The Future of Mobile TV: When Mobile TV Meets the Internet and Social Networking

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Abstract First-generation mobile TV has involved delivering content to cell phones. But as mobile TV evolves, it will find greater significance as part of a multifaceted video offering that combines multiple screens, devices, networks, and content types. Content, or a particular viewing session, moves with the user, across devices and across networks. Furthermore, in addition to providing an alternate screen, a mobile device may provide complementary functions like programming TiVo remotely, streaming video from the cell phone to the TV set, or creating video content for distribution on the Web and uploading it directly over wireless networks. In the new TV ecosystem, all end-user devices collaborate across the whole video value chain, from content creation to distribution to consumption. Finally, as mobile devices become integral components of the new video ecosystem, their personal nature will drive the development of social TV, defined as a new way of delivering TV based on users sharing all aspects of the experience within the context of social networks. This chapter presents our view of mobile social TV: a shared TV experience that uses the power of the Internet and social networks to "move" from screen to screen and network to network to unite family and friends.

Introduction

Over the past few years, on-line video services and telco IPTV have rocked the traditional model of television. As content delivery moves to an all-IP platform, connecting old and new providers to a growing array of increasingly personal and multipurpose devices over fixed and mobile networks, the TV experience has become extremely versatile. Mobile TV is not immune to these upheavals, and is itself a disruptive force. In fact, it will soon make little sense to think of mobile TV as distinct from TV in general. Rather, it will be an integral part of an increasingly rich TV experience.

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This chapter provides a vision for the future of mobile TV as it evolves from stand-alone to integrated service. This shift will be examined in context of the more general transformation of television, with a focus on the recent integration of social networking. Our vision will thus build toward community-based approaches that harness the power of individuals, from their technologies to their behaviors.

We begin by redefining mobile TV, and then give a brief overview of the key trends related to the television infrastructure and industry landscape. From there, we outline the mobile TV ecosystem of content, connections, and devices in more detail, and then demonstrate the growing importance of service features in this new environment, particularly in terms of integrating mobile and social TV.

We would like to point out up front that many of the scenarios described in the paper are fraught with issues related to usability, technical difficulties, business models, and/or legalities. We do not intend to provide solutions for resolving these challenges here; rather, we provide a conceptual framework for understanding the evolution of a multi-platform TV experience. (Also note that in this chapter we use the terms "TV" and "video" interchangeably when referring to content, as any distinction between the two has sufficiently blurred.)

Redefining Mobile TV

The term mobile TV typically refers to the delivery of video content to cell phones, including the carriers' packaged subscription services like VCast and premium mobile Web services like MobiTV, or more recently, mobile versions of on-line video services like YouTube. Mobile video adoption in the USA and in Europe is still low. According to Nielsen Mobile,[1] the percent of mobile subscribers who access mobile video each month in North America and Europe does not exceed 5%. In comparison, 50% of cell phone owners in Japan and South Korea watch video content on their phones. The number of mobile phone users who watch video on their cell phones, along with the number of mobile video applications, is, however, increasing. Overall, subscriptions to carrier mobile video services in the USA have risen by 24% from September 2007 to September 2008, to reach 16.4 million subscribers.

Despite the growing interest in mobile TV, both its definition and use value are still not clearly understood. The first generation of mobile TV has emerged mainly as a stand-alone service – separate from home delivery models – and valued strictly in terms of the ability to consume video on the go. As such, the first-generation mobile TV experience is often considered secondary (and inferior) to that of the increasingly rich home theater, but market expectations are high, in line with the billions of mobile phone users around the world.

However, in this chapter we demonstrate that as mobile TV evolves, it will find additional, if not greater significance as part of a multifaceted video offering that

[1] Nielsen Media, "Turned into the Phone: Mobile video use in the U.S. and abroad," January 2009, available at http://www.nielsen.com/solutions/Nielsen_MobileVideo_January2009.pdf

combines multiple screens, devices, networks, and content types. Cell phones and other mobile devices are being integrated into a cross-platform offering so that content, or more importantly, a particular viewing session, moves with the user, across devices and across networks. Video service providers must integrate solutions into their offerings that enable consumers to purchase content once and enjoy it anytime, anywhere, on any device. In this sense, when we think about mobile TV, it is not just the devices that are mobile; content too, is mobile.

Furthermore, the other functions of a mobile device besides viewing, or "rendering" must be considered. In other words, rather than serving as an alternate screen, a mobile device may provide a variety of complementary functions (some of which may have nothing to do with mobility per se) like voting on American Idol via SMS, purchasing a product seen in a show or advertisement, programming TiVo remotely, streaming video from the cell phone to the TV set (or even projecting it onto a wall, eventually), or using a cell phone's video camera to create content for distribution on the Web and uploading it directly from the phone over wireless networks. In the new TV ecosystem, all end-user devices collaborate across the whole video value chain, from content creation to distribution to consumption.

Finally, as they become integral components of the new video ecosystem, the personal nature of mobile devices will drive the development of social TV.

The Evolving TV Landscape

This next section looks at the evolving TV landscape into which the elements of mobile TV are being integrated. The television industry has become complex enough to warrant a high-level mapping of its evolution, highlighting some of its more salient technical, business, regulatory, and behavioral aspects. A historical perspective is especially relevant since, at the time of writing, all delivery platforms from the original analog broadcast model to IPTV, are currently in operation (to one degree or another) presenting numerous challenges related to user expectations, legacy infrastructure, regulatory regimes, and business models.

Disrupting the Original Broadcast Model

We begin with a brief history of television in order to establish what we mean by "traditional TV," and point out that the TV systems that are being disrupted today – over-the-air, cable, and satellite – are themselves disruptors of the original broadcast model. In this sense, traditional TV constitutes the first reinvention of television, while the more recent trends mark the beginnings of its second reinvention.

Television began as an over-the-air (OTA) analog radio transmission service in the 1930s. The industry was dominated by three large networks (ABC, CBC, and NBC

– and later joined by Fox in the late 1980s) and their affiliates, all delivering content over licensed spectrum to a device designed specifically to receive their signals – the TV set. For several decades, the TV set was the exclusive domain of the big networks along with the smaller individual stations, and the sole receiving and viewing (end-user) device. By the mid-1970s the industry had undergone a couple of important technological transformations that precede today's disruptive trends.

