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US audiences' responses to digital TV multicasting: A case study comparing commercial and public broadcast digital TV subchannels

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Abstract

This study examines audiences' awareness and use of digital TV multicast in an online survey and compares the use of commercial and public broadcast digital subchannnels because of US government's early support of public broadcast digital subchannels and its laissez faire approach to commercial digital broadcast. We found public broadcasting digital subchannel use is higher than commercial subchannel use. Using the Actor Network Theory, this study illustrates the flaws in US digital TV implementation leading to low use of over-the-air antenna (OTAA) reception and overall lack of awareness of digital TV subchannels, resulting in failure to achieve increase in broadcast content choice for the consumers at large. Use of OTAA reception is the only strong predictor of awareness and use of digital TV subchannels. The lack of effect of online streaming media use on the use of DTV subchannels indicates the two video services are non-competitive to each other.

Keywords

Audience, Digital TV subchannels, Multicast, Public Broadcast, Digital TV policy, Digital Television, Over-the-air antenna reception, Actor Network Theory, Survey, Digital Broadcast

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Six years have passed since the United States' implementation of the mandatory transition to digital TV (DTV) for all US TV broadcasters in 2009. Apart from better pictures in high definition signals, another important attribute of DTV is to provide multicast opportunities for broadcasters to offer digital subchannels to its audience. Although a few studies documented the low use of multicast in broadcast television stations (Kordus, 2014; Wise, 2010), how the TV audiences respond to this change is still largely unknown.

Digital TV (DTV) networks are created to provide TV services on these digital TV subschannnels. Several DTV networks have been launched including ethnic channels such as *V-Me* (in 93 markets), *Enlace Spanish* (33 markets) as time-fillers and money-makers for local TV stations (Malone, 2014a) and other DTV networks such as *Grit* targeting at men, *Escape* targeting at women and the *Justice Network* (Lafayette, 2014a & b; Malone, 2014b). Other minor networks such as *CW* and major networks such as *ABC* and *CBS* also seek to add carriage in local markets using the subchannel spaces (Kordus, 2014). Ultimately, the fate of the DTV networks and other broadcast networks utilizing these subchannel spaces depend on sufficient viewership. Hence it is necessary to understand the use and non-use of DTV subchannels by TV viewers to guide TV station programming strategies and policy development on multicasting. This study fills this gap by providing empirical evidence of audience use of these channels and reasons for non-use by examining the implementation of multicasting in DTV.

This study employs the social construction of technology (SCOT) perspective in analyzing the implementation process of DTV at the local market level. Previous studies on DTV set adoption commonly utilized the uses and gratifications and adoption of innovation

theories, which are individual consumer level theories. These theories cannot explain the complex political, economic and social environment that DTV channels are being offered with many stakeholders in place who have different interests and expectations in DTV as shown in the Feng and colleagues' (2004) study of Chinese DTV adoption. They explained the primary obstacles facing the transition to DTV in China involve infighting among administrative units, the heavy-handed policymaking processes, and the pursuit of self-interest and centralized control by the state network.

This study is divided into two parts. The first part we adopted actor-network theory (ANT) in analyzing the actor-network relationship between the government represented by FCC, the broadcast TV industry and the cable and satellite TV industry to explain the reasons for the low DTV subchannel awareness among the consumers. In the second part, the researchers in this study identified several major structural factors that might influence in the use of DTV subchannels as a new technology: 1) access (ability to receive DTV signals), 2) awareness of the DTV channels, 3) changing media environment: online streaming media use as a low cost alternative to traditional pay TV, and 4) importance of TV to the audience (TV usage, multi-TV set use), 5) media market competition/geography of audience (rural, urban). Each of these factors were examined in the empirical consumer analysis.

Literature Review

Diffusion of Innovation

Previous empirical studies on DTV use typically adopted Rogers' (1995) diffusion of innovation framework in examining the adoption or resistance toward technology adoption. For example, Atkin et al. (2003) used the innovation attributes of DTV to explain the adoption of DTV sets among consumers. Li (2014) compared the diffusion of digital terrestrial television

with the diffusion of digital cable in Taiwan using the diffusion of innovation model. She found Rogers' model unable to predict the diffusion of digital terrestrial TV because of its pro-innovation bias without considering the disadvantages of the innovation. The diffusion of innovation paradigm has been criticized for putting too much emphasis on the demand side (the audience) and missing the critical supply side (the broadcasters/content providers) perspective. The complexity of implementing the DTV technology requires close examinations of both perspectives and, additionally, the policy related decision making process should be also considered to provide a full picture of the diffusion process. The role of the government regulation is an important factor to consider. For example, Kordus (2014) criticized the relaxed rule of the Federal Communications Commission (FCC) to digital broadcasters in causing the low use of multicasting in the broadcast industry.

