T-DMB WHITE PAPER
TERRESTRIAL DIGITAL MULTIMEDIA BROADCASTING WHITE PAPER
## Executive Summary

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T-DMB services were unveiled in Korea on December 1, 2005, marking the beginning of a full-fledged mobile TV era for the country. Currently, mobile TV services are provided in Seoul, the Korean capital, and its surrounding areas, by six operators (multiplexers), covering a population of 20 million. The operators provide seven TV channels and 13 radio channels, and will add seven data channels in the near future. Efforts to improve service quality are underway, and new service components, such as two-way data broadcasting, are under development.

The T-DMB service, accessible through mobile phones, PDAs or other dedicated DMB devices, permits the transmission of CD quality sound and may be received while traveling at high speeds of over 300 km/h. T-DMB can also provide a variety of broadcasting-telecom convergence options through two-way data services.

T-DMB is intended as a personal, two-way multimedia broadcasting medium, with high mobility and accessibility being its defining characteristics.

Supporting an unprecedented level of mobility, T-DMB enables users to watch TV while on the move and has resolved the spatial limitations of existing broadcasting services. These features, optimally adapted to the ultra-mobile lifestyle of today’s consumers, offer the convenience and accessibility they demand, ultimately contributing to the overall quality of life.

As a service provided via broadcasting networks, T-DMB is unaffected by network bottlenecks and is able to deliver large-volume multimedia content to a virtually unlimited number of users, without loss of quality. Best of all, by combining the advantages of digital technology-based broadcasting and telecom, T-DMB is capable of meeting consumer needs at highly affordable prices. These features make T-DMB an ideal solution to the widening digital divide, whether between generations or income groups, extending the benefits of information technology to all segments of society.

Six months into service, T-DMB is now being used by more than one million Korean consumers. Demand for T-DMB is expected to further rise in early 2007, when the geographical coverage, currently limited to the Seoul metropolitan area, is extended nationwide. The strong showing by T-DMB is in part thanks to the availability of a large array of DMB-supporting devices and an improvement in the
manufacturers’ supply capabilities. While most of the latest models of mobile phones, GPS navigators, laptops, digital cameras, PDAs, PMPs and MP3 players support T-DMB, a host of affordable, standalone dedicated devices, such as USB module-based T-DMB set-top-boxes, are also hitting the market.

Of all these devices, T-DMB mobile phones have thus far proved to be the most popular, and their outstanding mobility appears to have been a decisive factor in their appeal. In addition, for less than USD 100, support for T-DMB can be added to existing mobile phones that are already equipped with a built-in color LCD screen and 64-chord polyphonic sound processing capability, making access to T-DMB service affordable for the millions of potential customers who already own a mobile phone as well.

As most of these handsets provide built-in support for mobile communication protocols such as Code Division Multiple Access (CDMA) or Global System for Mobile Communications (GSM), they are optimally suited for two-way broadcasting-telecom convergence services. These strategic attributes make T-DMB a strong candidate to lead in the broadcasting-telecom convergence age.

In Korea, T-DMB is regarded as a public service and a variant of the existing over-the-air broadcasting services. As such, T-DMB service is provided free of charge in order to reach the broadest possible segment of the population. For this reason, just as it is for radio and television, advertising is the primary revenue source for T-DMB providers. Meanwhile, because of Korea’s leading role in offering T-DMB services, the country’s public service business model has established a precedent that has led to the perception of T-DMB as a free service by providers around the world.

There is an important distinction to be made between technology and business models. A billing system is all it takes to make T-DMB a fee-based subscription or pay-per-view service. Also,

T-DMB may be adapted for a wide-reaching variety of uses to create desired business models. Efforts to develop new revenue models by bundling the service with data broadcasting and two-way value-added services, among others, are underway among Korean T-DMB operators.
For example, by interfacing T-DMB broadcasting networks with mobile communications networks, providers can offer two-way services in mobile environments. Unlike mobile networks, which are able to support only a limited number of voice and data services, T-DMB networks can deliver large-capacity multimedia content, fully meeting consumers’ need for a high-quality multimedia service. T-DMB networks, furthermore, are an ideal, low-cost alternative to mobile networks, which are staggeringly expensive to build. In addition, by introducing value-added services such as T-Commerce and VOD, operators can readily increase content revenues.

T-DMB, when integrated with an emergency response system for natural disasters, crime-related emergencies or traffic accidents, may be used to transmit (intra-cast) accurate situational data to police and fire stations and other emergency service providers. Moreover, using low-power broadcasting for limited geographical coverage, T-DMB can offer narrowcasting to target a particular population. Also, the business potential of fee-based service models like traffic and travel information (TTI) services using T-DMB has been well recognized. Finally, light DTV, a method that uses T-DMB to create SD-class digital broadcasting, provides developing countries with an affordable way to switch to digital systems.

Research into T-DMB is continuing in Korea, to further fine-tune related technologies. The ‘advanced T-DMB technology,’ a next-generation T-DMB technology currently under development, is expected to deliver a better picture quality significantly superior to that supported by SD-class broadcasting, and provide crisp images even on large display screens of over 20 inches, in mobile environments. This service could initially be introduced to buses, trains and other public transportation vehicles that require large display screens.

T-DMB is also an economical solution, requiring only a small facility investment. Hence, using the T-DMB infrastructure as the main digital broadcasting network could dramatically reduce the service costs of digital broadcasting. In this case, T-DMB would ideally be offered as a total digital broadcasting solution, in a business model that bundles portable, mobile broadcasting and over-the-air digital broadcasting.
A growing number of countries around the world have shown interest in T-DMB, appreciative of the promise offered by this technology. T-DMB is currently being piloted or is already in service in several countries outside Korea. In Germany, T-DMB service was introduced during the 2006 World Cup. The service, provided through Debitel and T-Systems, currently covers six German cities. The coverage is expected to be expanded in the near future to include 12 cities in all. Meanwhile, a pilot program is underway in Regensburg and Munich. This program by the German broadcasting regulator BLM involves the participation of 70 institutions from nine countries. T-DMB is also being piloted in the UK and France.

T-DMB is eliciting an especially strong response in Europe partly due to the compatibility of this technology with the existing broadcasting infrastructure, which is based on the DAB (Eureka-147) system, the European digital radio standard. Germany and other European countries possess a wide coverage of DAB networks, making DAB services accessible to over 95% of their total population. However, the diffusion of DAB has been stalled in most European countries, with the exception of the UK, and its market prospects now appear doomed. T-DMB is an appealing proposal to European countries insofar as it can put to use their idle DAB infrastructures with no facility investment and only a small investment in equipment like encoders, the existing DAB networks can be enabled to provide video services, thereby offering DAB providers a new business opportunity.

Asia is another big potential market for T-DMB. A pilot program has already been completed in a number of Chinese cities including Beijing and Shanghai, and its commercial introduction is expected in the near future, pending the government’s approval. In Delhi, India, a consortium named MoTV will be formed in the fall of 2006 to prepare a pilot launch with a view to an eventual full commercial rollout of T-DMB. The Korean digital broadcasting system has met with a positive response, in fact, in nearly all major developing world markets.
The triumphant debut of T-DMB in worldwide markets has been helped by two major factors: its adoption as a global standard and its sizeable business potential. In December 2004, T-DMB was selected as a standard by WorldDAB, and in July 2005 it became an ETSI standard. Once the ITU’s standardization process has been wrapped up in the second half of 2006, the adoption of T-DMB technology will become convenient worldwide.

Commercialized ahead of its competitor technologies, T-DMB has had the opportunity to prove its reliability while potential competing technologies remain plagued with difficulties and thus unproven. A wide range of devices supporting T-DMB is already available in the consumer market as well. Through successive releases, manufacturers have already identified and resolved instabilities and other performance issues. These devices have now reached a highly competitive level, as significant progress has been made in terms of both the production processes and product quality, while mass production has led to a significant price drop.

Meanwhile, the signing on June 16, 2006 of the Geneva 2006 (RRC-06) Regional Agreement at the ITU RRC-06 meeting has been another favorable development for T-DMB. This agreement, reserving band III (174-230MHz) exclusively for DAB services, grants the same privileged status to T-DMB, a DAB-based system. This decision will facilitate, among other things, access to frequency resources for the provision of T-DMB in Europe, Africa, Russia and Iran in particular, and help eliminate such problems as the frequency interference that results from band sharing.

T-DMB, provided via broadcasting frequency bands, is a high-quality mobile TV service, accessible virtually anywhere and at any time. The unprecedented level of convenience offered by T-DMB is sure to make it a leading service in the telecom-broadcasting convergence market, ushering in the age of ubiquitous networking. A major milestone in the history of broadcasting, T-DMB will spawn new business models while helping IT sectors to increase revenues.
1. Introduction

1.1 Emergence of T-DMB

1.2 Significance of T-DMB
1. Introduction

1.1 Emergence of T-DMB

Advances in transportation and communications systems development are further broadening modern people's activities, allowing them to travel greater distances. Furthermore, people are increasingly conducting domestic and work activities away from the home and office. Such lifestyle changes are prompting the demand for information acquisition and the use of contents while traveling. This trend is clearly evinced by mobile services, which have spread explosively since the mid 1990s.

Amid circumstances in which mobility has found its place as an important aspect of our culture to such an extent that today's citizens are modern-day nomads - the demand for mobile services using information and communication services anywhere, anytime is growing rapidly. Mobile services, responding effectively to such a demand, have successfully spread ahead of other similar services. Likewise, voice communication services, wireless Internet, multimedia messaging service (MMS), and other wireless data services are now able to satisfy consumers on the move. However, with consumers shifting their needs from voice communications to multimedia contents, thus requiring premium services, the limitations of wireless networks are being revealed.

Multimedia services provided through mobile communication networks are primarily conducted by the point-to-point method, and thus the growing number of users is increasing the network load proportionally. To resolve this problem, various next-generation mobile communication technologies, such as IMT-2000 (improving on data transmission speeds), 3.5G High Speed Downlink Packet Access (HSDPA), and Mobile WiMAX (WiBro), have been developed, but as yet they lack the capacity to overcome unicast limitations, and have not yet addressed the huge costs incurred by the incessant need for additional infrastructure. These problems have translated into reduced quality and high service fees for consumers.

Suggested here is a practical alternative solution to the said problems which uses broadcasting networks to provide large-capacity multimedia services in mobile environments. Broadcasting technology can simultaneously deliver high-quality contents to vast unspecified audiences, and the related infrastructure is less costly.

