CONSULTING

Report for the New Zealand Commerce Commission

Introduction to broadcasting technologies

Joan Obradors, Fabio Fradella, Gabriele Granella, Alessandro Galli

9 December 2019

Ref: 2019875-495

Contents

Analysys Mason Spain S.L.U.
José Abascal 57, 7ºD
28003 Madrid
Spain
Tel: +34 91 399 5016
madrid@analysysmason.com
www.analysysmason.com

Registered in Spain, N.I.F. B88015565
A wholly owned subsidiary of Analysys Mason Limited
North West Wing, Bush House, Aldwych, London WC2B 4PJ, UK, Reg. No. 5177472

1 Introduction

1.1 Context

The recent amendments to the Telecommunications Act[1] have extended the jurisdiction of the New Zealand Commerce Commission (NZCC) to cover broadcasting transmission. This change has had an impact on the telecommunications development levy (TDL). The NZCC will publish a consultation on the changes to the TDL and engaged Analysys Mason to produce a report on the main broadcasting methods in New Zealand.

1.2 Overview

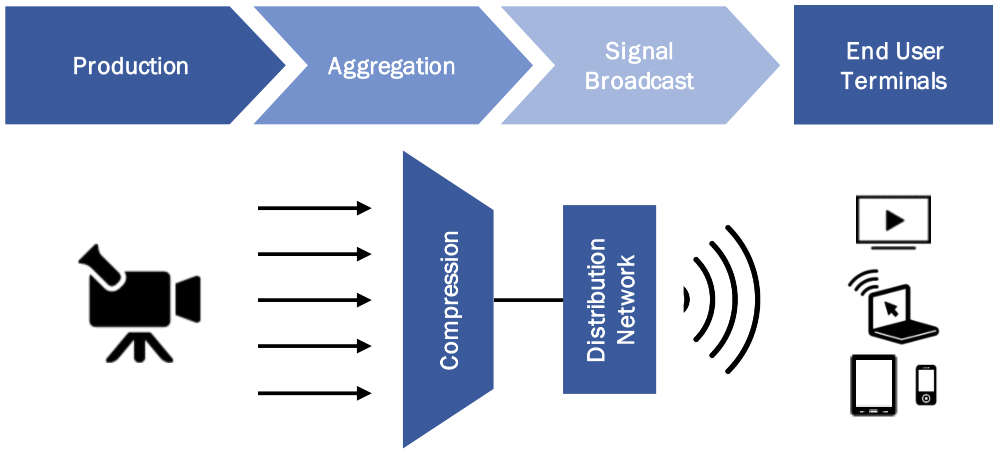
The main objective of this report is to provide an overview of the transmission platforms used for broadcasting in New Zealand. This report covers the different types of radio and TV transmission platforms.

Broadcast distribution is referred to as 'one to many', as the content produced from one single source is delivered through a three-step value chain to multiple end-user devices, as shown in Figure 1.1.The main application for such platforms has been the distribution of radio and TV signals to end-users.

In 1920, first commercial radio broadcast distribution appeared in Pittsburgh, and commercial television broadcast then began in the 1930s both in the USA and the UK. Both radio and TV services quickly spread to become part of every-day life around the world.

[1] See http://www.legislation.govt.nz/act/public/2001/0103/84.0/DLM124961.html

Figure 1.1: TV Broadcast value chain [Source: Analysys Mason, 2019]



▪ Production and acquisition of content – Tv channels – Major film studios – Independent content producer	▪ Transport of the signal from content source to aggregation locations ▪ Aggregation of all signals in a single stream, made available for distribution	▪ Distribution of the aggregate signal to broadcasting sites ▪ Transmission of signal from broadcasting sites to end users	▪ Reception at end user premises – Various devices can support different transmission technologies

Broadcast can be analysed according to the following dimensions:

- **Transmission platforms**, i.e. the networks and the technologies through which content is delivered (broadcast) to the end user.
- **Content type**, i.e. linear and non-linear (on demand).
- **Broadcast network operators' business models**, i.e. the way through which the players in charge of distributing (broadcasting) the content create economic value.