The first transformation involved the rise of alternate transmission systems, starting with cable. In the late 1940s, cable operators began retransmitting local broadcast programming to rural areas that were outside the reach of broadcast signals. By the early 1950s, the cable providers had started retransmitting signals from TV stations in other regional markets across the country, which they could now receive via satellite. In this way, cable companies began competing with local broadcasters by offering additional programming, which in turn initiated the regulation of the cable industry. By the mid-1970s, cable *programming* networks had emerged, producing original content for the cable operators. Initially considered inferior to the broadcast networks, cable TV networks have evolved tremendously, particularly during the 1980s, to produce award-winning shows.[2] Thus, what began as an *access* service evolved into a highly competitive *content* service.

Satellite delivery followed suit in the early 1980s, transmitting both traditional broadcast and cable programming to TV sets via consumer satellite dishes, and providing competition for the cable operators (and leading to more regulation).

Although these new transmission systems gave birth to a new content industry (the cable networks) and introduced multichannel, subscription-based business models, they did not fundamentally change the user experience; TV viewing remained a passive, push-based activity, meaning users basically turned on the TV and watched whatever was being broadcast at the time – a model compared to spam by today's technologically savvy youth.

Furthermore, while the increase in the number of channels and content providers expanded programming choices, the distribution model essentially remained a closed system in the sense that the cable and satellite operators delivered a "walled garden" of acquired content over their pipes, keeping content and conduit ownership tightly linked, and maintaining their role as content aggregators.

The second important technological transformation during this period was the introduction of the video cassette recorder (VCR) in the late 1970s. The VCR was the first TV add-on and was intended for recording TV content onto tape cassettes for time-shifted viewing and archiving. The entertainment industry attempted to stop its distribution in a case that made it to the Supreme Court, where it was declared that copying programs was a legitimate use, as long as the copied material was not used for profit. Ironically, few people could figure out how to set the clock or program the VCR, so its primary recording function went largely unused.

[2] Broadband directions LLC, "The Top 75 Basic Cable TV Networks: An Analysis of Their Broadband-Delivered Video Opportunities and Current Initiatives" July 25, 2005, available at http://www.broadbanddirections.com/pdf/BroadbandDirectionsTop75reportnew.pdf

Instead, the playback function reigned, and the VCR became more important as a new distribution channel to the TV, spawning the retail video tape industry and becoming a crucial source of revenue for the entertainment industry.

Although a rather primitive playback technology by today's standards, the VCR is significant because it introduced the concept of time-shifting, even though the practice was not widely adopted. It can even be considered an early form of video on demand, especially given that the video rental business is now threatened by the operators' VOD offerings (as well as on-line streaming and downloading services like Amazon, Netflix, and iTunes). Additionally, the recordings of TV programs comprised the first instances of user-generated content, where viewers strung together episodes of their favorite shows (with the ads roughly chopped out) or random clips that resembled many of the playlists compiled on YouTube today. Furthermore, these were shared with friends, often by bringing tapes over to one another's homes – a rather rudimentary form of mobile social TV. And as a channel for both user-generated content tapes and those rented or purchased from the video store, the VCR gave the first important non-broadcast function to the TV. The other non-broadcast function available at the time was video gaming (e.g., Pong), introduced in the early 1970s. (While gaming has not figured prominently in the TV ecosystem until recently, the gaming console is now positioned to compete with both the PC and the STB to become the media hub in the home.) In this sense, the seeds of today's disruptions were already planted three decades ago.

In summary, by the end of the 1970s, a new ecosystem of competing delivery platforms (OTA, cable, and satellite) and the first non-TV end-user device (the VCR) had completely engulfed the original OTA landscape. This became the new standard – the new "traditional" TV – and experienced more incremental than disruptive innovation for about 20 years.

Starting in the mid-late 1990s, several technological developments have been fundamentally reshaping the TV industry once again, comprising what is actually television's second reinvention. These include a new set of transmission technologies (digital, IP, and mobile networks) and new end-user devices.

The Era of Digital Television

The next part of our discussion will look at the digitization of television, including transmission and recording, and the subsequent integration of TV with the PC, PDAs, and broadband value chains.

Digital Transmission

All traditional delivery platforms started off transmitting analog signals but are now switching, or have already switched to digital. Most satellite services in the USA went digital by the mid-1990s, while cable and OTA are in the final phases of the transition.

Transmitting digital signals enables the delivery of more data, which means the ability to deliver HDTV (and now 3D) and, for the cable and satellite operators, a greater number of channels. But more significantly, digital TV introduced interactive services like the electronic program guide and video on demand.

Most cable companies in the USA have started to deploy *switched* digital video (SDV), an advanced digital transmission architecture that delivers signals more efficiently in order to free up further bandwidth for more programming, HD and 3D content in particular. SDV is viewed as a transition strategy toward the eventual migration to IPTV because it provides some of the advantages of IPTV but leverages the installed base of digital cable STBs.

Digital Recording

The digital video recorder (DVR) enables the recording and storing of TV programs on a hard disk. The original models were designed to digitize and compress analog video signals, while subsequent models were made for digital delivery platforms. The concept of recording live TV had already been introduced with the VCR, but as noted above, it was not a widely adopted practice, even among VCR owners. The DVR provided a more friendly user interface that was integrated with the electronic program guide, so that selecting a program to record was as easy as selecting a program to watch. The instances of recording and time-shifted viewing among DVR owners has doubled compared to VCR owners, disrupting programming and content development strategies for networks and advertisers.

Same as the VCR, the DVR was introduced to the market as a third-party, standalone device, but the digital cable and satellite network operators began adding DVR functions to their digital STBs shortly thereafter, taking away market share from third-party DVR providers, currently dominated by TiVo. TiVo's strategic response has been to work with operators to provide the UI on their proprietary boxes, since TiVo's UI has thus far provided a superior user experience than most of the operators, who have been impaired by legacy agreements with traditional UI providers.

Software has also been developed to enable PCs (equipped with TV tuners) to function as a DVR, including Linux-based SageTV and MythTV, and Windows Media Center (and more recently MediaRoom for IPTV).

