ABSTRACT
This survey paper tries to investigate the boundaries of fixed line IPTV and Mobile TV Services. In particular, we look at the infrastructure implications and the standards that have been established to provide IPTV services for a mobile user. We postulate a convergence that will unify the fixed, mobile and peer to peer TV services. Examples and use cases are provided to illustrate this convergence.

Keywords
IPTV, 3G Mobile TV, MBMS, BCMCS, DVB-H, DMB

1. INTRODUCTION
IPTV describes a system whereby a digital television service is delivered to subscribing users using Internet Protocol over a broadband connection. This service is often bundled with Voice Over IP, Video On Demand and traditional Internet services like web access. Many service providers call it Triple Play where the three dimensions are namely Voice, Video and Data. A couple of questions immediately come to mind. Are these technologies heading towards a convergence? What does this mean for mobile users with the same need? In this paper we address the momentum for such a convergence and visit technologies and standards that the operators are implementing to provide mobile TV services.

IPTV promises to offer viewers an innovative set of choice and control over their TV content. Two major U.S. telecommunications companies, AT&T and Verizon, have recently announced significant investments to replace the copper lines in their networks with fiber optic cables for delivering many IPTV channels to residential customers. Similar investments and interests are also happening in Europe and Asia.

Mobile TV services require networks that support high data rates, low latency and better than best effort quality of service (QoS). Multimedia application require higher priority QoS compared to pure data to ensure lower latency. Current cellular networks (2.5G and 3G) can support variable data rates and low latency requirements, but cannot support high bandwidth application such as video. On the other hand, mobile broadcast networks can potentially support a large number of users within the area of coverage for transmission towers in “transmit only” mode. However, to offer services similar to IPTV in a home, the cellular networks must handle personalization services or interactivity like video on demand. These require an uplink request path from the mobile device to the network. The juxtaposition of broadcast and cellular networks that can leverage low latency and bidirectional capabilities of a cellular network and a high capacity broadcast network is essential in creating innovative services. It is this aspect that we revisit in this paper, in particular look at the implications for the cellular network service and its impact on the evolution of the standards.

IMS TV - IP Multimedia Subsystem (IMS) is a next generation networking architecture for telecom operators that want to provide both fixed and mobile multimedia services. Telecommunication operators can provide services to users regardless of location, access technology and terminals. However, it is important to note that while IMS provides a well defined architecture for multimedia based applications, there is still some work needed in its interworking with IPTV infrastructure. IMS application servers may interwork to offer access to presence, location, call control and other network resources. For peer to peer services, operators are looking at deploying multi-player games, media sharing and multimedia streaming. It is possible to deploy such P2P services that bypass the operator, however, in “IMS based P2P services” authentication, registration, service discovery, address resolution and recipient invitation will be provided by the IMS infrastructure.

Convergence for all the above mentioned systems (fixed, mobile and P2P) is taking place, and the migration towards a unified architecture is envisioned. IMS will be the platform of choice for many operators to provide end users a wholistic communications portfolio encompassing interworked triple play services. A converged IMS-TV solution will provide converged subscriber management, converged content and device management with the ability to couple session mobility. Figure 1 illustrates this.
2. TECHNOLOGY CHALLENGES

Mobile video and TV services, even person-to-person applications (e.g., video messaging), are still in the very early stages of consumer adoption and it is difficult to assess what end-user demand ultimately will look like.

2.5G and 3G cellular networks have enough capacity to handle the current traffic load from data and video services. As mobile video services and accompanying handsets become more widely accepted, there will be a bigger push for cellular providers to consider offloading traffic to mobile broadcast networks. However, timing for this scenario is unknown until service providers better understand user demand for these services.

Broadcasters need to vacate spectrum bands that have been allocated for mobile broadcast networks.

Compelling mobile TV solutions will not be ready for prime time until 2007, when a wide range of handsets become available, user demand for related services is better understood and network topology is optimized for both broadcast and cellular usage.