Social Construction of Technology and Actor Network Theory

Social Construction of Technology (SCOT) theory is useful for our research because it seeks to show that technologies do not develop from "an inner technical logic, but [are] instead a social product, patterned by the condition of its creation and use" (Williams & Edge, 1996, p. 866). Pinch and Bijker (1984) also posited that technologies in their earliest stages of development are open to more than one interpretation by users. This "interpretative flexibility" of the technology is what causes technologies to develop in societies in different directions. Some groups may see the benefit of a technology, but others may see it as a threat. A more comprehensive approach is the Actor Network Theory (ANT) that explains the implementation of a technology initiative as a four-stage translation process from problematization, interessement, enrollment and mobilization (Law & Hassad, 1999).

The four stages of technology translation was tested in the context of universal Internet access in a local community (Hsieh et al., 2012). In that study, during the first stage of problematization, the city mayor took the initiative and saw that providing Internet service via TV sets could help the socio-economically disadvantaged groups. During the interessement stage, in order to garner support from different actors, the promise of profit to the service providers was made without taking into consideration of the users' needs and interests in the service especially from those who have to pay for the service. Without the interest, the service became irrelevant to their users. At the enrollment stage, many socio-economically disadvantaged groups did not see the service important to their survival while the taxpayers resented the subsidy to the service. No proven success to the socially disadvantaged and the inability to realize profits for the companies led to the ultimate termination of the initiative. The mobilization stage failed.

More recently, ANT scholars tried to elaborate on SCOT by examining how actors are involved in making meaning of technologies (Paterson & Domingo, 2008). They argue that the focus of research should be on how associations are formed between both human and material objects. In the language of ANT, actors are persons, institutions, and material artifacts that contribute to making meaning of any given technology. The premise of ANT is that our understanding of a technology is facilitated by a number of things. It is influenced by our prior experiences, by our culture, and by the inherent characteristics of the technology itself. The process of understanding a technology is the combined networking of our a priori ideas with the inherent characteristics in a technology. It is a negotiated meaning influenced by both human and non-human actors (Latour, 2005).

DTV Multicasting and Content Diversity

The FCC had a great vision for DTV system projecting that a broadcaster simultaneously transmit multiple standard digital TV (SDTV) channels for local news, national news, weather and sports (Graham, 2003). Although multicasting was not an initial goal in the creation of DTV, but it offers the opportunity for the broadcast television space to be reimagined in reality. Multicasting of DTV not only provide free programming streams, it also could offer more voices onto the airwaves and provide more hours devoted to discussion of local and public issues. The intention of the FCC was to reinvigorate TV as a place for people to update community information and diverse ideas about relevant public issues (FCC, 1997).

Multicasting in DTV showed strong potential for increasing content diversity in broadcasting. It not only can offer greater variety in voices, sources and addressed, but also can set some new public interest standards or existing public interest obligation of broadcasters (Cass, 2000; Graham, 2003). Although multicasting of DTV could revitalize television as a marketplace of idea by greatly expanding the hours available for programming, with the potential for innovation, new variety in programming, and wider access to the airwaves, Kordus' (2014) content analysis of multicast TV channel offering in different markets in the U.S concluded that the FCC failed to exploit this opportunity for new public interest programming to create new diversity in programming content. He argued that specific public interest obligation had not been articulated for multicast programming. If the broadcaster could use the public airwave for free, they should cover some local issues or public affairs. He found that many small size markets' multicasts are simply airing traditional major such as ABC and minor broadcast networks such as CW rather than local programs or DTV networks. Larger markets are more likely to offer more non-broadcast networks' multicasts.

Actors in DTV in the U.S.

DTV technology allows broadcasters to transmit multiple digital audio and video signals in one channel bandwidth (Kordus, 2014, P. 2). There are two main digital signal transmission standards widely used in the world, which are high definition television (HDTV) signals and standard definition television signals (SDTV). Because the U.S. TV broadcast industry is largely made up of local broadcasters who are mostly network affiliates, local TV stations have different choices in making use of their digital spectrum allocation as focusing on high definition or multicast of SDTV during the DTV implementation.

