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Title:

Opportunities and Challenges for Converged Platform for Audio-Visual and Data Services in 470-790 MHz UHF Broadcasting Band

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Abstract

In this paper, we will investigate the potential opportunities and challenges for deploying a converged platform in the UHF Broadcasting band (470-790 MHz) to replace the legacy systems and provide terrestrial audio-visual and data service. As recent development shows, both mobile broadband and terrestrial broadcasting (DTT) now overlap to offer audio-visual services to customers. Whereas DTT is designed only for audio-visual content, mobile broadband systems are converged all-IP platforms that may carry a multitude of services in unified and device-agnostic way. DTT used to be highly effective, when the task was to distribute a few TV channels to large audiences. However, for the rapidly increasing "long-tail" of "niche" television channels, each with diminishingly few viewers, DTT is no longer an efficient way of using the spectrum. Progressively re-farming of the UHF broadcasting band for more flexible and efficient use, is high on the list of discussion items in the upcoming World Radio Conference 2015, it is highly relevant to evaluate this option with a holistic view. This paper will present findings from the analysis of the inherent strengths and weaknesses of mobile and broadcasting industries in their new roles in the converged ecosystem. Detailed discussions are focused on identifying the possible benefits and threats from the perspectives of the broadcasters, mobile network operators, digital terrestrial network operators and the society as a whole. Overall we consider such a converged platform is a win-win solution for most of the stakeholders thanks to the increase in spectrum and network efficiency and flexibility improvement in the all-IP network. Nevertheless, there are still challenging issues to be addressed, such as the compensation and new business model for the digital terrestrial network operator and ensuring the quality of service for audio-visual content delivery in cellular network.

Key words:

Convergence, DTT broadcast, mobile broadband, UHF broadcasting band

1 Introduction

Efficient utilization of the radio spectrum, particularly in the sub-1GHz band due to its favourable propagation characteristics, is essential for both TV broadcaster and mobile operator's future success. In response to the increasing importance of mobile service (See Figure 1.) and its demand for high quality spectrum in sub-1GHz band, the spectrum band between 790 and 864 MHz have been reallocated from TV broadcasting to mobile broadband (MBB) in Europe by 2013. Despite the loss of 100MHz spectrum, the transmission efficiency gain from digital switchover has allowed the digital terrestrial TV (DTT) to continue improving its service quality and gaining popularity in Europe during the last decade. However, the recent agreement at the 2012 World Radio Conference (WRC-12) to allocate the 694-790MHz (also called as 700MHz band) to MBB alongside DTT in ITU region 1 (EBU 2013) has casted a great uncertainty to the prospect of DTT service.

Meanwhile, the consumption pattern for audio service is shifting rapidly. High definition (HD) and 3D content are getting increasingly popular, but more importantly the demand trends seems to be shifting towards more diversified contents. On-demand service has begun to challenge the dominance of linear broadcasting. In fact, audio-visual and Internet data services are increasingly consumed in a unified way, especially on mobile and portable devices. Whilst the combination of DVB-T2 and high efficiency video coding (HEVC) seems to be a natural choice for the TV broadcaster to support a few spectrum hungry high quality services, the growing trends towards 'long-tail' viewing and the possible loss of one third its available spectrum after WRC-15 may necessitate a revolutionary approach rather than an evolutionary upgrade.

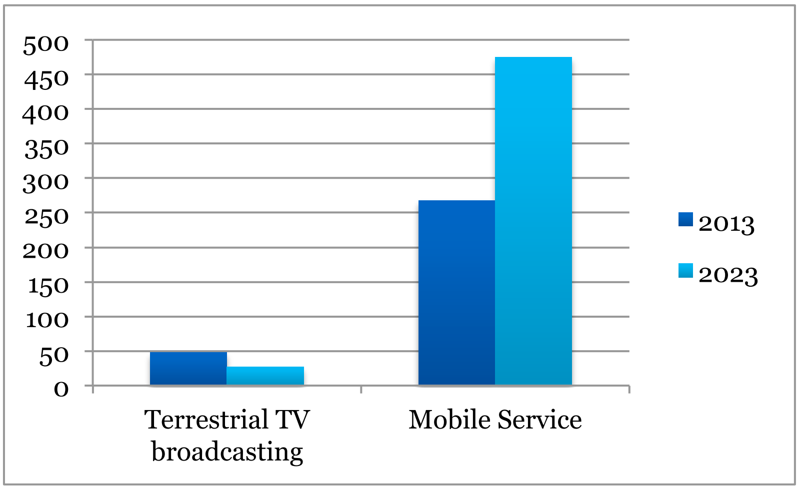

Figure 1. The economic value of mobile service and terrestrial TV broadcasting service in the EU at 2012 price in billon Euros. (source: Plum Consulting 2013)