These dimensions and the available options for each of them are analysed in detail in the following chapters, as follows:

- Chapter 2 outlines a high-level overview on transmission platforms' value-chain, content types and business models.
- Chapter 3 contains an overview of each transmission platform with a specific focus on the main differences between their value chains and on their specific technologies.

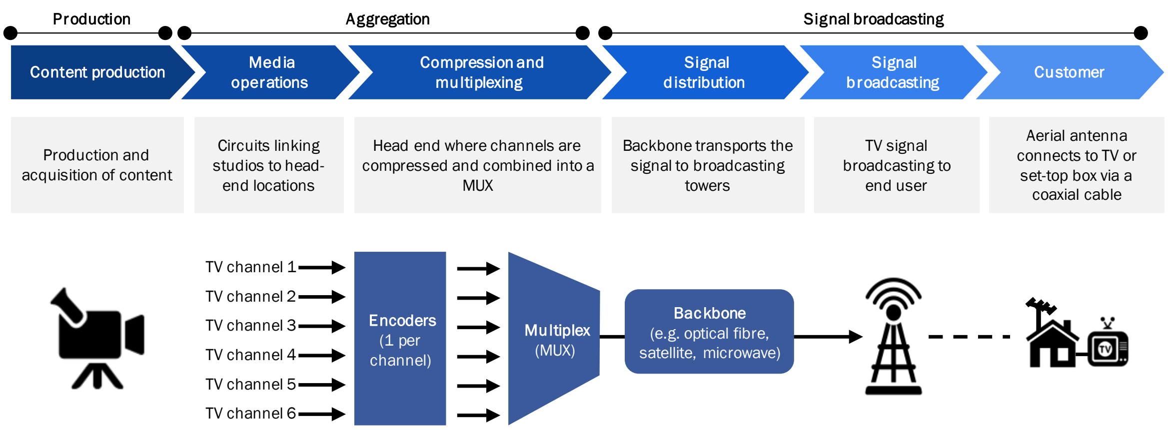
Annex A provides an overview of the players in New Zealand's TV broadcast market.

2 Broadcasting value chain, content types and business models

While the value chains are similar, there are some differences between TV and radio, or depending on the transmission platform. We first introduce the value chain for TV terrestrial transmission and then in Chapter 3 we highlight the differences in the value chains according to the transmission platforms.

2.1 Value chain

Figure 2.1: TV value chain [Source: Analysys Mason, 2019]



Several actors are involved in different parts of the value chain to deliver TV services to the end user. The value chain can be segmented into three parts:

- **Production** – Content to be delivered to the customer is produced by TV channels or acquired from major film studios or independent content producers

- **Aggregation** – At this stage the content from different TV channels reaches head-end locations, (i.e. control centres) where all the signals are encoded and multiplexed into a single broadcast stream. Aggregation is composed of two main elements:

  – Media operations, where circuits link TV studios to the head-end locations

  – Compression and multiplexing, in which the head-end channels are encoded and converted into standardised data streams, which are then multiplexed in spectrum portions and shared mediums resulting from the combination of multiple analogue signals.

- **Signal broadcasting** – Once channels have been combined and compressed into a multiplex (MUX), the resulting signal is transported to main transmission sites, from where it is then transmitted to end users' premises. This last stage differs depending on the transmission platform.

In this case, Figure 2.1 can represent a typical value chain for digital terrestrial television (DTT) with a signal that is transported through a telecoms backbone network to transmission sites, where it is then transmitted to end users' antennas.

2.2 Content type

In this section, we outline the forms of media content that can be delivered by broadcasting transmission platforms. We differentiate between two types of delivery:

- **linear delivery**, the more traditional method, which is still widely used to deliver content to TV sets
- **non-linear (on-demand) delivery** which has emerged more recently.

2.2.1 Linear content

Linear content usually refers to the traditional way for broadcasters to air content, that is, using a schedule of programming with content broadcast at a specific time and day of the week: in TV broadcasting, viewers can watch linear TV programmes on a specific channel at a scheduled time. This type of content is now primarily consumed by older viewers who are used to traditional TV, whereas younger viewers who have had access to on-demand content from a very early age typically only watch linear content in the form of live events, such as sports.