Against such background, T-DMB technology was born. T-DMB, utilizing efficient compression technologies, error-correction technologies along with other technologies, can provide high-quality mobile TV services on up to seven-inch display screens. Also, T-DMB can deliver CD-quality audio (better than FM) and data services. Thus, T-DMB can provide broadcasting and multimedia content services at the most economical and efficient rates.
1.2 Significance of T-DMB

T-DMB enables users to use multimedia broadcasting services anywhere, anytime, even while on the move. This has enabled T-DMB to secure the same multimedia competitiveness as broadcasting, and the same mobility as mobile services. As such, T-DMB is armed with market competitiveness in the information and communications field, has a broad demand base, and is consequently expected to spread rapidly.

Furthermore, T-DMB is based on digital technology, and therefore can be converged physically with the already digitalized communications infrastructure with relative ease. Portable T-DMB terminals, converged with mobile phones, which have outstanding mobility and multimedia functionalities, are expected to become ideal terminals for upcoming convergence services combining broadcasting and communications. Thus, existing mobile operators and broadcasters can expect to create new revenue models as they link with existing services, bolster competitiveness, and provide new value to customers.

Korea will synchronize its communications networks with broadcasting networks from the end of 2006, and provide new interactive services through T-DMB. Therefore, mobile phone-converged T-DMB terminals are expected to evolve into the interactive broadcasting and communications convergence devices of the future. T-DMB has core competitiveness that responds to market needs in the broadcasting and communications convergence age, and is expected to lead broadcasting and communications convergence and become a new IT growth engine.
Furthermore, T-DMB will contribute to improving the quality of life of information-alienated classes and promote the public good. As T-DMB can be viewed anywhere, anytime, the technology looks poised to become the medium that best befits emergency disaster warning broadcasting. T-DMB is considered the most suitable medium for providing information on the occurrence of earthquakes, fires, and other calamities in particular. And because T-DMB can provide convenient and friendly services to users at an affordable cost, it will ultimately contribute to bridging the widening information divide between different generations and classes of people in the digital age.
2. Market

2.1 Creating New Value

(1) Free Public Broadcasting
(2) Fixed Light DTV Model
(3) Disaster Warning Broadcasting Services
(4) Pay-based Premium Services
(5) Communication and Broadcasting Convergence Services
(6) Intra-casting Model
(7) Low-Power Service Model

2.2 Responses from T-DMB Market

(1) T-DMB Video Quality Satisfaction Level
(2) T-DMB Usage Time
(3) T-DMB Usage Location
(4) T-DMB Contents
(5) T-DMB Service Fees

2.3 Dynamic Market

(1) Official T-DMB Launch
(2) T-DMB Market Outlook

2.4 Global Market Trends

(1) Global T-DMB Market
(2) Global T-DMB Market Outlook
(3) Global Mobile TV-related Frequencies
2. Market

2.1 Creating New Value

Worldwide mobile communication operators and broadcasters who intend to start or participate in mobile TV services, as well as new operators, are exploring and reviewing diverse business models, and Korea and Japan, the first to launch mobile TV services, are keenly interested in mobile TV business models. In Korea, T-DMB services are provided for free with advertising considered as the primary revenue source; in essence T-DMB in Korea has inherited the business model of existing over-the-air broadcasting services. However, it is important to note that technology does not exercise any limits on business models. T-DMB, when combined with subscription, fee-based systems, can readily be adapted to a pay broadcasting service model. Furthermore, T-DMB can provide diverse business model applications backed by mobile broadcasting competitiveness, thus creating unique business models.
While diverse business models can be created by using T-DMB technology, each business model does not have to be independently operated. Since T-DMB operators, as multiplexers, can provide numerous channels simultaneously, they can provide public contents through free channels and high-quality private contents through pay-service channels. Thus, operators can select the models from the business model pool that are best adapted to the business environments they operate in, enabling them to prepare diverse, flexible business strategies.

These suggested business models are only the starting point of a number of emergent mobile business models.

(1) Free Public Broadcasting

T-DMB broadcasting, like existing over-the-air broadcasting services, can be provided for free, using advertising revenues from large business advertisers to finance its operation, much the same as the over-the-air broadcasting revenue model implemented in most nations. Korea regards the video and audio services of T-DMB as public services, and thus provides T-DMB services for free in the same way as existing broadcasting services, which are operated on the basis of advertising revenues.

Free T-DMB services mean uncertainty of revenue creation until certain levels of users are secured, and consequently it may take longer than it would for a pay service to generate return on investment, namely the costs incurred for structuring initial broadcasting networks, manufacturing and purchasing contents, and publicizing services. However, free services are an important user attraction factor, and a quality guarantee for services and content may prompt rapid adoption of the service. In addition, T-DMB can provide more advanced services and content than existing broadcasting media, and ultimately is expected to develop competitively different media, thereby establishing T-DMB’s own unique advertising market that will create new revenue streams.

**T-DMB Model as Free Services based on Advertising Revenue**

- **Contents Providers**
  - Contents
  - Contents fees

- **Industries**
  - Request for advertisements
  - Charge for AD

- **T-DMB Broadcaster / Multiplexer**
  - Program arrangement & T-DMB network operation
  - T-DMB Service

- **Customers**
  - Eyes for Advertisement

- **Increasing Sales**
(2) Fixed Light DTV(Advanced T-DMB) Model

When the Advanced T-DMB technologies currently being developed are completed, it will be possible to provide SD-class clear videos and 3D Surround-class audio contents on 15~25-inch displays via T-DMB networks. Ultimately, then, T-DMB could be provided to large 20-inch screens on buses, subways, trains and other transportation means, apart from portable terminals, offering various types of traffic and lifestyle information.

Although digital broadcasting is being widely adopted thanks to its utility and the need for its services, huge infrastructure costs remain a stumbling block to its continued spread. In particular, some developing nations may have financial difficulty shifting over-the-air broadcasting systems to digital systems, and consumers may also have reservations about the currently pricey digital TVs consequently, it will take a long time to impart the utility of the digital broadcasting infrastructure to an entire nation, even if it does become established. Such nations see a greater role for broadcasting, and the improvement of the quality of broadcasting is considered crucial in enhancing the people's cultural life.

Given these circumstances, Advanced T-DMB is expected to be an effective alternative measure that can provide SD-class digital broadcasts with low infrastructure investment costs. In addition, T-DMB can provide mobile TV and digital radio services, thus making Advanced T-DMB services very cost-effective technology as a total digital solution. Advanced T-DMB is suited to global trends where the resolution of economic problems and information and communications technologies are converging it provides a total digital broadcasting solution to nations which are yet to determine their digital broadcasting methods, and diversifies the available services for nations which are preparing T-DMB services, facilitating the provision of competitively different broadcasting services compared to other types of broadcasting services.
(3) Disaster Warning Broadcasting

If a system is established to deliver accurate information to the nation on typhoons, earthquakes, tsunami, and other emergency disasters rapidly, human and property damage can be prevented or minimized effectively.

T-DMB can be received and watched anywhere, anytime, and can be provided on channels for free for public purposes, making it a suitable medium for disaster warning broadcasting. In T-DMB, as shown in the following illustration, disaster warning messages received from the disaster management center are sent via the T-DMB transmission system’s Fast Information Data Channel (FIDC) and Emergency Warning Systems (EWS) channels to the receiving terminals, which then display them. According to their severity, warning messages can be simply displayed on the terminal screen, or a loud alarm given, alerting users in time for them to better cope with the situation in an informed manner. Also, even with T-DMB turned off, if the user has set it to Sleep Mode, a function for the automatic provision of very urgent emergency information can command the receiver to turn itself on and sound the alarm. As the situation progresses, T-DMB can receive guidelines and information from the disaster management center and provide them via wireless channels to enable users to cope with a changing situation. Finally, users in a given disaster area can interact with the disaster management center by sending SOS messages and receiving related replies and information.

The said disaster warning broadcasting service model is not a profitable business model, but it is a service that combines the advantage of mobility and the characteristic of mobile broadcasting with the public good, adding the dynamics and the public good of the medium to existing services and boosting the value of mobile broadcasting.
(4) Pay-based Premium Services

Pay-service models, like the existing cable and satellite broadcasting services, provide diverse high-quality contents and collect fees from viewers in return. Simply adding subscriber authorization systems such as CAS to the existing systems allows T-DMB to readily provide pay services.

Currently, in Korea, T-DMB A/V (Audio and Video) services are provided for free, but upcoming data broadcasting services will most likely be provided on a fee basis. Data broadcasting can be provided one-way or interactively, depending on whether or not it is synchronized with communication networks, thus allowing the structuring of diverse business models.

T-DMB data services are categorized into program-linked type and independent type according to the relationships between existing A/V programs and added data content. Linked type services provide A/V program-linked data along with the delivered content, satisfying viewers’ information needs for A/V programs, enhancing their understanding, and bolstering the service utility.

Program independent data services are different from A/V programs, and provide data information either together with A/V broadcasting or independently. For instance, while watching a program, viewers can receive market information, news and weather information, regional and other sources of information, as well as services such as the downloading of games, music and other programs.
**Program-linked Data Services**

(a) Movie/drama-linked data broadcasting  
(b) Music broadcasting-linked data broadcasting  
(c) Sports-relay-linked data broadcasting

**Program Independent Data Services**

(a) Stock information Service  
(b) Weather information service  
(c) Game downloading service
Traffic and travel information, for which data services are now being prepared, is the most promising service and is expected to represent a lucrative new revenue source. TTI services, if combined with navigation systems using GPS, will allow users to receive real-time traffic information and explore the shortest route in terms of time and distance, thus raising the prospect that it will be in high demand in large cities where traffic is heavily congested. Also, TTI will provide location-based services such as tourism and regional information, constituting an additional service that will make the most of mobile broadcasting’s competitiveness. This will have ripple effects not only on mobile broadcasting service providers, but also on traffic information content providers and terminal manufacturers.

(5) Communication and Broadcasting Convergence Services

T-DMB broadcasting networks and mobile communication networks, if combined, will provide interactive services in mobile environments, provide wider varieties of content, and enhance the quality of multimedia services. The combination of T-DMB networks and mobile communication networks could also provide an additional service of communication and broadcasting convergence, thus creating yet more new revenue sources. Furthermore, convergence will provide existing voice and basic data services through mobile communication networks, and massive-volume multimedia content through T-DMB networks, thus allowing each to complement the other mutually to create diverse synergies.

First, broadcast operators can improve one-way services by interfacing different networks, simultaneously
enhancing the quality of data services markedly and meeting viewer needs. In this way, they can diversify contents and services to create new business models. These services will be able to insert diverse links with T-DMB contents, and allow viewers to choose their preferred contents and services in a quick and convenient operation. Currently, Korean operators are preparing services such as T-Commerce, T-government, queries, public opinion surveys, and education programs with the aid of convergence technologies. T-DMB, if converged with next-generation mobile technologies such as HSDPA and Mobile WiMAX (WiBro), will allow real-time streaming and the downloading of a massive volume of video, music and other content, enabling the provision of VoD, AoD, and online game services even while users are on the move.