Following several years of legal battles, the network DVR (nDVR) reemerged in 2008 as a centralized solution to digital recording by storing recorded content remotely, i.e., on a DVR that is owned by the MSO and part of the network core, rather than locally, on a home DVR (think of voice mail versus an answering machine). For MSOs, the nDVR eliminates the cost of supplying and installing STBs for each customer (cable operators reportedly spend around 10% of capital investment on DVR boxes[3]).

[3] Reuters, "Court rules in favor of Cablevision network DVR" August 4, 2008, available at http://www.reuters.com/article/marketsNews/idINN0448712120080804?rpc=44&sp=true

In effect, the recording function has become less tied to a single-purpose device (which has become commoditized) and integrated in other points in the value chain including the PC and operators' STB at the edge of the network, and the operators' servers (the nDVR) at the core.

As more content is consumed on demand, the function of recording becomes less relevant, but it will nonetheless remain valuable to viewers, programmers, and advertisers for scheduled TV.

Transferring and Redistribution

Like its analog tape predecessor, the DVR serves other purposes besides recording, and some of these have likewise proven to be more significant than the ability to record and archive content.

The first of these involves the transfer and redistribution of operator content to devices and networks that are outside the control of the operator. From a value-chain perspective, the DVR is perhaps most disruptive in that it has led to a secondary, edge-based redistribution network for recorded content.

When connected to home networks (or as PC software), the DVR functions as an "outbound" channel to other devices by enabling the transfer of recorded programs (as well as other personal data like family photos or home videos) to new viewing devices including the PC and portable media players via USB or other connection standards. Transferring recorded TV content by cracking DRM systems is illegal, but services like TiVoToGo offer a legitimate way to transfer content to the PC and certain PDAs. Again, the cable or satellite operator does not provide this functionality, i.e., it is not part of the cable or satellite offering.[4]

Once on the PC however, recorded content can also be redistributed over other networks. In this way, the DVR provides an integration point between traditional TV content and the Internet. The merging of these two value chains has been one of the major sources of disruption of traditional TV. Recorded and subsequently edited (sliced and diced) TV programs are an important – albeit often unauthorized – source of user-generated content (UGC) for on-line video services like YouTube, representing both a threat (piracy) and opportunity (promotion) for traditional content providers. Although the majority of content found on UGC sites today are amateur-produced, YouTube in particular initially gained popularity after clips of recorded content showed up on its site. It could be argued that the networked TiVo was instrumental in making on-line video analogous, and therefore a potential competitor, to traditional operator-based services. While video was certainly available on the Internet prior to YouTube and Hulu, it was not quite perceived by viewers as "TV," until traditional TV started showing up on PC screens.

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[4] The TiVoToGo service was offered on the TiVo Series2; however, the TiVo Series 3 HD does not include this feature. Cnet reviews, "TiVo Series3 HD DVR (32-HD hours)", September 11, 2006, available at http://reviews.cnet.com/digital-video-recorders-dvrs/tivo-series3-hd-dvr/4505-6474_7-32065631.html

Placeshifting technology is another form of redistribution, although in this case the operator's video feed is literally rebroadcast over the Internet, making a subscriber's content package accessible from any broadband connected device. Today's placeshifting market is largely based on hardware, the most popular device being the Slingbox STB. In addition to the original PC client software, versions now exist for cell phones and the Blackberry. Software solutions are becoming more popular, where a PC equipped with TV tuner functions as the STB, redirecting content over the Internet.

Placeshifting technology, the Slingbox in particular, has (not surprisingly) led to some interesting unauthorized business models. While it is legal for a Slingbox user to tune in to their cable subscription remotely over the Internet, it is not legal to use the technology as a broadcast platform to third parties. In December 2008, *Newsweek* reported on the growing practice of "Slingbox hosting," where certain Slingbox owners share their video feeds with third parties, often for a fee.[5] As the article explains, these Slingbox owners effectively function as mini-cable companies, using the Internet as an unauthorized distribution channel.

Third-party placeshifting, like transferring recorded content, is outside the control of the operators; however, satellite operator DishTV has integrated placeshifting into its service through a "Slingloaded" STB. But for most cable and satellite providers, the Slingbox is a user-managed solution for remote access.

Inbound Channels

Just as the VCR created a new content channel to the TV, the DVR and other set-top-boxes, when connected to the Internet, have also come to serve as an "inbound channel" for on-line video services. The inbound channel tends to support more authorized services than the outbound channel. The more recent TiVo models for example, can download or stream select Web content like YouTube and Netflix, for easy viewing on a TV set. In this way, the DVR competes with the Internet-to-TV devices that have appeared on the market, most of them single-purpose, proprietary boxes that deliver a Web-based video service providers' content to the TV. These will be discussed in the section on on-line video services below.

The Internet Changes Everything

While digital delivery and recording set the stage for interactivity and have expanded the boundaries of the TV industry, IP delivery platforms will truly reinvent television.

[5] Newsweek, "The Slingbox was built to stream your favorite TV shows to your laptop via the Internet. But users are finding other new and controversial uses," December 17, 2008, available at http://www.newsweek.com/id/175602

IP provides a standard way to enable interactive services that seamlessly integrate video, voice, and data communication, as well as fixed and mobile networks and devices, to facilitate the multi-platform vision of TV.

We distinguish between two basic types of IP-based video delivery systems – IPTV and Internet TV or on-line video. These are typically described as closed or open delivery platforms respectively and as we will discuss below, the introduction of an open delivery platform has been another major driver of disruption in the TV industry.

IPTV

Although the term IPTV (Internet Protocol Television) is often used to include on-line video, we use it specifically to refer to video services delivered end-to-end (from the head-end to the STB) over the carriers' closed IP networks, as opposed to the public Internet. Like cable and satellite services, connectivity and content services are tied (i.e., the connectivity and video service provider are one and the same), and the connection offers a guaranteed quality of service as opposed to the public Internet's best-effort delivery. Content is delivered directly to the TV via an IP-enabled STB.

Telcos are currently leading the IPTV trend, primarily as a strategic response to cable companies' provision of bundled voice, data, and interactive video services (the triple play). Their goal is to reduce customer churn and generate revenue from proprietary video services and advertising. The cable companies are currently upgrading their existing networks to switched digital video as a transition to IPTV. As the mobile carriers' upgrade from 3G to all-IP 4G networks over the next few years, they will enter the IPTV game, but in its early incarnations, IPTV is focused on the home-delivery model. Mobile IPTV will be discussed in greater detail below.