The first actor in the DTV transition is the US government represented by the TV standards committee and the FCC. In 1996, the Advanced Television System Committee (ATSC) announced discontinuing the old National Television System Committee (NTSC) analog standard in ten years. With this decision, transition to DTV was gradually implemented. TV producers could start buying high definition cameras and making new widescreen DTV programs. Also, TV stations started to install new digital equipment and broadcast in separate new digital channels.[1]

Another important actor is the broadcast TV stations and broadcast TV industry represented by National Association of Broadcasters who negotiated with the U.S. government to keep broadcast frequencies and auction for television use (Kordus, 2014). In April of 1997, the Advisory Committee published a deadline for all the TV station for broadcast digitally. Initially, this deadline asked all US commercial TV stations to adopt DTV before 1 May in 2002, and all the public broadcast TV stations to adopt by 1 May in 2003. The committee's deadline was then extended and all of DTV stations must finish signal switch from analog to digital before 2005. When the transition is complete, the consumers can purchase either DTV set, or the converter

[1] Part of the motive of the DTV transition is to use the more efficient digital compression technology to free up spectrum for other use such as cell phones (Grunwald, 2001).

boxes that allow analog television sets to receive the digital broadcast (Futch et. al, 2001). Unfortunately, many stations were not able to meet the deadline and some stations were outraged at the mandatory DTV adoption because they had to bear the high cost of DTV transmission facilities with no clear additional revenue in return (Current, 2002). The FCC extended the deadline to 2009 for full power TV stations after consulting the broadcast TV industry and, later, the FCC announced a proposal to set a hard deadline of 2012 for low power stations to broadcast in digital. Broadcasting stations on channels 52 to 69 were required to vacate those channels by December 31, 2011. At the same time, the government ordered all analog television transmitters must shut down by September 1, 2015. But, this decision was postponed again by the FCC due to the overwhelming transition cost to many low-power television stations (FCC, 2014).

The diffusion of DTV in the US has been slow. Over 1,700 country's TV stations shifted to digital signal until 2009, but only 10% of US households could receive DTV over the air because most people use cable, phone, and satellite companies to receive their TV signals (Lowry, 2009). Although the government required broadcasters to provide mandatory DTV education materials to local audiences, the effort put to DTV promotion varied widely nationally (Ha, 2009). Viewers were just told to switch to DTV and take advantage of the converter box coupon program but they did not understand the capacity of DTV or equate DTV as only HDTV or buying a digital TV set. Indeed, receiving digital TV over-the-air was much more complicated. The consumers must either have a converter box for its analog TV set and a DTV set with digital antenna to receive the signals. On the top of that, digital signal has a cliff effect problem (i.e., either they received the signal or not received the signal. There is no in between signal strength detected by a converter box or a Digital TV tuner). Viewers have to scan for new channels every time when they adjust the antenna (Eastman & Ferguson, 2013).

The third actor is the pay TV industry who may benefit from consumers subscribing to cable and satellite TV as a result of the digital transition (Baldwin, 2008). In fact, the easiest way to avoid the hassle of receiving over the air digital broadcast with converter boxes or installing new antennas is to subscribe cable and satellite TV service. The number of subscribers to satellite TV went up after the transition. Bernstein research estimates Satellite TV gained 3% growth in subscribers and Internet Protocol television (IPTV) doubled its subscribers in during the DTV transition year in 2009 (Kafka, 2012). Cable companies lost customers to satellite TV during the transition. The cable industry is only willing to carry the main digital channel of the broadcast TV station and refused to adopt a digital must carry rule for all other digital subchannels (Kordus, 2014). Most of the current cable/satellite providers typically do not carry any digital subchannels of the broadcast TV station.

One important context that has been overlooked is that conversion to digital broadcast was implemented during the growth of broadband internet penetration and proliferation of online video streaming subscription services. They have become an alternative to cable/satellite TV subscription. Now when National Cable Telecommunications Association (NCTA) reported the top 10 multichannel video service providers, streaming services such as Netflix are the top pay video subscription service with 36.2 million subscribers and Hulu Plus as the sixth largest subscription service with six million subscribers (NCTA, 2014). The sharp growth of the online video services made them a powerful actor in terms of digital transition through providing alternative service choices to consumers and becoming strong content producers and buyers in the content market.

