What is mobile DTV (MDTV)?

Which networks can deliver true DTV experience to mobile devices?

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Abstract

True Mobile Digital TV (MDTV) means watching live Digital TV (DTV) on mobile devices, with a user experience similar to the one the consumers are used to on their home TV. This means having a big variety of shows to watch, with high quality high frame rate video and quick response time for channel switching. While there are elements in the market that try to confuse true MDTV with other forms of TV/media distribution that offer poor quality video and a poor offering of channels, true MDTV is distributed through a dedicated broadcast MDTV network.

The most common alternatives of DTV distribution to mobile devices are to get the DTV content through the WiFi network or through the cellular network.

This article explains the different available methods, why the true MDTV experience can be achieved only by a dedicated broadcast MDTV network and how the MDTV offering can be broadened by wise usage of all the methods for distribution of DTV, which can provide the best value and best user experience to the consumer.

1 Methods for Mobile DTV distribution

1.1 Distribution of Mobile DTV through the cellular network

The cellular network is conceptually a unicast network, meaning that the content is transmitted to each receiver individually, even if several receivers are consuming the same content simultaneously. Thus with the current deployed and used technologies, distribution of mobile DTV content through the cellular network is no different than the distribution of any other data through the cellular network.

There are some technologies for broadcasting content over cellular networks, including Multimedia Broadcast Multicast Service (MBMS), Integrated Mobile Broadcast (IMB), and Evolved MBMS (e-MBMS) for LTE networks. These technologies are currently either not mature yet or not widely used (i.e. deployed). Nevertheless, though currently cellular networks use unicast transmission for distributing DTV content, this article refers also to optional future usage of these broadcast technologies.

The main concern that is related to mobile DTV distribution is its relatively high bandwidth requirement. Watching live DTV content at good quality on mobile devices requires continuous reception of streaming audio/video (A/V) content at a rate of about 500Kbps. This reception rate enables the display of good quality video at QVGA resolution and at a frame rate of 30 frames-per-second (FPS).

In developed countries, current cellular networks are already congested with the increase of video consumption (YouTube, etc.), live gaming, web surfing and other data-consuming applications over mobile devices. These networks do not have the bandwidth to provide live DTV services with a similar user experience to stationary DTV in terms of video quality and content variety. Recent testimonials to this problem were made public by AT&T, which is now setting a cap for its subscribers' data usage, since they need to “ease the congestion” (http://blog.taragana.com/index.php/archive/theres-a-cap-for-that-att-will-limit-data-consumption-for-new-smart-phone-users /).

Although in developed countries the coming years will see the current 3G cellular network be upgraded to a 4G network based on LTE technology, the bandwidth requirement problem of live DTV will still not be solved with the LTE network.

According to IDC *“Verizon expects LTE average data rates of 5 to 12 Mbps on the downlink and 2 to 5 Mbps on the uplink in real-world environments”.* This bandwidth is not enough to serve even a handful of users who consume live DTV simultaneously without severely harming the network’s capability to provide voice and data services.

This bandwidth shortage is relevant not only to the end base station, but also to the entire cellular backhaul. Cellular networks are designed for average usage, for cost reasons. They cannot service “all users at once”. So, even future 4G cellular backhauls will collapse in case of massive live DTV consumption, for instance when a major sport event is transmitted, when a popular TV show is transmitted or in the case of an emergency, like a hurricane or another disaster.

The following quote from a white paper of IDC from March 2010, summarizes the incapability of cellular networks to distribute live DTV content *“… the cost of providing video broadcasts over the cell networks — even 3G and 4G networks — is prohibitive because the unicast nature of these networks was not designed to serve broadcast-sized audiences simultaneously.”*

As mentioned before, there are technologies for broadcasting content over cellular networks. What follows is a brief description of these technologies and of their inherent weaknesses that originate from the structure of the cellular network.