There is currently relatively little IPTV activity in North America. Most deployments are in Western Europe and Asia, with Europe accounting for about 61% of IPTV subscribers worldwide – 8.2 million subscribers total. North America, with less than 5% of IPTV subscribers is behind other markets primarily because of the well-established cable and satellite offerings, which, as premium services, compete with IPTV, whereas in Europe in particular, the market is dominated by free antenna TV.[6]

On-line Video

On-line video, or Internet TV as it is sometimes called, refers to services that deliver content over the public Internet. These include P2P services and the more commonly known Web services like YouTube and Hulu, the traditional programming

[6] Communications Technology, "The Yanks Are Coming – Eventually," March 8, 2007, available at http://www.cable360.net/ct/news/ctreports/22406.html

networks' sites like NBC.com and History.com, and the latest breed of Web-original content producers like Tiki Bar TV.

On-line video is largely consumed on the PC in "lean forward" mode; however, there are more and more solutions for watching on-line content on the TV in "lean back" mode including proprietary STBs like the Apple TV that streams iTunes to the TV, as well as YouTube and potentially other Web content. Other boxes of this type include the Roku for streaming Netflix's "Watch Instantly" service from the PC to the TV, and the Vudu, which connects the TV set to a proprietary on-line catalog of movies and TV shows. In addition, the recently available Boxee service moves the lean-back experience to the PC platform and combines it with the lean-forward activities related to social TV.

In addition to stand-alone boxes like the DVR and AppleTV, etc., the PC-based media hub is another model for bringing on-line video to the TV, streaming video content acquired from Web video services from the PC to the TV, and increasingly via mobile devices.

Internet-enabled TVs began appearing on the market in 2009. For the time being, these TVs do not offer general Web browsing capabilities, rather, the TV manufacturers have partnered with software providers to enable widget-based access to limited sets of content. For example, Toshiba has partnered with Intel, Microsoft, and Yahoo to create its Combo TV. As the end user has access to the Web uniquely through the Yahoo widget, it is the software provider that controls (for now) what content will be available from the device.

On-line video is becoming increasingly accessible over the mobile Web – and has proven thus far to be more popular than the mobile carriers' services – with some services providing special on-line versions designed specifically for the mobile experience, like YouTube Mobile. Mobile on-line video will be discussed in the next section.

With on-line video services, the content provider is usually a third-party to the ISP. This model thereby challenges the closed "content-conduit"[7] model of traditional, as well as the emerging telco IPTV and cell phone TV services. This fundamental difference in the business model for video content provision – where content is decoupled from connectivity—is at the heart of the net neutrality debate, and the basis of what has become known as the "over-the-top threat." For operators who function as both ISPs and TV service providers, the risk is that TV subscribers will cancel or downgrade their subscriptions in favor of "free" or *a la carte* online content that runs "over-the-top" of the broadband service provided by the same company. Anecdotal evidence is increasing, especially during the economic crisis, that people are cutting their cable or satellite service and only watching video on-line. Nonetheless, statistics show that while on-line video consumption is increasing, it is not necessarily at the expense of traditional TV. Rather that substituting for traditional TV, on-line video often complements it. Some studies have shown that it may even lead to more viewing on traditional platforms.

[7] David Clark, "Network Neutrality: Words of Power and 800-Pound Gorillas," International Journal of Communication 1 (2007)

This second reinvention of television triggered by digital and IP-based platforms has initiated the upheaval of a traditionally operator-controlled industry. Not only has the Internet provided new opportunities for content distribution – by content owners themselves and new third-party aggregators – but also a whole world of end-user devices has emerged. The "edge" occupied by these end-user devices comprises a very dynamic part of the value chain for all new TV systems. Devices integrate multiple content and value-added services – both authorized and unauthorized – and their respective value chains into the TV ecosystem, expanding its boundaries and creating new opportunities for both network operators and non-network players to create and capture value while dramatically changing the TV experience for consumers. The next section will look more closely at the role of mobile networks and devices in the new TV ecosystem and its impact on edge innovation.

The Mobile TV Ecosystem

As we pointed out at the beginning of this chapter, the first generation of mobile TV has emerged primarily as a stand-alone service created specifically for viewing on cell phones. We use the term stand-alone to imply a single platform solution. For example, while the popular show CSI can be watched on Verizon's VCast mobile service, on-line at cbs.com (over both the fixed or mobile Web), or as part of a cable TV subscription, these represent three separate services from the user's perspective. In other words, it is not an integrated, cross-platform solution provided by a single entity.

The most typical model is the subscription packages offered by the cell phone carriers. These come in two basic flavors: unicast services delivered over 3G networks, and broadcast services delivered over a separate, dedicated network that uses different frequencies than those for voice and data but still controlled by the carriers.

3G networks are used to deliver both "clipcasting" services – short, on-demand video clips that are downloaded to the phone – and direct streaming of content to the phone. The service may be the carrier's branded service, like Verizon's VCast, or a premium Web video service provided by a third-party aggregator like MobiTV. Because the network used to deliver video content is the same as that used to transport voice and data, bandwidth is a limiting factor in this model, especially when considering delivering video to a mass audience.

The separate, dedicated networks are a proposed solution to the problem of video's high bandwidth consumption. However, there are still few dual-tuner handsets available on the market. A variety of standards have been adopted around the world for these networks. MediaFlo is leading in the USA, while DVB-H is used in Europe and Asia. Some carriers, like Verizon, offer services over the two different types of networks (VCast over its 3G network and VCast Mobile TV over MediaFlo).

While some users have valued the ability to watch TV on the go enabled by these early mobile TV offerings, for a lot of them it has been a frustrating and expensive proposition, and we believe that mobile TV will eventually find greater value as part of a multifaceted, cross-platform offering. In this section, the focus will go

beyond the mobility of the *device* to include the mobility of the *content,* and perhaps even more intriguing, we will explore some of the roles played by mobile devices other than receiving and viewing content, some of which have little or nothing to do with mobility per se. The emphasis in this next stage of mobile TV is on the personal and social nature of mobile devices and the influence they will have in taking social TV to the next level.

