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1. Introduction

The research question addressed in this paper is how developments of network technologies and new IP-based standards in the audiovisual markets influence the prospects of traditional broadcasters. The decline and end of traditional broadcasting has been forecasted for long because of Internet in general and more specifically the advent of streaming services such as Netflix, HBO, Amazon Prime, etc. The basic technological reason is that the position of traditional broadcasters has been based on a privileged access to using limited resources in terms of terrestrial spectrum frequencies and access to cable or satellite transmission. With streaming services, anybody can in principle upload audiovisual material for transmission on Internet, challenging the privileged position of traditional broadcasters, whether public service broadcasters of commercial broadcasters.

However, traditional broadcasters have until now turned out to be more resilient than previously anticipated – for different reasons. One of these reasons is that the term broadcaster in reality is misleading. Only few broadcasters have actually broadcasted their programs themselves. They are producers and curators of audiovisual material, and other entities have done the actual broadcasting. The producers/curators of content have held a privileged position because they have had the right or possibility to have their programming broadcasted, but they can also use new infrastructures to get their material transmitted and have largely been able to include streaming of their content as one of the means of transmission. This obviously means that what has been denoted as traditional broadcasters enter a much larger and more diversified audiovisual market and only become single entities among a myriad of offers to viewers and listeners. This,

furthermore, means that they are dependent of their other resources and capabilities including funding and that they have to develop new competences in order to compete under new circumstances.

At first, broadcasters tried with a hybrid model in the form of HBBTV (hybrid broadcast broadband TV) combining traditional broadcast technologies and Internet – but still basically as two separate channels. This has not turned out to be a success – not because the idea of combining different means of transmission is wrong, but because the specific HBBTV suggestions, neither technologically nor business model wise, have been in sync with technological and market developments. Therefore, work on developing new standards that are based on the Internet Protocol (IP) and that combine different modes of transmission has continued, and part of the aim of this paper is to examine the developments of new standards and technological solutions that already are and will be available for transmission of content in the coming years. This includes using mobile technology as one of the primary infrastructures for broadcast, multicast and unicast combining it with cloud and edge computing.

These technology developments will be seen in connection with developments in the audiovisual markets including new business models and ecosystem constructions. The implementation and use of novel technology solutions will require innovation of business models and the construction of new modes of cooperating between various business partners and institutions. The issue addressed in the paper is thus how new infrastructure solutions and business models and ecosystems are developing in the audiovisual markets. Special emphasis will be on the prospects for traditional broadcasters in order to better understand the conditions for these institutions to transform their modes of operation in accordance with new technology and market circumstances. In addition and complementary to the examination of business model and ecosystem developments, the paper will also discuss the implications of infrastructural developments on innovations of audiovisual content. The actual content of audiovisual media constitutes the value proposition of media entities and is thus part of the examination regarding business and ecosystem models.

First, there is presentation of existing and upcoming infrastructure technologies for broadcast, multicast and unicast. After this, there is a section on recent technology and market developments

including a suggestion for a potential platform for distributing audiovisual content. Moreover, there is a section on implications on the content side of audiovisual media. The following section discusses theoretical approaches within business studies that can be applied for analyzing the prospects of broadcasters within the audiovisual area, resulting in an analytical model for such an analysis. The aim of the paper is thus to develop and discuss an analytical model to be used for analyses of the challenges and prospects of broadcasters within the new and upcoming world of audiovisual media.

2. Broadcast technology developments[1]

The first radical change in broadcasting in the last decades was the transformation from analog to digital. Transmission of TV signals using ground-based transmitters in a terrestrial network has traditionally been the most used and known delivery form for TV channels. In markets where other multi-channel platforms are not well developed, digital terrestrial broadcast platforms are highly important for the delivery of broadcast services. The major advantage of using digital terrestrial TV is the possibility for a relatively high number of TV channels on the terrestrial platforms. This is very important, as historically in the analog era, only a few TV channels were available on the terrestrial platforms, primarily due to spectrum scarcity that in many markets resulted in monopoly or duopoly situations with little competition and variety. Digitalization, indeed, also enables other qualities such as ease of reception, mobility, higher resolution of TV channels, etc. (Tadayoni and Henten, 2013).

The new generations of TV standards utilize the spectrum more efficiently and, therefore, enable the possibility to increase the number of TV channels even more. This has resulted in the creation of multi-channel platforms in the terrestrial networks in many countries. However, the precondition for multi-channel broadcast in terrestrial TV is that the political environment accepts using the resources to send more TV channels rather than better quality TV channels. This has been the case in European countries which have created real multi-channel platforms in the terrestrial networks. However, in recent time, due to efficiencies achieved, more and more

[1] Section 2 is an abbreviated and edited version of a section in Henten and Tadayoni (2020).

spectrum is taken away from the broadcast sector and allocated to other uses like mobile communications, the so-called digital dividend spectrum (Henten et al., 2010).

With respect to other TV infrastructures, Direct-To-Home (DTH) satellite networks were the first delivery networks to be digitized and cable TV the last platform to be fully digitized. Digitization of satellite networks for broadcast purposes was driven purely by cost reductions related to the transition to digital technology. Cable TV had, on the other hand, for long time enough capacity to deliver multi-channel TV services in analog form in a cost-effective manner. However, in recent years, due to huge demand for broadband services, many cable TV platforms in developed markets have become fully digitized.

The next wave of changes that has dominated the multimedia and entertainment industry in recent years started around a couple of decades ago and is mainly characterized by the use of IP-based network infrastructures as the distribution platform and a change from flow to on-demand media. The first deployment of IP-based infrastructures for distribution of professional audiovisual content that directly competed with dedicated multi-channel broadcast infrastructures was using managed IP networks for the distribution of TV on IPTV (Internet Protocol TV) platforms. As IPTV is delivered over managed networks, the operator can guaranty certain levels of QoS and deliver qualities comparable with dedicated broadcast infrastructures. The major driver of IPTV development was the need to monetize the unused capacity in broadband networks by the broadband operators. Delivery of TV services was an obvious choice and became a standard service offered by many broadband operators as part of triple-play services. The emergence of IPTV created a new infrastructure for the delivery of TV and consequently created more competition in the TV markets but it did not change the structure of the market. The revenue models were adapted from traditional multi-channel TV infrastructures, however with more possibilities for on-demand services.

