9

TV Broadcast and 5G

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9.1 Introduction

The traditional TV broadcast value chain is today subject to significant pressure due to new OTT market players such as Netflix and HBO entering the market. Traditional players are being by-passed by new market players in the value chain. Advanced 4G- and 5G mobile networks is expected to accelerate the pressure on the existing value chain even further, with LTE-Broadcast (eMBMS) being the disruptive trigger point. This chapter provides an overview of TV broadcast and 5G with outset in a historical perspective. In particular, the changes to the traditional TV broadcast value chain are described together with key technology drivers, and a view of TV broadcast in a future 5G scenario is presented.

This chapter focuses on TV broadcast and 5G. My reason for choosing this topic is not only the fascinating aspects of the technological development of Information and Communication Technology (ICT) but also the mere fact that television takes up a lot of our time. Just as an example, the average TV viewing in Denmark is three hours every day. Hence, it is clear that television plays a significant part of our lives.

The first part of this chapter looks at TV broadcast in a historical context. In order to reflect on TV Broadcast in a 5G era it is important to understand television in a historical context and the traditional TV broadcast industry, as we have known it for many years. I will walk you through the main milestones of the technological development in Denmark as well as the traditional TV broadcast value chain.

The second part focuses on the disruptive changes which the TV broadcast industry is undergoing these years. In fact, television as we have known it since the 1940's is subject to enormous changes caused by ground breaking developments in ICT technology and subsequent changes in viewing habits especially from the younger part of the population.

The internet, and especially IP and WiFi have resulted in an enormous disruptive change to the traditional broadcast TV value chain. New players have entered the value chain and existing players, especially the distributors of TV signals, are under pressure from Internet Service Providers who distributes the TV signals at lower costs mainly due to economies of scale and standardization.

9.2 Traditional TV Broadcast

The Figure 9.1 shows an American family watching TV in the living room in 1958. The picture illustrates the fact that there was only one television in the home and that it was something that the family gathered around to watch together. In a Danish context, public TV broadcast took its beginning in 1951 when Statsradiofonien started to transmit regular TV broadcasts each lasting one hour, three days per week, to only approximately 200 TV receivers.

In the following years, eight TV transmitter towers were established giving nationwide coverage for public service TV broadcast in Denmark in an analogue terrestrial TV broadcast network. In 1987, a competition public

Figure 9.1 An American family is watching TV in 1958. The family was gathered around the same screen [3].

broadcaster, namely TV 2, went live on air, following a political decision that Danmark's Radio should no longer have a monopoly on broadcast TV. This expanded the transmitter infrastructure to 34 main towers, which we also have in Denmark today.

In the 1980's the Danish government decided to liberalize, a part of the Danish TV broadcast industry and open up for commercial TV broadcasters when cable-TV and satellite-TV access technologies became available. The next major milestone in Danish TV history took place on 2 November 2009 when the analogue terrestrial TV network was shut down and the Digital Terrestrial TV (DTT) network based on DVB-T1 was launched 15 minutes later. A part of the network was later upgraded to DVB-T2. All that was needed was a digital set top box, which connects to the TV. At the same time, Boxer TV went live on air as a new DTT commercial pay TV provider in Denmark. Suddenly, it was possible to view more than 45 TV-channels on the terrestrial TV network.

Having introduced the main historical milestones let us look at what we could call the traditional TV broadcast value chain. The value chain is illustrated in Figure 9.2.

In the first part of the value chain, we have the TV broadcasters, who is responsible for production of their own content and who buys content from other content owners. The TV broadcasters can be either public service TV broadcasters such as DR, or pay-tv providers such as Boxer-TV or WAOO! In Denmark. The content is arranged and divided into TV channels, which is transmitted to the viewers via different distribution platforms.

The distribution network technologies include the DTT platform, satellite, Cable TV, DSL using copper cables and fibre. The third part of the value chain is the receiving end equipment, namely the televisions and set top boxes supporting either DVB-T/T2 for the DTT network or DVB-C for fiber based networks. The last part of the value chain is the consumers who receive the

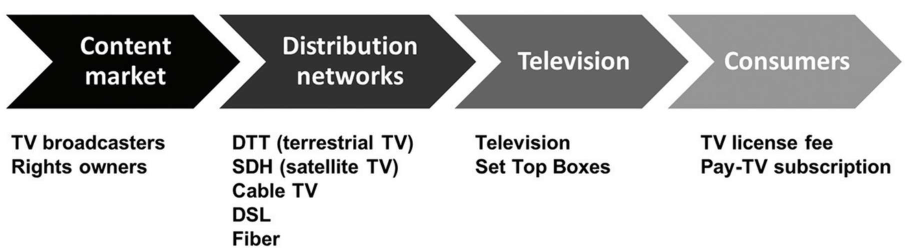

Figure 9.2 The traditional TV value chain as it have looked until a few years ago.

content and pays a TV license fee for the Public Service content and as an option pay-tv subscriptions for the pay-tv content.