Multi-Screen TV

As mobile TV becomes integrated into a multi-screen, cross-platform experience – typically called "3-screen TV" in reference to the PC and cell phone as the second and third screens – there are several strategies for designing and delivering these types of experiences. As a preamble, it is interesting to note that while the TV is still considered the first screen, there is increasing anecdotal evidence that the lean-forward PC experience, once considered inferior to the lean-back mode of traditional TV viewing, is gaining importance as behaviors change. Similarly, some mobile phone users have blogged that the only way they have been able to watch TV is on their phones, in transit, because they are perpetually too busy to lie on the couch to watch a show on a regular basis. The traditional TV set, while valued for its own qualities, including size and the ability to connect to fatter residential pipes for delivering high-definition services, may not always be held as the standard. Rather, each screen will be equally valued on its own terms as behaviors evolve, and screen ranking will be different for different users.

Conceptually speaking, the most basic model for 3-screen TV involves treating the mobile device as an alternate screen; one that is smaller but mobile. This view is accurately reflected in the promotional images used for multi-screen TV, which typically show the same image on each screen, in different sizes and proportions. In this way, 3-screen TV essentially means a service provider's content is available on all device types, a trend that is often referred to as "device-shifting."

For on-line video providers, the key challenge thus far – in the absence of truly Internet-enabled TVs – has been to bridge the technical gap between PC and TV. Some of the solutions have been discussed above, for example, using TiVo as a distribution channel to the TV, or via proprietary boxes like Apple TV or the Roku for Netflix.

With regards to the third screen, many cell phone subscribers use the carriers' 3G network as well as WiFi hotspots and home networks for Internet access to connect to on-line video content, some of which is formatted specifically for the mobile experience, like YouTube Mobile or Joost's iPhone application. In this scenario, users bypass the carriers' content offerings (the mobile version of the "over-the-top" threat). A survey conducted by ABI in 2007 found that of the relatively small number (14%) of subscribers who did watch video on their cell phones, 35% had watched content from Internet sites like YouTube, compared to 31% who watched the carrier services, and 5% who watched from a third-party service like MobiTV. Although these mobile services are in their very early stages

– and complaints regarding the experience abound – they indicate a general trend toward 3-screen TV among Web video content providers. Side-loading models that copy downloaded content from one device to another, like iTunes + video iPod have been around for several years.

For operator-based services (i.e., cable, satellite, and telco offerings), delivering to multiple screens is more challenging for a variety of reasons including that the rights for the content they have acquired apply to their delivery platform only. Several operators are developing Web video services positioned as "device-shifting" strategies. In these models, the operators are essentially on-line video providers, distributing a limited selection of their acquired content over any broadband service, in other words, separate from connectivity provision.

Most of these models have started as a PC-only service with mobile versions to be added for access via the mobile Web. Comcast's Fancast is perhaps the most advanced of these. For its latest version Comcast partnered with Hulu to offer content from various broadcast and cable networks like NBC, CBS, Fox, MTV, and BET. Comcast announced last September that a mobile version of its Fancast service would be available for cell phones. The mobile application should include the same features as the original service: allow users to watch TV shows on their phones and share them, as well as interact remotely with their DVR to schedule recordings. This model is in contrast to the placeshifting model described above, where the operators' actual video package is accessible by the subscriber via the Internet.

AT&T U-Verse's 3-screen model called OnTheGo lies somewhere in between Fancast and Slingbox in the sense that it rebroadcasts (as opposed to redistributes via on-line channels) a limited selection of its live and on demand programming to U-Verse subscribers via the Internet to a PC or cell phone (although there are only a few cell phones with this capability at this time). The video is rebroadcast from the U-Verse head end rather than the subscriber's STB.

It is difficult to say at this time which of the operator-based models for content mobility will be more successful. As more traditional content is available on-line, cable and satellite subscribers may increasingly log onto Hulu, or their favorite network's Web site to watch content on their PC rather than logging onto their traditional service provider's Web site. On the one hand, services like Fancast may drive the reported trend that on-line viewing stimulates demand for traditional TV by enhancing Comcast's traditional offering, e.g., providing an enriched PC-based electronic program guide as a complement to their traditional TV service. On the other hand, Fancast may end up cannibalizing its traditional TV business. But if cable subscribers are going to give up their cable TV service for Web TV, the cableco would prefer it be their own Web TV service. A Web TV offering is one strategy for retaining control over the customer and maintaining its role as a content aggregator.

A more primitive (and less common) mobile TV model involves broadcasting traditional over-the-air (OTA) television to cell phones or other mobile devices that are equipped with an analog or digital TV tuner – basically a miniaturized version of old-fashioned broadcast TV. Mobile analog OTA cell phones became

available in the early 2000s but these were not successful because of the poor quality of reception and battery drain. More recently, the ATSC (Advanced Television Standards Committee) approved a mobile version of its digital TV standard for cell phones, laptops, portable media players, and other mobile devices called ATSC-M/H. Mobile digital OTA – often referred to as mobile DTV – is viewed by the ATSC as an alternative to building out separate broadcast networks as discussed below, since the spectrum and transmitting equipment are already available, and most content will be free. In 2007, several major local and national TV stations in the USA formed the Open Mobile Video Coalition Mobile[8] to develop mobile DTV products and services that would complement existing free, ad-supported content, including interactive services and paid content (broadcast and download). Although Japan and Korea have enjoyed some success with mobile DTV, critics point to the inferiority of the ATSC standard and the greater rate of adoption of other standards for both digital OTA TV and dedicated mobile TV networks (e.g., DVB-H and MediaFLo) around the world. Overall, mobile OTA has not been very popular.

The 2- and 3-screen services that we have looked at so far provide the means for the user of a particular service to access the provider's content over various devices and networks, however, another differentiator involves the mobility of a *viewing session* across devices for a persistent experience. As video services become multi-platform, providers – whether cable and satellite operators, or aggregators like iTunes, or content owners like NBC – have recognized that mobility of a TV session is an important application. The typical scenario involves starting a program at home on TV, pausing, and then picking up where you left off from your mobile device. In this scenario, all end-user devices are connected to a media server or DVR, either in the home (at the edge of the network) or at the network core.

This vision requires several conditions to be successful, including all IP delivery to the edge; ubiquity of broadband access; transcoding services to adapt content for each of the screens in the rendering ecosystem, and – perhaps the most challenging – a multi-platform business model. The latter enables the vision of personal broadband, defined by the MIT Communications Future Program (CFP) as "a set of capabilities and interfaces that allow users (or their agents) to select the connections that best meet their needs within a particular context." [9] Personal broadband is essentially about connecting a service to a person, rather than to a specific device.