In light of the converging trends of audio-video consumption in both mobile broadband and TV service, a unified solution based on single IP-access network is envisaged for providing both broadband and broadcast service to both fixed and mobile reception in UHF broadcasting band. A few conceptual systems based on LTE eMBMS (evolved Multimedia Broadcast Multicast Service) technology have been developed for delivering HD-quality audio-visual service using mobile networks, which is expected to be more flexible and spectrum efficient than the legacy system (Kürner, o.a. 2013) (Shi, o.a. 2013). However, despite its promising outlook, studies on this issue are still at an infant stage, usually with an emphasis on the spectrum gain from the mobile operator's perspective (Huschke, o.a. 2011). The DTT industry has also clearly recognized the need to adapt and top ranking scientist in the European broadcasting union (EBU) looking for alternatives (Reimers 2013) (Kürner, o.a. 2013). At the same time, they are also actively lobbying against any proposal on converged systems (Broadcast Networks Europe 2013) (EBU 2011) (Beutler 2013), as it threats their very existence as DTT network operators.

The upcoming 2015 World Radio Conference (WRC-15) will confirm the decision for allocating 700MHz to MBB on a co-primary basis, and more importantly it will discuss the long-term vision for the future use of UHF broadcasting band. Therefore, it is a unique opportunity to introduce the innovative approach for delivering both mobile broadband and audio-visual service in UHF broadcasting band over an IP-access network based on cellular technology and existing mobile network infrastructure. We consider it highly relevant and timely to discuss the real benefit of the converged solution with a more balanced view and to identify any potentially inhibiting challenges. More specifically, the following questions are investigated from the perspectives of each stakeholder in the audio-visual service ecosystem, the mobile network operator (MNO), the broadcasters, the DTT network operator and the society as a whole:

- What would be the changes to their roles and business models in the new ecosystem with the converged platform?
- What are the strength and weakness of each player and the opportunities and potential threats for adopting the converged solution instead of competing for exclusive spectrum access with legacy systems?
- What are the implications on the social benefits and challenges in regulations for the implementation of the converged platform?

The rest of the paper is organized as follow: Section 2 provides an overview of the recent developments in terrestrial audio-visual services; the potential scenarios for spectrum regulation in the UHF Broadcasting band after WRC-15 are discussed in Section 3, followed by a brief description of the converged platform based on cellular infrastructure in Section 4; in Section 5 we investigate role and business model of each player in the audio-visual service ecosystem and illustrate the potential changes to their roles with an example of the possible new service models in the converged platform.; Section 6 presents the detailed analysis of the benefits and challenges from each stakeholder's perspective and finally Section 7 summarizes the main findings and concludes the discussion.

2 Recent developments in audio-visual services

The digital switchover to DVB-T has revitalized the terrestrial broadcasting industry. By March 2013, DTT broadcasting is used in 40%[1] of the households in Europe for receiving TV, establishing itself as the most popular platform for TV reception (Satellite TV 23%, Cable TV 19%) (TNS Opinion & Social 2013). It is predicated that by year 2018, more than half of the European household will be receiving DTT (including both primary and secondary TVs) (Digital TV research 2013). But DTT take-up varies significantly across EU-27, from rather marginal take-

[1] BNE questionnaire online shows over 50% households use DTT (Backlund 2013).

up, e.g., less than 10% of households in Germany (Reimers, 2013), to very high take-up, e.g., more than 90% of households in Spain (March, 2011).

The long-term success of DTT, however, may not be as certain due to the changes in the consumption pattern of audio-visual contents. It is not only that the TV service is shifting from linear to on-demand, but also that the TV programs are expected to be available on different mobile platforms (Hirsch 2013). Indeed, many TV broadcasters have started to offer video streaming via Internet. For instance, video streaming applications 'iPlayer' from BBC and 'SVT play' from the Swedish national channel are both highly popular mobile/web applications in their respective countries. In addition, the increasing amount of 'long tail content', i.e., more diversified video content with low usage pattern and the transition to advanced formats, such as High Definition (HD) or 3D contents, are also emerging challenges to be faced by the DTT network operator.