3. IMPLICATIONS FOR MOBILE TV OPERATORS

What does this mean from a cellular network provider’s standpoint? Web TV is being drafted by the W3C committee [7]. This group is trying to standardize a broadcast markup language with a goal to explore new issues arising for Web technology due to TV/Web integration. IETF has been working on IP TV standards as well [2]. It has been recognized by the industry that an overall standardized framework is mandatory for bringing success to the IP TV market. Members of the IETF have standardized Real-time Transport Protocol (RTP) that defines a transport layer for carrying the multimedia streams, however the missing link is in how the data will be organized within the transport layer. Media delivery networks today must be able to support each user downloading different content in different ways. This complex infrastructure must also deal with the fact that each user may now want to send back information to the server. The direct implication for a cellular provider is to be able to capture a large number of asynchronous content uploads from the numerous users and redistribute this content to their friends on the downlink. Alternatively, in a peer-to-peer model, users may want to share content with other subscribers directly. This model is effective if the content is reasonably standardized and the software/hardware is also reasonably standardized. In the case of broadcast television networks, television hardware has for the most part been reasonably consistent [3]. The same is not true for cellular phones where form factors can vary considerably.

Cellular networks obey an inverse relationship between the number of users, the performance/capacity in a cell site and service latency. Due to the limited shared radio resource and spectrum availability, increasing the number of users limit the performance and capacity of the cell site. On the contrary, mobile broadcast networks offer a fixed amount of capacity regardless of the number of instantaneous users. Such a network however, cannot provide personalized services due to its inability to support interactivity.

A marriage of the two networks’ (broadcast and cellular) capabilities will be ideal whereby a user can enjoy high bandwidth applications while at the same time have interactive personalized services. Towards this end, there are several technology trials that are concentrating on mobile TV tech-
4. A LOOK AT COMPETING CELL PHONE MULTIMEDIA BROADCASTING TECHNOLOGIES

In the following sections we will attempt to give an overview of the mobile broadcasting standards. More specifically, we will touch on emerging broadcasting technologies namely Digital Multimedia Broadcasting (DMB), Digital Video Broadcasting - Handheld (DVB-H), 3GPP’s Multimedia Multicast Broadcast Service (MBMS) and 3GPP2’s Broadcast Multicast Service (BCMCS). Each has its own advantages and disadvantages. Figure 2 shows the classification of the various standards available worldwide [8].

4.1 Digital Multimedia Broadcasting - DMB

Digital Multimedia broadcasting, DMB is based on the Eureka 147 Digital Audio Broadcast or DAB system that is widely deployed in the UK and many other countries and now gaining considerable popularity. This system could be used without much modification, simply increasing the level of error correction to cope with the mobile environment. Eureka 147 / DAB uses a form of transmission known as Coded Orthogonal Frequency Division Multiplex (COFDM). It uses a large number of close spaced carriers, each carrying low rate data. These carriers are arranged so that they are orthogonal and do not interfere with each other. This allows very efficient use of the bandwidth used. For DAB and DMB each transmission occupies approximately 1.5 MHz bandwidth and for the VHF broadcasts the transmission contains 1536 Carriers. DMB is also ideally suited to the delivery of material to handheld devices. DAB inherently includes time slicing by using an effectively using a Time Division Multiplexing delivery method. In this way the receiver is only switched on when it is required, thereby saving battery power.

4.2 Digital Video Broadcasting (DVB-H)

The other standard is Digital Video Broadcasting - Handheld, DVB-H and this is based upon the DVB-T (Digital Video Broadcasting - Terrestrial) standard that is used for digital television transmissions within Europe and other countries. The basic DVB-T television standard has been modified to enable the receivers to be less power hungry, as DVB-T is used in an environment where power consumption is not a major consideration. This power reduction has been achieved by time slicing so that the receiver is only switched on in those time intervals when viewing the channel of interest. These intervals could be anything between a few milliseconds and a few seconds. It therefore reduces power consumption by being switched off for the rest of the time when non-required data is being transmitted. There is therefore a trade off between the data rate required for the service and how much this can be packed into short bursts to save the battery power of the receiver.

Like DMB, DVB-H uses COFDM but with a bandwidth of either 6, 7, or 8 MHz. Additionally it uses a range of different types of modulation from QPSK up to 64QAM and this enables it to have a very high data rate. However it is more susceptible to signal variations and synchronisation problems. Additionally higher transmitter powers are required than those needed for DMB. Also frequencies that are likely to be used have not yet been allocated but it is thought they might be within the existing television bands. The wide RF bandwidth also means that current drain is increased, as wide bandwidth amplifiers are inherently more power hungry. Although not orders of magnitude greater than that required for DMB, it nevertheless will have an impact.

Trials and development are under way for both systems. Korea has lead the way with trials of DMB, and many other countries are looking at the options open to them. On the development front, LG Electronics has a DMB compatible phone, and Nokia is developing options for DVB-H.