The 4-stage ANT analysis of digital TV

I. Problematization

DTV was presented as a solution to spectrum scarcity and reinvigorate the U.S. broadcast industry (Grunwald, 2001). Although first developed by Japan's NHK (Carey, 1999), some European countries, such as Germany, France and British, started to study DTV technology since 1980s (Zhuang, 1993). In 2006, the Netherlands turned off all of analog television service and became the first DTV country in the world (*Business Wire*, 2012). It took many years for the U.S. respond to European and Japanese counterparts. Because the analog signal did not have enough room for portion of spectrum allocated to television broadcasting, it took a few years for television broadcasters to add extra 6 MHz spectrum band to fit digital television spectrum requirement. After many negotiations and discussions among the relevant parties, digital signal could be transmitted in new bandwidth frequencies and the analog signal would be dropped when consumer penetration of new technology was deem sufficient (Terry, 1998).

II. Interessement

In order to garner the support from the broadcast TV Industry, the government allows the broadcast TV stations to keep the frequencies and let them utilize the frequencies as they want with the option for sharing revenue in auction of the spectrum. On the other hand, broadcast TV industry had no obligation to utilize the extra channel space to serve the public interest or required to do anything with the space (Napoli, 2003; Kordus, 2014). It was not surprising that many U.S. commercial TV stations chose the lowest cost route by not broadcasting in high definition for local productions and developing no original programs for the digital subchannels. The stations held on the transition to wait for more incentives from the government and slow down the adoption process (Galperin, 2003). Unlike the commercial stations, public broadcasting service (PBS) was required to broadcast in high definition and was encouraged to

multicast with some initial funding support (CPB, 2002). PBS stations, at least initially, were much advanced in embracing the multicast DTV than commercial broadcasters.

III. Enrollment

The government mandates the adoption of DTV by local TV stations with the final deadline of 2009 after several postponements with no financial support. The only incentive provided to broadcasters were the freedom to utilize the spectrum they were allocated and no requirement to broadcast in high definition (with exception of national broadcast TV networks). DTV networks rely on advertising revenue and share revenue with the broadcast TV stations as affiliates (McVoy, 2011). However, TV stations see them as unpaid affiliates and potential competitors for viewership and rather than sister stations needing their support. Unlike the local PBS station fully promoting its digital subchannels as part of the family, none of the commercial TV stations in the Midwest market under this study listed or promoted the DTV networks on their own station web site or in their TV programs.

IV. Mobilization

In the final stage of transition, initiators try to ensure the original premise of DTV adoption was followed by the broadcasters during the mobilization. Because the primary goal of DTV in the U.S. as stipulated by the FCC focused on the transmission in DTV signals and returning the unused spectrum to the government for future auctions (Grunwald, 2001), the FCC's mandate for low power stations to digitally transmit signals concluded its role in DTV transition. As of the writing of this paper, spectrum auction is still the primary concern and struggle between the broadcasters and the FCC. No mention on the broadcasters' optimization of the use of the assigned spectrum nor broadcasters' DTV programming was found in recent

reports of the FCC or National Association of Broadcasters (National Association of Broadcasters, 2014).

Hypotheses

Based on our above explication of the Actor-Network Theory, the lack of vested interests and regulatory support such as no digital subchannel must-carry rule, the local station's perceived threat of DTV channels as competitors rather than complementary channels (especially commercial TV) resulted in a lack of resources and interest in promoting DTV subchannels and unawareness of the channels, hence low awareness of these DTV subchannels. Structural factors also affect viewership of programs (Webster et al., 2005). In this study, we separate awareness from use because we want to examine whether the low use is primarily due to awareness rather than other structural factors. Hence we posit the first hypothesis.

H1. Lack of awareness of the DTV subchannels is the primary reason for low digital TV subchannel use.

Multicast is the default strategy and digital subchannels are viewed as sister channels instead of unrelated additional channels of PBS TV tations. The PBS TV stations typically include the subchannels on its web page and promote them unlike their commercial counterparts. Based on the support of PBS multicast as its digital broadcast mission and cross promotion of main digital channels and subchannels, it is expected that public broadcast DTV subchannels will have higher use than its commercial counterparts. Hence we hypothesized higher awareness and viewership of public broadcast DTV subchannels than commercial DTV subchannels.

H2. Respondents are more likely to be aware of and watch public broadcast DTV subchannels than commercial DTV subchannels.