Multimedia Broadcast Multicast Service (MBMS), is a point-to-multipoint service in which data is transmitted from a single source entity to multiple destinations, allowing the networks' resources to be shared. However, there are several obstacles related to the high-power requirements of MBMS from the base station. These requirements severely diminish the efficiency of MBMS over regular unicast transmissions. Currently, though MBMS was standardized several years ago, it has not been adopted by any cellular operator.

Integrated Mobile Broadcast (IMB) is a new technology adopted by the 3GPP committee. IMB is intended for delivering point-to-multipoint service over the TDD spectrum of current 3G networks, without affecting the FDD service. Many European mobile operators own or lease this spectrum, but currently it remains largely unused because of a lack of appropriate technology.

Although IMB is a cellular technology, it requires a completely separate dedicated end-to-end infrastructure and a dedicated receiver at the device. IMB is still an immature technology and is just at pilot trial, but still it can be predicted that the cost of IMB network deployment will be much higher than the cost of a broadcast MDTV network. A broadcast

MDTV network requires only a very small amount of transmission stations. More on broadcast MDTV and about its transmission infrastructure is described in chapter 2.3. On the other hand, IMB requires an immense amount of transmitters – owing to the following

- IMB should fit into the cellular network with its widely scattered base-stations.
- Short propagation distance of the relatively high frequency band that IMB uses (1900MHz-1920MHz).
- Relatively low power that is used for cellular transmission, including IMB.

Other than that, IMB is relevant only for 3G networks that have unused TDD spectrum and is not relevant for future LTE networks. In LTE networks there will be no such unused TDD spectrum and the 3GPP has standardized another method named Evolved MBMS (e-MBMS) for multimedia broadcasting over the LTE network. The concept of e-MBMS is similar to MBMS, and it suffers from the same inherent high-power requirements of MBMS. Nevertheless, cellular networks could provide complimentary service to the broadcast network and be used in order to distribute the less popular live DTV content that is not going to be carried by the broadcast network. Chapter 3 further broadens this concept of using the multiple DTV distribution method in order to achieve the best value and best experience to the consumer.

1.2 Distribution of Mobile DTV through the WiFi network

As with the cellular networks, the high bandwidth requirement of live DTV distribution is relevant also for WiFi networks, although it is less severe. This is because WiFi networks have higher bandwidth than cellular networks. Apart from the total bandwidth requirement, live DTV content distribution is also not tolerant for bandwidth and delay fluctuation. For that purpose modern WiFi networks as well as the Internet network, incorporate Quality Of Service (QAS) mechanisms that are already in use for applications such as IPTV.

The main problem with the WiFi networks is their coverage. WiFi networks by themselves cannot provide a solution for live DTV distribution to mobile devices due to their limited coverage. Nevertheless, they could provide a complimentary service to the cellular network for live DTV distribution. This complimentary service could be used in order to distribute the DTV content through the WiFi network instead of through the cellular network, wherever a WiFi network is available.

1.3 Distribution of Mobile DTV through the dedicated Broadcast network

Broadcast networks for distribution of live DTV content to mobile devices, are dedicated networks that are deployed for this purpose. These networks are similar to the broadcast networks that are used for distribution of live DTV content to stationary TVs, though there are some characteristics that distinguish between these networks and will be further explained in this chapter.

Contrary to reception of live DTV from the cellular or WiFi network, which does not require any dedicated hardware on the device, reception of broadcast DTV requires special hardware. This special hardware includes dedicated antenna and dedicated receiver chip.

A basic architecture of a cellular device, which supports reception of broadcast DTV is described in the following figure.

