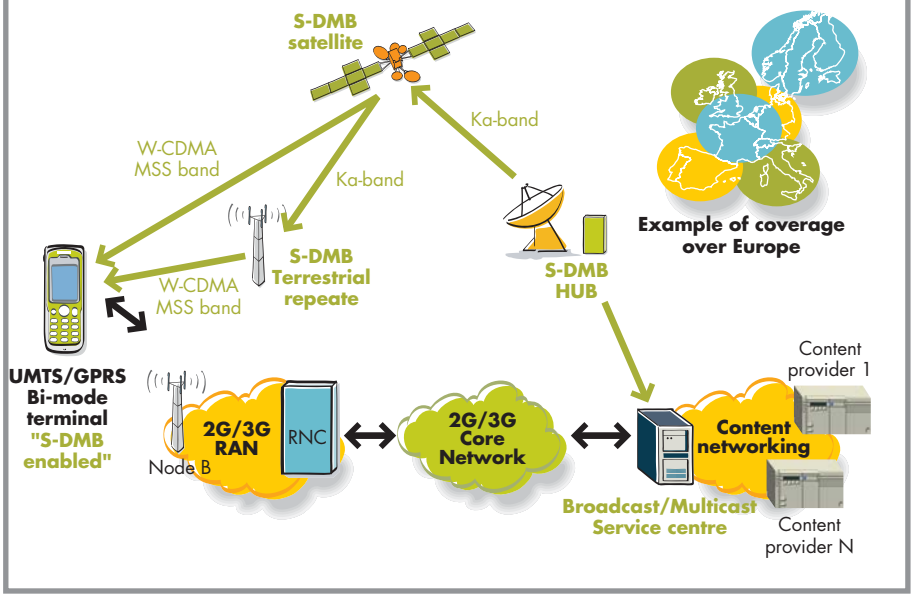


Fig. 5 S-DMB system overview



Satellite systems: S-DMB

S-DMB [1] is a hybrid satellite/terrestrial gap-filler system. It employs a high power geo-stationary satellite and a network of medium and low-power gap-fillers co-located with mobile base stations to provide urban indoor coverage. It targets mainly the delivery of multimedia push & store and streaming services to mobile handsets.

The S-DMB solution entails a Single Frequency Network (SFN) in the satellite band of IMT-2000 (MSS - Mobile Satellite Service - band). The system has been designed to be fully compliant with the 3GPP (3rd Generation Partnership Project) standard for MBMS, including its air interface, which allows a bare minimal cost increase for UMTS terminals to support the adjacent MSS receiving band. Figure 5 gives a high level overview of the S-DMB solution. Signals from the satellite and the gap-fillers are synchronized so that the terminal can combine them.

The preferred beam arrangement for Western Europe is the multi-beam configuration (see Figure 5) with one spot per linguistic area (6 in total). In this solution, by applying a frequency reuse scheme it is possible to achieve a capacity of up to 2 Mbits/s per beam with good outdoor and first wall indoor reception. Depending on the deployment and service scenario, S-DMB can play a complementary role to any terrestrial broadcasting networks, including DVB-H.

[1] S-DMB also supports point-to-point services in the UMTS MSS Uplink band (1980-2010 MHz); however, this paper focuses on the broadcast application of the technology.

Terrestrial broadcast systems: DVB Standard

DVB-T [3] was designed for TV reception and mainly targets stationary and 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.

To overcome these limitations, DVB-H [4] was developed by adding elements at the physical and link layers of DVB-T to reduce power and improve its performance in urban indoor environments while making use of IP technology for transport.

DVB-H can offer a maximum capacity of 11 Mbits/s on an 8 MHz channel. Depending on the configuration, an average number of 60 video streams at 128 Kbits/s should be possible. Providing good urban indoor coverage requires that networks use a mix of medium and high-power transmitters and medium and low-power gap-fillers, with comparable density to cellular deployments in urban areas.

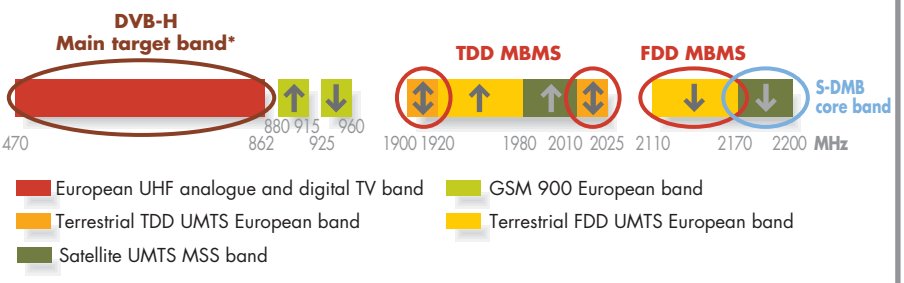
Mobile cellular systems: UMTS/MBMS

MBMS [5] is a unidirectional multicast service over an enhanced UMTS network. It can achieve 3x128 Kbits/s with minimum changes to the UMTS air interface.