9.3 Disruptive Changes

The Figure 9.3 illustrates the new TV value chain. Notice that new players have entered the different parts of the value chain. The traditional TV broadcasters now also face competition from on-demand content aggregators and Over The Top (OTT) providers such as Netflix and HBO. The traditional television is today only one of many devices from which it is possible to watch TV. This includes smart phones, tablets and game consoles, which now support TV viewing via apps. The traditional TV itself has been "internet enabled", which is also called smart TV's, and supports a long range of apps for the user.

Thus, new players have entered the market, and the market has become more fragmented with new roles. Examples of new roles in the value chain are OTT-providers, application developers, new device types and the fact that the consumer can create his or her own "video" channel (e.g., on YouTube).

The main reason for this disruptive development in the TV market is the convergence or melting together of different industries. Convergence in the TV market is a term used to describe the melting together of internet, broadcast and telecommunications industries. IP and internet is an enabler, which breaks down industry barriers, as it has been the case for other technological innovations during recent years. Refer to Clayton Kristensen's famous book on innovation for other examples on disruptive innovations. New business models and market players emerge and incumbent players in the value chain are challenged. The market also becomes more fragmented.

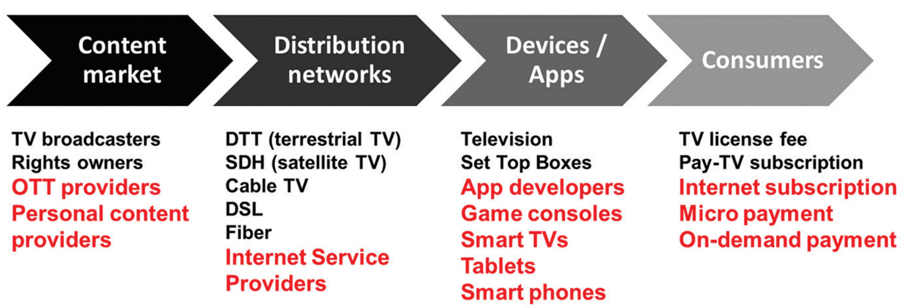

Figure 9.3 The disrupted TV broadcast value chain with many new players entering the market. New player categories are indicated with red text.

Historically, internet, broadcast and telecommunications have been separate and isolated industries. However, all of this is changing now with new players entering the market. Netflix who entered the Danish TV market in the autumn of 2012 with their Internet TV offering is an example of this. Netflix have entered the TV market with big strength not only in the Danish TV market but also on a global scale. Netflix provides a stand-alone OTT service, which operates across any Internet Service Providers network, whereas HBO offers their OTT TV offering as a valued added service to Telia Broadband.

Via Play, TDC Play and TV2 Play are examples of other new OTT streaming apps where broadcasters stream TV over IP directly to the consumer and are thus bypassing traditional distribution links in the TV value chain, such as terrestrial distribution, cable and satellite.

However, new hybrid standards such as Hbb-TV have also emerged. The Hybrid solutions combine broadcast and point-to-point IP communication, where broadcast transmits TV signals downlink to the consumers and internet is used uplink to provide new interactive services such as personalized services based on metadata. Examples of metadata are personalized electronic program guides where program highlights are presented based on the consumer's interests and preferences as well as predefined language and audio settings again according to the consumer's preferences.

9.4 Technology Drivers

IP and the internet are together with new wireless access technologies the main technology drivers behind the disruptive change in the TV broadcast value chain. Flow TV is just only one of many services and applications, which will be supported from the same network infrastructure in the future. In order words: ICT is becoming a utility just like electricity, water and energy. The main technology drivers are described in the following.

9.4.1 IP-based Communication

Common IP-based ICT infrastructure networks bring significant advantages for the operators and the users compared to digital proprietary distribution platforms. Firstly, all components in an IP-based network can be supervised and remote controlled from central locations. This is possible because all components have a unique IP address in the system, which also is the prerequisite for Internet of Things. In other words, supervision, operations and maintenance of the network is centralized, which drives down operating costs to a lower level compared with analogue or digital proprietary systems. For this reason, the Network Operation Center (NOC) plays a central role with a long range of remote services.