**Interactive Services**

- (a) T-Commerce
- (b) T-Government
- (c) Poll
- (d) T-learning

T-DMB technology can provide Broadcast Website Service (BWS) which is currently being prepared to relay websites via broadcasting. This service is implemented in such a way that users store HTML files provided via MOT protocols by broadcasters in the receiving terminals’ memory chips, and then are able to browse the sites. Of course, semi-interactive services, even without uplink channels, can be implemented, but if CDMA, WiBro or others are utilized as uplink channels, TCP/IP method-based interactive data services can be used, thus enhancing the utility factor.

BWS services provide screens similar to those of the Internet, so they are expected to spread rapidly among online surfers and younger generations who are familiar with the Internet. Furthermore, the service will be available while users are on the move, which will put it in direct competition with wireless Internet services, whose service fees are seen as costly, with BWS being very price competitive in comparison.
For their part, mobile operators can provide massive volumes of multimedia content to their existing mobile subscribers through T-DMB networks, meeting subscriber needs for high-quality multimedia services. With the 2G, 2.5G, and 3G mobile networks now available worldwide, current technologies cannot effectively provide the downloading or streaming of great volumes of multimedia content owing to the costly fees, relatively poor video quality and slow transmission speeds, among others. However, since upgrading mobile networks to over 4G levels requires astronomical investment costs and considerable amounts of time, efforts to counter this setback are being vigorously undertaken to ensure that broadcasting networks employ mobile broadcasting technologies such as T-DMB in a response to consumer needs.
This service model starts with the need to overcome the communication or broadcasting technologies' own limitations, expand consumer utility, and step up service competitiveness. Mobile phone-type T-DMB terminals, which are currently the most popular, embed both mobile and T-DMB functionalities, so the convergence of different networks and combinations of services through single terminals can be achieved easily. Therefore, the convergence of different networks, which will begin at the terminals, will provide an opportunity for communication and broadcasting operators to create new revenue sources, making it the first success case in the broadcasting and communication convergence services.

(6) Intra-casting Model

In general, the trunked radio system (TRS) is used for communications between related personnel in the event of a crime, fire or traffic accident. However, this system delivers information only in the form of voice and sound, with limitations in terms of the diversity and level of information provided, making it difficult to ensure speedy and accurate countermeasures.

The intra-casting model allows police stations, fire stations and other public safety network authorities to structure their T-DMB transmission systems and send and receive information for sharing among their members in real time via the T-DMB networks. For instance, a large fire scenario could be sent as video multimedia content in real time, providing ample information to the relevant command upon which to establish the appropriate countermeasure strategies. This would also enable the fire fighters who are sent to the scene to obtain an accurate picture of the scene in advance and acquire an enhanced understanding of their duty, thereby making their counteracting capabilities all the more effective.
(7) Low-Power Service Model

The low-power service model, designed to reduce the T-DMB transmitter's transmission power and provide services to limited areas, is a different concept from those universal T-DMB services providing the same contents to wide areas such as a city, province or nation.

Low-power services can provide diverse contents by region and purpose of usage, thus augmenting the utility of mobile broadcasting considerably. For instance, low-power services can provide game relay, commentary and related data to spectators, increasing their enjoyment accordingly. Furthermore, when viewers approach a particular commercial area (market, shopping mall, etc.), low-power services can effectively publicize the area and provide shopping information. Corporations and schools can also provide information via low-power T-DMB rather than by telephone and other existing methods of communication, making it convenient to deliver useful information to their members through T-DMB terminals, PCs, and notebooks, and allowing them to acquire information via the same devices. This method enables the structuring of broadcasting networks that are capable of multimedia transmission at a low cost, which will boost the value of in-house broadcasting.

These specific uses can create diverse business models that meet the unique needs and wants inherent to stadium spectators, regional merchants'sponsorships, corporations, universities, and other operators, according to each user's operational purposes. The infrastructure creation costs are low, and diverse application areas can be developed, thus contributing to the spread of mobile broadcasting.
2.2 Responses from T-DMB Market

During the 2006 FIFA World Cup, test T-DMB services were provided in Munich, Germany, host nation to the event. Key personnel, journalists, and selected consumers were given terminals with which to view T-DMB, and the market response to T-DMB was subsequently measured. T-DMB booths were installed in various areas throughout the stadiums to enable ordinary people to experience the T-DMB services. Their satisfaction concerning the T-DMB services and their subscription intentions were also surveyed.

*(Survey Outline)*
- Period: June 8, 2006 – June 9 (two days)
- Targets: 140 Munich residents and tourists
- Method: Questionnaire-based surveys targeting visitors during the T-DMB demonstration period.

(1) T-DMB Video Quality Satisfaction Level

During the test service period, five video channels were provided. Regarding the video quality of T-DMB, about 90% of the survey respondents declared it to be "great" or "good," while only 7% found the quality to be either "Ok / so so" or to "leave much room for improvement." The results suggest a high level of consumer satisfaction regarding the video quality as viewed via the terminals.
(2) T-DMB Usage Time

56.4% of the respondents said that they would use mobile TV if there were particular contents that they wanted to see. 55% said that they would use mobile TV if the contents were interesting. This tends to confirm that mobile contents will be very important to the successful launch of T-DMB.

Meanwhile, 48% of the respondents said that they would use mobile TV if they were bored or while traveling to and from work, suggesting that they would use mobile TV during their free time. However, only 12% responded that they would use mobile TV while staying at home, suggesting that users are much more likely to use T-DMB services during activities that occur away from the home.
(3) T-DMB Usage Location

To the question about where and under what circumstances respondents would use the T-DMB services, about 63% said "during a longer run (e.g. on the train).” About 47% said "during a break or while waiting for some time, and on the bus or subway." This result matches the abovementioned preferred time for using T-DMB. Furthermore, over 30% said they would use the T-DMB services "on holidays or travels, or while waiting for a short time (e.g. at a bus stop). A further 30% said "everywhere, wherever it is possible,” suggesting that the T-DMB services may be used actively, irrespective of the time and place.

(4) T-DMB Contents

Regarding the preferred programs (arrangement/types) of the T-DMB services, about 70% of the respondents said they would watch "the same (programs) as at home," while 34% said they would watch "the same or similar programs, but the presentation should be different." No higher-than-expected percentages were measured regarding "new programs with special formats" and "programs where users can positively participate.”

These results show that TV contents currently have a certain dominance, but as mobile TV services are gradually activated and carve their own position in the years to come, special programs made exclusively for T-DMB will raise their stature in the viewing market.
The most popular types of programs for the T-DMB services were also surveyed. Sports and music/concerts were the types most respondents preferred, with news, comedies, and movies following in their wake. In Korea, where T-DMB services are now being provided, drama contents are the most popular type of program. There is, in this regard, a difference in viewer preference between Korea and Germany.

This suggests that the potential operators of mobile TV services including T-DMB should closely survey the purposes for which the viewers in related regions use the media and pay attention to which contents they prefer.
(5) T-DMB Service Fees

The level of service fees that German viewers are willing to pay for T-DMB services was surveyed. 26% of respondents said that they would pay over 5 euros, 24% over 10 euros, 17% over 15 euros, and 9% 30 euros. As such, a total of 76% of the respondents offered a positive evaluation of fee-based T-DMB services, while only 24% responded that they would not pay for mobile TV services.

This result provided confirmation that German viewers see a practical value in T-DMB services, supporting the possibility of creating mobile TV business models and, consequently, the mobile TV industry's growth.

2.3 Dynamic Market
T-DMB commercial services and experimental/test services are currently being tested in various parts of the world. This chapter takes a look at those of Korea’s T-DMB services which have already been commercialized, as well as T-DMB service spread trends in Germany, France and China, all of which are now providing experimental/test services and selecting mobile broadcasting technologies.

(1) Korea’s Official T-DMB Launch

A. Service Market

On December 1, 2005, Korea launched the world’s first terrestrial Digital Multimedia Broadcasting (T-DMB). Four of six service providers – KBS, MBC, SBS, and YTN DMB – initiated the services and, on March 1, 2006, the remaining two operators - U1 Media and Hangook DMB – also started the services. Currently, these six are operating a total of seven TV channels and 13 radio channels and, starting in mid-2006, they will provide 7 data channels.

Commercial services are currently being provided only to Seoul and its metropolitan areas. The Seoul metropolitan area has the densest concentration of the nation’s population, (approximately 20 million people, or 40% of the population), and is the nation’s political and economic hub. In areas other than the Seoul metropolitan area, the services will be provided from 2007.

Service operators in the Seoul metropolitan area were each allotted 1.536MHz frequency bandwidth. Among them, KBS, MBC and SBS are existing broadcasters who currently provide over-the-air television and radio broadcasts. Each of them already owns 1-2 TV channels and 2-3 radio channels, and they produce and transmit diverse programs including news, dramas, and entertainment. Korea’s content industry exercises strong market control since such content is provided by over-the-air broadcasters. These three T-DMB channels are providing mainly over-the-air TV content.