At the same time, satellite TV, cable TV and IPTV continue to grow across much of Europe, which could potentially make DTT less attractive in the future because its lack of interactivity and limited capacity for providing HD content (Mullooly 2012). The DTT industry has attempted to retain its competence in the VoD/nonlinear service by offering Hybrid Broadcast Broadband TV (HbbTV) service. However, as HbbTV requires broadband connections, it has very limited added value as compared to cable or IPTV alternatives. The attempt for reaching mobile users was equally unsuccessful: DVB-H, the digital terrestrial TV broadcasting standard for mobile reception, failed to reach a wide audience, due to the lack of suitable devices and, more crucially, viable business model for mobile TV based on linear content (Winslow 2012).

On the other hand, the mobile broadband industry has experienced explosive growth in the last decades. The data traffic is expected to increase by 30 times in the next five years by 2017 (Cisco 2013), with mobile video constituting two-thirds of the total traffic. This won't be surprising if we consider the rapid proliferation of mobile devices with screens of ever-larger sizes and higher resolution. Although recent adjustment to the forecast indicates the mobile data traffic growth is more linear rather than exponential (See Figure 2), the increasing amount of high quality audio-visual content accessible via Internet still exert a great pressure on mobile network operators (MNOs) to provide sufficient capacity for multimedia content streaming.

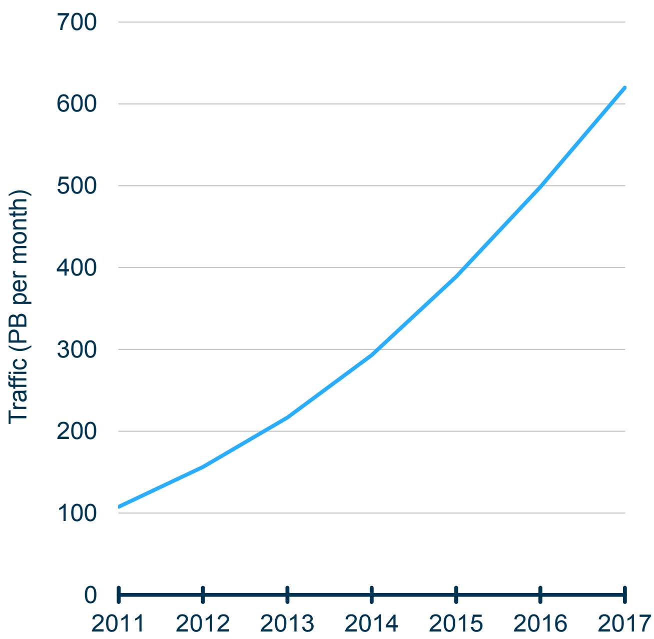

Figure 2. Wireless data traffic, Europe, 2012-2017. (Source: Analysis Mason 2012)

3 Spectrum regulation in UHF Broadcasting band

The 470-790MHz UHF Broadcasting band is allocated for digital terrestrial TV (DTT) broadcasting service in Europe, but in many other regions[2], the 700MHz band was allocated for MBB. In an attempt to create an internationally harmonized frequency band in sub-1GHz for MBB, WRC-12 allocated the 700MHz band for mobile services on a co-primary basis with broadcasting, making future authorization for mobile use in this band easier and more attractive (OFCOM 2013). This decision on co-primary allocation will be confirmed in the next WRC in 2015 (WRC-15) with immediate effect. But it is expected that the EU Member States would not be obliged by the commission decision to make the 700MHz band available for MBB use. Recently European commission has issued a mandate for CEPT to develop a set of technical conditions required for EU Member States to deploy MBB service in the 700MHz band, which will be delivered in 2016. While it is unlikely that WRC-15 will retract from the co-primary allocation, there are also concerns within European Commission that 'an early and isolated decision on co-allocation of 700 MHz band as of 2015 in the UE could potentially detract from the more comprehensive and coherent inventory process' (RSPG 2012). Thus, there are several possible scenarios for the actual usage of the 700MHz following its co-allocation to terrestrial broadcasting and MBB after WRC-15.

- **Status Quo**

This scenario assumes that either the member states decide to maintain the primary status of terrestrial broadcasting or the MNOs were not attracted by a geographical interleaved spectrum sharing arrangement due to inter-system interference constraint. The DTT broadcaster is

[2] 700MHz band is allocated for MBB in the USA, Canada, some African countries, Latin Americia, Japan, South-East Asia, Australia and New Zealand.

therefore able to consolidate the position of broadcasting after the digital switch over and intense investment in 700MHz band. It would allow countries with significant reliance on terrestrial reception to gradually migrate to more spectrum efficient technology (DVB-T2/HEVC) for offering spectrum hungry services, e.g. ultra-HDTV. However, it is predicated that if the linear TV broadcasting remains as main form of terrestrial TV service, it would face congestion problem and demand more spectrum than available in 470-790MHz beyond year 2022 (Borrell, o.a. 2012).