Both DMB and DVB-H have their supporters, and which standard will win remains to be seen, although many predict that both systems will be used, but in different countries. What seems sure is that multimedia broadcasting will take off in a big way because it offers a low cost medium for accessing many video services. A lot of momentum has been gained for DVB-H in the past few months [4].

4.3 3GPP mobile multimedia standards, MBMS and BCMCS

The 3rd Generation Partnership Project (3GPP) standard for GPRS networks has been enhanced to offer significantly increased performance for packet data and broadcast services through the introduction of high speed downlink packet access (HSDPA) and multimedia broadcast multicast services (MBMS) [1]. Similarly for 3GPP2 CDMA2000 networks a novel broadcast and multicast service (BCMCS) has been standardized [5]. Both MBMS and BCMCS multicast approaches have challenges in its ability to move beyond best effort delivery. For 3G IP applications there is limited support for reliable multicast techniques. Reliable Multicast Transfer Protocol (RMTTP) enables designated receivers to collect status messages from nodes and provide repairs such as retransmission of missing data. Another protocol, Pragmatic General Multicast (PGM) provides reliable transport of multicast traffic with optional network assistance. Figure 3 shows a typical architectural elements of a BCMCS system.

The BCMCS content server resides in the serving network. The content server derives its content from a content provider. The content server can reformat multicast content prior to reaching the RAN. The content server may store or forward content from a content provider or aggregate content from multiple content providers. The Subscriber Profile Manager is an application that updates the subscriber profile in
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Figure 2: Mobile TV handset bearer technologies

Figure 3: 3GPP2 BCMCS architecture
the database with BCMCS-related access information. The AAA servers in the home and serving networks are RADIUS-compliant servers that authenticate and authorize users and store user service profiles. The AAA can allocate IP addresses for mobile subscribers and collect accounting records from mobile providers from the Subscriber Profile Database. The Packet Data Serving Node (PDSN) communicates with the BSC to add and remove IP multicast flows. It may use IP multicast protocols to manage bearers supporting IP multicast flows between itself and the nearest router connecting back to the BCMCS content server.

5. DEVICE AWARE CONTENT REPURPOSING AND RIGHTS MANAGEMENT

A framework needs to be established to repurpose content adaptively such that it is presented to the user in a reasonably consistent manner. In cable TV settop boxes, Tivo and ReplayTV record personalized broadcast programming for replay at later times. While such an approach matches the very philosophy of broadcasting to the more limited capabilities of a mobile device it will make this type of solution harder to achieve today. As devices become more content aware and standardized by virtue of the standards process or a particular vendor dominance in the market, it will become easier to deliver content to the network from the devices and vice versa. Content personalization can be handled by an adaptation proxy in the network which refers to a stored profile in the user’s home network subscriber profile manager (3GPP) for example. More capable devices will act as PVRs (Personal Video Recorder) in the way settop boxes, TiVO and DVRs do in the cable TV space. In the meantime as an alternative, services can be offered by the mobile TV operator; for example, a user request is made to the provider for recording a TV broadcast show which will later be delivered to the device (download and play or progressive playback). This type of feature however, corresponds to a VoD unicast solution where each customer has its own channel.

Mobile content will transform media and entertainment consumption worldwide. Traditional media and entertainment services have been augmented with new distribution channels (broadcast TV, papers, magazines, and now the digital age via mobile devices). Advertising and customer based revenue models have been integrated with subscription based revenue models. Leading vendors and operators expect DRM to protect the rights of all players in the industry value chain, while offering them an extension to the current model of distributing and selling content. To operators, higher usage of content download services means higher data traffic and revenue per user. Historically, the mobile value chain has been driven by mobile operators and equipment manufacturers. Today content providers are also eager to get a share of the pie. This convergence of the media and entertainment conglomerates (eg. Hollywood studios, Disney) together with the mobile industry is an evolution of the mobile value chain.

6. CONCLUSIONS

The key challenges to provide mobile TV services are quality of service, scalability, compression techniques and seamless integration of services. Service providers and handset vendors are closely watching which technology becomes the industry standard. Nokia for example, is already deploying DVB-H solutions with a keen interest on 3G mobile TV technologies as well. 3G mobile TV is breaking up traditional business models whereby mobile operators are establishing themselves as content aggregators and broadcasters. The media rights owners are licensing mobile rights directly to mobile operators. It is still uncertain as to what a viable model is for licensing rights to mobile operators. A brief overview of the various mobile TV technologies was presented together with a discussion on the implications for a cellular network operator to provide an IPTV environment for mobile users.

7. ACKNOWLEDGMENTS

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8. REFERENCES