In most cases, linear content supports limited or no interaction between the broadcaster and the end users and does not allow users to select specific content or 'time-shift' their viewing (at least without the integration of a specific tool, e.g. video recorder). There are a small number of cases where end users can access certain personalisation services (such as alternative commentary of a sports event, but in fact these are multiple forms of linear content delivered at the same time).

2.2.2 Non-linear (on-demand) content

Non-linear content refers to the anytime ad-hoc delivery of content to specific users who request it. This content is stored on an on-demand platform and is interactive by design, as it requires input from the user before it can be played or downloaded.

Broadcasters on cable TV and internet protocol TV (IPTV) platforms are increasingly turning linear content into non-linear content by introducing online storage platforms, effectively centralised digital video recorders (DVR). As a result, users can access content at any time and benefit from time-shifted viewing.

Non-linear content offers major benefits to users of IP-based platforms – including IPTV and 'over-the-top' (OTT) platforms – in terms of flexibility and portability, as it allows them to access content from different locations and devices, provided they have an internet connection. In some cases, the content can be downloaded onto portable devices for off-line viewing[2].

Broadcasters on other platforms have looked for alternative ways to offer content in a similar way. For example, TV providers are offering on-demand services as an additional option on top of their linear programmes (e.g. Sky-GO).

2.3 Business models

Depending on the way they decide to monetise the content delivered, there are several business models that broadcasters may adopt:

- **Free to air (FTA)** – Channels and broadcasters provide content that is unencrypted, allowing all users with appropriate receiving equipment to access it without needing to pay a subscription or one-off fee. This business model is typical of DTT. In some cases, this content can also appear in other broadcasters' offers, such as those using cable TV, direct -to-home (DTH) TV and IPTV or OTT platforms. With this business model, an FTA commercial broadcaster's main source of revenue is advertising. Public service broadcasters (PSB) typically receive most of their revenues from licensing (e.g.TV licence in UK or in Italy), directly from taxes (as is the case in New Zealand) or funds levied from telecommunications providers. In some countries, such as Italy, PSBs may also be authorised to carry commercial advertising.
- **Subscription** – Customers pay a recurring fee at regular intervals, e.g. every month, to obtain access to specific content. This business model is typical of DTH, cable TV, IPTV and OTT platforms.
  - Subscription video on demand (SVOD) – Customers enter a subscription agreement to obtain access to the VOD platform, from which they can access all the content available in their subscription.
- **Pay per view (PPV)** – Viewers must purchase each item of content that they want to watch. This method of charging customers is typically used by cable TV and DTH broadcasters for sport and music events.
  - Transactional video on demand (TVOD) – Customers are not required to pay for a subscription, but they are charged a set amount for each item of VOD content they watch. There are two categories of TVOD:
    1. electronic sell-through (EST) or downloaded to own (DTO), under which purchased content can be accessed without limitations, and
    2. downloaded to rent (DTR), under which content can be accessed for a limited time period.

2 A podcast would be the non-linear content equivalent for radio broadcasting.

3 Transmission platforms

In this section we explain the main platforms used for TV transmission (Section 3.1) and for radio transmission (Section 3.2). These platforms are in widespread use around the world, and all of them are available in New Zealand.

Each broadcast transmission platform is presented and analysed using a standard framework:

Figure 3.1: Transmission platform overview [Source: Analysys Mason, 2019]

N.	Item	Details
1	Overview	• High-level description
2	Value chain	• High-level diagram (detailing the general one reported in Figure 1.1) • Main differences between each transmission platform value chain
3	Technology	• Standards for each technology • Recent technology evolutions (e.g. DVB-T to DVB-T2)
4	Comparison	• Comparison of TV transmission platforms

3.1 TV transmission platforms

Below we describe the main platforms used for transmission of TV broadcasting services, i.e.:

- DTT
- satellite TV (DTH)
- cable TV
- IPTV
- OTT.