Online streaming service users can subscribe the service as an alternative to broadcast and cable TV service. As video streaming services are increasingly used in these years after the DTV transition, those who use streaming service should have their need satisfied by the service and will not seek the DTV subchannels to gratify their video service needs.

H3. Online streaming service users are less likely to watch DTV subchannels

Apart from online streaming, cable and satellite TV services are what most US consumers use as their TV service providers. However, cable and satellite TV typically do not carry DTV subchannels to save their valuable limited transmission bandwidth when there is no must carry rule for these channels. They do not list those channels in their electronic program guide as they do not carry them. But for those who use the over-the-air antenna can view DTV subchannels to fulfill their information and entertainment needs. Hence we hypothesize only over-the-air antenna users are more likely to be aware of and watch digital TV subchannels respectively.

H4a. Over-the-air only users are more likely to be aware of DTV subchannels than cable/satellite users.

H4b. Over-the-air only users are more likely to watch DTV subchannels than cable/satellite users

In addition to the video service providers, this study examined the factors of number of TV sets in households and hours of TV use which are indicators of the importance of and interest in TV to the consumers. We hypothesized that importance of TV to the consumers and the consumption time of TV in general should be conducive to digital TV subchannels as their additional TV consumption choices.

H5a. Multi-TV set households are more likely to be aware of digital subchannels than

single-TV set households.

H5b. Multi-TV set households are more likely to watch digital subchannels than single-TV set households.

H6a. Heavy TV users are more likely to aware of digital TV subchannels than light TV users.

H6b. Heavy TV users are more likely to watch digital TV subchannels than light TV users.

Finally, due to lower penetration and higher cost of cable and satellite in rural areas, we hypothesized that rural residents are expected more likely to watch digital TV subchannels to fulfill their TV program needs.

H7. Rural residents are more likely to watch digital TV subchannels than urban and suburban residents.

Research Method

The researchers decided to use an online survey to ask the residents in a Midwest market to examine their over-the-air-antenna (OTAA) adoption, awareness and use digital subchannels. The study was a census of the public university population in that local market. They were chosen because the university owns one of the two PBS stations in the area and were easily reachable by e-mails. The university population consists of faculty, staff, and students who were invited to participate in the study via email in this study. The researchers believe that such affiliation will entice more people to participate in the survey. In total, 21,855 faculty, staff and students were contacted via email. The total number of responses from the university population was 656 (response rate = 3%). Two e-mail reminders were sent for the online survey.

TV market characteristic

The TV market under this study has two PBS stations, one from the city metro area and one from the university. Both PBS stations broadcast 3 digital channels, of which the primary channel (DT1) is the main station channel. The university owned-PBS station under study began broadcasting digital signal from 2003. Since December 15, 2008, it only transmits digital signals and stopped analog broadcasting. Hence the PBS station has a longer history of digital broadcast than its commercial counterparts in the market. The primary channel is broadcast in HD, and the subchannels are PBS Encore and Create (a how-to channel). The subchannels were all listed on the PBS station main web page as its sister channels and received cross-promotion.

There are 4 local commercial broadcast stations which are network affiliates (ABC, CBS, NBC and Fox) in the market and they all multicast: each has at least two channels with a primary digital TV channel and a sub-channel. However, all the digital subchannels were not listed in the primary channel's web page so there is no apparent relationship between the primary channel and the subchannel. None of the PBS and commercial DTV subchannels were listed in the local newspaper TV guide. CW is affiliated with the local cable origin and it is not a broadcast station in this market. Because the university has an agreement with the local cable service provider that all the PBS digital subchannels must be carried in the market, the PBS has the advantage of a virtual digital must carry for all its digital subchannels, which other commercial digital TV subchannels do not enjoy. The market is also served by multiple cable TV providers in different parts of the market and two satellite TV services: Direct TV and DISH network. But they do not provide digital must-carry for any of the PBS subchannels.

Theoretically, a broadcast TV household in the market under study with DTV over-the-air-antenna can receive up to 20 DTV channels, of which seven are main channels, and 13 are subchannels. These subchannels include two ethnic channels: Bounce-TV for African

Americans and Mundo Fox for Hispanics. In addition, there are home and garden TV like digital subchannels such as and PBS Create, health and life-style channel such as Live Well owned by ABC Network, classic TV similar to cable network TV Land such as Retro Network and Me-TV. There is also 24 hour weather channel Weather Nation. It's almost like subscribing to a basic cable package with ethnic interest. Because reception varies by locations and positioning of the antenna, the use of these channels can be affected by the location of the household and whether the household uses an outdoor antenna or indoor antenna to receive the signals. The former is much better in reception power than the latter.