- **Release of 700MHz band as 'second digital dividend'**

This scenario assumes that the 700MHz band will follow the steps of the first digital dividend, i.e. the 800MHz band, which were given co-primary status since WRC-07 and made available exclusively for MBB by 2013. It foresees that the 700MHz band will be eventually allocated for MBB exclusively as a second digital dividend, forcing the incumbent DTT network to evacuate the spectrum. In countries with high DTT service penetration, the DTT network operator must re-plan the network to better utilize SFN and upgrade it to more spectrum efficient technologies to compensate the loss of spectrum. Taking away 30% of the post-switchover spectrum capacity for terrestrial broadcasting will certainly limit the future development of terrestrial TV services. On the other hand, a harmonized spectrum in sub-1GHz for exclusive MBB use will facilitate the development of MBB and help to achieve the ambitious targets set out in the Digital Agenda Europe for ubiquitous broadband coverage with high capacity.

- **Re-farm 470-790 MHz for a converged platform**

This scenario assumes that following the mobile allocation of the 700MHz band, the discussion in WRC-15 agenda item 1.1 (additional spectrum allocation to the mobile service to facilitate the development of terrestrial mobile broadband) has prompt further mobile allocation in the 470-694MHz, creating a converged platform to provide broadcasting and mobile service via MBB network. The development of a converged terrestrial broadband network is well in line with the European Commission's long-term vision for the convergence of broadcasting and broadband services (European Commission 2013). A converged all-IP platform will better serve the converging trends in audio-visual consumption and promote innovation and economic growth. Although it may not be realistic shortly after WRC-15 due to barriers of structural nature at EU level and resistances from established interests, it can still be achieved through progressive restructuring of the broadcast landscape and development of new standardization and business models. Incentive auction, for instance, could be one way to encourage the DTT network operator to release its spectrum license (FCC 2012).

4 Converged system based on cellular network

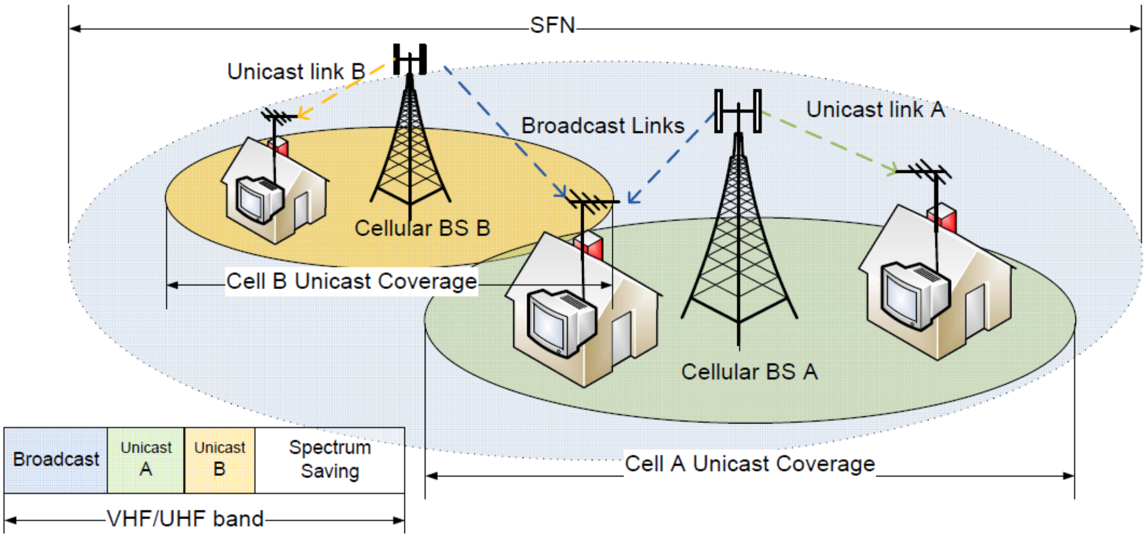

Figure 3. Converged platform based on cellular network for terrestrial audio-visual and data service

The converged platform we envisaged is based on Long Term Evolution (LTE) technology and cellular infrastructure. The audio-visual content will be delivered by either broadcasting or unicasting, depending on the popularity of the content. To enhance the transmission efficiency for broadcasting the most popular TV channels, the network can utilize the evolved Multimedia Broadcast Multicast Service (eMBMS) feature in LTE system and group multiple transmitters to form a single frequency network (SFN). Other TV channels, either with linear or nonlinear content, can be delivered to each individual receiver via unicast link.