MBMS has a very fine service granularity, one single cell, and is capable of selecting unicast or broadcast transmission on a single-cell basis to deliver the broadcast/multicast data. Its major drawback is that it must share the spectrum with unicast applications.

Figure 6 shows the main frequency bands each of the different technologies targets. There are other possibilities not shown in the figure: the IMT-2000 extension band (2500 - 2690 MHz) for MBMS and some parts of the VHF (Very High Frequency) band (174-230 MHz) for DVB-H.

Fig. 6 Main frequency bands involved in mobile broadcasting in Europe



* *In case a terminal supports both GSM 900 and DVB-H, the usable frequency range is limited to channels below 698 MHz*

Tab. 1 Key selection criteria and technology assessment

Criterium \ Technology	Terrestrial DVB-H BW=8MHz (~11Mbps)	Satellite S-DMB Terrestrial + satellite BW=15MHz (~2.3 Mbps)	Cellular MBMS BW=5MHz (~0.25-0.38Mbps)
Number of channels @ 128 Kbps	60 (+)	18 (=)	2-3 (-)
Timing	2006-2008 (+)	2008 (=)	2007 (+)
Indoor reception	with repeaters (+)	with repeaters (+)	(+)
CAPEX (large EEC country)	High (=)	Medium (+)	Low (+)
Coverage (% population)	65-95% (+)	95% (+)	50% - linked to UMTS (-)
Regulation environment and legal aspects	(-)	(=)	(+)
Services	TV broadcast Push & store	TV broadcast Push & Store	Multicast

Key selection criteria and technology positioning

This section presents the criteria for selecting the mobile broadcasting technology that best suits the different markets and players involved in the value chain. It also includes an assessment of how each technology ranks in all of the chosen criteria. A summary can be found in Table 1.

Satellite: S-DMB

A satellite-only solution is not feasible for urban indoor coverage but it performs quite well in Line of Sight (LOS) situations, providing good outdoor coverage and "first wall" indoor reception. A rough maximum of 18 channels at 128 Kbits/s can be achieved in 15MHz with terrestrial repeaters employed for urban coverage. Up to 8,000-10,000 medium and low-power gap-fillers are needed to guarantee

95% coverage in one of the linguistic areas. Several ongoing processes in a number of international organisms should result in a favorable regulatory framework for S-DMB.

Taking into account these regulatory issues, as well as other aspects such as technology maturity and strategic agreements between the players involved in the S-DMB value chain, 2008 seems a feasible horizon for the availability of commercial services.

Tab. 2 Video throughput for different types of terminal

Terminal	Screen size (inches)	Minimum throughput	Recommended throughput
Handset	2-3	64 kbit/s	128 kbit/s
Smartphone	4-5	128 kbit/s	256 kbit/s
Laptop	14-17	384 kbit/s	700 kbit/s

Terrestrial: DVB-H

This technology offers the highest capacity out of all the candidates considered – up to 60 channels at 128 Kbits/s. Deployment will depend on regulatory issues such as the re-planning of the UHF band and the varying pace of analog-to-digital TV switchover each country is embarked on.

Given that deploying antennas is a sensitive matter in Europe, a sensible approach to deploying a large number of DVB-H gap-fillers, 4,000 to 8,000 depending on targeted indoor coverage, is co-locating them with mobile base stations, which would also cut down on deployment costs. However, as the GSM 900 MHz frequency band is located near the upper UHF (Ultra High Frequency) channels, the possible Radio Frequency (RF) issues of co-locating DVB-H gap-fillers with GSM (Global System for Mobile Communications) antennas and base stations need to be looked into carefully.

Cellular: MBMS

MBMS offers limited capacity, three channels at 128 Kbits/s in the 5 MHz band. However the impact on network design is minimal since no new transmitters need to be deployed and the ratio between unicast and multicast can be dynamically adjusted on a cell-by-cell basis. With the advent of the High Speed Downlink Packet Access (HSDPA) for unicast transmission and the opening of the 3G extension bands, the capacity freed could be used for more video content delivery. It is expected that pre-MBMS equipment will be available as of 2006, while fully compliant infrastructure should not be available before 2007.