While we are close technologically to such a vision, the biggest obstacle is business-related. Operators are reluctant to open their STBs to other network operators; however, as we will discuss in the section below, they may be encouraged to do so to remain competitive. Personal broadband will be the new "triple-play."

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[8] http://www.omvc.org/about%2Domvc/

[9] A Vision of Personal Broadband, MIT Communications Futures Program, January 2006, http://cfp.mit.edu/publications/index.shtml

Complementary Devices

So far we have looked at the role of mobile devices as small, portable screens in a multi-platform TV experience. But mobile devices can play complementary roles that use the mobile device's other capabilities besides image rendering.

Typically, the mobile phone (as well as the PC and even the traditional landline phone) is used to complement the living room TV experience. This may involve loosely coupled processes like voting on American Idol, or more technically integrated processes such as programming a TiVo remotely, or streaming from a cell phone to the TV. A more advanced level of technical integration occurs when all end-user devices become part of a community of collaborating devices. This is especially useful when the peering device contains more storage and complements the mobile's own capabilities. This vision of a peer network of collaborating devices will be discussed in more detail in the section on community TV at the end of this chapter.

Mobile phones are also increasingly being used as cameras for user-generated videos, and like Web cams, are directly integrated into the distribution infrastructure. They effectively function as mobile TV studios, broadcasting to sites like Kyte, Qik, and Flixwagon, and providing interesting insider perspectives on public events.

It Is All About the Applications

The TV landscape is becoming more exciting, more diverse and, as a consequence, complicated. Leveraging the opportunities of the new offerings will mean the difference between success and failure for many services. Recent work by Chintan Vaishnav at MIT provides interesting insights regarding competitive dynamics in this complicated industry landscape.

Vaishnav's research applied systems dynamics theory to model innovation in the TV industry. The results show that for video service providers to keep market share in a highly competitive environment, they must offer ancillary services; those services that are secondary, or supplemental to the "me too TV" of linear and VOD offerings. Such ancillary services eventually become integrated into the normal or primary offering as users start expecting these services as part of the mainstream offering.

This perspective reflects a shift in the competitive dynamics of the TV industry, which, with the introduction of each new delivery platform, started off as platform vs. platform (e.g., cable vs. satellite, cable and satellite vs. telcos, etc.). But competition is now more accurately described as service versus service (on-demand vs. live, mobile vs. fixed) and even feature vs. feature (interactive vs. noninteractive).

At this stage in the evolution of TV, both mobile and social TV are considered ancillary. Both services emerged independently, but not surprisingly, their trajectories have now begun to intersect, particularly as social networking applications in general and social TV applications in particular are being developed for mobile devices. In this next section, we explore the relationship between mobile and social TV.

Social TV

The meaning of mobile TV was discussed at the beginning of this chapter; this section addresses its relationship to social TV, and how social TV will win its place in the multi-screen TV world.

While the social aspect of TV is not new, the term "social TV" has emerged fairly recently to describe a new breed of video services that integrate other communication services like voice, chat, context awareness, recommendations, and peer ratings. Its goal is to support a shared TV experience with one's peer groups, defined more and more by social networking sites like Facebook and YouTube. Social TV applications are currently geared primarily at real-time interactivity with friends such as shared viewing and peer recommendations, e.g., What are my friends watching right now? What are their "favorite" shows? How can I watch what they watch?

The adoption of social TV services is driven, on the one hand, by the rise of social networking, and on the other by the availability of Web applications across the TV ecosystem. It is also fueled by the seemingly paradoxical trend of individualized viewing on personal devices like PCs, smart phones, other PDAs and cell phones, or simply one's own TV.

Social TV involves the rediscovery of TV as a shared activity. Back in the 1950s, when television came of age, watching TV was typically a communal activity, with family and friends gathered in the living room around the TV, choosing what to watch and reacting to the same program and exchanging comments. In the 2000s, TVs are no more a luxury item and it has become common for the typical home to have more than one, where individuals or smaller family groups watch their preferred programs separately. In 2006, Nielsen Media Research reported that only 19% of American homes have no more than one TV, and the typical home now has more TVs than people – 2.73 TVs for 2.55 people.

In effect, we have seen the growth of "anti-social TV" watching, where the social aspect of exchanging comments and making program recommendations is delayed – or asynchronous – occurring the next day around the water cooler and in other social contexts. A lot of the social aspects of the living room TV have moved to sports bars and other more public spaces.

But the shared TV experience is now returning, in a new form. A person's social networks are replacing the typical family room of the 1950s. These virtual communities can extend far beyond the home to span entire neighborhoods, cities, countries, and hemispheres. And like the traditional living room, they are increasingly organized around video, connecting families, friends, and some strangers alike in a shared video space defined by interactions, common interest, or location.

In the world of cable and IPTV services, efforts to integrate social networking features began in the early 2000s, with STB-to-STB communications provided by a few operators. Today, social TV offerings are on many operators' roadmaps. IPTV middleware like MediaRoom as well as next generation versions of OCAP (recently branded as Tru2way) middleware for digital cable, are offering shared viewing applications and converged telecommunication services. These systems use Instant Messaging-like capabilities with buddy lists, etc. that overlay the

watched content, text bubbles, or even avatars to convey the friend's messages, enabling friends watching the same program in separate homes to exchange comments about the show they were watching. Other early incarnations of social TV have involved traditional TVs with added interaction and widgets.

Nonetheless, most of today's social TV experiences originated online with services like YouTube, Joost, Hulu, and now Boxee integrating social networking features like sharing content among peer groups, program ratings, "favorites" lists, discussion forums, and multi-user chat sessions directly into their offerings.

At the same time, Web-based social networks like Facebook and MySpace have been embedding video applications into their sites, both user-generated and professional content from commercial sites, thereby becoming both video viewing sites and video distribution platforms in their own right. Viewing on those sites is, by definition, a social experience. In addition to getting movie and TV recommendations from their peers, subscribers to these social networks can now stream selected content on a personal page for a shared viewing experience with visitors and "friends."