This ability to unicast the less popular channels significantly improves the overall spectrum efficiency, as the network can easily adapt to the different video consumption patterns both in temporal and spatial dimensions. For instance, in dense populated area, more TV channels can be broadcasted thanks to the spectral efficiency gain from a denser SFN. On the other hand, in rural area where SFNs are less attractive due to larger inter-site distance, the lower population density also means that only a few TV channels would be unicasted simultaneously. Any unused spectrum remaining in UHF broadcasting band can then be used for providing broadband data service.

While the converged all-IP platform has advantages in interoperability and flexibility, it must also ensure its role as terrestrial broadcast network is being fulfilled properly. The key requirement for terrestrial broadcasting is the near-universal coverage, which has been regarded as the main barrier for mobile network to be successful in providing terrestrial broadcasting. However, in our recent study we have illustrated that, from a technical point of view, it is feasible to provide adequate TV service using existing cellular infrastructure for countries like Sweden, which has moderate DTT service penetration (30% as of 2012 (TNS Opinion & Social 2013) and good cellular coverage (Shi, o.a. 2013). In fact, we have identified considerable spectrum saving by replacing DTT with the converged platform in urban areas by year 2020 with foreseeable increase in audio-visual content quality. Moderate spectrum saving can also be achieved in rural area if the aerials would be replaced by multiple-input and multiple-output (MIMO) antennas to improve the reception quality.

5 Audio-visual service model comparison

In this section, we compare the legacy service model for delivering audio-visual content using DTT network and MBB network with the envisaged model using the converged platform. We intend to identify the changes in the roles of key players in the audio-visual service ecosystem.

5.1 Distribution via DTT and MBB networks (current)

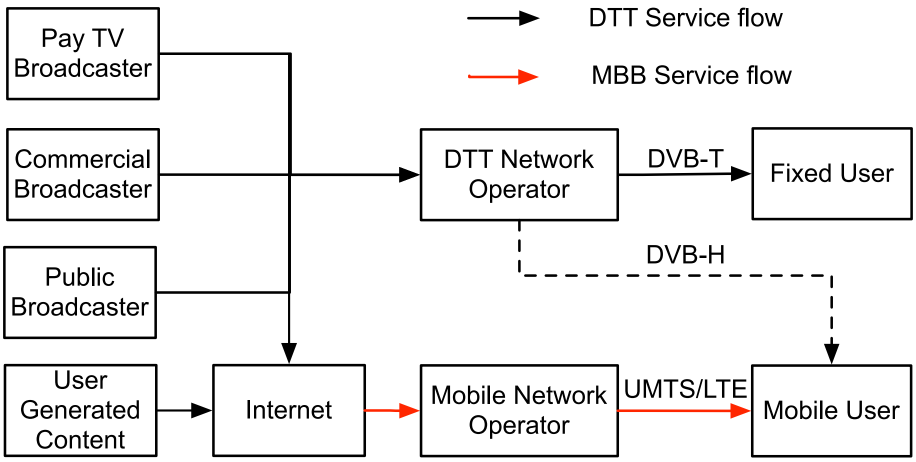

Figure 4. Current terrestrial audio-visual service model.

Currently, the terrestrial audio-video services are delivered to fixed and mobile users in different ways. While the great majority (over 96% of the total viewers (Backlund 2013)) of fixed user are receiving linear content via DVB-T broadcasting for four hours per day on average, only a minor fraction of mobile users are receiving linear content via DVB-H broadcasting and their average viewing time is limited to a few minutes per day. In fact, most of the audio-visual consumption on mobile/portable devices is streaming via wireless broadband. The content includes both the on-demand service offered by the broadcasters and user generated content online. In the following we analyse the roles of the main players in this ecosystem:

- **Broadcaster:**

The broadcaster is responsible for the production of audio-visual program and aggregating TV channels into multiplexes. It holds the media/broadcast license. In some cases it also holds a frequency license and operates its own DTT network.

Based on their revenue sources, the broadcasters are categorized as public--financed by tax and license fee; commercial--mainly refinanced by advertising revenue; and pay TV channels--mainly financed by subscription fees or pay per view for premium content. The commercial broadcaster and pay TV broadcaster also receives payment from DTT network operator who purchases their content for distribution. Some of the broadcasters now have made their content accessible on the Internet as well.