Measures

TV service provider. Four choices were given to respondents: 1) over the air antenna (OTAA) only, 2) both OTAA and cable/satellite, 3) cable/satellite, and 4) other service.

Digital subchannel use. Respondents were asked if they watched the DTV subchannels of PBS – Create and Encore, and commercial DTV subchannels. If they said they watched commercial DTV subchannels, they were asked to list the subchannels they watched. Only those who listed the subchannels in the market were counted as watchers of the digital subchannels.

Online video streaming use. Respondents were asked the number of hours they watched pay and free online video content with examples such as Netflix for pay and YouTube for free content respectively. The total online video streaming use is the sum of the time they reported viewing those online video content services.

TV use. Respondents were asked to report the number of hours they watched TV in a typical week.

Multi-TV set use. Respondents were asked to report the number of TV sets they had in their household. Those who had more than one TV set would be counted as a multi-TV set household.

Income. Respondents were asked to indicate their annual household income level in 8 intervals from less than $10,000 a year to over $150,000 a year with an option of "prefer not to answer."

Education. Respondents were asked to indicate their highest level of education completed in six intervals from less than high school to doctoral degree.

Results

A total of 655 complete responses were received. The respondents were lower than national average in TV use. On average they spent 30 hours per week watching TV compared to the national average of 35 hours a week (Hinckley, 2014). There were more females (67.6%) than males (32.4%) among the respondents who answered the survey. Their median age was 31 to 40. Only one quarter of the respondents were college student age showing that most of the respondents were faculty or staff. As expected, respondents' education is higher than general population as it is a university population. Only 35% have not completed a college degree. The median annual household income is $40,000 to $59,000. About 17.9% live in urban/downtown area, 49.7% live in suburbs, and 32.7% live in rural areas. As for TV service providers, 66% used cable/satellite TV service only, 5.9% used a combination of cable and over the air reception at home, 12.9% used only over-the-air antenna reception, and 15.7% used other video services.

H1 purported that low awareness of the DTV subchannels was a major reason for not using the DTV channels. Despite the university's ownership of the PBS station, about 62% of our study's respondents were not aware of the university PBS station's DTV subchannels: Encore and Create, 37% of our study respondents who reported not watching DTV subchannels

said they did not know the existence of any of the DTV subchannels (see Table 1). It was the most common reason for not watching any of the commercial DTV subchannels. We also ran a correlation between awareness of the digital subchannels and watching of the subchannels and found a significant moderate correlation ($r=0.37$, $p < 0.01$). Hence H1 is supported.

[Table 1]

H2 hypothesized that DTV channels of PBS are more likely to be watched than commercial DTV subchannels. Our survey showed that 23% of our respondents watched at least one of the PBS station's digital subchannels, but only 13% of our respondents watched at least one of the commercial TV subchannels. Hence this hypothesis is also supported.

We conceptualized online streaming as a competition to the use of DTV subchannels as many cord-cutters flock to online for lower cost online streaming programming services such as Netflix. However, our results show that the amount of online streaming video use has no relationship with the use of DTV subchannels (see table 2). Hence Hypothesis 3 was not supported.[2]

H4 hypothesized that over-the-air antenna users are more likely to be aware and use digital subchannels because they can maximize their choice of programs with digital subchannels. The standardized regression coefficients between OTAA and DTV subchannel usage is 0.43 ($p < 0.01$); and between DTV subchannel awareness is 0.41 ($p < 0.01$, see Table 2). Thus both hypotheses that OTTA use as predictor of awareness (H4a) and use of subchannels (H4b) are strongly supported.

[Table 2]

[2] Regression analyses were used to examine the relationship between online streaming, TV use, TV service provider and awareness and demographic factors, use of DTV subchannels. Multicollinearity diagnostics such as VIF and Tolerance were checked and no regression equations showed any problem of multicollinearity.

As shown in Table 2, multi-TV sets in the household have no relationship with the use of DTV subchannels awareness (beta= .00, n.s.) or use (beta=.02, n.s.). H5a that multi-TV set households are more likely to be aware of digital subchannels than single-TV set households (beta=-0.04, n.s.) and H5b that Multi-TV set households are more likely to be use digital subchannels (beta=0.02, n.s.) than single-TV set households were both rejected.