3.1.1 DTT

Overview

Wireless terrestrial TV was the first platform for the transmission of TV broadcasting services and has remained the main platform in many countries. Prior to 2000[3], TV signals were analogue, and each TV channel occupied a full radio channel. DTT is a transmission platform of digital audio-visual media content delivered by land-based TV stations which broadcast via radio waves to consumers' TV sets.

In 2006, the International Telecommunication Union (ITU) established a plan for the global migration from analogue TV to DTT, between 2012 and 2020. DTT platforms have now replaced analogue platforms in many markets around the world. However, some European countries, such as

3 Strictly speaking, DTT operations started in UK in 1998 and in Spain and Sweden in 1999.

Belgium and Switzerland, have already decommissioned DTT. The switchover has been favoured by the fact that DTT has lower spectrum requirements and transmission costs per channel than analogue TV.

Users can access DTT services in parallel with other transmission platforms such as DTH, cable TV or IPTV and streaming services on the open internet, often referred to as OTT services. Compared to the other TV transmission platforms, DTT is characterised by a lower rate at which information can be transmitted on the communication channel (referred to as 'channel capacity').

As shown in Figure 2.1, DTT combines several TV channels into a MUX. A MUX typically uses 6–8MHz of spectrum and usually transmits between four and eight TV channels. A similar bandwidth would have been needed for each analogue TV signal, which would have carried only one TV channel. DTT has thus allowed a reduction in the spectrum required for TV services. The actual number of channels that can be transmitted through a MUX depends on technical parameters such as quality, encoding (i.e. transforming channels into data streams), and the transmission standard that is used.

The content is then transmitted to broadcasting towers spaced around a given region either through the backbone network or even satellite networks. These towers broadcast the DTT signal in the ultra-high frequency (UHF) spectrum band[4]. The frequency range allocated for DTT in New Zealand lies between 510 and 694MHz although as of today only the range 510–622MHz has been assigned[5].

The signal broadcast by local broadcasting towers is received by the aerial antenna at end-user premises and is delivered to the TV set or set-top box (STB) via coaxial cable.

Technology

A MUX capacity can be measured in terms of bitrate (in terms of Mbit/s), i.e. how much data can be transferred in a certain amount of time, per channel. Migration to technologies with higher compression can significantly reduce the bandwidth required for each TV channel and thus increase the MUX capacity in terms of TV channels. For example, the transition from Moving Picture Experts Group 4 (MPEG-4) to High-Efficiency Video Coding (HEVC) compression technologies is expected to reduce the bitrate required by channel between 30% and 50%.

5 Source: Radio Spectrum Management Agency https://www.rsm.govt.nz/assets/Uploads/documents/ab6e11fc39/digital-television-channel-usage-table.pdf

Figure 3.2 presents the bitrate required for each channel by different content format and coding standard.

Figure 3.2: Bitrate per channel, by video content format and coding standard [Source: Analysys Mason, 2019]

Video content format	Coding standard	Bitrate (Mbit/s)
SD	MPEG-2	3.5–4.0
SD	MPEG-4	2.5–3.1
HD-720p	MPEG-4/AVC	6.1–7.5
HD-1080i	MPEG-4/AVC	7.0–8.3
HD-1080p	MPEG-4/AVC	11.2–13.0
HD-1080p	HEVC	9.4–11.0
UHD4k	HEVC	21.0–32.0

DTT is a linear TV broadcasting technology; no signal return channel is available on early DTT standards. This issue has been addressed by creating variants of the DTT standard to create hybrid models, such as the hybrid broadcast broadband TV (HbbTV) or multimedia home platform (MHP). These support some degree of interactive services, e.g. interactive news and programme recording. HbbTV, which was developed by the European Telecommunications Standards Institute (ETSI), is able to seamlessly provide DTT services delivered via broadcast alongside broadband-based content and does not need a return channel. In other cases, these solutions require a set-top box with an internet connection.