Figure 9.4 shows an example of a TMA based proprietary digital switch from 1999 used for coastal emergency radio voice communication between a control room and ships in distress. Notice the left picture with the cross-connects, which often require physical measurements to troubleshoot. The entire switch fills up more than a 40 square meter room.

The next picture in Figure 9.5 shows an IP-based "exchange" supporting the same coastal radio service as the proprietary digital exchange shown in Figure 9.4.

Figure 9.4 Digital exchange for ship-to-shore radio anno 1999 in Denmark [6].

Figure 9.5 IP-based digital exchange for ship-to-shore radio anno 2016.

The difference in size, power consumption and ultimately cost speaks for itself. Troubleshooting is done using software based protocol tracing tools in different layers of the OSI stack. The cost is also substantially lower because Commercial Off-The-Shelf (COTS) hardware is used.

9.4.2 Broadcast vs. Point-to-Point Communication

Today, the main difference between broadcast networks and present 3G (UMTS) and 4G (LTE Advanced) cellular mobile network, is the fact that broadcast networks transmits the same information to all users, whereas cellular mobile networks use point-to-point communication. The main advantage with broadcast networks compared with 3G and 4G mobile networks is the fact that the capacity requirements in the networks are the same no matter how many users receive the transmitted signal. In other worlds, it does not matter if two thousands or two million viewers are receiving the signal.

The disadvantage is the lack of interactivity, which is on the other hand, is the key advantage in point-to-point communication. In point-to-point communication networks the issue is that the capacity requirements are dependent on the number of concurrent users connected to the network.

9.4.3 LTE-Broadcast

The disadvantage of point-to-point communication compared to broadcast with respect to capacity is the main reason for the introduction of LTE-Broadcast, or also called eMBMS, in the 3GPP specifications. LTE-Broadcast was initially introduced in release 9 of the 3GPP specifications and further refined in releases 10 and 11.

However, to date only KT in Korea has commercially launched an LTE-Broadcast service. There is approx. ten trials in different parts of the world according to Global mobile Suppliers Organization (GSA).

9.4.4 Data-rates and Bandwidth

Bandwidth efficiency has increased significantly in 4G compared to 3G since IP communication is also used in the wireless access part of the mobile network. This improves the frequency band more efficiently compared to traditional TDMA, FDMA and CDMA coding schemes used in 2G and 3G networks. Thus, new and enhanced coding and modulation schemes have improved the bandwidth efficiency.

Table 9.1 Technologies and bandwidths for 2G, 3G, 4G and 5G technologies

Generation	Year	Standards	Technology	Bandwidth	Data-rates
2G	1991	GSM, GPRS, EDGE	Digital	Narrowband	<80–100 Kbit/s
3G	2001	UMTS, HSPA	Digital	Broadband	<2 Mbit/s
4G	2010	LTE, LTE Advanced	Digital	Mobile broadband	xDSL like experience 1 hr HD mobile in 6 minutes
5G	2025–2030	–	Digital	Ubiquitous connectivity	Fibre like experience 1 hr HD mobile in 6 seconds

The Table 9.1 shows the technologies and bandwidths for 2G, 3G, 4G and 5G networks respectively.

Notice the exponential increase in data-rates in the developing generations of mobile networks. The increase in data-rates in 5G networks in mainly due to the use of higher frequencies above 3 GHz with limited geographical coverage of 50–500 m in each cell. This concept is also called Small Cells.

Flow-TV and On-demand video requires that high bandwidths are supported in the access network and for backhaul connectivity. A main prerequisite of the increased data-rates in 5G networks is the availability of spectrum allocated to 5G networks.

At the ITU World Radio Conference (WRC) in Geneva in 2012, it was decided to reallocate the 700 MHz band ranging from 694–790 MHz from DTT to mobile internet. The main argument for this reallocation was the availability of enhanced codecs video compression in DTT networks such as HEVC. The other argument was that the 700 MHz band is more suitable for rural areas in Denmark, due to the longer geographical reach of this frequency band compared to other frequency bands, which are currently available for mobile internet. At WRC 2015, it was decided to postpone a proposal for the sub-700 MHz band to 2023.

The sub-700 MHz band is currently reserved for downlink TV-broadcast. Hence, it can be expected that the current DTT distribution platform will remain in service at least until 2030 in most countries including Denmark.