YTN DMB, U1 Media, and Hangook DMB, however, are new operators who entered the terrestrial broadcasting service market in more recent times. YTN DMB owns cable and satellite channels, and provides mainly news and news report-related content. Hangook DMB and U1 Media were established by consortia comprising IT companies, equipment manufacturers, and content providers that wanted to enter the T-DMB service market. Hangook DMB operates one video channel and two radio channels that provide comprehensively arranged contents. U1 Media uses one video channel and one radio channel, and has leased one video channel to KBS (KBS2 TV).
## Composition of T-DMB Channels in the Seoul Metropolitan Area

<table>
<thead>
<tr>
<th>Provider</th>
<th>Channel</th>
<th>Broadcasting type</th>
<th>Transmission capacity</th>
<th>Operational method</th>
<th>Broadcasting area</th>
</tr>
</thead>
<tbody>
<tr>
<td>KBS</td>
<td>KBS-Mobile 1</td>
<td>TV</td>
<td>548K</td>
<td>Used by the provider</td>
<td>Comprehensive programs</td>
</tr>
<tr>
<td>KBS</td>
<td>KBS-Mobile 3</td>
<td>Radio</td>
<td>128K</td>
<td>Used by the provider</td>
<td>Music</td>
</tr>
<tr>
<td></td>
<td>U1-R</td>
<td>Radio</td>
<td>128K</td>
<td>Leased (KMMB)</td>
<td>Living and economy</td>
</tr>
<tr>
<td></td>
<td>OZIC</td>
<td>Radio</td>
<td>128K</td>
<td>Leased (CJ Media)</td>
<td>Music</td>
</tr>
<tr>
<td></td>
<td>KBS-Mobile 5</td>
<td>DATA</td>
<td>220K</td>
<td>Used by the provider</td>
<td>Comprehensive programs</td>
</tr>
<tr>
<td>MBC</td>
<td>MBC DMB TV</td>
<td>TV</td>
<td>548K</td>
<td>Used by the provider</td>
<td>Comprehensive programs</td>
</tr>
<tr>
<td></td>
<td>MBC DMB Radio</td>
<td>Radio</td>
<td>128K</td>
<td>Used by the provider</td>
<td>Comprehensive programs</td>
</tr>
<tr>
<td></td>
<td>MBN Economy Radio</td>
<td>Radio</td>
<td>128K</td>
<td>Leased (MBN)</td>
<td>Economy</td>
</tr>
<tr>
<td></td>
<td>Arirang English Radio</td>
<td>Radio</td>
<td>128K</td>
<td>Leased (Korea International Broadcasting Foundation)</td>
<td>Korean culture</td>
</tr>
<tr>
<td></td>
<td>MBC DMB Data</td>
<td>DATA</td>
<td>220K</td>
<td>Used by the provider</td>
<td>Comprehensive programs</td>
</tr>
<tr>
<td></td>
<td>SBS DMB TV</td>
<td>TV</td>
<td>544K</td>
<td>Used by the provider</td>
<td>Comprehensive programs</td>
</tr>
<tr>
<td></td>
<td>SBS DMB Radio</td>
<td>Radio</td>
<td>128K</td>
<td>Used by the provider</td>
<td>Comprehensive programs</td>
</tr>
<tr>
<td></td>
<td>TBS DMB Radio</td>
<td>Radio</td>
<td>128K</td>
<td>Leased (TBS-Seoul City)</td>
<td>Traffic</td>
</tr>
<tr>
<td></td>
<td>Kyonggi DMB Radio</td>
<td>Radio</td>
<td>128K</td>
<td>Leased (Kyonggi Broadcast)</td>
<td>Culture and arts</td>
</tr>
<tr>
<td></td>
<td>Hankyoreh DMB Data</td>
<td>Radio</td>
<td>128K</td>
<td>Leased (Hankyoreh Newspaper)</td>
<td>Occupation and education</td>
</tr>
<tr>
<td></td>
<td>SBS DMB Data</td>
<td>DATA</td>
<td>32K</td>
<td>Used by the provider</td>
<td>Leisure and entertainment</td>
</tr>
<tr>
<td></td>
<td>LGT DMB Data</td>
<td>DATA</td>
<td>96K</td>
<td>Leased (LG Telecom)</td>
<td>New technology and new service development</td>
</tr>
<tr>
<td>YTN</td>
<td>YTN Plus</td>
<td>TV</td>
<td>512K</td>
<td>Used by the provider</td>
<td>Comprehensive programs</td>
</tr>
<tr>
<td>DMB</td>
<td>TBN Traffic Broadcasting Network</td>
<td>Radio</td>
<td>160K</td>
<td>Leased (Road Traffic Authority)</td>
<td>Traffic</td>
</tr>
<tr>
<td></td>
<td>Satio+</td>
<td>Radio</td>
<td>160K</td>
<td>Leased (Satio)</td>
<td>Music</td>
</tr>
<tr>
<td></td>
<td>YTN Premium</td>
<td>DATA</td>
<td>320K</td>
<td>Used by the provider</td>
<td>Comprehensive programs</td>
</tr>
<tr>
<td>Hanguk</td>
<td>Hanguk DMB TV</td>
<td>TV</td>
<td>548K</td>
<td>Used by the provider</td>
<td>Comprehensive programs</td>
</tr>
<tr>
<td>DMB</td>
<td>i4U</td>
<td>Radio</td>
<td>128K</td>
<td>Leased (CBS)</td>
<td>Living and culture</td>
</tr>
<tr>
<td></td>
<td>Live4U</td>
<td>Radio</td>
<td>128K</td>
<td>Leased (Music City Media)</td>
<td>Performing music and cultures</td>
</tr>
<tr>
<td></td>
<td>Hanguk DMB Data</td>
<td>DATA</td>
<td>348K</td>
<td>Used by the provider</td>
<td>Comprehensive programs</td>
</tr>
<tr>
<td>U1 Media</td>
<td>U1 TV</td>
<td>TV</td>
<td>512K</td>
<td>Used by the provider</td>
<td>Comprehensive programs</td>
</tr>
<tr>
<td></td>
<td>KBS-Mobile 2</td>
<td>TV</td>
<td>512K</td>
<td>Leased (KBS)</td>
<td>Family culture</td>
</tr>
<tr>
<td></td>
<td>U1 Radio</td>
<td>Radio</td>
<td>128K</td>
<td>Used by the provider</td>
<td>Economy and news</td>
</tr>
<tr>
<td></td>
<td>U1 Data</td>
<td>DATA</td>
<td>128K</td>
<td>Used by the provider</td>
<td>Comprehensive programs</td>
</tr>
</tbody>
</table>
Starting around the time of the 2006 World Cup tournament, T-DMB coverage in the Seoul metropolitan area was expanded from the surface area to include the entire subterranean subway infrastructure. The Incheon area, the first zone to be equipped with gap fillers in the subway system, has seen all of its 21 subway station locations covered by T-DMB services from March of this year. In the Seoul area, which has eight subway lines totaling 300km of track, most of it subterranean, T-DMB reception and viewing has been available since June 2006, after some 29 billion won (USD 30 million) were injected into the infrastructure costs.

Furthermore, northern Seoul and some southern areas of the city which have been confirmed as low-reception or shadow areas will receive an installation of additional transmission stations and gap fillers in the 2006-2007 period to address the problem. These measures will enable 20 million people in the Seoul metropolitan region to receive smooth mobile broadcasts in all areas. As such infrastructure efforts continue to improve T-DMB service quality and extend its reach to more and more areas of the nation, the market for T-DMB is energized by corresponding increased consumer demand.

Korea's T-DMB service coverage is divided into the Seoul metropolitan area and the non-metropolitan area. The non-metropolitan area, in addition to the Seoul metropolitan area, where the services are now being provided, has seen the commencement of services from the end of 2006 after selection of the service providers.
B. Terminals Market

In Korea, some varieties of T-DMB-receiving terminals are already selling in the market, further energizing the momentum of T-DMB. Currently, more than 40 manufacturers are producing a diverse range of terminals including mobile phone-converged, navigation-converged, PMP-converged, USB module, notebook/PDA internal, and digital camera types.

Out of this array of terminals, mobile phone-converged terminals, which come with Korea's mobile protocol CDMA handsets packed with T-DMB chipsets, are exploding in terms of popularity. Mobile phones are the most portable IT devices, and the convergence of mobile phones and T-DMB is considered a very effective T-DMB penetration strategy. First, mobile phones are equipped with HD LCD panels, 64-chord polyphonic sound, and other TV-receiving functionalities. Thus, with only the additional costs for installing chipsets and making other minor adjustments, they can be made DMB-ready. This significantly lowers the cost barriers to the services to millions of mobile phone owners. The addition of DMB functionality to a mobile phone in Korea costs an additional 100US$. Most advanced nations have a mobile phone penetration ratio of a hefty 100% or thereabouts among their economic populations, constituting a broad potential demand base. In addition, mobile phones have a shorter life cycle of 1-2 years, prompting the penetration of T-DMB services over a short period of time when existing mobile phones are replaced with new T-DMB enabled units.
However, the battery duration time of mobile phones has been cited as a technological problem for mobile phone-type terminals, but in the wake of efforts to reduce power consumption by T-DMB chipsets and enhance battery efficiency technologies, the battery duration time has now been upgraded to three hours of broadcast viewing.

In Korea, terminals for viewing T-DMB installed in car navigators are now becoming popular. Also, USB memory type receivers are being marketed and widely adopted -mainly among young people - thanks to a low average price of USD 80. In only seven months, from the official T-DMB launch date to June 2006, a total of one million T-DMB terminals have been sold, signaling a sound rate of growth. With this trend in mind, 2006 alone will see the generation of USD 337 million in sales, and sales are forecast to rise to USD 1,009 million by 2012.

### Domestic T-DMB Terminal Market Outlook

<table>
<thead>
<tr>
<th>Description</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-DMB Terminals</td>
<td>337</td>
<td>406</td>
<td>652</td>
<td>744</td>
<td>882</td>
<td>912</td>
<td>1,009</td>
</tr>
</tbody>
</table>

* Reflecting increments only following the installation of T-DMB modules

### Domestic T-DMB Terminal Type Ratio Outlook (2006-2012)

- PDAs(sales), 0.5%
- USB modules(sales), 7.0%
- Mobile Phones(sales), 59.4%
- Cartypes(sales), 27.2%
- Portable Multimedia(sales), 50.9%
Domestic Market-Released T-DMB Terminals

- Mobile Phone-converged Terminals

- USB Module Terminals
Market

- **T-DMB Set-Top Box**

- **Combined Functionality Terminals (GPS+PMP+DMB)**

- **Other Terminals (PDAs, MP3Ps, digital cameras, notebooks, and dedicated terminals)**
(2) Korea's T-DMB Market Outlook

With the commercialized T-DMB services already launched, 2006 will see the activation of T-DMB services and the opening of the mobile broadcasting age in earnest. In Korea, the number of T-DMB service subscribers will grow by 36% annually from 2006 to 2012, rising to 11 million people by 2010, and 14 million people by 2012 (ETRI). Despite varying forecasts from the related agencies, 2006 alone will see over 2 million T-DMB subscribers, and thereafter, T-DMB subscribers will increase steadily to reach over 10 million people by 2010.

With such a penetration of T-DMB services, related sales will rise by leaps and bounds. Advertising will likely be the key revenue source until data broadcasting, interactive services and a wide array of additional services are consistently provided. As the number of T-DMB subscribers rises, the value of T-DMB advertising will expand, and with the emergence of advertising techniques tailored to the T-DMB services, the value of T-DMB advertising will be reevaluated. In particular, with the future provision of communications and broadcasting convergence services, the utility of T-DMB advertising will increase markedly, sales are forecast to grow 124% annually by 2012, and service sales will surge from less than 4 billion won in 2006 to 28 billion won in 2010 (ETRI). Despite varying forecasts by agencies for such service sales - with KOBACO responsible for T-DMB advertising contracts and their assignment giving the lowest figure - the overseas research agency InStat gives the highest evaluation of the profitability of future T-DMB services. This difference comes as KOBACO has forecast that the domestic advertising market will not significantly expand even after new media have been introduced, while the foreign survey agency has forecast that T-DMB will diversify its services and expand sales rather than simply depending on its advertising revenue.
With the launch of the T-DMB services, sales of terminals and systems will rise, and service markets will open up, thus generating a wide range of ripple effects: the projected resulting influence on the nation's economy is shown in the following table. Production triggering effects following the creation of new terminal and service markets involve an economic value rising from USD 956 million in 2006 to USD 4.5 billion in 2012, and a corresponding value-added size increasing from USD 336 million in 2006 to USD 1.93 billion in 2012. The creation of production and service markets during this period will generate a further beneficial effect with the hiring 15,000 workers by 2012.