- **DTT network operator:**

The DTT network operator is responsible for the deployment of DTT network and the transmission of TV content to both fixed and mobile receivers. It must hold a frequency license itself or providing service for a third party who owns the frequency license.

Its ownership varies: either owned by broadcasters (e.g. Freeview in UK), independent (e.g. Digita in Finland) or owned by the government (Teracom in Sweden). Its main source of revenue in DTT business is subscription fees from customers for access.

- **MNO:**

The MNO is responsible for the deployment of mobile network and the transmission of mobile broadband data to the mobile users. The broadband data transmission is typically agnostic to the content it carries, thus it is difficult to maintain the quality of service (QoS) for the video streaming service. MNO must hold a frequency license for its transmission in certain band. Its revenue primarily comes from subscription fees, transmission and billing.

5.2 Distribution via converged all-IP platform (future)

With the converged platform, there will be no more differentiation between mobile and fixed users from the service flow perspective, as both are receiving signals from a single converged network. Both linear and non-linear audio-visual content can be broadcasted to a group of users or streamed to each individual user, and as such the user could enjoy a seamless audio-visual content consumption experience. In the following we highlight the changes to the roles of the main players in this new ecosystem:

- **Broadcaster**

The business model for the broadcaster will remain largely unchanged, but channel aggregation would no longer be needed as each TV channel is delivered independently in the all-IP system.

- **DTT network operator**

The major change comes to the role of DTT network operator for terrestrial broadcasting, as it will now be replaced by MNOs, which would provide broadcasting service using LTE-A/eMBMS technologies. Instead of operating the broadcasting network, the DTT network operator can utilize its tight connection with the broadcasters and advantage in customer base to take the role as converged service provider, which in turn purchases content from the broadcaster and capacity from MNOs in a wholesale model. Its revenue would be the subscription fee from individual users.

- **MNO**

Alternatively, the role of converged service provider can be taken by MNO(s), who purchases content from individual broadcaster and form a vertical model. The MNO must be obliged to deliver the audio-visual content to subscribed users as well as the 'free-to-access' public services. The MNO may provide additional broadband data service within UHF Broadcasting band provided that there is spare spectrum/time resource remaining after delivering the audio-visual service. Its users would pay for subscription and data traffic, but they should not be charged for the cost incurred by receiving public service.

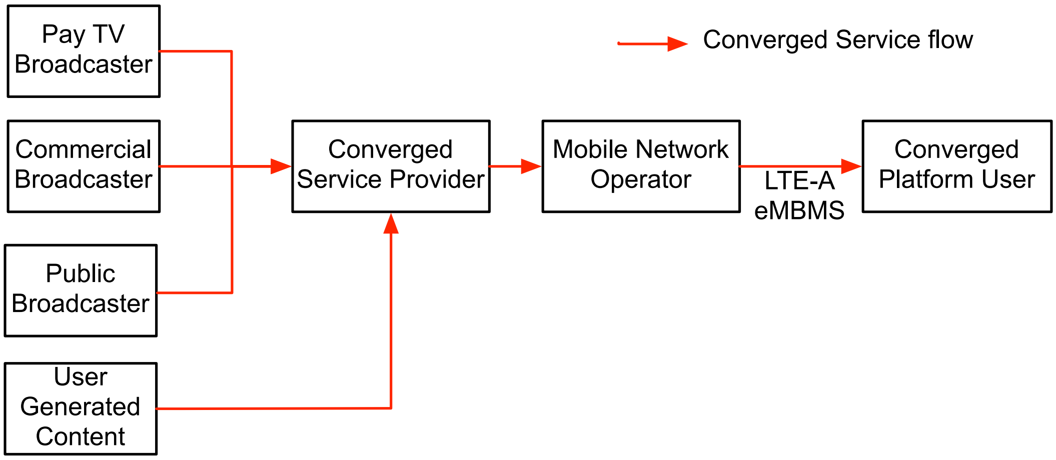

Figure 5. Possible terrestrial audio-visual service model in the converged platform

6 The benefits and challenges for adopting the converged platform

Having identified the changes in their respective roles in the new ecosystem, we will evaluate the key advantage and disadvantages for each stakeholder. Firstly, SWOT analysis is performed on behalf of the broadcaster and MNO for the decision to adopt the converged platform instead of to maintain two distinct platforms on separate frequency bands and wait for a second digital-dividend-like reallocation. Separate discussions for DTT network operator and societal issue are presented in later subsections.