Another deployment of IP platforms for the delivery of audiovisual content is the Over the Top (OTT), which means delivery of content over the best effort Internet, bypassing the traditional gatekeepers. While the first development (digitization of broadcast platforms) was mainly driven by the need for more capacity and higher technical quality and did not change the structure of media distribution, and IPTV was driven by the broadband operators' monetization of excessive

capacity in their infrastructures, the best effort IP-based distribution, in particular the OTT paradigm, massively changed the structure of the market where new players have entered the scene. One of the most important drivers of these changes has been the development in the broadband infrastructures both in terms of reach and capacity.

Broadband networks of the future may be capable of providing media services of high quality and high reliability. However, broadcast platforms still can have a role to play in the provision of media services due to their fundamental characteristics such as managed one-to-all network using licensed spectrum, unified user experience, low latency and zero marginal cost of adding new customers. In the last couple of decades, one of the major questions regarding the future of broadcast media markets has been how we can utilize the strengths of broadband as well as broadcast platforms in the provision of media services (Gimpel, 2015; Leal et al., 2017). Many solutions have been proposed that have not worked due to the completely different technologies used in these platforms and the proposed business models - some examples being DVB-H (DVB-Handheld) in mobile broadcast broadband and HBBTV in the fixed hybrid broadband/broadcast (Domínguez et al., 2018).

The new broadcast technologies and standards such as DVB-T2X, DVB-I (DVB-Internet) may open the possibility of re-introducing a unified user experience in an era where broadcast and OTT co-exist. Furthermore, broadcast technologies used in the 4G and upcoming 5G networks like LTE (Long Time Evolution) Broadcast (Yrjölä, et al., 2016) and eMBMS (evolved Multimedia Broadcast/Multicast Service) (Calabuig et al., 2015) are important developments that enable seamless delivery of content to the users deploying the most optimal combination of broadband and broadcast infrastructures. DVB-T2X is a gradual upgrade of existing DVB-T2 ecosystem to all-IP and may define a new TV service infrastructure inspired by the work done with the US ATSC 3.0 (Advanced Television Systems Committee) standard. However, from the industrial and practical perspective, DVB-T2 was not an all-IP standard; it is more like a patch to support the delivery of a transport stream over IP. However, DVB-GSE (DVB-Generic Stream Encapsulation) for example supports the full migration to IP over terrestrial and satellite broadcast network but has never been adopted due to the lack of the CPE (Customer Premises Equipment) support from device manufacture or from the tech vendors to deploy the standard. DVB-I is a standard developed for accessibility of quality broadcast content over the best effort broadband network. FeMBMS

(Further evolved MBMS) is a standard enabling broadcast in 5G mobile broadband networks. Using these technologies or other relevant technologies, the possibilities of forming a true converged broadcast-broadband service platform is in the making.

Content delivery networks

In recent years, we have seen a strategic focus on streaming services in many broadcast companies. However, Internet was not in its original architecture a medium to be used for broadcast services. The best-effort IP-based Internet cannot guaranty the Quality of Service (QoS)/ Quality of Experience (QoE) necessary for broadcast quality services. In the original Internet architecture, the QoS parameters were meant to be dealt with at the edge of the network, but massive use of the network for distribution of audiovisual content in a one-to-many architecture necessitated changes in the Internet infrastructure. As Sandvig (2015) puts it: 'As the Internet evolved, a remaining technical challenge was adapting its point-to-point architecture to the one-to-many asymmetries of audiences and attention'. Furthermore, 'A commercial breakthrough came when an MIT applied mathematics professor created the spin-off company Akamai', which established one of the world largest Content Delivery Networks (CDN).

To provide TV services with decent QoS/QoE using the open best-effort Internet infrastructure, it is important to push the content as close to the users as possible. This is done by using CDNs, which is considered as a suitable option to be deployed by telecom operators and ISPs internally within their network infrastructure by placing cache nodes in geographically distributed locations, close to end users (Hasslinger et al., 2011).

Mobile Edge Computing

While development and deployment of CDNs have been important for enabling the distribution of streaming services using OTT technologies like HLS (HTML Live Streaming), there are some challenges using CDNs in particular when it comes to mobile networks and mobile devices, specifically, when it comes to the latency, and the need for pushing the content even closer to the users. In mobile networks, a new paradigm of Mobile Edge Commuting (MEC) is emerging focusing on latency sensitive services and the services where it is more optimal to do processing at the edge of the network rather than in devices (Mach et al., 2017).

The huge advantage of broadcast has so far been the nature of the managed network, the wide-area coverage and the dedicated spectrum to ensure a unified experience when receiving TV signals. This ensures a reliable high-quality low latency reception of a live signal. This is especially important when watching live events like sports, where you should be able to watch the goal, when it is being scored, and not 30 seconds later due to limitations in the nature of the best-effort IP networks and the streaming protocols optimized to ensure somewhat reliable delivery in ever-changing network conditions (WIFI, mobility etc.). However, within wired and especially wireless IP technologies, newer and much more reliable low latency protocols are gaining momentum ruling out the obvious advantages of using broadcast over broadband. As seen above, in the mobile networks, MEC is an obvious choice in this respect.

Martin et al. (2016) also have emphasis on the latency issue: 'MEC turns a base station into a service catalyzer, which dynamically improves application performance and user experience for a specific service. The target features span ultra-low latency and round-trip time (RTT), optimized bitrates, extra physical security and efficient caching'. Furthermore, Martin et al. (2016) propose a model where MEC, based on analytics, changes between CDNs and by that delivers the best QoE. Viola et al. (2018) proposes a MEC proxy model to deal with the degradations of CDN performance and outage due to high concurrency rates of media sessions that impact negatively the Quality of Experience. Both of these models emphasize that MEC is not a replacement for CDNs but is complementary to CDNs.

When it comes to 5G and, in particular in the use cases related to eMBB (enhanced Mobile BroadBand), media and audiovisual streaming services will play an important role. High quality audiovisual content needs high capacity in the network and pushing content ever closer to the users becomes more important for saving valuable resources in the backbone networks but also to effectively deal with QoS /QoE parameters in media distribution. For this, using Mobile Edge Computing architectures in 5G in combinations with CDNs enables more efficient distribution platforms for media services and solves some of the challenges of using CDNs.