### T-DMB Service Sales Outlook

<table>
<thead>
<tr>
<th>Year</th>
<th>Production Effect</th>
<th>Value-added Effect</th>
<th>Employment Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>956</td>
<td>336</td>
<td>9,563</td>
</tr>
<tr>
<td>2007</td>
<td>1,216</td>
<td>446</td>
<td>11,564</td>
</tr>
<tr>
<td>2008</td>
<td>1,964</td>
<td>730</td>
<td>18,385</td>
</tr>
<tr>
<td>2009</td>
<td>2,696</td>
<td>1,048</td>
<td>23,829</td>
</tr>
<tr>
<td>2010</td>
<td>3,567</td>
<td>1,418</td>
<td>30,518</td>
</tr>
<tr>
<td>2011</td>
<td>4,143</td>
<td>1,686</td>
<td>34,253</td>
</tr>
<tr>
<td>2012</td>
<td>4,701</td>
<td>1,930</td>
<td>38,322</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>19,628</strong></td>
<td><strong>7,724</strong></td>
<td><strong>170,471</strong></td>
</tr>
</tbody>
</table>

### T-DMB-triggered Economic Effects (production, value-added, employment)

<table>
<thead>
<tr>
<th>Description</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production effect</td>
<td>956</td>
<td>1,216</td>
<td>1,964</td>
<td>2,696</td>
<td>3,567</td>
<td>4,143</td>
<td>4,701</td>
<td>19,628</td>
</tr>
<tr>
<td>Value-added effect</td>
<td>336</td>
<td>446</td>
<td>730</td>
<td>1,048</td>
<td>1,418</td>
<td>1,686</td>
<td>1,930</td>
<td>7,724</td>
</tr>
<tr>
<td>Employment effect</td>
<td>9,563</td>
<td>11,564</td>
<td>18,385</td>
<td>23,829</td>
<td>30,518</td>
<td>34,253</td>
<td>38,322</td>
<td>170,471</td>
</tr>
</tbody>
</table>
2.4 Go to the Global Market

(1) Global T-DMB Market

T-DMB services are being provided not only in Korea, but also in Europe, other Asian nations, and the United States, in the form of experimental/test broadcasts and official commercial broadcasts. In particular, following the 2006 Germany FIFA World Cup, full-scale penetration is expected. Such global penetration will be triggered significantly by global technology standardization and the potential competitiveness of T-DMB.

A. T-DMB Standardization and Business Competitiveness

T-DMB was adopted as a standard by WorldDAB in December 2004, and was officially selected as a standard by ETSI in July 2005, earning its technological superiority in the European market. Furthermore, the ITU standardization project is scheduled for completion in the second half of 2006, thereby paving the way for recognition of T-DMB as an international standard and the introduction of T-DMB technology worldwide.

Also, compared to its competitor mobile broadcasting technologies such as DVB-H and MediaFLO, T-DMB enjoys a number of factors that contribute to its strongly competitive business edge. First, T-DMB started its commercialized services ahead of its competitor technologies, boosting its technological confidence among potential service providers, and bolstering publicity for its ability to supply related products. In particular, regarding T-DMB terminals, a massive number of improved terminals are now being manufactured, following marketing experience and feedback from consumers, enabling the supply of a large number of
competitive terminals which have improved in terms of quality and lowered production costs through process enhancement. These processes have had the effect of providing opportunities to providers and manufacturers alike to benchmark experiences in service operation and diverse business models, providing a wide range of information necessary for business preparation and successful operation.

Moreover, with the addition of T-DMB encoders alone, T-DMB, which is based on Eureka-147, enables the provision of its services in regions where DAB networks are already installed, thereby minimizing infrastructure costs. In particular, various European nations had experience of introducing DAB and operating its networks in the late 1990s, and DAB is a proven, time-honored technology on the continent. Broadcasters can use such DAB networks as they are, and can easily introduce T-DMB. Also, one channel uses a 1.5MHz band, thus partially dispersed unused frequencies can be utilized. Commercialized terminals for BandIII and L-band bands have been released in the market, favoring the securing of frequencies. Moreover, for T-DMB, existing DAB frequencies can be utilized as they are, facilitating the securing of frequencies. Its competitor technology, DVB-H, is having difficulty securing frequencies, while T-DMB has the advantage of having secured and securing frequencies.

B. Germany

Germany (Host nation of the 2006 FIFA World Cup Soccer tournament) began T-DMB service in June of this year, and the T-DMB trail project for the development of future DMB technology also started in Munich in June 2006.

BLM (Bayerische Landeszentrale für neue MedienHeinrich) has initiated the MI FRIENDS (Mobile Interactive Favorite TV, Radio, Information, Entertainment, New Digital Service) project with Korean partners and obtained the CELTIC EURECA label on November 20, 2005. Seventy-five companies and institutes from nine countries are participating in this project.

The project is composed of four sub-projects: Regensburg, South Tyrol, Lake of Constance, and the FIFA World Cup. The FIFA World Cup 2006 project was launched first in Munich with 400 sets of L-Band/BandIII dual band phone-type receivers and 1,000 sets of USB receivers. The public broadcaster in Bayern, BR (Bayerischer Rundfunk) and the broadcasting R&D institute, IRT (Institut für Rundfunktechnik GmbH), broadcast five video and three audio channels on VHF 11D and 12A spectrum. The contents mainly covered World Cup games and related information, entertainment, and travel information, and were provided for the most part by ARD (Germany's 1st public broadcasting channel) and BR (public broadcaster of Bayern). The BandIII/L-Band dual band GSM/UMTS phone from LG electronics was provided for this trial.

This project is aimed at establishing a new architecture for inter-working media services based on broadcasting/ telecommunication infrastructures for the media needs of a mobile information society. The project goal is to develop and test new mobile media technologies from an economic point of view, paying particular regard to social and cultural aspects with the media consumer at the center. To make media available "anywhere, anytime, any way" and thereby meet the needs of users in Europe is the project's main goal. In November 2005 MI FRIENDS was awarded a CELTIC label by the European R & D initiative, thereby
qualifying it for national funding within the EUREKA program network. The CELTIC initiative (Cooperation for European sustained Leadership in Telecommunications) supports comprehensive research and development projects in the telecommunications sector within the pan-European EUREKA R & D program.

Regular T-DMB programs have been scheduled for broadcast in six major cities including Berlin, Munich and Cologne, and they are soon to be expanded to 12 cities before the end of this year and nationwide within the next year. Germany’s third largest broadcasting station, Mobile Comm. Debitel, has handled the T-DMB hardware logistics, while T-Systems (Germany’s biggest) has handled the system broadcasting portion. Unlike Korea, Germany’s commercial service by Debitel uses 1.4GHz, L-bandwidth frequency, which can be easily modified using part of the RF channel spectrum. Meanwhile, Debitel with Samsung Electronics and LG Electronics to receive a supply of T-DMB Players. Debitel first began its mobile services with Samsung’s hardware, and then incorporated LG’s DMB cell phones from this past summer. Debitel are broadcasting 4 TV channels including ZDF (public channel) with 2 audio channels via T-DMB signals. The audio broadcast service, also known as “viewing audio,” includes video slides within the audio broadcast.

※ Source : BLM(Bayerische Landeszentrale für neue Medien)
C. UK

The T-DMB trial commenced in London in June 2006, with the emphasis placed specifically on comparing the technological aspects of the different applications of the WorldDAB Eureka-147 standard, the Korean T-DMB application, and the enhanced packet IP-based variant implemented in the UK by BT Movio. The trial had a closed engineering user group. L-Band spectrum, which is available nationally, was used. Samsung Electronics and LG Electronics provided GSM mobile phone type receivers for this trial.

Trial participants included BT Movio, Arqiva, Virgin Mobile, Samsung Electronics, LG Electronics, Perstel, OTT and Pixtree.

D. France

The French government installed a Mobile TV Forum, and the CSA (Conseil Supérieur De l'Audiovisuel) allowed four experiments starting in September and October 2005.

A six-month trial of DAB's DMB application was launched in Paris in October 2005 by the digital network provider VDL. Partnered with VDL in the trial were the main French TV broadcasting group, TF1, the mobile operator Bouygues Telecom, and the manufacturers Samsung and Perstel. A single transmitter transmitted 3kW on BandIII block 11B. A technical test for the encoder, multiplexer, indoor/outdoor coverage and receiver test was conducted. A consumer test was also carried out with 100 receivers.

T-DMB Technical Test in Paris

- Tour Defense 2000–PARIS
- One transmitter : 3kWERP
- Frequency : band III, block 11B

E. China

Recently, China’s State Administration of Radio, Film and Television (SARFT) has been conducting the work of selecting DMB-related standards step by step. China will likely announce DMB standards (sender standard, key frequency standard, video standard, etc.) on a gradual basis.

The Beijing, Shanghai and Guangzhou areas completed the purchase of related equipment in early 2006, and are now conducting experimental broadcasts through 2-3 channels. Official T-DMB services were planned to start in April-May 2006, but were postponed due to delays in the announcement of Chinese standards and the approval of the SARFT.

Areas other than these three key city areas are also reviewing T-DMB favorably, but there are still issues to be resolved such as the selection of standards, the securing of extra frequencies, and the selection of responsible agencies, so it will take time to introduce the services. However, Beijing, Shanghai, and Guangzhou are China's key cities, and they will have a decisive impact when determining mobile broadcasting methods in other areas of the country.
F. India

A T-DMB trial will be launched in Delhi, India’s capital, in October 2006 by the consortium MoTV. MoTV is led by ABSi Korea and includes the public broadcaster All India Radio (AIR) and other Indian content providers. BandIII of AIR will be used for this trial service. Pixtree and SM CNS (Korean system manufacturers) are providing the systems. A commercial service will be provided in 2007.