Broadcast technology interoperability

Considering the respective strengths and weaknesses of these broadcast technologies, their different positioning may actually result in quite effective complementary roles.

- DVB-H seems the most relevant technology to deliver a large choice of high-quality live TV, multimedia, and other content in a mobile environment. However, due to economical and regulatory constraints, it may prove difficult to achieve an adequate nation-wide DVB-H coverage in large European countries like France or Spain, or to anchor the role of mobile operators in the mobile broadcast value chain.
- Mobile operators willing to deliver their own mobile broadcast content can then take advantage of the S-DMB network as a complementary overlay of DVB-H networks. Considering that S-DMB functionality can be implemented at a marginal cost on a 3G handset, this cooperative scheme based on such 3G–DVB-H handsets could represent a very cost-effective solution. It will ensure seamless nation-wide service continuity of the mobile operator's broadcast services and consequently differentiate them more from other DVB-H service providers.
- MBMS is well suited to complement dedicated broadcast networks by delivering local content over limited coverage areas to a limited audience.

Impact on terminals

Making a mobile terminal capable of displaying video requires more functionality than that offered by a regular 3G terminal:

- Handheld terminals supporting video require a larger screen (4-inch VGA) with a higher resolution so that video can be watched comfortably. In the longer term, disruptive technologies may arise, such as displaying video images on glasses (or even right onto the retina), allowing high-quality video to be watched on the move.
- A video coprocessor to provide the necessary processing power is needed to handle the H.264 codec.
- Micro hard disk and memories capable of storing gigabytes of data will provide the capacity needed to store non-real-time video and for push service models to succeed.

The road ahead for mobile broadcasting

Various challenges have to be anticipated and overcome to successfully introduce mobile broadcast services.

End-user usage

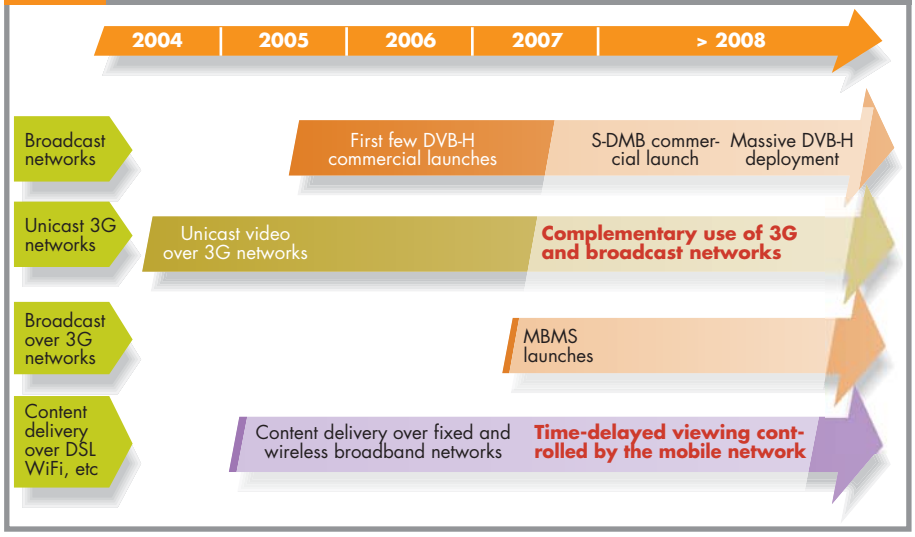
End users may consider "postage stamp" mobile handset screens as too small to persuade them to opt for the mobile broadcasting experience. This challenge might be overcome in different ways:

- Focus group results show that watching TV anywhere largely compensates for the screen size, as end-users adjust to the small screen size in their quest for a new experience in new situations with new motivations,
- Specifically developed mobile content takes into account the mobile screen size.

Availability of handsets

The first mobile broadcast commercial launches and handset manufacturers' roadmaps show that mobile broadcast handsets are already available and with increasing diversity – dual-cell/broadcast mobile phone or PDA (Personal Digital Assistant), built-in in-car receiver, portable with special card, etc. With growing competition between handset manufacturers, as observed with color screens and camera handset features, mobile broadcast will soon become a mandatory feature in handsets.

Fig. 7 Possible mobile broadcasting roadmap



Technical challenges and regulatory issues

The push and store capability naturally enhances the quality of service with the possibility to watch programs in asynchronous mode and even outside of the coverage area. Nevertheless, broadcast quality remains critical for streaming services. In parallel, other issues need to be solved to guarantee a favorable homogeneous regulatory environment across regional markets and consequently to benefit from scale effects.