3. Recent technology and market developments

The technological developments in the ICT and media industry have enabled more efficient and seamless ways to access content, particularly video, regardless of place, time and device.

However, the new technologies have introduced unprecedented challenges, e.g. rapid shifting in users' viewing behavior from broadcast to broadband streaming services, which has resulted in a global spiraling supply of and demand for streaming TV and VOD (Video On Demand) services. Today, there are huge amounts of content being streamed in high immersive qualities such as 4K, and in the near future we will see content streamed in 8K and 16K on the market. This has driven the broadcasters to come with their own standalone streaming services into an extremely fierce competitive market. Consequently, the pressure on Internet capacity has accelerated and is getting even stronger with the Covid pandemic. This accelerated pressure on the Internet capacity has created an urgent need for more capacity in the broadband networks to cope with the current and the future demand for the immersive video services.

A traditional and easy solution to this challenge could be the deployment of broadband networks with higher capacity, such as FTTH (Fiber To The Home) or 5G eMBB. Although the 5G eMBB is a very promising technology, it will not be able to cope with the increasing demand when scaling is needed. FTTH infrastructures, on the other hand, are costly and lack the mobility aspect. The same applies to IP broadcasting technologies such as DVB-NIP, DVB-I and ATSC 3.0, that use multicast. Multicasting technologies alone will not either be the solution.

Many scholars have pointed to the fact that converged platforms utilizing the complementary strengths of broadband and broadcast platforms are the most effective solutions to the problem. According to Fanari et al. (2019), convergence between broadcast and broadband would provide the spectrum efficiency and the capacity needed for supplying the continuous demand for advanced video services with highly improved quality of services. However, the key challenge in getting the two networks interconnected is the lack of interoperable converged frameworks.

A clear example of the importance of the convergence between broadcast and broadband carriers is the existing synergies between ATSC 3.0 and 5G. According to Kurz (2020), SK Telecom has expressed that while 'they see the value of broadcast and they see the value of 5G, they see the hybrid network as the way the future will end up going'. There are a number of demonstration projects that illustrate the power of the converged platforms. For example, to illustrate the synergies between ATSC 3.0 and 5G, a demonstration project on the Jeiju Island was developed in 2019 (Gage in Kurz, 2020). In the demonstration project, a Maserati SUV got equipped with both

ATSC 3.0 and 5G receivers. According to Gage (in Kurz, 2020), the demonstration projects showed that video content could be received through the broadcast network while maps, navigation, way marks, and advertising were received via the 5G network.

In the same context, an argument has been brought forward in the debate as to why the telecom operators want to cooperate with broadcasters, e.g., on offloading unicast traffic to the broadcasters' networks? The answer came down to the saving of costs and resources of telco networks. It is more cost effective to offload the video traffic to a broadcast network. The same applies for data. If a telco must send updates to millions of cars, it will be much more cost and resource effective to use broadcast networks.

The DVB organization in collaboration with 3GPP has added further support to multicast and broadcast for bringing the best of two worlds together. The collaboration is materialized in 3GPP Release 17, which doesn't have CPE support yet. This illustrates the necessity of establishing and coordinating business ecosystems when launching new services. Also, different innovative companies work on developing and promoting such solutions. Mediathand, for instance, which is an innovative company in Denmark have proposed a unique implementation of OTT-B (OTT-Broadcast), which utilizes the complementary forces of broadband and broadcast by pushing the content and processing to the edge of the network that communicates with gateways in the homes (Hammershøi, 2020).

The collaboration between DVB and 3GPP and different implementations of OTT-B illustrates that there is no single type of distribution network that can do it all, and the combination of IP multicast/broadcast together with unicast 5G in an interoperable heterogenous network would be the best way to go to accommodate the supply and demand of TV, VOD and other bandwidth-intensive content services. Such a collaboration is vital for broadcasters if they wish to stay relevant on the market by utilizing the ongoing convergence process, including the new IP broadcasting technologies, CDNs, Mobile Edge Computing and the complementarities with the broadband networks and particularly with the 5G.

A macro view on the audiovisual markets indicates that direct-to-customer (D2C) streaming launches have saturated the market. According to OMDIA (Oct. 2021), there were 5359 media streaming services reaching 1 billion subscribers across the globe at that point in time. In response

to the pandemic, cord cutting has accelerated by around 30% (OMDIA, Oct. 2021), and while linear TV streaming viewing hours of users have crossed the barrier of three and half hours per day, video quality is getting higher and higher, making lower bandwidth consumption per customer and extending the currently available bandwidth urgent needs for the industry. (OMDIA, Oct.2021).

This has put more constraints on the satellite and terrestrial spectrum, as more of these two spectra are allocated for mobile services (Harmonic Webinar, Nov. 2021). On the user experience side, the lean-back experience is the most targeted experience - in other words the TV set is the favorite screen for watching content, while android TV is the dominating OS for accessing content. On the competition side, telcos are the super aggregators of the future (linear/live TV, VOD, gamification, IoT etc..), heavily dependent on 5G and MEC technologies, as services increasingly will be processed at the edge for final delivery to viewers.

The impact on broadcasters can be viewed from two perspectives – a strategic perspective and a technology perspective. From the strategic perspective, it is now clear for broadcasters that deploying an effective D2C strategy will not be easy to achieve, as the ocean is very 'red'. Yet, the broadcasters have not given up on the D2C strategy, but for the time being it is on hold. Also, broadcasters have crafted a new strategy based on keeping their traditional business model, a B2B model, while changing their way of reaching out to customers and mainly targeting the lean-back experience. The broadcasters, particularly in the US, the Baltics and Eastern and parts of Western Europe, see a potential in transforming their services into a readymade streaming services able to be fetched by streaming service providers, e.g. OTT, IPTV, vMVPDs (virtual Multichannel Video Programming Distributor), MNOs (Mobile Network Operators) and MVNOs (Virtual MNOs), for restreaming fees. Broadcasters put three conditions for deploying this strategy: first of all, full control over ad stitching, secondly, transparent exchange of data analytics, and thirdly, taming piracy of content, which according to OMIDA, Technicolor and Elisa Streaming reaches about 64+% of the broadcasted content (OMDIA, Oct. 2021)