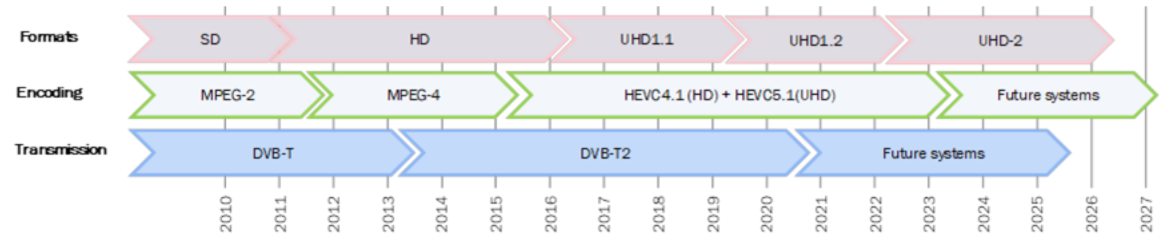
Countries around the world use a variety of methods and standards to convert the transport stream, i.e. standard format for transmission, into a broadcast signal. These standards include:

- **Digital Video Broadcasting-Terrestrial (DVB-T)**, a European standard which is the most widely used globally, with deployments across Europe, Asia and South America, Africa and the Middle East, as well as New Zealand.
- **Integrated Services Digital Broadcasting-Terrestrial (ISDB-T)**, a Japanese standard which has been widely adopted in Latin America, and some Asian and African countries.
- **Digital Terrestrial Multimedia Broadcast (DTMB)**, a Chinese standard, primarily adopted in Asian countries.
- **Advanced Television System Committee (ATSC)**, a North American standard which has been adopted in the USA, Canada, Mexico and South Korea.

These standards have different technical specifications for signal compression and transmission, which means that each requires different consumer and transmission equipment.

Figure 3.3 shows the historical and expected evolution of DTT technologies.

Figure 3.3: Historical and expected evolution of DVB-T technologies [Source: Analysys Mason, 2019]



The migration to newer transmission technologies (DVB-T2 etc.) supports the delivery of higher-resolution video content, e.g. ultra-high definition (UHD), through improvements in the 'spectral efficiency'. One way to measure this efficiency is the number of channels that can be carried by each MUX, which has increased by approximately 1.5 times as a result of the migration from DVB-T to DVB-T2 (see Figure 3.3). New Zealand's DTT MUXes use a combination of DVB-T and DVB-T2 standards.

Figure 3.4: Comparison of number of channels per MUX with DVB-T and DVB-T2 [Source: Analysys Mason, 2019][6]

Video coding	DVB-T		DVB-T2		
	SD format	HD format	SD format	HD format	UHD format
MPEG-2	6–8	n/a	10–12	n/a	n/a
MPEG-4	8–10	3–5	14–16	4–6	n/a
HEVC	n/a	n/a	n/a	7–8	1–2

3.1.2 Satellite TV (or DTH)

Overview

Satellite or DTH broadcast services have historically been used to deliver TV broadcast services in areas with low population density. TV was first broadcast via satellite in the 1960s, but it was in the 1990s that the platform really began to gain popularity as a way to receive domestic TV services worldwide. In developed markets the production and broadcast stages of the value chain (see Figure 3.5) are usually controlled by the same integrated players.

DTH has some advantages over DTT (and cable TV):

- DTH broadcast supports higher bitrates and can encode more information, generating higher levels of spectrum efficiency than DTT. This efficiency means that satellite broadcasts can carry more channels than DTT using the same amount of bandwidth.

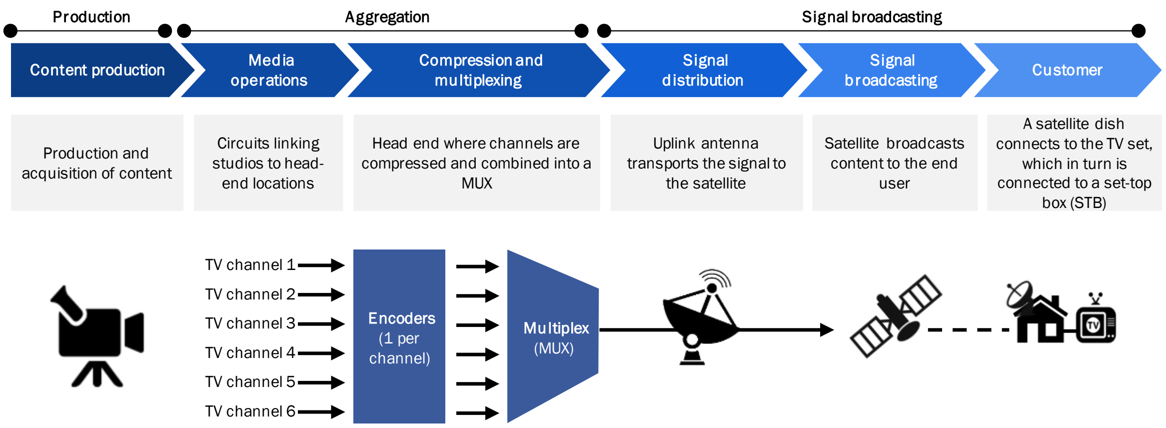
6 SD = standard definition, HD = high definition, UHD = ultra-high definition.