(2) Global Mobile TV Market Outlook

The global T-DMB market is expected to develop in earnest following the 2006 Germany FIFA World Cup. During the World Cup event period, test services were launched in Munich, and commercialized Debitel and T-mobile services began operating in 12 German cities, thereby allowing T-DMB to advance into the European market. Beginning with these efforts, Mi Friends, a partnered project among European nations and mobile broadcasters, began full-scale activities, and other European nations are expected to conduct test T-DMB services and other related tests. Alongside this, Beijing and Shanghai in China are experimenting with T-DMB, and have been providing test services since May, thereby raising expectations that China - with the 2008 Beijing Olympics in the offing - will soon begin commercialized T-DMB services.

With the global spread of T-DMB and other competitive mobile services, the number of mobile TV users will surge in 2007. It will rise from 2.6 million in 2006 to 210.6 million in 2011, showing the amazing CAGR of 141%. And corresponding mobile TV handsets sales will be expanded from 2 million units in 2006 to 120 million in 2011, through 128% CAGR, while T-DMB terminals would reach 43 million units until 2011 occupying 36% of global mobile handset market. Furthermore, with the expected increase in users, the global revenue from the mobile TV services will increase from USD 275 million to USD 26.7 billion during the period.

It should be noted, however, that since the current expectations reflect only the one-way multimedia services, additional market expansion can be realized with the highly likely services, such as the bi-directional interactive services linked with telecom networks, CDMA, GSM, WDCMA, Wi-Fi, WiBro and etc.

<table>
<thead>
<tr>
<th>Description</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile TV Users</td>
<td>2.6</td>
<td>6.9</td>
<td>22.9</td>
<td>59.0</td>
<td>120.0</td>
<td>210.6</td>
</tr>
<tr>
<td>Mobile TV Terminals</td>
<td>1.97</td>
<td>4.57</td>
<td>17.32</td>
<td>42.07</td>
<td>76.27</td>
<td>120.12</td>
</tr>
<tr>
<td>Revenue from Mobile TV</td>
<td>275</td>
<td>793</td>
<td>2,837</td>
<td>7,246</td>
<td>15,202</td>
<td>26,680</td>
</tr>
</tbody>
</table>

*Source: Mobile TV: Broadcast and Multimedia(2nd ed., 2006), ETRI(2007,4.)*
Mainstream T-DMB terminals in the global market were found to be mobile phones, as in surveys of the Korean market. However, the global ratio is somewhat higher than Korea’s 51.8%. This difference arises because overseas T-DMB markets, unlike Korea’s T-DMB market, create business models where certain service fees are charged, as with existing pay-based broadcasting and IT services (mobile communications, Internet, etc.). Likewise, the T-DMB services are provided in alliance with mobile operators, which have established charging and payment processes, and thus T-DMB service publicity and marketing activities are centered on mobile phones.

However, car type terminals, USB modules, portable multimedia players and other terminals provide larger screens (4 - 15 inches) than mobile phones do, enabling functionalities such as GPS, MP3P, multimedia players, and Internet connection in addition to the T-DMB receiving functionality as such, they will carve their own individual market niches. In particular, the models of car type T-DMB terminals that are currently selling in Korea feature converged T-DMB receiving, GPS, PMP, electronic dictionary, game and other functionalities. Since T-DMB radio channels provide by far the best sound quality (CD level) than regular FM radios, car type T-DMB terminals are worthwhile devices capable of providing convenience while driving as well as so-called "car infortainment."

(3) Global Mobile TV-related Frequencies

Frequencies are indispensable to the provision of mobile TV services, and the availability of frequencies from very limited sources can be a crucial factor in selecting mobile TV technologies.

T-DMB terminals, which are available at 175-240MHz (BandIII), 791-796MHz (UHF) and 1452-1478MHz (L-Band) have either been released or are now being developed.

DVB-H is available at the UHF bands, although of these, 470-650MHz (BandIV) is the most efficient.
Pittsburgh in the United States is conducting experimental broadcasts using the 1670-1675 MHz band (L-Band), but commercialized terminals are yet to be developed.

MediaFLO can be enabled at less than the 800MHz band and, currently, U.S. Qualcomm is securing the 700MHz band No. 55 channel through frequency auctions in the US.

The United States and advanced nations in Europe and elsewhere in the world are conducting a frequency allotment system to meet the demand for frequency resources that is growing in line with the digitalization of broadcasts and the development of the mobile communication industry. In particular, with the progress of broadcast digitalization, attention is being paid to the utilization of the extra bands that are created when analogue broadcasts are converted into digital systems. Over-the-air broadcasters are striving to secure extra bands to expand their terrestrial DTV channels, provide additional services such as data broadcasts, and offer HD broadcasts. At the same time, extra bands are being reviewed for the expansion of mobile communication services, provision of mobile TV services, and other diverse IT services.

With the whole world paying attention to the effective utilization of frequencies, the ITU RRC-2006 meeting, which was held in Geneva on June 16, 2006, and attended by the representatives of 104 nations from Europe, Africa, Russia and the Middle East (Iran), witnessed the signing of a regional agreement on the digital terrestrial broadcasting plan (GENEVA 2006 (RRC-06) REGIONAL AGREEMENT). In the frequency plans of the agreement, the digital plan stipulates that the Band III (174-230MHz) band should be used only for T-DAB services, so if DAB technology-based T-DMB services advance into Europe, Africa, Russia and Iran, problems such as the securing of frequencies and frequency interference with services can be resolved easily, providing T-DMB a favorable position in the global mobile broadcasting market.
Most nations are using the BandIII band for analogue TV, although the securing of nationwide channels or just regional channels is possible depending on the country. France, India, Sweden and a number of other nations can secure the BandIII band nationwide, but Germany and the UK can only secure the BandIII band in restricted areas, and the L-Band nationwide.

Germany, led by Debitel’s initiatives, launched commercialized T-DMB services on the L-Band from the end of May 2006 in the six major cities where the World Cup championships were held. Munich started test broadcasts using BandIII, thereby allowing users to receive both Debitel services and Munich’s test service content through the L-Band and BandIII dual terminals.

With analogue TV broadcasts due to end after 2012, the UK is expected to take a long time in securing the extra frequency bands of the UHF bands. Furthermore, over-the-air broadcasters are preparing to launch HDTV broadcasts and data broadcasts virtually, but it appears that it will be difficult for the UK to use the UHF band for mobile TV. Thus, operators will be competing fiercely for the L-band auction scheduled for 2007, which is being offered as an alternative to the situation.

The US announced measures designed to transfer analogue TV frequency bands ranging widely from Ch.2 - Ch.70 to Ch.7 - Ch.51, the previous band of 700MHz. Thus, the nation has secured 108MHz, the extra frequencies of the UHF band, and is allotting some of them by auction.
As such, with the situation regarding frequencies varying from one nation to another, T-DMB has superior competitiveness compared with other technologies. Likewise, the DVB-H and MediaFLO services have been developed so that they can be provided only on some UHF bands, and they are technologies that make integrated use of 6~8MHz bands. In the case of T-DMB services, commercialized terminals for the BandIII, L-band and dual bands have already been released, and terminals for the UHF bands will soon be marketed. In addition, 1.5MHz band-based multiplex composition is possible with T-DMB, making it much easier to secure extra frequencies. Thus, T-DMB provides the dual advantage of securing nationwide channels and making the most of regional frequencies, as in the example of Germany.
3. Technology

3.1 Overview

3.2 Review for T-DMB Technology

(1) DAB (Digital Audio Broadcasting)
(2) T-DMB (Terrestrial Digital Multimedia Broadcasting)

3.3 Technologies for Emerging Service

(1) Data Services (BWS, Slide Show, etc)
(2) Interactive Data Service (BIFS)
(3) T-DMB Middleware
(4) TTI (Traffic and Travel Information)

3.4 Essential Technologies

(1) CAS (Conditional Access System)
(2) DRM (Digital Right Management)

3.5 Future Technologies

(1) Advanced T-DMB
(2) 3D DMB
3. Technology

3.1 Overview

T-DMB is based on the Eureka-147 DAB system, which is the digital audio broadcasting standard of Europe. Under the Eureka-147 DAB system, audio services using the MPEG-1/2 audio (MUSICAM), data services closely related to audio, and data services not related to audio are all possible. T-DMB enhances Eureka-147 by applying MPEG-4 technology to the Eureka-147 DAB to deliver CD-like quality video, even in a moving vehicle. Moreover, it upgrades the data service specifications of Eureka-147 DAB, and adds new data service technologies such as MPEG-4 BIFS, middleware, traffic and travel information service technology, disaster broadcasting technology, conditional access technology, and the combining technology of broadcast and wireless network, etc.

Finally, T-DMB researchers have been quickly developing new technologies such as 3D DMB and Advanced T-DMB, in order to provide even more value added services.
3.2 Review for T-DMB Technology

(1) DAB (Digital Audio Broadcasting)

The DAB system, which is known as the European standard-ETS 300 401 and as Digital System A in ITU-R, can provide reliable, multiplexed digital audio broadcasting services, including data for mobile, portable and fixed receivers, via a simple, non-directional antenna. The system can be operated at frequencies up to 3 GHz for the various service systems such as terrestrial, satellite, and cable broadcast networks.

The DAB System employs a modulation scheme known as Coded Orthogonal Frequency Division Multiplex (COFDM), which transmits high-rate digital data through parallel low-rate signals using numerous sub-carriers that are orthogonal to each other. Thus, the technology is known to be very robust in fast fading channels.

Audio and data signals are source and channel encoded, and time-interleaved in the DAB Audio Frame Path and the Packet Mode Data Path, respectively. In the DAB Audio Frame Path, the audio source encoding scheme complies with ISO/IEC 11172-3 (MPEG-1 Audio Layer 2) and ISO/IEC 13818-3 (MPEG-2 Audio Layer 2). This audio data includes Program Associated Data (PAD), which delivers dynamic range control information, labeling information, and small amounts of text and graphic data. In addition, audio independent data services, Non-Program Associated Data (NPAD), can be provided through both continuous stream and data packets, which are called stream mode and packet mode, respectively. The encoded applications explained above are finally multiplexed into Common Interleaved Frames (CIF) in the Main Service Multiplexer every 24 ms.

In the transmission frame multiplexer, the CIFs are combined with the Fast Information Channel (FIC), which contains service and multiplex configuration information. The transmission frames are modulated in the COFDM modulator through the $\pi/4$-Differential Quadrature Phase Shift Keying (DQPSK) method to form different types of COFDM symbols, which constitute Synchronization, FIC, and Main Service Channel (MSC). Before the modulation process, as inner channel coding, the convolutional bit-interleaving technique is used to satisfy a Bit Error Rate (BER) level of less than $10^{-4}$. Finally, RF conversion is applied to the modulated DAB signal and transmitted over the air after high-power amplification. In order to cover various transmission environments, the transmission modes are defined with a combination of different frequency bands and applications.