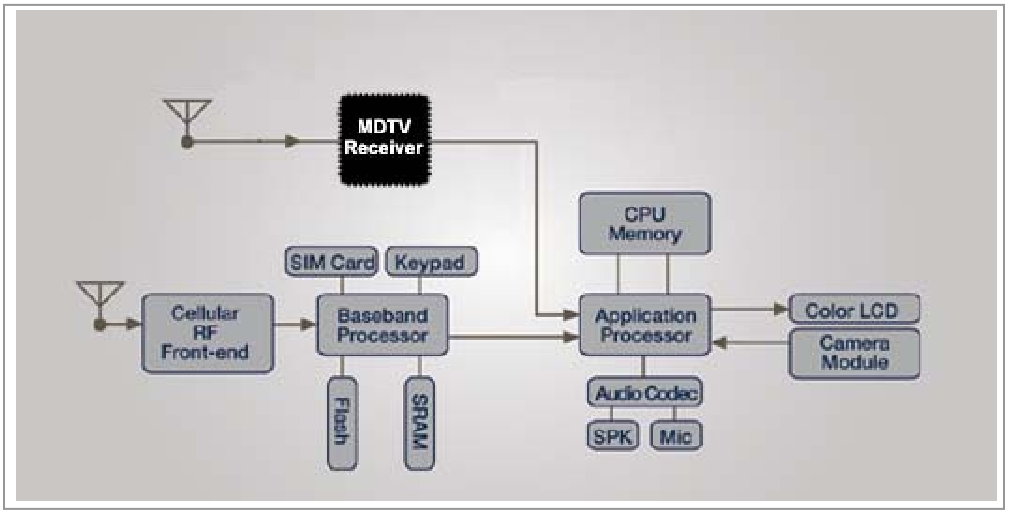

Figure 1: *Basic architecture of cellular device with broadcast DTV support*

As with regular broadcast DTV networks, Mobile Digital TV (MDTV) networks also use high power transmitters, transmitting from a small amount of high TV towers to cover big metropolitan areas. The number of transmitters depends on several parameters such as the transmitter's power, the TV tower height, etc., but usually one to five such transmitters could cover a big metropolitan area, such as Tokyo or Shanghai.

Due to the broadcast nature of the transmission, the transmission serves an infinite amount of concurrent users. Like regular broadcast DTV networks, the MDTV networks also use the VHF/UHF bands that have been cleared thanks to the transition from analog TV to digital TV transmission and the shut-down of analog transmissions. The following figure is an example of two channels subset of the broadcast DTV network in Washington DC.

Figure 2: *DTV network example*

Unlike regular broadcast DTV networks which use modulation schemes intended for stationary TVs, MDTV networks use modulation schemes that are optimized for reception by mobile devices with small screens, limited power, etc.

The optimization includes:

- Transmission of TV channels in low resolution that matches the resolution of popular mobile devices
- Embedded mechanism that enables reception of the TV content by devices with small antennas incorporated
- Embedded mechanism that enables reception of the TV content while moving at high velocity
- Embedded mechanism for low power consumption during reception of the TV content

1.3.1 Short history of broadcast mobile DTV

Although broadcast MDTV is a relatively new technology, quite often standards have emerged for it. Different countries adopted different standards and many countries are still debating about the standard that they should use. The following map shows the most updated information about the adoption of broadcast MDTV around the world.