If this strategy is to see light at the end of the tunnel, there is a list of technological needs and challenges that have to be sorted out. First and foremost, the importance of full alignment with the cloud, which will not be on prem due to high cost. Aligning with cloud technology is a fast and safe way for broadcasters to gradually adapt to the IP world, as it will not only enable the

broadcasters to offload their content from the broadcast network to the cloud for being transformed into readymade streaming services for streaming service providers to re-stream, it will also provide the broadcasters with transparent data analytics coming from the CPEs. For the first time, the door will be open for broadcasters to provide viewers with personalized experiences and dynamic personalized ad stitching. However, things are not that easy to achieve. For broadcasters to come into the cloud world, two main missions have to be fulfilled. First, reliable partnerships with telcos have to be established, as the delivery of video streams is now dependent on telcos more than ever. Tech vendors are to provide the broadcasters with solutions that support legacy CPE devices with minimal modifications to the receiving infrastructure, i.e. interoperable and integrable with the different media transmission networks for network convergence for seamless and reliable offloading from broadcasting network to cloud based networks. At the same time, the technological solutions must be future proof to avoid the cost of fragmentation complexities when supporting new standards for new services, adding new features, updating the existing ones or integrating with third party systems (MAM (Mobile Application Management), AI analytics, caption, etc.). Secondly, the technological solutions have to be bandwidth efficient by supporting advanced video compression and bandwidth efficient transmission protocols to relieve the load on the edge and CDNs - an example of such protocols could be multicast adaptive bit rate.

4. Implications for content

With the ever-increasing importance of Internet as infrastructure for access to audiovisual content, it is not only the structural aspects of business models and ecosystems of the media that change. It also has significant implications on the content side – in the business modelling language, the value propositions. The close relationship between the available infrastructures and the content of the media is a well-known topic, but also a topic that has tended to fade away in media research in periods of relative stability in the dominant means of communication (Henten and Tadayoni, 2020). In the long period of traditional broadcast technologies, in reality stretching from analog terrestrial over-the-air transmission to cable and satellite and the digitization of broadcast networks, the close relationships between the infrastructural means of communication and the content of the media have not been central to media research. As discussed in Henten

and Tadayoni (2020), in periods when the infrastructure seems to be a relatively stable given, the focus will be on other aspects including traditional content.

There are obviously big technological differences between analog terrestrial over-the-air transmission, analog cable and satellite transmission and the digital versions of these infrastructural technologies. However, they are basically one-way broadcast technologies though they allow for different levels of QoS of the transmitted signals and of the number of channels. However, seen from a content point of view, the differences with respect to the individual channels are limited. The same applies to business models, which also for a period of time were relatively stable. In fact, the concept of business models itself was only developed with the appearance of Internet, which had a disruptive effect in many industries and which, therefore, required a reflection on the way businesses are constructed and developed. The lack of emphasis on technology developments in media systems research can, for instance, be exemplified by the influential research by Hallin and Mancini (2004), where technology changes did not have any central importance.

During the past recent years[2], however, there has been an increasing interest in the material infrastructure of the media in media research (Gillespie et al., 2014; Bollmer, 2019). In social sciences in general, there is an ongoing 'return to matter' and materialism after a longer period of reigning social constructivism and critique of technology determinism (Fox and Alldred, 2016; Lievrouw, 2014). The 'new materialism' is not to be seen as any crude materialism of a determinist character but as an interest in conducting research into the interaction between various human and non-human actors and actants (Fox and Alldred, 2016). In media research, the materialist trend is related to the increasingly dominant infrastructure for all kinds of media – in one word the Internet. Indeed, there has all the while been parts of media research that have had an emphasis on the materiality of the media. In his book from 1986, 'No sense of place', Meyrowitz's coined the term 'medium theory' to describe how the means of communication influence human communications. And, the most famous and controversial expression of this thought is McLuhan's often cited phrase, 'the medium is the message' from his book 'Understanding media: The extensions of man' (McLuhan, 1964).

[2] This paragraph and the following also appear in Henten and Tadayoni (2020).

This phrase has been subject to much criticism for being technology determinist (Williams, 1974), and technology determinism is, indeed, always a danger if one focuses on implications of technology developments and puts little emphasis on how technology developments are shaped by social practices and society in general. However, if understood in the manner that the media for communications influence the ways people communicate, the content which is being communicated, and the manners in which 'messages' are being received and interpreted, the most provocative corners of 'the medium is the message' phrase can well be grinded and seen in light of a more dialectic relationship between technology developments and the social context in which they are developed and adopted. After decades of relative technology stability in the media and consequently emphasis on the content side, we have witnessed significant technology changes for the past two decades, which still, and at an increasing pace, are affecting media systems. These technology changes are centered on the Internet in its broadest possible conception comprising not only the core Internet communication technologies but also all its services and applications and ways of using the Internet.

There are, indeed, other important technological developments that contribute to shaping the media and its content. The ongoing developments of artificial intelligence (AI) with respect to algorithms and big data are among the most important. AI has in waves been developed for many years but has lately with new machine learning algorithms and big data developments that Internet facilitates become an increasingly important technology area for any industry including the media. The interactive communications that Internet facilitates, as opposed to one-way broadcast, provides the possibility for collecting and assembling immense amounts of data on users of media content. And, the convergence of IT, telecommunications and media constitutes the basis for the development of what used to be called multi-media. The complementarity of Internet and AI being based on this convergence is at the foundation for the interactivity and multi-media trends that epitomize the current developments of the media.

In order to characterize the implications on the content side, Noam (2021) writes that 'the content of visual media will evolve from narrative to experience' – he also calls it 'from story to experience'. Inspired by theories regarding the experience economy (e.g. Prahalad and Ramaswamy, 2004), Noam (2021) describes the current and future developments of the media as a transition from media products, which like a traditional novel has a progressive story line entirely

determined by the author towards media products where the user has an active participatory role in the development of the experience. In the paper by Prahalad and Ramaswamy (2004), they characterized this as 'staging experiences'.

The dimensions of such experiences as listed by Noam (2021) are as follows: 'Individualized; user-generated; location-based; mobile; 3-dimensional; immersive; interactive vertically with platform, advertisers, and content; interactive horizontally with peers; global in reach'. As described in the paper by Noam (2021), these dimensions are partly overlapping, partly separate. Some of them are still in their infancy and at an experimental stage, but they are all important dimensions of the future of media content.