Hours of TV use has no relationship with DTV subchannels awareness (beta = -.0.4, n.s.) or use (beta= -0.02 , n.s., see Table 2). H6a that heavy TV users are more likely to be aware of DTV subchannels than light TV users (beta = .00 , n.s.) and H6b heavy TV users are more likely to watch DTV subchannels than light TV users (beta= .02 , n.s.) were both not supported.

Due to lower penetration of cable and satellite in rural areas, rural residents are expected to use DTV subchannels to fulfill their TV program needs as posited in H7. However, rural residents are not more likely to watch or aware of DTV subchannels than urban and suburban residents. Hence H7 was rejected.

Comparing the predictors of public broadcast and commercial DTV subchannels awareness and use, we found that OTTA use is a stronger predictor of PBS digital subchannel use (beta=0.40, $p < 0.01$) than commercial digital subchannel use (beta = 0.30, $p < 0.01$, see Table 3). Gender is also a significant predictor of DTV subchannel use with males more likely to watch commercial DTV channels. But all other factors are not significant in predicting their specific PBS and commercial DTV use. See Table 3.

[Table 3]

In addition, we asked the specific DTV subchannel use of the respondents. The two PBS subchannels, Create and Encore, are much more likely to be watched than the rest of all the commercial DTV channels combined. The slightly higher focus on male demographics of the

more popular DTV channels ME-TV and WeatherNation partially explained the higher male use of commercial digital TV use (see Table 4).

Discussion

This study's actor network analysis approach to examine DTV multicast use reveals the lack of support to multicast by the various actors in the DTV technology caused the low promotion and awareness of DTV multicast. As a result, our consumer survey confirmed that the major cause of low use of DTV subchannels is the lack of consumers' access to DTV broadcast signals, rather than the consumers' low interest in TV or other structural and demographic factors. Over-the-air antenna reception is the strongest predictor of both DTV subchannel awareness and use, especially for public broadcasting digital subchannels. When people use OTAA for TV reception, they are motivated to find out what subchannels are available to them and use those channels of their interest. Because of the lack of digital must-carry rule for the subchannels, all the commercial subchannels are not available on cable or satellite TV service of the market while the PBS subchannels are available due to franchise agreement in the market. As the majority of the market residents use cable and satellite TV service, it is no surprise most respondents did not know and use commercial DTV subchannels.

Another factor is the lack of promotion of the DTV channels and commercial DTV channels in particular. Commercial TV broadcast stations (or station groups) do not see these subchannels as sister channels (probably worrying about them taking away audience from the main channel) but simply as affiliates using their channel space. Therefore, consumers can find those subchannels only when OTAA users scan their channels on their TV or go online for specialized Digital TV guide such as TitanTV. No other official sources such as the primary DTV channels web site nor the regular TV guides in newspapers show the listing of the DTV

subchannels. Most digital TV subchannels are national networks which have little resources and local connections in promoting at the local market level. Indeed, the lower predictive power of OTAA reception on commercial DTV subchannels and that lower viewership of commercial DTV channels than public broadcast DTV channels support our argument of the lack of promotion of the DTV subchannels is the cause of the low awareness and viewership of commercial DTV channels. In addition, we noted that the lack of interest is the second most frequently mentioned reason for not watching commercial DTV channels. Current commercial DTV subchannels with no original programs and promotion are hard to draw interests from the consumers to those subchannels. Hence it becomes a vicious cycle.

The lack of significant relationship between online streaming media use and the use of DTV subchannels indicates the two types of video content services are non-competitive to each other. The content of many DTV subchannels are either ethnic, education, weather, and classic TV channels which appeal to the older and male demographics. DTV subchannels, at least in this market, offer some diversity in content from the main commercial and public broadcast TV channels. Yet, they are far from being a threat to the commercial local broadcast TV viewership. DTV subchannels really benefit the main PBS station with additional viewership. But it's unclear whether the commercial DTV subchannels help their main channel affiliate in getting viewership from other broadcast TV or even cable TV channels. Among those who did not watch commercial DTV subchannels, about a quarter of them stated that they did not watch because they did not like the programs in those channels. Although it was a minority opinion in numbers, four respondents responded that they do not watch sub-channels because of low TV signal quality. The advantage of HDTV is better picture and sound quality. But in our research, some audiences did not receive satisfactory signal quality for some digital subchannels and gave

up watching. Quite a number of them requested help from PBS in their antenna installation and the variation of the signal reception seems like an important factor in the DTV environment.