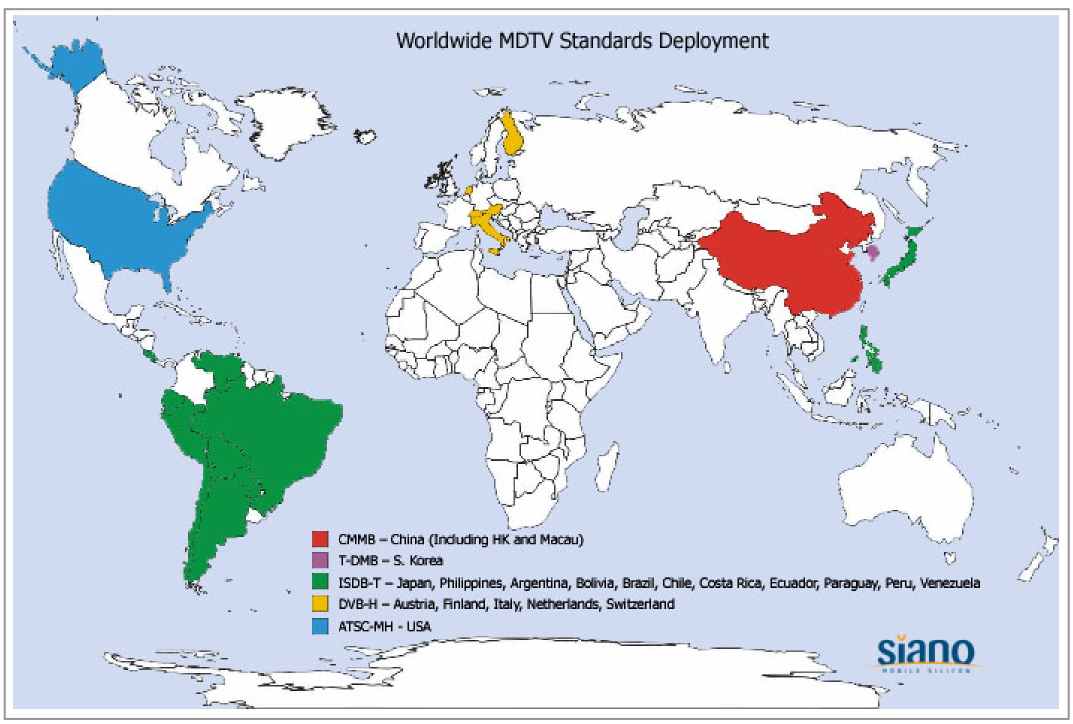

Figure 3: *Adoption of broadcast mobile TV around the world*

Deployment of dedicated broadcast networks for mobile DTV started as early as 2006. Deployment of DVB-H started in 2006 in Italy, and in 2008 the DVB-H standard was endorsed by the European Union as the preferred technology for terrestrial mobile broadcasting.

The ISDB-T 1-seg Service in Japan began experimentally during 2005 and commercially on April 1, 2006. In Brazil, broadcasting of ISDB-T 1-seg started in late 2007. Currently most of the South American countries have adopted ISDB-T and are starting commercial services with it.

The T-DMB service in South Korea started at the end of 2005 and full service has been available since 2006.

The CMMB service in China's 37 largest cities started before the Olympic Games of 2008, and the commercial service in more then 300 cities started at the beginning of 2010.

The MediaFLO service in US started on March 2007 by Verizon, and on May 2008 by AT&T. The first non-phone TV-only devices were released in late 2009.

While broadcast mobile TV was a great success in some part of the world, such as Japan and South Korea, with penetration of up to about 90% of cellular devices in Japan, broadcast TV in other parts such as Europe was a failure. In China and South America it seems that broadcast mobile TV is going to follow the Japanese and South Korean success, though real commercial service in these counties has only just started.

The reason for the failure or success of a broadcast mobile TV is related to many things such as the spectrum availability, regulations, business models, the conditional-access concept, etc. and are beyond the scope of this paper.

1.3.2 Advantages of broadcast mobile DTV

Unlike cellular networks or WiFi networks, the broadcast networks never get congested. Therefore no matter how many viewers watch a TV show in parallel, they never experience any degradation in the video quality or availability due to network overload.

Since the cost of broadcasting DTV content is constant and does not depend upon the amount of viewers, for popular TV channels it is much cheaper to transmit the DTV content through the broadcast MDTV network than through cellular or WiFi networks.

2 The best user experience and value to the consumer - Usage of multiple DTV distribution methods

Each one of the described DTV distribution methods can be used for live DTV distribution and each one of them is more suitable for different types of DTV content distribution.

The cost of DTV content distribution with broadcast MDTV is constant per TV channel, no matter how many viewers watch a TV show in parallel. Therefore broadcast MDTV is a very efficient way for distributing a small amount of popular TV channels. For the same reason, broadcast MDTV is not that efficient for distributing of less popular channels.

On the other hand, cellular and WiFi networks care only about the number of viewers who watch live TV and not about the number of channels, so they are very efficient for distribution of the less attractive TV channels.