9.5 TV Broadcast in the 5G Era

One of the main characteristics with 5G networks is the use of higher frequencies over 3 GHz which have limited coverage from approx. 50–500 meters from the base station antenna. 5G networks will support bandwidths of up to 10 Gbit/s. TV everywhere is a term used to describe:

- Freedom of choice to only pay for TV-channels that the consumer wants to watch.
- Freedom to watch the TV-channels irrespective of the time.
- Freedom to watch the TV-channels irrespective of place (at home, commuting, in the summerhouse etc.

The in 5G area these capabilities are mandatory for the consumer. A significant part of these capabilities will most likely be supported in future 5G networks.

However, security is a major concern one major when it comes to TV broadcast using LTE-Broadcast in 5G networks is security which needs to be addressed is security. Adequate security measures are critical in terms of securing service continuity, service integrity and service confidentiality. TV viewers demand a stable and robust TV-broadcast service and they have an increasing demand to have the privacy in terms of preferences and choices of content. Cybercrime is becoming an increasing issue on IP- and internet connected systems.

Thus, the future ICT communication landscape for TV broadcast should not only consist of both IP and internet based content but also non-IP digital TV broadcast platforms that cannot be hacked and which continues as a robust and reliable communication means to the population both in everyday life and in case of major crises. As an example, a major fire occurred outside of Stockholm in 2014. The internet in the area was down for three days but the TV and radio broadcast networks continued to broadcast important information and messages to the population during the crises.

To conclude, a combination of both IP- and non-IP TV-distribution platforms for flow-TV are to be expected even in the 5G era, which not only serves to entertain but also to be an important communication means for the society in case of major crises in the society. Well, at least until 2030.

9.6 Conclusions

This chapter has analyzed the disruptive changes to the traditional TV-value chain, which has occurred in recent years. No doubt, IP and the internet have affected many industries, and TV broadcast is no exception. In addition, new market players have entered into the value chain, which increases competition but also new revenue opportunities being the end-result.

However, although the internet has changed the TV broadcast industry for good it is important to note that the IP and the internet and traditional

DTT-broadcast should be regarded as complementary platforms in order to secure a reliable and robust TV broadcast service.

Thus, a combination of both IP- and non-IP TV-distribution platforms for flow-TV are to be expected even in the 5G era, which not only serves to entertain but also to be an important communication means for the society in case of major crises in the society. Well, at least until 2030, as the former Director-General of the World Trade Organization, Pascal Lamy, also recommends in a report to the EU commission [11].

What happens after 2030 is difficult to say at the point of writing this chapter. No doubt, it will take time to get the security aspects solved with respect to TV-broadcast over IP-based networks and the internet with the increases in cybercrime. However, there is no doubt that in the longer run even more frequencies, especially in the higher frequency bands above 6 GHz, are likely to be allocated to 5G networks. This will in turn increase the capacity of OTT viewing even further, and especially when combined with the concept of Content Delivery Networks (CDN) meaning that the OTT content is located close to the end user, which in turn reduces load on the mobile network.

So to conclude: Only time will tell how TV-broadcast is distributed after 2030. However, one thing is for sure. Adequate ICT infrastructure is an important prerequisite in order to move viewing of moving images to the next level.

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About the Author

Lars Kierkegaard is currently Head of Strategy & Business Development at Teracom A/S. Lars is an expert on ICT and network convergence and have a 17 years background from international hi-tech ICT companies within media, broadcast, telecom and public safety industries.

He joined Teracom in 2010 where he was responsible for standardization of existing technical broadcast solutions into market oriented ICT product and service portfolios.

In 2013, Lars was appointed with the responsibility to head a new business innovation department to drive growth initiatives. At the same year, Lars was awarded with the title “Employee of the year” in TeracomBoxer Group in the category “Profitable Growth in our whole business”.

In 2015 Lars, lead Teracom to win a 15-year contract for design, system integration and operations of a new nationwide coastal radio system in Denmark.

Main responsibility areas include business development & sales, people management, product management, innovation, and bid management. He is also a frequent speaker on ICT and convergence at international conferences.

Prior to his employment at Teracom, he has held senior product management and business development positions in Terma, Anritsu and Ericsson with Information and Communication Technology (ICT) being the “red thread”.

Lars is board member of the Danish Consumer Electronics Association. He is also advisory board member at Center for Communication, Media & ICT at Aalborg University, board member of the IEEE Joint Chapter for Denmark, and external censor at the technical universities in Denmark. Finally, Lars is board member of the WorldDAB Association.

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