Video-oriented social networks essentially become "virtual operators," servicing the user and their group of friends. This changes the traditional role of the user in the video consumption value chain. The members of a peer group influence and alter each other's behavior. Like a traditional operator, the virtual operator (the social network) effectively programs the service (chooses and rates content) but based on peer recommendation lists and ratings, not generic population statistics.

While enhancing the user experience by making it more relevant, peer-based programming also creates tremendous opportunity for targeted advertisement, and the ad industry is taking note. Already one can see a huge difference in the advertisements for a given show when viewed on prime time TV versus video on demand versus on-line. Social networks take ad targeting to a new level: identify the main programmer – or "power influencer" – and use their social graph to influence the group. It is useful to note here that there has also been a rise in social features in gaming, where users can connect to friends or meet new people using various applications. These developments in gaming will influence user expectations vis-à-vis the TV experience, especially as gaming becomes more integrated with TV viewing.

Operators are also starting to incorporate aspects of Web-based social networking directly into their offerings via the STB. Sites like Facebook and MySpace have been complementing operator services with features like movie recommendations for the past few years, but in a loosely coupled way. Consumers discover content through their on-line communities, and then turn on the TV and interface with the EPG (electronic program guide). Although the process can be more synchronous than the water cooler scenario, it is a technically separate process.

Recent work with social networking extensions to the TV user interface, like TiVo for example, show that various social features can now be technically integrated with the actual TV viewing experience, similar to on-line video services described above. The social network look and feel is incorporated into the TV user interface with some minor changes, e.g., a menu item (e.g., my friends' favorites) and/or a real-time chat application for shared viewing. For example, the "favorites" list can be influenced by what a subscriber's friends in their social network are watching.

The list of one friend's favorites can also be used to determine what to record on another friend's DVR.[3] As in the on-line examples above, this creates the opportunity for more targeted advertising. While some critics are skeptical, claiming that too much of the information about users is fake or out-of-date, or that connections to social groups can be meaningless because they are so remote (many degrees of separation) or no longer relevant, the social network for a typical user is still considered valuable by advertisers.

The Facebook TV prototype, developed at MIT's Media Lab, has shown that commercial operators see value in the opportunity to build a new type of user interface – the social network user interface – over and above the services they already offer. This raises more general questions regarding the value of social networks beyond target audiences for advertisers. As David Reed of the MIT Media Lab notes, "From a business point of view, almost all of the value (economic utility) of our communications arises out of the shared context that we have created, so as part of understanding what the communications business is about, we should be studying the value that is created through the elements of context, rather than the speeds and technologies of the particular pipe."

Social TV Goes Mobile

Mobile social TV is a natural evolution of the current trends. YouTube and Facebook, for example, have launched mobile versions of their applications (YouTube Mobile and Facebook Mobile Video). Twitter offers a platform to comment on mobile (and traditional) TV. And according to Opera Software Mobile Web report, 63% mobile traffic in the USA is to mobile-social sites, most of those now having a video component. YouTube Mobile is the leading mobile social TV service because of its availability on a variety of mobile platforms. Developers working on the mobile version of YouTube ensured that the interface and the features are the same on a smart phone as on a PC and use a variety of wireless media from 3G to WiFi, and soon to 4G, it is offering an Internet service that is network agnostic.

However, YouTube mobile offers only basic social features. One can only rate, share, flag, and add a video to a list of favorites. Only user-generated content is offered, and advanced social features like multi-user chat sessions are not supported yet. This service is used mostly because it allows users to easily upload videos taken from their phones. Overall, the ability to upload and share videos shot directly from the cell phone seems to be the most salient feature of mobile social TV. And those tend to be short clips not full featured videos.

Itsmy.com offers a more complete mobile social TV experience. Itsmy.com is a portal that offers several services: chat with friends, video and picture uploading and viewing, forums, flirting, etc.; however, not all of these features are integrated. These types of services are developing extremely rapidly, especially among the younger demographic. According to the recent Opera Software Mobile Web report, itsmy.com ranks amongst the top ten most-visited mobile sites.

At this point, the most advanced mobile social TV initiative is Mogulus. This Internet and mobile platform allows users to watch and shoot videos from their PCs and cell phones. Chat rooms are associated with the shows, and videos can also be shared, flagged, and rated. Mogulus' creators boast more than 5.8 million unique viewers each month, and more than 400 million unique viewer minutes watched each month, and the 2,972th Alexa rank. A number of other services resemble Mogulus. These services are however also still emerging, and are currently much less significant in terms of traffic. Kyte, mogulus' most threatening competitor has only the 65,325th Alexa rank. Other emerging services include Qik, Flixwagon, Phanfare.

So what does it mean for wireless networks and operators? According to Alexa.com, the YouTube.com domain accounts for 15% of the total Web traffic. Even thinking that 1/1,000 of YouTube's traffic is mobile, this is still a hugely successful Mobile TV service, one that is both social (YouTube connect feature) and viral (top video recommendations) and risks to drain all capacity from current networks. But can it be stopped? And can mobile social TV become even more social? As was shown by the recent CNN/Facebook event for the American presidential inauguration the use of peer-to-peer technologies could alleviate some of the network congestion associated with mass social events.

True Community TV

Most social TV applications offered by cable operators, IPTV, and IP video services, and mobile portals alike still follow traditional head-end/STB mechanisms or client/server models of TV delivery. However, once TV becomes truly social – a shared experience among peers – the next logical step is to consider user-controlled, peer-to-peer (P2P) *delivery networks* for rights-protected and user-generated content.

Mobile devices are perfect for peering and exchanging information at close range. Can that include video? Peering is the basis of a community-focused approach that harnesses the combination of the now almost ubiquitous WiFi hotspot at home and on the road; Bluetooth file exchanges; related protocol stacks including Digital Life Network Alliance (DLNA); end-user technologies (like the whole-home DVR) for content distribution to local communities, and the collective knowledge of these communities for programming and content discovery via social interaction. It also enables the ever-growing number of power users – those who tend to use the more advanced features of technology – to shape the social consumption of content.

Unfortunately, *peer-to-peer* is still often associated with stolen bandwidth and illegal file sharing. But it can also enable the legitimate exchange of TV content. Bringing peer-to-peer to the TV experience means both P2P in the network sense, using short-range or local connectivity, and in the more literal sense of sharing content among a social group. It is social mobile TV based on physical proximity and shared interests.