- Because DTH does not require any network build-out, the start-up costs are lower than for cable TV or DTT platforms; in addition, an entire market or region can be covered with DTH, including locations with both low and high population densities, making it a more economical proposition than DTT or cable TV in more sparsely populated areas. It also allows nationwide coverage from day one.

However, DTH involves some significant costs to end users when compared to DTT and cable TV, as customers are usually required to pay to install an STB and the antenna required to set up a new connection.

Value chain

Figure 3.5: DTH value chain [Source: Analysys Mason, 2019]



The differences between the DTH value chain and other transmission platforms are mainly concentrated in the signal broadcasting phase. In this stage, the signal is transmitted from uplink antennas to satellites, which broadcast it to end-user premises. In order to access a DTH service, consumers need to be equipped with three primary components:

- **TV receive only**, i.e. the DTH distribution system for delivering programming to end user premises. It usually includes devices to amplify and convert radio frequencies into STB-compatible content.

- **STB**, where the satellite signal is demodulated i.e. extracting the signal from a carrier wave and decrypted.

- **Middleware**, i.e. the system block in charge of transferring digital content from the STB to the TV screen. This tool allows service providers to interact with customers and to track their usage (e.g. via an interactive programme guide). The middleware is typically embedded in the STB.

Technology

DTH mostly transmit signals in Ku-band frequencies[7] of the electromagnetic spectrum. These frequencies are much higher frequencies, i.e. from 12 to 18GHz than the UHF areas of spectrum used for DTT and radio distribution.

DTH signals include all the content available from a DTH provider and are broadcast to all end users. However, each end user's STB is configured so that they can only access those parts of the content which are included in their subscription, as happens in other pay TV systems (DTT, cable TV or IPTV).

The main disadvantage of DTH services compared to those that use physical cabling (such as cable TV or IPTV) is that there is no 'one-to-one' connection. As a result, it is very difficult for DTH to deliver truly interactive services – (VOD) or time-shifting options such as stop and play functions – as the lack of a return channel means it is not possible to request specific services. For this reason, DTH providers have increasingly sought ways to provide a return channel to their customers, often by using an alternative access network (e.g. the telecoms network).

3.1.3 Cable TV

Overview

Cable TV is a transmission platform that was originally developed as a way to deliver TV content to consumers through a coaxial cable network. Cable TV was intended to serve communities that did not have an acceptable off-the-air TV signal, either due to topographic obstacles or because of the long distance from the nearest transmitters. Over time, however, the technologies used on cable TV platforms have been upgraded to allow the provision of telecoms services (i.e. voice and broadband access).

In contrast to DTT and DTH, cable TV platforms that have been upgraded to provide telecoms services support communication in both directions between the service provider and the end users. This gives customers access to on-demand services, with the ability to select what content they view and receive from their service provider.