Conclusion and Suggestions for Future Research

There are several limitations in the study. First, our study did not have a representative sample of the population in the market with only university population. Another problem is the relative high percentage of missing data in demographic information (about 25%) which reduced the total sample size in the regression analysis. Readers are cautioned not to generalize the results to the national population. Future studies can use a national sample to further evaluate the consumers' perception of the performance of public broadcast and commercial DTV multicast programming in meeting their needs and awareness of various subchannels available in their markets.

To truly realize the benefits of digital multicasting based on the results of the study, the FCC, along with the broadcast TV industry, should continue to educate consumers on how to receive over-the-air digital broadcast using outdoor antenna to receive all the available DTV channels in the market and the benefits of receiving these channels for broadcast TV households and cable/satellite subscribers. Another route is to require must carry of DTV networks as long as they provide the cable and satellite providers carriage for free as part of the basic cable package to serve cable subscribers and enrich the basic cable offering of cable/satellite companies. However, because of the non-local nature of most of the DTV subchannels, it is hard to justify must-carry protection for these DTV networks to cable/satellite providers. But, if the DTV subchannels were local production of the local commercial TV stations, then digital must-carry for those subchannels should be mandated. Encouraging the use of OTAA reception with installation education and positioning OTAA as a complementary service, rather than

competitive to pay TV or broadcast network TV services, can give a new life to these DTV networks and facilitate multicasting. OTAA can co-exist with pay TV service for those who are interested in both services and can alleviate the burden of cable/satellite TV service to carry the DTV subchannels/networks. Viewers then can have a real choice of having only broadcast signals for free or enjoy both complete broadcast with main and DTV subchannels and pay TV service rather than a partial service. By changing the stepchild status of the DTV subchannels, broadcast TV can contribute to diversity of programming serving different interests of the viewers.

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Table 1

Reasons for not watching commercial DTV subchannels

	N=474 Count
Didn't know they exist	144
Don't like/not interested in the programs in digital TV subchannels	106
Cable/satellite providers did not carry them	48
Could not receive them over the air	28
Don't have TV service	11
Don't watch TV	9
Signal quality	4
Other	8

Note: Missing cases excluded

Table 2

Predictors of DTV Subchannel Awareness and Use

	Awareness (n=428)		Use (n= 427)	
	Beta	t	Beta	t

OTAA use	.41**	8.97	.43**	9.43
Online video streaming use	0.02	0.47	-0.05	1.06
TV use	-.04	-0.95	-.02	-0.50
Multi-TV set HH	.00	0.65	.02	0.47
Age	.11*	1.85	.07	1.22
Gender (0=male, 1=female)	-.10	- 2.14	-.06	1.22
Education	-.03	.47	0.01	0.14
Income	0.00	.13	-0.01	0.19
Location	-0.05	.77	0.01	0.25
	Adjusted R^2=0.18		Adjusted R^2=0.18	

*p < 0.05, one-tailed

** p < 0.01, one-tailed

Note: Missing cases excluded

Table 3

Comparison of PBS and Commercial DTV Subchannels Awareness and Use

	PBS digital subchannel use (n= 428)		Commercial digital subchannel use (n=427)	
	Beta	t	Beta	t
OTAA use	.40**	8.75	.30**	6.23
Online video streaming use	-0.03	-0.5	.04	0.72
TV use	-0.02	-.305	-.03	0.65
Multi-TV set use	-0.03	-.31	.06	1.12
Age	.08	1.35	.07	1.14
Gender (0=male, 1=female)	-0.03	0.61	-.13*	-2.77
Education	.01	.23	- .06	-.93
Income	-.05	-.89	-.01	.30
Location	.00	.11	.03	0.57
		Adjusted R^2=.16	Adjusted R^2=.09	

**p < 0.01

*p <0.05

Note: Exclude missing cases

Table 4

Specific Digital Subchannel Use

	Count
PBS – Create	96
PBS – Encore	72
ME-TV (CBS)	11
Weather Nation (ABC)	10
Retro Network (NBC)	9
LiveWell (ABC)	4
Bounce TV (Fox)	3