The following figure describes how channels' audience volumes are divided between the different channels. Most of the audience watches the 10-20 most popular channels, while only a small audience watches the many other channels.

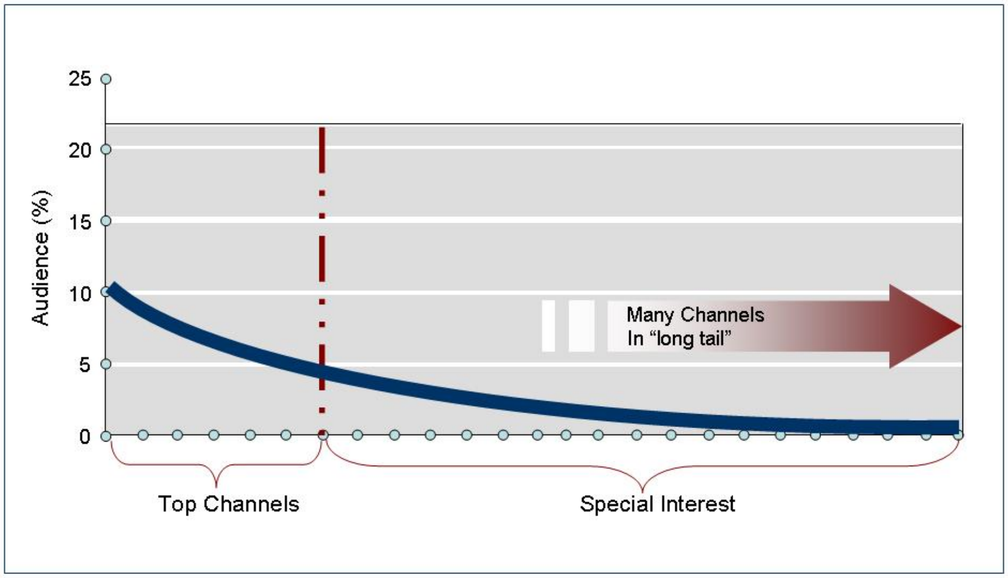

Figure 4: *TV channels audience*

3 Summary

Mobile device users are becoming more and more multimedia-savvy, consuming data-rich applications, web-surfing and also high quality live TV content, like live sports events, live news, live whether reports, or their favorite shows. Cellular and WiFi networks cannot serve this demand due to their inherent unicast network architecture, and due to the enormous bandwidth that is required to serve a wide audience of live TV. The outcome is a poor user experience when watching live TV on these networks or worse than that, even a complete crash of the service in the event of excessive demand. Conversely, broadcast MDTV networks can easily provide this demand. Furthermore, broadcast MDTV is the only option for watching live DTV with mobile devices that do not have cellular or WiFi connectivity.

A wise service offering can exploit the advantage of the broadcast MDTV network as well as the cellular and WiFi network and provide the 10-20 most popular TV channels through the broadcast mobile TV network and a complimentary offering of the other less popular channels with the cellular and WiFi networks.

About the Author

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Mr. Klein joined Siano in May 2007 and served as the CMMB program manager, responsible for the development of Siano's first CMMB chip. In August 2008 Mr. Klein became the Director of the CMMB product line; responsible for Siano's CMMB related marketing activities. He assumed his current position in January 2010.

From 2003 to 2007 Mr. Klein held key engineering positions in Metalink – a fabless semiconductor company which developed chips for xDSL and for 802.11n. As part of his responsibilities, he served as principle architect of Metalink.

From 2000 to 2003 Mr. Klein served as a Chief architect and project manager in Tiaris – a fabless start-up company.

From 1997 to 2000 Mr. Klein held key engineering positions in Zoran – a fabless semiconductor company. As part of his responsibilities, he served as a manager of architecture and algorithms development team.

From 1993 to 1997 Mr. Klein served as a VLSI developer in Motorola Semiconductors.

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