Content production

The success of mobile broadcast services will require significant content development and formatting to adapt offerings to the specifics of the mobile broadcast environment and market demand. This will impact content production cost and will introduce delays. To overcome this challenge, specialized companies have started focusing on this part of the value chain. Content providers and broadcasters themselves have shown interest in investing in this activity so as to reach new consumers.

Mobile broadcasting roadmap

Video streaming is already available over 2G/3G networks, although the number of simultaneous connections is limited. These networks will not be upgraded with more efficient broadcasting and multicasting capabilities (MBMS) until at least 2007, though some pre-MBMS non-standard compliant solutions could be available from 2006.

Alternative solutions, for example, content download using existing broadband technologies such as DSL (Digital Subscriber Line) or WiFi (Wireless Fidelity), will be commercially available starting in 2005. The unicast mobile network can be employed to control access to content. The Alcatel Service Delivery Platform will ensure seamless operation on cellular and fixed access networks.

The first DVB-H networks should be available by 2006. But the massive deployment of DVB-H networks will take more time, since the regulatory environment and business models still need to be clarified. The first broadcast services to be delivered over these networks will probably be free live-TV for devices such as mobile handsets, but also portable devices such as Personal Computers or MP3/DVD/Video players. More developed services entailing cooperation between cellular and broadcast networks should become a reality by the end of the decade.

After the business assessment and system validation phases, the commercial launch of S-DMB system could happen in 2008.

Conclusion

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 with unicast streaming using current 3G technologies to finally arrive at massive broadcast over DVB-H or satellite networks. During that evolution, not only will access to the information evolve, but the terminal storage capabilities as well as the display size and precision will also dramatically improve.

A simple extension of the traditional TV concept to mobile reception will not exploit all of the possibilities that a converged cellular and broadcast solution can offer in terms of value added services. Mobile operators, with their cellular knowledge, technical expertise, and cellular user experience, are in an ideal position to cooperate with media companies to make the most of the potential this new market offers.

To deliver the solution that best fits each operator's needs, Alcatel is evaluating and developing several solutions (terrestrial broadcast, satellite, and cellular), taking into account their technical capabilities, their scope of application, and the regulatory situations. Alcatel can also deliver short-term alternatives such as content download using an existing fixed (e.g., DSL) or wireless (e.g., Wi-Fi or soon WiMAX) broadband technology.

To be able to offer a flexible and evolving solution, the Alcatel Service Delivery Platform has been designed as a layer of systems that collectively act as a framework for the

provisioning, delivery, charging, and management of services, whatever the solution selected by the operators. In addition, it provides the rules between content, applications, network, and business systems allowing the offering to be adapted to the rapidly evolving environment. The Alcatel Service Delivery Platform will play a key role in a complementary cellular/broadcasting environment by facilitating the launch and integration of the new services.

Glossary

2G 2nd Generation (GSM, cdmaOne, ...)
3G 3rd Generation (UMTS, CDMA2000, ...)
3GPP 3rd Generation Partnership Project
ATSC Advanced Television Systems Committee
BCMCS Broadcast and Multicast Service
CDMA2000 Code Division Multiple Access 2000
DRM Digital Rights Management
DSL Digital Subscriber Line
DVB-H Digital Video Broadcast Handheld
DVB-T Digital Video Broadcast Terrestrial
FDD Frequency Division Duplexing
GSM Global System for Mobile Communication
HSDPA High Speed Downlink Packet Access
IMT-2000 International Mobile Communications 2000
IP Internet Protocol
ISDB-T Integrated Services Digital Broadcasting - Terrestrial
LOS Line of Sight
MBMS Multimedia Broadcast and Multicast Services
MBSAT Mobile Broadcasting SATellite
MP3 Motion Picture expert group audio layer 3
MSS Mobile Satellite Service
PDA Personal Digital Assistant
RF Radio Frequency
S-DAB Satellite - Digital Audio Broadcast
S-DMB Satellite - Digital Multimedia Broadcast
SDP Service Delivery Platform
SFN Single Frequency Network
T-DAB Terrestrial - Digital Audio Broadcast
TDD Time Division Duplexing
T-DMB Terrestrial - Digital Multimedia Broadcast
TV Television
UHF Ultra High Frequency
UMTS Universal Mobile Telecommunication System
VHF Very High Frequency
Wi-Fi Wireless Fidelity
WiMAX World-wide Interoperability for Microwave Access

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From 1995 to 2001, as marketing manager in the Mobile Networks Division, he handled the promotion of GSM, GPRS, and 3G mobile systems. Based on this experience, he joined the Network Strategy Group to define and promote the corporate vision for the evolution of wireless networks.

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