However, though one can see such developments in the media, most current developments are more incremental, and the traditional forms of content still dominate. For most users, the changes in audiovisual media that they experience are related to streaming services like the ones provided by Netflix, HBO, Amazon Prime, etc. The primary types of content that they provide are not much different from what one can find on flow-TV. The prime type of products that these companies offer are series, and later on they have gone into motion pictures. Series is a product that has existed in audiovisual media for decades, and motion pictures have been the products of the motion picture industry for one hundred years. The only change that traditional broadcaster then have had to emulate is the VOD character of the products, so that the viewers can decide when and what to watch and can 'binge' series.

The major content-related issues that audiovisual media companies including traditional broadcasters are currently facing, and that obviously also will affect the experience of users, are concerned with the curation and recommendation of content including how to fit user data and the improvement of meta-data on the content. Curation of content has always - in addition to producing content – been one of the main functions of broadcasters. Keeping users 'tuned-in' has all the time been a prime concern of broadcasters – with, at least ideally, differences between commercial broadcasters and public service broadcasters (PSB), where commercial broadcasters have focused on delivering popular and easily 'consumable' content in order to expose users to advertisement, and where PSBs with the obligations that this entails have attempted to curate content so that users would have access to informational and educational material as well as

entertainment. But how does one construct user interfaces and recommendation systems that keep users 'tuned-in' - and for PSBs, expose users to a diversity and pluralism of content?

This is the subject of an important line of research in current work on media developments (Sørensen, 2020). Another important line of research is on user generated content (UGC) (see, for instance Wyrwoll, 2014). This was one of the first lines of research associated with the potentials of Internet for anyone, in principle, to produce content and have it viewed or listened to by anyone else. UGC has become a very widespread phenomenon, where especially younger people use a great amount of their 'screen-time' watching videos of various kinds. A related and overlapping line of research is concerned with news. Where news for a greater public has traditionally been provided by newspapers and broadcasters, news consumption – although this is still one of the important content genres of broadcasters – has to a large extent shifted to news found on social media. Such news may well have been produced by professional news media, just as well as professional news also may use UGC in their programs.

There is thus a cross-feed between professional news on social media and UGC material in professional media, and as with entertainment programming such as series and motion pictures, an important issue is what kind of news, users get access to. For traditional broadcasters this is a curation issue, but it is also becoming an issue for social media, as their responsibility for the content that is provided via their platforms is an increasing public and political concern. The thing is that the decentralization in the shape of UGC goes well in hand with an ongoing concentration of the media. This applies to content platforms for UGC such as YouTube, social media streaming platforms such as Facebook, subscription-based streaming video content platforms such as Netflix, etc., which has been documented, e.g., by Noam (2020).

The implications on content of the use of Internet and related technologies and of the beginning application of AI and big data is thus already significant. However, developments are mostly incremental, accumulating over time to changes of a more radical character. The more radical kinds of media content innovations as listed by Noam (2021) with respect to interactivity and immersiveness are advancing relatively slowly, while other dimensions relating to individualization, user generation, and mobility are progressing more quickly.

5. Theory framework and analytical model

As has been elaborated upon in the former sections of the paper, the most important technology developments in the transmission area, which the broadcasting sector has encountered during the past twenty years, are IP-based streaming and advanced mobile technologies allowing for high transmission capacity. However, these technology developments in themselves do not constitute a 'life and death' challenge for the traditional broadcast sector. It is the loss of privileged access to viewers and listeners due to the decreasing importance of over-the-air, cable and satellite transmission, on the one hand, and the decline of flow TV and radio because of on-demand viewing and listening, on the other, which are at the core of the challenge that the sector has been facing for a number of years and still forcefully faces today.

On the supply side, Internet with its potential for anyone to distribute audiovisual material and especially for new content providers such as Netflix and HBO to access users has ended the oligopolistic competition among large public service and commercial broadcasters, based on the limited transmission resources that traditional over-the-air, cable and satellite provide. Broadcasters, presently, compete in a much wider market not only with many small and large newcomers but also in a context of direct international competition. On the demand side, users increasingly view and listen to audiovisual material in an on-demand manner, challenging the curated flow of content, which has been the content distribution model of broadcasters for decades. Downloading and streaming facilitate this, and the application of mobile communication networks for transmitting content enables many other communication devices than traditional TV and radio sets to be used for audiovisual consumption, allowing for more individual and personalized viewing, listening, and communication. These developments constitute the bases for the challenges to the traditional overall business model with its different variations in terms of public and commercial funding that the audiovisual sector has encountered.

The business model concept has been increasingly used in academic business research and even more so among business practitioners during the past 30+ years. Many definitions of the concept have been put forward with David Teece's explanation as one of the most cited ones, saying that a business model 'describes the design or architecture of the value creation, delivery, and capture mechanisms it employs' (Teece, 2010). The business model literature has mostly focused on

business model tools and approaches and on analyses of concrete business cases and has focused less on theorizing the concept (Foss and Saebi, 2015). However, for a number of years, there has been an increasing attention to innovations of business models instead of understanding business models as stable states (Chesbrough, 2010; Amit and Zott, 2012). Lately also, there has also been an increasing interest in seeking to theorize the concept with a focus on the architectural and systems aspects of business modelling (Foss and Saebi, 2015). In this paper, emphasis is on the innovation perspectives in business modelling and on the architectural and systems aspects. The challenges for companies and institutions coming from a traditional broadcasting world relate to the necessity to innovate their business models and to better deal with the architectural and systems characteristics of business models with respect to the interrelatedness between the various elements of their business models and the relations to the business ecosystems in which the operate. The most successful business model tool, which is the one developed by Osterwalder and Pigneur (2010), operates with nine so-called building blocks, which deal with the various aspects of business models from front-end elements relating to customers segments, etc. to back-end elements regarding resources, etc. and with the value proposition as the center piece and the costs and revenues taken into consideration. Although their business model tool does not very explicitly deal with the ontological relationships between the different blocks, it is apparent that changes in one block will need to be followed by changes in other blocks as well.