(2) T-DMB (Terrestrial Digital Multimedia Broadcasting)

At the time of the first design of the Eureka-147 DAB system in the 1990s, the major objective was to provide high quality digital audio through 1.5 MHz system bandwidth. However, during the changeover period from the DAB to the T-DMB system, due to the widespread adoption of mobile communication terminals, there was an increased necessity for moving picture services to be included in the terminals. After absorbing the results of a trial and error process to upgrade the traditional DAB system, and then combining them with recent high technologies, the T-DMB system became a reality.

The T-DMB system upgrades the traditional DAB system in the source coding and channel coding areas. The source coding technology compresses the video signal into smaller data size than before, and the channel
coding technology gives greater robustness by using the spaces remaining as a result of compression. For the compression, MPEG-4 technology was used, and Reed-Solomon and byte interleaving technology were used for the additional channel coding scheme.

**Additional Error Protection Mechanism**

<table>
<thead>
<tr>
<th>Description</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency band used</td>
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<tr>
<td>Bandwidth</td>
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<tr>
<td>Modulation method</td>
<td>DQPSK</td>
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<td>Transmission method</td>
<td>OFDM</td>
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<tr>
<td>Channel coding</td>
<td>RS(204,188), Convolutional Byte Interleaver</td>
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<td>Multiplexing</td>
<td>MPEG-4 SL, MPEG-2 TS</td>
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<td>Audio</td>
<td>MPEG-1/2 Layer 2(MUSICAM)</td>
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<td>A/V CODEC</td>
<td>Video: MPEG-4 Part 10 AVC(H.264)</td>
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<td></td>
<td>Audio: MPEG-4 Part 2 BSAC</td>
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<td>Data service</td>
<td>MPEG-4 Part 1 BIFS</td>
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<td></td>
<td>PAD, NPAD, TDC, MOT, BWS, IP-tunneling,</td>
</tr>
<tr>
<td></td>
<td>Slideshow, TTI, middleware, etc.</td>
</tr>
</tbody>
</table>

A. Video Coding

AVC|H.264 is the state-of-the-art video compression standard developed by the Joint Video Team (JVT) of the ISO/IEC Moving Picture Experts Group (MPEG) and the ITU-T Video Coding Experts Group (VCEG). The coding algorithms of AVC|H.264 are based on the same block-based motion compensation and transform-based spatial coding framework of prior video coding standards such as the MPEG-2/4 Video scheme. However, it provides higher coding efficiency, namely a 50% coding gain against the MPEG-2 video coding
scheme, owing to highlighted features, such as enhanced ability of prediction, transform methods, and entropy coding methods. AVC|H.264 also has certain features that improve error robustness and flexibility for operation over various types of network, including the Network Abstract Layer (NAL) unit syntax structure, Parameter set structure, Flexible Macroblock Ordering (FMO), Arbitrary Slice Ordering (ASO), redundant pictures, and data partitioning.

There are three different profiles available in AVC|H.264, and the baseline profile at level 1.3 is adopted by T-DMB. However, some of the features in the baseline profile, such as FMO, ASO and redundant pictures, are not used in T-DMB system.

B. Audio Coding

Bit-Sliced Arithmetic Coding (BSAC) is one of the MPEG-4 general audio coding tools based on the perceptual coding approach, as used in the MPEG-2/4 Advanced Audio Coding (AAC) scheme. The compression methods of BSAC are similar to those of AAC except for the lossless coding algorithm, ensuring that the coding efficiency of BSAC is almost the same as that of AAC. HE-AAC, also known as AACPlus, is the combination profile of two MPEG audio technologies comprising AAC and Spectral Band Replication (SBR). The SBR tool in the HE-AAC profile improves the performance of low-bitrate audio codecs by increasing the audio bandwidth consequently, the HE-AAC profile provides significantly better audio quality than AAC at lower bitrate (under 48 kbps). Both BSAC and HE-AAC are defined as audio compression schemes in the DMB specifications of ETSI.

C. MPEG-4 Systems

MPEG-4 Systems is not only the standard for packetization, synchronization, and multiplexing as provided in the MPEG-1 and MPEG-2 Systems, but also the standard for Scene Description (SD) for screen composition, and Object Description (OD) for contents. MPEG-4 Systems comprises the Delivery Layer for multiplexing, the Synchronization Layer for synchronization, and the Compression Layer for data compression, thus compressing and sending/receiving MPEG-4 contents are performed organically. Scene Description is the information on the temporal/spatial composition of each coded media object, and provides interactive functionality, while Object Description provides attribute information of each object.

MPEG-4 Systems has various formats of profiles for application to diverse devices and applications. Profiles are comprised of onion structures, making each of them compatible. T-DMB adopts Core2D profile/Level 1 for its Scene Description and graphics, and thus it is expected to help activate MPEG-4 Systems-based interactive broadcasting.
D. MPEG-4 over MPEG-2 Systems

MPEG-2 Systems is a widespread transport infrastructure in digital broadcasting environments. MPEG-2 contents is composed of a natural video stream and an audio stream; however, an interactive MPEG-4 contents consists of a variable number of media streams such as multiple video streams, audio streams, and images. The abovementioned difference between the media configurations of MPEG-2 and MPEG-4 requires another multiplexing mechanism in order to carry MPEG-4 contents over the MPEG-2 Systems.

"MPEG-4 over MPEG-2" has been standardized to transmit MPEG-4 contents in the MPEG-2 Systems environment. It provides a multiplexing mechanism that packetizes MPEG-4 contents into MPEG-2 TS and synchronizes MPEG-4 OCR (Object Clock Reference) with MPEG-2 PCR (Program Clock Reference). In addition, it provides a buffer model for the management of buffers such as the TB (Transport Buffer), MB (Multiplex Buffer), and DB (Decoding Buffer) in the terminal's decoder.

3.3 Technologies for Emerging Service

(1) Data Services (BWS, Slide Show etc.)

T-DMB includes data transport protocols such as MOT (Multimedia Object Transfer), IP (Internet Protocol) Tunneling, and TDC (Transparent Data Channel), which are specified in the Eureka-147 DAB specification for the provision of various data services. The MOT protocol specifies the protocol for broadcasting various object data through the DAB data channel. That is, the MOT protocol defines the fundamental expression and manipulation of the multimedia objects including text, static image, moving picture, audio sequence, and the like. Moreover, the MOT protocol is designed to be suitable for the transmission of various multimedia objects so as to guarantee interoperability, although the manufactured heterogeneities of the transmitter and receiver or the heterogeneities of the data service and application exist.

Broadcasting protocol stack in T-DMB

Data services using such data transport protocols include BWS (Broadcast Website) and Slide Show, and other similar services. By using the MOT protocol, BWS sends all files related to a website, and then receives them at the receiver and provides a service through the web browser. In that way, BWS provides a similar service as the Internet web service. The following illustration shows the configuration diagram and service example of the broadcast website service using the MOT. In the transmission side, the web page files, in which several files are linked, are repeatedly sent in the form of a carousel. These links are expressed as URL on the web page, and the BWS server designates the URL regarding the files transmitted in the MOT carousel. In the receiver, the files are obtained through the URL corresponding to the Internet address. Essentially, the receiver stores the web page files in advance and then presents them to the user.

Slide Show Transmits the objects of the successive images via the DAB transmission system, and then receives them at the receiver for provision of the multimedia service. The Slide Show service, using the MOT protocol, also sends the images repeatedly. Therefore, the bit error generated in the wireless broadcasting channel can be corrected and user random access is also possible. Moreover, in order to compensate for the reception delay, (which is generated due to the fact that the receiving conditions differ according to each terminal), the images are transmitted in advance and the presentation time is controlled by setting up the trigger time parameter.

(2) Interactive Data Service (BIFS)

The most valuable functionality in T-DMB is mobile TV service, which has been known for a fixed one. Another promising functionality is interactive data service. This service provides viewers with the ability to initiate an ancillary data service, enabling viewers to use additional data selectively. This interactivity is provided by an international standard, MPEG-4 Systems. Because BIFS (Binary Format for Scene) is one of the core parts in the MPEG-4 Systems specification, often interactive data service is referred to as the BIFS service.
The MPEG-4 Systems standard provides a functionality for managing individual multimedia objects including audio, video, image, 2D/3D graphics and text data in order to compose a scene in terms of the spatiotemporal positioning of objects, as well as the behaviors triggered by the viewer's interactions and/or time events. Therefore, it provides a far more active, mobile rich-media consuming environment compared to the traditional fixed and passive AV service. The capability of the interactive data service combined with a mobile communication link will accelerate the era of convergence between broadcasting and telecommunication.

MPEG-4 Systems specifies essential information, such as scene description, object description and synchronization among various types of media streams, to describe and communicate the coded representation of interactive contents. The scene description addresses the organization of audio-visual objects in a scene in terms of both their spatial and temporal attributes. This information allows the composition and rendering of individual objects properly; it also defines the behavior of each object by user inputs and/or time events. The object description identifies and describes the media streams. This information also associates media streams appropriately to a scene description.

MPEG-4 BIFS is a scene description scheme that provides interactive functionality for media objects and the spatiotemporal positioning of objects. The foundation of BIFS is VRML (Virtual Reality Modeling Language), which is a modeling language that structures 3D virtual reality. The hierarchical structure expressed by a scene graph organizes objects in an object-oriented manner. BIFS provides a flexible combination of media objects by accommodating the functionalities of scene composing, replace/insert/delete scene, and binarizing on the basis of the structural characteristics. The following illustration shows an example of scene composition using MPEG-4 BIFS.
The basic elements forming BIFS are nodes. A set of nodes describes a scene, and media objects are expressed spatially and temporally by associated nodes. The necessary attributes and environmental variables are assigned to a node by various fields in the node. The fields of a node also provide a handle to process events by linking the Sensor and Route nodes.

Besides the scene description, OD (Object Descriptor) is required for each media object. OD provides the type, attribute, and decoding environment of a media object. The leaf nodes of the scene description tree usually associate to media objects. OD connects a media object described in the scene description to actual media content.

The streams comprising T-DMB contents (BIFS, OD, and media streams) are MPEG-4 SL (Sync Layer) packetized for the synchronization of media streams. SL packetized media streams (audio, video, JPEG, and PNG) are PES (Packet Elementary Stream) packetized. OD and BIFS streams are PES packetized if timing information is required. Otherwise, they are packetized by the ISO/IEC 14496 section. Both PES and 14496 section packetized streams are multiplexed and packetized into MPEG-2 TS (Transport Stream). Then, this TS is transmitted over the air after the additional channel coding schemes described in Section 3.2 have been applied.