The peering model may be more advantageous than the client/server model (mostly unicast) in terms of bandwidth and supports the sharing of nearby resources. As early business card exchanges via infrared on cell phones have shown, if the

required information is available nearby, you do not have to go fetch it from the other end of the network. The availability of Bluetooth and the development of interface specifications from the DLNA, for example, have demonstrated the value of storing and exchanging content among devices in a home ecosystem. With WiFi or other wireless access, the ecosystem can be extended to a city block or neighborhood or even a small town, and profit from shared resources like DVRs or other storage. The social networks, as mentioned in the previous section add a wider distribution area and an element of content management.

If we want to take peer-to-peer "out of prison," then the shared content should not be commercial, unless it is DRM-free. But as a starting point, the availability of both camera phones and Internet-enabled digital cameras makes it easier to exchange user-generated content within a local community. While this practice is still in its infancy, and the issue of content storage and cell bandwidth remain unresolved, the concept of streaming UCG in a peering network that could also include PCs and other video-ready devices is carving a very compelling path for social media.

This vision of mobile TV is not just social; it is "neighborly." It creates a "social mobile TV" experience at the local level, whether the peer groups are based on Facebook friends, or real-world connections (e.g., parents of the children of the neighborhood school), etc. In this context mobile TV is also "social" in the sense that the content itself relates to a community.

Several trends are overlapping to support this vision of community TV. First of all, the combination of social networking and personalization is driving a shift in the distribution of the TV experience away from the living-room TV in a single household to multiple homes as well as to a multi-device ecosystem. More specifically, social networks are driving the transition from the whole-home DVR – a centralized hub serving a single household (an approach supporting the traditional living room scenario) – to the community DVR. The community DVR is essentially a social version of the core-based network DVR, where one household's DVR serves a community of users who are defined by their membership to a social network. This trend will eventually progress toward true "community TV," as described above, where members of a social network will connect to each other's mobile devices via peer-to-peer networking technologies.

Secondly, although consumers are concerned with the security of locally stored – un-backedup—data, concerns about the reliability of the operator-controlled network devices are equally important. As one analyst puts it, "[w]e're … looking at a living-room analog to cloud computing. What if the cloud goes offline? What service expectations should consumers have? Should there be TV service-level agreements that somehow translate into community requirements?"[10]

A tremendous opportunity therefore exists for a shift from distribution based on a core network infrastructure and a single content source to community-based distribution. This change can happen, and is happening, at many levels including the physical layer, where autonomous systems manage the organization of the network;

[10] http://www.techlare.com/blog/entry/23528/A-Cablevision-Win-for-Network-DVR-AKA-Cloud-TV/

the architecture level, where users are both content sources and/or consumers; and the management level, where power users are responsible for guaranteeing connectivity and the legality of the experience. It is even more impacted by the mobile Internet requirements and affecting the distribution and consumption of TV content at the edge. Users will have different expectations for live popular events like the Olympics than for user-generated content dedicated to local consumption.

In order for this P2P network to be functional, intelligence must be added to otherwise dumb devices; adding "self" capabilities like self-configuration, self-detection, and self-management. As the MIT Media Lab's work on the P2P platform is demonstrating, P2P-based community TV will encourage the move away from the monster media hubs of the early 2000s – where a single device is overloaded with features – toward a peer network of collaborating devices that share functions based on service and user profiles. For example, the DVR with large enough disk space could become the designated community storage device while an attached PC can provide the transcoding to allow image rendering (viewing) on a handset. The community can also extend beyond a geographical area with one member in the USA, for example, watching content subscribed to by a friend in France via a super peer in New York – the global-based "Slingbox" adding community to the mobile (content) experience.

Community TV closes the circle in defining the future of Mobile TV as it is affected by and in turn affects viewing behavior and the sharing of the TV experience inside and outside the home. The community is essentially where TV started and it is appropriate that it is where TV returns.

Conclusion

Mobile TV is still in its infancy. We still think of it as a distinct service. We still think that its main purpose is to offer the ability to watch timely, "snacky" content like sports and news when we are away from home. But as a more general TV experience in itself, we find it frustrating and not worth the high cost; it is simply an overpriced, lesser version of the real thing. These sentiments were eloquently expressed in the following statement:

"Why put long-form video on a linear service? Mobile viewing by definition isn't appointment viewing. Who wants to miss both the start and end of something, watch what's in between and then try to figure out what it was all about? Why ask us to pay $5 or $10 on top of the $50 or so we already pay for phone service so that we can watch ancient television episodes in low resolution on a tiny screen? Sorry, this is not a compelling proposition."

Our understanding of mobile TV has to change. As this chapter has demonstrated, the role of mobile networks and devices must be reconceptualized and their development must be examined in context of the more general transformation of TV itself. Furthermore, the definition of mobility per se, and the means to provide

it must be expanded. This perspective takes us away from the *mobile TV = mobile network + mobile device* view to a much richer world in which our original notions of mobile TV all but disappear.

To turn this vision into reality, mobile TV initiatives must move from the lab to the street. Focus must shift from technology features like screen size and bandwidth to real benefits like content choice, social networking, community TV, location based services, etc. User behaviors are key (even the unauthorized ones – *especially* the unauthorized ones) and must be carefully studied. This is a world where doing things with content once you get it, as well as creating your own content, has become more important than just watching a live broadcast video feed. It all started with recording shows off the TV onto tape about 30 years ago, and has evolved to wonderfully creative endeavors like YouTube and personal mobile TV broadcasting networks as end-users are increasingly empowered.

The mobile dimension of TV will remain largely in control of the operators as long as handsets (and content) are locked in. But this model is changing. At the same time, on-line video, with its expansive range of choice, is increasingly moving to the mobile Web as wireless broadband improves. The 4G era will undoubtedly open more capacity and more channels, further encouraging the growth of open, rather than walled-garden services. Combined with social networking, where peer groups become de facto operators recommending and rating content, operators face some tough competition. We believe, however, that the benefits of mobile TV will arise through competition as well as cooperation. One of the key conditions of our vision – a multi-platform business model for personal broadband – requires a new approach to partnerships.

We believe that the future of mobile TV is embedded in the future of TV in general. This chapter has provided a vision for the future of mobile TV as it evolves from stand-alone to integrated service.