The business ecosystem concept has become equally popular among business practitioners, as it reflects an immediate understanding of how dependent individual companies are on their customers, business partners, competitors, and the general business and regulatory contexts in which they work. In terms of academic contributions, there are far less than one finds with respect to the business model concept. Often, the academic literature on business ecosystems refers to contributions from the 1990s and beginning of the 2000s from, for instance Moore (1993 and 2006) or from Iansiti and Levien (2004). However, also here, the concept is continually coming up for debate, for instance by Fuller and Jakobides (2019). The borderline between business models and business ecosystems are, indeed, blurry, as many business model concepts also include or take into considerations, at least, the immediate environment in which individual companies position themselves. However, the business ecosystem concept takes a broader environmental perspective than the business model concept, including not only the close business partners and

the customers of the company, but also the broader business as well as social and regulatory circumstances for the company. This perspective is directly relevant for this paper, as the broad environment in which broadcasters exist is of the highest importance for how they can and will develop. Broadcasters have become dependent on telecoms, Content Delivery Networks (CDNs) and Internet service providers (ISPs), including the development of new mobile technologies. They are also very dependent on policy and regulatory frameworks, which not only applies for public service broadcasters but also for commercial broadcasters.

The issue of disruptiveness, which was at first developed theoretically more comprehensively by Clayton Christensen and his research associates, with the concept of disruptive technologies and innovations (Christensen, 1997 and 2003), is furthermore very useful in the context of changes in the audiovisual sector. Broadcast operators built up business models that dominated the area for decades. These have been business models building on the 'broadcasters' curating a flow experience for users based on in-house produced content and content produced by external content providers. The 'broadcasters' would mostly buy transmission capacity from over-the-air transmission operators, cable companies and satellite operators. And later, as a supplement, they would add website services and also offer OTT Internet streaming of different programs - which points at new audiovisual modes of content distribution. It is only when new large and global OTT content providers started to make their presence felt that a change of business model really began to be considered by traditional broadcasters. A company like Netflix started as a videotape distribution enterprise and can really be seen as a disrupter of the broadcast industry in the Clayton Christensen sense of the concept. Netflix came from 'below' and contributed to developing a new market for streaming video. This new market has currently developed into a worldwide very successful business, and traditional broadcasters are severely challenged. The question is whether or how traditional broadcasters will be able to change their business models to compete with these newcomers. When the channel for reaching customers is changed towards OTT provision and when the value proposition is changed, several other aspects of the business model will have to be changed.

The last theory perspective discussed in this paper thus deals with the capacity of traditional broadcasters to change and their ability to adapt to new market developments and circumstances. The literature on change management (e.g. Cameron and Green, 2020) can be helpful in this

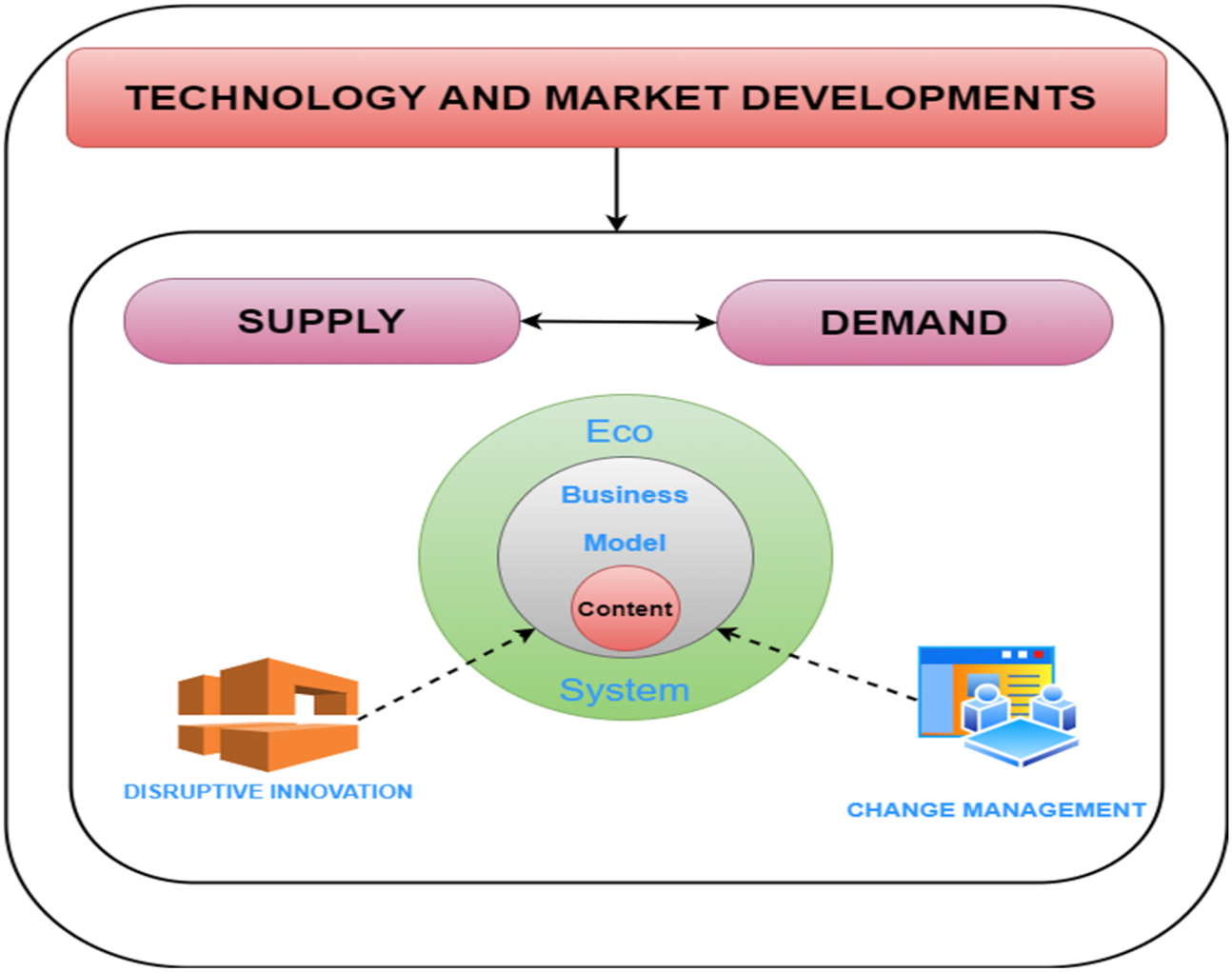
context. However, it has to be rooted firmly in the disruptiveness of the changes in the industry, as we are not dealing with minor incremental nor just radical technology changes. We are dealing with changes that are upsetting the whole audiovisual industry and the way is has been functioning during many decades. This is a process that has been on-going for more than ten years, and the 'death' of traditional broadcasters has been proclaimed many times. However, it seems that the resilience of the incumbent broadcasters is stronger than anticipated, and the implications of this is the issue, that this paper is examining – not only whether they will be able to change, but also what this will require and how.