6.1 Broadcasters' Perspective

For the DTT broadcaster, its expertise as a professional content provider and the dominance of linear TV in audio-visual consumption will help it to retain its privileged position in television ecosystem. Its successful experience for providing on-demand services could also be advantageous when competing with third party application and user generated content. The only weakness of the broadcaster is its lack of preparation for interactive service that would become available in the all-IP network.

Substantial opportunity for the broadcaster could be brought by the converged platform. The significant increase in capacity and the ability to deliver 'long-tail-low-usage' content by unicast could be a clear incentive for the broadcasters to adopt the new platform for terrestrial TV service. Besides, the interoperability allows the broadcaster to reach out to the mobile/portable users seamlessly. Lastly, with the help of the return channel, the broadcaster can provide new interactive service and track the user behaviour for personalized service and advertisement, both of which would become new sources of revenues.

On the other hand, the broadcasters may have to share the screen time with other Internet applications, e.g., Facebook, YouTube, etc., which may consequently affect its advertising business that closely associated with linear programs. Furthermore, without a dedicated network like DTT for content distribution, there is a risk that QoS of TV service may be compromised in the general-purpose platform, unless it can be managed as a controlled network.

Table 1. SWOT analysis for TV broadcasters

Strength	Weakness
• Professional content is preferred over user generated content • Linear content delivered via broadcast network remains as the most popular form of audio-visual service (Backlund 2013) • On demand service is growing—successful experience with BBC iPlayer, SVT play, etc	• Not fully prepared for interactive services
Opportunities	**Threats**
• More capacity for more channels, HD and other services • Access to the growing market of mobile/portable users • Interactivity option—potential for new creative content and services • Better user behaviour tracking--personalization/customization—new opportunity for advertising	• Losing its prominent role in the living room-facing competition with third party/internet application and content providers • Reduced importance of linear program affect advertising • Difficult to ensure the QoS and coverage for public service without direct control of the distribution network

6.2 MNO's perspective

The strength of the MBB operator lies in its efficient and fast evolving transmission technology and good overall population coverage of the cellular networks in EU Member States. The growing number of mobile equipment is a benign factor that leads to economy of scale and consequently lower equipment cost. The main weaknesses of the MBB operator are its limited area coverage and its inherent nature as a best effort network. The area coverage issue can be partially addressed for fixed reception by using high performance antennas. But the strict quality of service requirement may not be fulfilled due to sudden variations in traffic or too fast growth. The investment required for deploying the converged network in the whole UHF broadcasting band would probably be higher than a second digital dividend option. Because even though it has the technical means to realize the converged network, it may require additional base station deployments to reach the strict coverage requirement for broadcasting service and more radio equipment for the wider spectrum band.

For the MBB operator, the biggest advantages for deploying a converged network in the whole UHF broadcasting band, rather than simply extend MBB deployment into 700MHz band, is that it enables the access to more spectrum for network capacity boost and at the same time leads to opportunities for new service types and revenue sources. But the lack of clear business model for broadcasting services, especially for the public service channels, may lead to uncertainties in predicting the potential return of investment. Other uncertain factors, such as cooperation with other MNOs, which might be necessary to achieve the coverage requirement, and regulatory decisions on spectrum allocation and price, may also discourage the MNO to take the risk.

Table 1. SWOT analysis for MNO

Strength	Weakness
• Efficient transmission technology for broadcasting audio-visual service – eMBMS+SFN • Good infrastructure and coverage in populated areas • Growing number of user equipment--economy of scale	• Limited area coverage • Best effort QoS • Lack of commercially available device for fixed reception • Cost for network planning and upgrade
Opportunities	**Threats**
• Access to whole UHF Broadcasting band—more flexible capacity for both broadcast and broadband services • Increase the broadband service penetration of MBB • More revenue from video streaming traffic	• Responsibility for distributing public service broadcasting (Free-to-Air) • Need to cooperate with other MNOs to reach national coverage for broadcasting service • Uncertain regulatory prospect and spectrum cost

6.3 DTT network operator perspective

The DTT network operators are clearly facing a dilemma: on one hand, they are strongly against such a converged option and have been actively lobbying against it recently for obvious reasons,; on the other hand, even without losing the 700 MHz band, the future of DTT network is unpromising at best.