(3) T-DMB Middleware

The data services such as BWS and slide show currently provided in T-DMB are simple types of information provision, and thus have certain limitations in providing data services in which viewers can participate. T-DMB middleware provides an execution environment for such premium broadcasting convergence interactive data services regardless of the terminal platforms. To that purpose, T-DMB middleware based on JME (Java Micro Edition) CLDC/MIDP 2.0 has a structure by which linkage with the wireless internet platforms in mobile communication terminals can be achieved to a certain extent.

The T-DMB middleware has main functions for application reception and management, and provides high-level functionalities to the applications. The architecture of the T-DMB middleware is shown in the following figure. An operating system (OS) supports the middleware engine placed below the upper middleware API. In particular, the protocol decoder in the middleware engine receives and decodes data transmitted through various broadcasting protocols such as MOT, TDC, and IP tunneling. The application manager, a major entity in the T-DMB middleware, supports a variety of functions such as application reception, application storage, application execution, and others.
The system structure of broadcasting system for data services based on T-DMB middleware consists of an authoring tool producing T-DMB middleware contents, a data agent processing real time data for T-DMB middleware contents, a broadcasting data server creating signalling messages and transmitting all of them.

T-DMB middleware provides bidirectional data services to users using the mechanism in which Java-based applications are downloaded through broadcasting or telecommunication network and a small amount of live data additionally needed for their behavior is transmitted at real time.

Therefore, Java-based applications will be created by authoring tool and then transmitted to broadcasting data server, real time data such as stock, weather, news related to these applications will be collected by data agent. Finally, data broadcasting server gives database functionality managing T-DMB middleware contents and effective scheduling mechanism taking account of service scenario or broadcasting/telecommunication network conditions.

The T-DMB system structure for T-DMB middleware services
The T-DMB middleware has these notable characteristics.

- **Contents development with convenience**
  The receiver equipped with T-DMB middleware provides an execution environment that is platform independent. As such, it enables the content developers and service providers to provide various kinds of services rapidly.

- **Program-associated services support**
  T-DMB middleware can provide program-associated services. In particular, it is possible for an application to run through a specific channel or a specific program. Moreover, it can overlay video program associated data on top of the video, reduce the video screen size, or move the video screen position.

- **Efficient use of bandwidth**
  After having been transmitted through a narrow bandwidth, the Java-based application runs automatically at the receiver when it contains its execution time or the user requests it. At this time, the application can display newly changed information in real time after taking a small amount of real-time data through a narrow bandwidth.

(4) **TTI (Traffic and Travel Information)**

Among many other services, the Traffic and Travel Information (TTI) service is widely considered to be one of the next sensational and lucrative applications of T-DMB. This is because T-DMB-based TTI service can be easily combined with the various Location-Based Services (LBS) and telematics.

TPEG (Transport Protocol Expert Group), a well-known TTI service protocol for DVB, DAB and Internet, is also the basic protocol for the TTI service in the Korean T-DMB network. As a byte-oriented, bearer and language-independent protocol, TPEG frames are transmitted through either TDC or MOT of the T-DMB. Among the several applications of TPEG, Service and Network Information (SNI) application is mandatory for any TPEG service. SNI possesses the information related to how all the other applications are configured in a service, so that a TPEG decoder can decode all TTI components inside the frames of the TPEG service.

Due to the traditional systems used in the FM-based TTI service, the Congestion and Travel Time information (CTT) application was adopted the basic Korean TTI service standard through the T-DMB network with Road Traffic Message (RTM) and Public Transport Information (PTI). Furthermore, relatively new types of applications such as Point-of-Interest (POI) and NWS (news) services also will appear to be popular in relation to LBS applications.
3.4 Essential Technologies

(1) CAS

Except for DMB video and basic audio services, Korea is planning to make some data services fee-based and various nations including China and Germany plan to make all the T-DMB services, including DMB video, fee-based. For this, CAS is the essential apparatus for allowing only subscribers with applicable usage authority access to service programs.

In T-DMB, broadcasting data is hierarchically multiplexed according to the program characteristics, finally
being multiplexed into one ensemble frame and then transmitted. Therefore, CAS should provide the pay-
services in the various multimedia services such as slide show, the BWS (Broadcasting Web Site), and the TTI
(Traffic & Travel Information) service, etc, in addition to DMB video and audio.

The T-DMB CAS is different from the existing CAS for DTV, which can be applied to only DMB video
data. That is, according to the hierarchical layer and characteristics of the service corresponding to each
multimedia service, one mode is selected among three scrambling modes - the sub-channel mode, the data
group mode, and the multimedia object transfer (MOT) mode and then the conditional access can be applied.
The control word, which is the key used in the scrambling process, is protected by a separate encryptor and
transmitted with scrambled broadcast data within DMB ensemble after encrypting the CAS data such as ECM
(Entitlement Control Message), and EMM (Entitlement Management Message), etc.

In the receiver, only justified subscribers who have usage authority regarding the corresponding service is
able to decode the encrypted control word and to be provided the service normally.
(2) DRM (Digital Rights Management)

DRM (Digital Rights Management), which refers to a solution for the protection and management of the intellectual property rights of digital contents, consistently protects contents by using encryption technology as well as by governing the distribution of the secured content in accordance with the usage regulations and rights.

Recently, the market witnessed the emergence of a variety of new products, such as the Portable Multimedia Player (PMP) combined DMB receiver and the USB-typed DMB receiver, which can be used on notebooks with a massive storage. In this way, video recording and replay are becoming popular ways of viewing T-DMB contents. However, the illegal copying and unauthorized distribution of commercial DMB contents could seriously encroach upon the profit model of a broadcaster and lead to serious copyright piracy problems. By systematically supplementing the conditional access system (CAS), DRM technology can ultimately contribute to improving the quality of the T-DMB service while creating a new profit model.

The DRM system applied to the T-DMB service is comprised of the following major subsystems: (i) A tool server that provides various DRM tools such as encryption, watermarking, and authentication functions; (ii) A license server that provides licenses containing information on the usage regulations and rights of DMB contents; (iii) An authentication server that provides authentication of the device; (iv) DMB terminals that provide support to encrypt/decrypt the recorded DMB contents and provide copy control and governed usage of the secured DMB contents on secondary devices such as STB, PC, PMP and PDA, etc.

The overall architecture of the DRM system as it is applied to the T-DMB service is shown in the following illustration.
3.5 Future Technologies

(1) Advanced T-DMB

Along with the successful commercialization of the terrestrial DMB service in Korea and the acceleration of efforts for its overseas expansion, a method is urgently needed that can consolidate its relative predominance over DVB-H, MediaFLO, and ISDB-T, all of which exist in competition to varying degrees with T-DMB in terms of both technological and service aspects. Currently, data transfer rate is one of the relative disadvantages of the terrestrial DMB system compared with these competing services. In the Advanced T-DMB system, data rate should be greatly improved so that the quality and service of terrestrial DMB can be upgraded once again.

In the case of high-quality services, for example, after separating a SD video source into the base and enhancement layer video signals, and encoding, the Advanced T-DMB transmitter sends the two video signals through one preexisting T-DMB channel at the same time by using the hierarchical layered modulation technique. With the hierarchical modulation technique, the base and the enhancement layer have different error performances. The legacy T-DMB terminals can recover only the base layer stream from the received Advanced T-DMB signal, therefore support only QVGA-quality T-DMB service. However, the Advanced T-DMB terminals can recover both the base and the enhancement layer stream. So, SD-quality Advanced T-DMB service becomes possible.

The constellation of transmission signal generated with the hierarchical layered modulation is shown in the figure below. The base layer video signal, transmitted in an identical format to the current T-DMB signal, chooses a quadrant in which the constellation point of the transmission symbol is positioned, while the enhancement layer video signal determines one of the four constellation points within the chosen quadrant. The enhancement layer video signal has less margin to errors than the base layer video signal because the Euclidean distance between the constellation points is relatively short, a defect which can be improved by adopting coherent detection with channel equalization, a strong error correction technique, or other similar process.
The high data rate implemented by Advanced T-DMB technology can provide not only high quality video but also an abundance of additional data services. Therefore, the development of the Advanced T-DMB system is expected to raise the service level of T-DMB and provide opportunities to obtain relative predominance over competing mobile TV systems through successful international standardization and commercialization.

(2) 3D DMB

Mobile reception of broadcasting services has recently got much attention worldwide. DMB, Digital Video Broadcasting Handheld (DVB-H), MediaFLO are such examples. Among them, Korea commenced commercial T-DMB broadcasting for the first time to provide mobile multimedia services in 2005. Telecommunication Technology Association (TTA) of Korean and ETSI in Europe established a series of specification for T-DMB video and data services based on the EUREKA-147 Digital Audio Broadcasting (DAB) system.

Increasing the reality is another direction of future multimedia services. There have been a lot of research activities on 3DTV and UD (Ultra-high Definition) TV concepts and systems, though most of them stayed at experimental level. Providing a viable 3DTV service to the level of current 2D television is not yet feasible due to several technological limitations. A wide flat panel 3D display for multiple viewers without using glassed is not mature yet, among other things. However, a small size auto-stereoscopic display has recently been mature to be commercialized for single user environment.

Providing mobility and increased reality is thus a promising direction for new multimedia services. Specifically, 3DAV service over T-DMB system is attractive in that it is aimed for a single user; it adopts a small-sized auto-stereoscopic 3D display which can be made with a pretty mature technology at a very
reasonable price; visual fatigue problem is reduced due to a small range of binocular disparity. We believe that a portable and personal 3DTV will be a valuable stepping stone towards realizing the ideal 3DTV for multi-users at home.

We are now developing a 3D DMB system backward compatible with the existing T-DMB system. At the same time, we are developing a highly effective video coding technology using motion and disparity information, which is similar concept to MPEG-4 temporal scalability.

The key feature of the 3D DMB audio is to transmit the multi-channel audio signal with maintaining the compatibility with the T-DMB. To do this, we separate the multi-channel audio signal to the stereo audio signal and the additional information which is consist of spatial cue parameters. And then, the stereo audio signal and additional information are coded and transmitted. Because the bit rate of the additional information is less than 4kbps per channel, it is possible to provide the high quality multi-channel audio service through the existing DMB audio bandwidth, which is restricted to 128kbps or less. Moreover, by using the additional information and HRTF (Head Related Transfer Function) in the receiver, the stereo audio signal can be converted to the virtual multi-channel audio signal. This is useful to the device which hasn’t multi-channel audio playback system such as mobile phone, PMP (Portable Multimedia Player), and so on.

3D DMB technology can provide users with 3D contents anywhere and anytime in the area of 3D broadcasting, advertising, home shopping, and so forth.

[2] ETSI EN 102 428 Ver. 1.1.1 "Digital Audio Broadcasting (DAB); DMB video service; User application Specification".


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