The theoretical and conceptual model proposed by the paper thus includes an overall supply and demand dimension with new technology heavily affecting the supply and demand side, and with the changing viewing and listening habits of users departing from a flow experience towards and on-demand mode. Within this overall framework, the centerpiece is concerned with the new business models that have to be developed and the broader business ecosystem that incumbent operators have to work with and within. The perspectives that are enlightening this transition is the disruptiveness of the changes taking place, on the one hand, and the capability of broadcasters to change, on the other.

The following figure illustrates these elements and relationships and constitute the proposed analytical model. The model focuses primarily on technology and related market developments. These technology and market developments are, at least, partly endogenous to the developments of the audiovisual markets. However, to the individual broadcast company, technology and market developments are mostly seen as exogenous developments that have to be accounted for.

The model focuses on technology, market and business issues. Policy and regulation and broader cultural issues are, indeed, also extremely important for the developments of audiovisual markets. In this paper, we have chosen to look primarily at technology developments and related market developments. In previous papers, we have examined policy and regulatory aspects of media markets, for instance Tadayoni and Skouby (1999) and Tadayoni, Skouby and Henten (2017).

Figure 1: Analytical model for prospects of broadcasters in new audiovisual markets



6. Conclusion

The aim of this paper is to construct an analytical framework and model for analyzing the prospects of broadcasters in the new audiovisual markets, based primarily on streaming. While traditional broadcasters have hitherto had a privileged position in audiovisual markets because of their access to broadcast resources - terrestrial, cable or satellite - this position has been undermined by Internet streaming. New global and national content providers have forcefully entered the audiovisual markets, first and foremost in the video area but also on national bases in the audio area, and this constitutes a stark challenge to traditional broadcasters.

The demise of traditional broadcasters has been forecasted for a number of years, but it has turned out that broadcasters have generally been more resilient than expected at first. This applies both because of habits and technology adoption and adaptation on the user side and because broadcasters, indeed slowly, but actually have developed their streaming services. Some broadcast operators have, at least, in their developments plans started prioritizing streaming as their primary platform and traditional broadcasting as only their secondary platform. This applies, for instance, to the Danish public service broadcast station DR, which in October 2021 announced that content will now primarily be produced for DRTV, which is the streaming service of the broadcaster, and that traditional broadcast comes second. This is known in the industry as steaming-first strategy.

It has, however, taken broadcast stations a long time to come to reach such a stage, and the resilience of traditional broadcasters seems to become overstretched. It is, in a sense, not the distribution technology in itself, which constitutes a problem. Streaming content and using CDNs for their streaming services can be regarded as just another platform for distributing content. The problem is that broadcasters when entering the streaming market become just one out of a wide variety of other audiovisual content providers. Streaming has become a very 'red ocean', where broadcasters have to find new ways of strengthening their position. This applies to developing their content production to interactive Internet-based platforms. It, therefore, also applies to how to curate content and to learn to use data on their users for promoting and recommending their content. It, furthermore, applies to establishing new cooperative relationships and alliances with tech providers, content distributors including mobile operators and cloud providers, etc.

In order to construct a strong basis for understanding the distribution and access technology changes in the broadcast area, the paper presents the different basic broadcast technologies that have developed over time. In the present situation, focus is on CDNs and on cloud and edge computing and the role of mobile operators. This points at the new ecosystems in which audiovisual content producers are situated. More specifically, the paper discusses an OTT-Broadcast (OTT-B) model, which utilizes and unifies the different distribution platforms available, based on the IP protocol. In contrast to HbbTV, which uses traditional broadcast transmission and Internet streaming as two separate but interrelated platforms, solutions such as OTT-B unify the various platforms on the basis of the IP protocol.

There are different technology solutions for unifying distribution platforms on an IP basis, and it is very much still a game of trial and error in developing the solutions that will prevail. One of the issues that has to be dealt with is not in itself a technology question. When broadcasters use CDNs for streaming their services, the broadcasters are the customers of CDNs. There is, however, no solution given in advance to the relationships between content producers and curators and content distributors. It can also be the content producers and curators that sell their content to distributors who resell the content to end-users. This is the model known from cable and satellite transmission. This indicates that it is not only a question of technology implications but also of the business and ecosystem models that are being developed.

Streaming has had disrupting effects on the audiovisual market. It has changed market conditions significantly. However, though traditional broadcasters are struggling to change their mode of operation, it does not seem that the new streaming-based services will eradicate the traditional broadcasters. In that sense, the developments do not entirely live up to the criteria for disruptiveness that Clayton Christensen and colleagues originally described, namely that the incumbents in a market area would not be able to change their mode of operation and adapt to the new circumstances and that they would be substituted by new market payers that have brought the new innovations to market. The traditional broadcasters have been able to use the new means of transmission, but in order to fully adapt to the new market circumstances, they have to change their business model and the role in the ecosystem in which they operate in order to be a key influencing partner in the broadband and streaming ecosystem. This has and will continuously put focus on their ability to implement change in their organizations.