Switching to DVB-T2 might provide the capacity it needed to accommodate new TV content with high quality, but the process of network upgrade and cross-border coordination is lengthy. If the 700MHz band is reallocated to MBB exclusively, DTT network might not be able to migrate the channels currently in 700MHz and upgrade certain multiplex to DVB-T2 at the same time due to the lack of spectrum for simulcasting, which is necessary for service continuity before the channel migration and the changes of user equipment (receiver for DVB-T2 and wideband aerials) are completed. Therefore, by the time the whole process is finished, DTT user may have already changed to other transmission medium that offers HD service and on-demand services, e.g., IPTV or satellite TV. The content provider may thus lose interests in DTT distribution and the state could also decide to reduce the public programing over DTT. Without popular contents, the DTT platform would no longer be competitive and quickly lose its customer except in rural areas without any alternatives.

On the other hand, it is possible for the DTT network operator to leverage its existing customer base and close connection with broadcasters to take the role of the converged service provider. It is also possible for the operator to obtain compensation by selling its frequency license through incentive auction. Embracing the converged platform will force the DTT network operator to give up its most important asset, the DTT network, but it may be the only viable option for its survival in the evolving ecosystem of video-visual service in the long run.

6.4 Societal and regulatory perspective

For the society as a whole, the converged platform is certainly the most beneficial option: it greatly enhances the spectrum utilization efficiency in UHF broadcasting band; new applications and services will emerge from the all-IP platform, boosting the economy and improving user experience. It also helps to reach the targets of Digital Europe Agenda for extended broadband coverage. But the extra cost for receiver and aerial replacement might compromise the role of DTT for providing free to access public service, which is mandated to reach the broad public. From the regulatory perspective, there are also challenges for horizontal standardization and international coordination. There is also a risk for less competition by having only a single terrestrial network that monopolizes audio-visual content distribution.

7 Conclusions and implications

Recent development in audio-visual service has exhibited a clear trend for service convergence as well as platform convergence. The increasing demand for service quality and content diversity could no longer be adequately addressed by differentiated platforms based on incremental modifications of legacy systems, i.e., DTT and mobile network, due to technical limitations and spectrum scarcity. Therefore, a converged all-IP platform based on cellular infrastructure has been proposed to replace the existing systems and provide both audio-visual and data service in the UHF broadcasting band.

The recent regulatory decision in WRC-12 at allocating 700MHz band (694-790MHz) to MBB along side DTT service on a co-primary basis has opened up the possibility for further progressive spectrum re-farming in the UHF broadcasting band, which will be discussed in the upcoming WRC-15 as the long-term strategy for this band. Although technical study has shown that it is feasible for the converged platform deployed in the UHF TV spectrum (470-790 MHz) to provide near universal audio-visual and data services, substantial evidence for its real benefits and challenges are still needed to justify the regulatory decision and convince the stakeholders to forfeit their established interests and support the converged platform. Therefore, in this paper we have focused on analysing the strength and weakness of broadcasters, MNOs and DTT network operators in their new roles in the converged ecosystem and identifying the opportunities and threats for each player to adopt the converged platform instead of fighting for exclusive spectrum for distinct services.

From the analysis we conclude that this converged platform is a win-win solution that serves the best interests of the broadcaster, MNO and society as a whole. The capacity increase due to improved spectrum and network efficiency is a clear incentive for both MNOs and broadcasters, as it enhances the broadband coverage and the diversity and quality of audio-visual contents at the same time. With the ability to dynamically reconfigure channels between unicast and broadcast, the converged platform also allows the broadcaster and MNO to better predicate and adapt to future changes in audio-visual and data service usage. From the societal perspective, IP convergence could help achieve the EU Digital Agenda target and promote innovation and growth, while the customers would experience enhanced service quality with interactivity and cross platform accessibility.

Of course, there are also inherent risks and difficulties for developing the new platform. The first and foremost challenging issue is to provide enough incentive to convince the DTT network operator to shut down the DTT network. Although we have argued that seizing the opportunity to change its business model into converged service provider and thus avoiding further unnecessary investment in DTT network may be the only viable option in the long run, detailed investigations would be required on new business models for DTT network operators and plans for incentive spectrum auction. Another issue is that the area coverage requirement for public service may force MNO to increase its investment in infrastructure and share with other MNOs, while there is no clear business model for MNO to distribute free-to-access public service in cellular network. Further studies on technical issues, such as resource allocation between unicast and broadcast, are also necessary to ensure a stable quality of service in an intrinsically best effort network. Finally, in order for the converged platform to become a reality, the regulators must also take initiative in International coordination and horizontal standardization effort, however lengthy and difficult the process might be.

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