7. References

Ahmed, A., Rehmani, M.H. (2017) Mobile Edge Computing: Opportunities, solutions, and challenges, Future Generation Computer Systems, Volume 70, pp. 59-63

Amit, R. and Zott, C. (2012) Creating value through business model innovation, MIT Sloan Management Review, Summer 2015, pp. 36-44

Bollmer. G. (2019) Materialist media theory – An introduction, Bloomsbury Academic

Calabuig, J., Monserrat, J.F. and Gómez-Barquero, D. (2015) 5th Generation Mobile Networks: A New Opportunity for the Convergence of Mobile Broadband and Broadcast Services, IEEE Communications Magazine February 2015

Cameron, E. and Green, M. (2020) Making sense of change management, London/New York: Cogan Page

Chesbrough, H. (2010) Business model innovation: Opportunities and barriers, Long Range Planning, vol. 43, issues 2-3, pp. 354-363

Christensen, C. (1997) The innovator's dilemma, Harvard Business Review Press

Christensen, C. and Raynor, M. (2003) The innovator's solution, HBS Press

Domínguez, D., Agirre, D.M., Flórez, J., Lafuente, A., Tamayo, I. and Zorrilla, M. (2018) Deployment of a Hybrid Broadcast-Internet Multi-Device Service for a Live TV Programme, IEEE Transactions on Broadcasting. Vol. 64, no. 1, March 2018

Fanari, L. et al. (2019) Trends and Challenges in Broadcast and Broadband Convergence, 2019 IEEE International Conference on Electrical Engineering and Photonics (EExPolytech), pp. 153-156

Foss, N.J. and Saebi, T. (eds., 2015) Business model innovation: The organizational dimension, Oxford University Press

Fox, N.J. and Alldred, P. (2016) Sociology and the new materialism, London: Sage

Fuller, J. and Jakobides, M.G. (2019) The myths and realities of business ecosystems, MIT Sloan Management Review, vol. 60, issue 3, pp. 1-9

Gillespie, T., Boczkowski, P.J. and Foot, K.A. (eds.) (2014) Media technologies: Essays on communication, materiality, and society, MIT Press

Gimpel, G. (2015) The Future of Video Platforms: Key Questions Shaping the TV and Video Industry, International Journal on Media Management

Hallin, D.C. and Mancini, P. (2004) Comparing media systems: Three models of media and politics, Cambridge: Cambridge University Press

Hammershøi, A. (2020) Next generation OTT distribution architecture supporting Multicast ABR, HTTP/3 with QUIC and TLS1.3, SEMPTE online conference, Nov. 2020

Harmonic (2021) Online Summit, ACHIEVE 2021

Hasslinger, G. and Hartleb, F. (2011) Content delivery and caching from a network provider's perspective, Comput. Netw. 55

Henten, A., Tadayoni, R. and Windekilde, I. (2010). Spectrum war - The battle for the digital dividend spectrum. In Proceeding of the 18 Biennial ITS conference

Henten, A. and Tadayoni, R. (2020) Fading public control of audiovisual media, ITS Online Event, 14-17 June 2020, International Telecommunications Society (ITS), 22 pages

Iansiti, M. and Levien, R. (2004) The keystone advantage, Harvard Business Scholl Press

Kurz, P. (2020) 3.0's 'big data pipe' offers a reliable, cost-effective alternative to 6G, https://www.tvtechnology.com/news/30s-big-data-pipe-offers-a-reliable-cost-effective-alternative-to-5g

Leal, R.P., Marco, J.N. and Martinez, F.D.H. (2017) Analysis of the Technologies enabling the broadcast convergence, IEEE Xplore

Lievrouw, L. (2014) Materiality and media in communication and technology studies: An unfinished project, in Gillespie, T., Boczkowski, P.J. and Foot, K.A. (eds.) (2014) Media technologies: Essays on communication, materiality, and society, MIT Press, pp. 21-52

Mach, P. and Becvar, Z. (2017) Mobile Edge Computing: A Survey on Architecture and Computation Offloading, IEEE Communications Surveys & Tutorials, vol. 19, no. 3, pp. 1628-1656

Martin, A., Viola, R., Zorrilla, M., Flórez, J., Angueira, P. and Montalbán, J. (2019) MEC for Fair, Reliable and Efficient Media Streaming in Mobile Networks, IEEE Transactions on Broadcasting, 66(2), pp. 264-278

McLuhan (1964) Understanding media – The extensions of man, MIT Press

Moore, F.F. (1993) Predators and pray: The new ecology of competition, Harvard Business Review, May-June 1993, pp. 75-86

Moore, J.F. (2006) Business ecosystems and the view from the firm, The Antitrust Bulleting, vol. 51, no. 1, pp. 31-75

Noam, E. (2020) An Open Video system (OVD) to overcome market power in online video platforms, ITS Online Event, 14-17 June 2020, International Telecommunications Society (ITS), 20 pages

Noam, E. (2021) Into the next generation of online video: OTT video 3.0, preliminary draft, Columbia University, 37 pages

OMDIA (2021) Events and webinars, https://omdia.tech.informa.com/what-we-do/events-and-webinars

Osterwalder, A. and Pigneur, Y. (2010) Business model generation, John Wiley & Sons
Prahalad, C.K. and Ramaswamy, V. (2004) Co-creation experiences: The next practice in value creation, Journal of Interactive Marketing, vol. 18, no. 3, pp. 5-14

Ruiz, M., Germán, M., Contreras, L.M. and Velasco, L. (2016) Big Data-backed video distribution in the telecom cloud, Computer Communications, Volume 84, 2016, Pages 1-11

Sandvig, C. (2015) The Internet as the anti-television: Distribution infrastructure as culture and power. In 'Signal traffic: Critical studies of media infrastructures', pp. 225-245

Sørensen, J. K. (2020) The datafication of Public Service Media dreams, dilemmas and practical problems: A case study of the implementation of personalized recommendations at the Danish

Public Service Media 'DR', MedieKultur: Journal of Media and Communication Research, 69, pp. 90–115

Tadayoni, R. and Henten, A. (2013) Has digitization delivered? Fact and fiction in digital TV broadcasting. In Handbook on the Digital Creative Economy. Edward Elgar Publishing

Teece, D. (2010) Business models, business strategy and innovation, Long Range Planning, vol. 43, issues 2-3, pp. 172-194

Viola, R., Martin, A., Zorrilla, M. and Montalbán, J. (2018) MEC Proxy for Efficient Cache and Reliable Multi-CDN Video Distribution, 2018 IEEE International Symposium on Broadband Multimedia Systems and Broadcasting (BMSB), Valencia, 2018, pp. 1-7

Williams, Raymond (1974) Television: Technology and Cultural Form, London and New York: Routledge

Wyrwoll, C. (2014) User-Generated Content, in Claudia Wyrwoll: Social Media, Springer, pp. 11-45

Yrjölä, S., Mustonen, M. Matinmikko, M. and Talmola, P. (2016) LTE Broadcast and Supplemental Downlink Enablers for Exploiting Novel Service and Business Opportunities in the Flexible Use of the UHF Broadcasting Spectrum, IEEE Communications Magazine July 2016