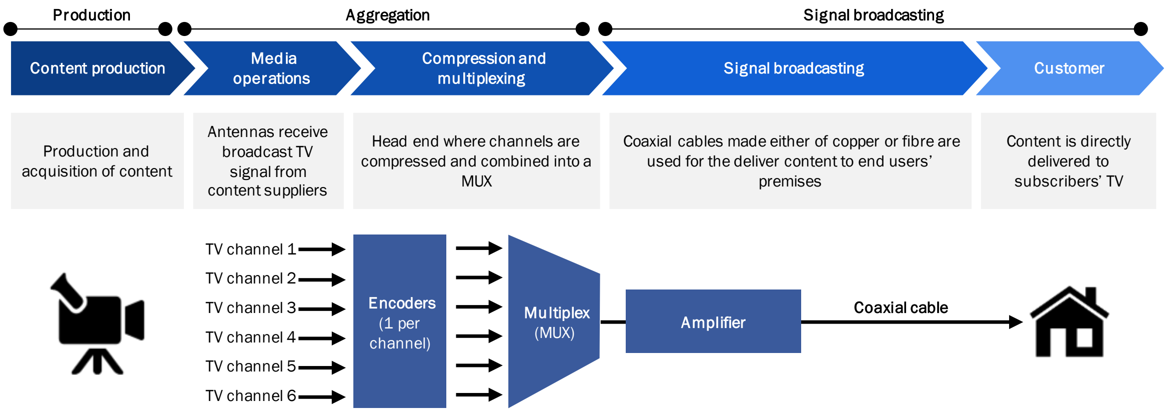
The main disadvantage of the cable TV transmission platform relates to its network coverage: as with any other wired access network, the roll-out of a cable TV network requires a significant upfront capital expense and is much less cost effective than wireless technologies in areas with low population density.

---

7 Very old systems also used the C-band spectrum in the 4–8GHz range (downlink transmissions (satellite to Earth direction) in the range 3.7–4.2 GHz).

Value chain

Figure 3.6: Cable TV value chain [Source: Analysys Mason, 2019]



The cable TV systems were originally designed to broadcast TV content, and (except for the distribution process) the cable TV value chain is similar to that of other transmission platforms. In this stage, channels are delivered from the head end to end-user premises through coaxial cables, which are usually strung on utility poles or placed in underground ducts. As the signal weakens as it passes through the cable network (attenuation), trunk amplifiers are installed along the grid, with a maximum of 20–30 per cable, to avoid deterioration of quality. Cable TV systems that have been upgraded use a combination of optical fibre and coaxial cable to deliver the signal to the end users, to create so-called hybrid fibre coaxial (HFC) networks.

Technology

Coaxial cables provide the basis for cable TV distribution There are two types of coaxial cable:

- Legacy analogue cables, which can be connected to a legacy analogue TV set without requiring an STB.
- State-of-the-art digital cables, which are compatible with digital TV and have become the cable TV industry standard.

HFC networks are used in combination with Data Over Cable Service Interface Specification (DOCSIS), a standard which allows high-bandwidth data transfers to be carried by an existing cable TV platform. This upgrade has increased the capacity of cable TV networks, allowing them to deliver ultra-fast broadband services.

3.1.4 IPTV

Overview

TV over internet protocol (IP) network services can be delivered with two alternative methods, either:

- through managed IP networks, commonly named IPTV (as discussed in this subsection)
- through streamed TV over the unmanaged internet, i.e. OTT services (as discussed in Section 3.1.5).

IPTV is a transmission platform on which TV content is delivered to subscribers through managed IP connections which benefit from a quality-of-service (QoS) mechanism, so that the service delivery is always undertaken in networks that can provide the required service quality. Managed networks are partitioned from the public internet, allowing operators to maintain control over traffic volumes, avoiding network overloads and also provide a guaranteed QoS for specific services. As a result, managed IPTV services offer greater reliability than unmanaged internet services (like OTT).

Because IPTV is based on IP technology, it provides a two-way communication channel (unlike transmission platforms such as DTT, DTH and legacy cable TV, where end users can only view the same linear content or store part of it in their STB for later viewing). The interactivity supported by IP technology enables 'one-to-one' distribution, allowing single viewers to select their preferred content, access on-demand services, and also benefit from 'trick-mode' facilities (e.g. live fast forward, rewind and pause).

In addition, IP technology allows service providers to collect information about users' consumption, to deliver additional services coupled to programming (such as gaming and online shopping), and to offer 'time shifting' of content (where users can record video material for later viewing and start watch the beginning of a show before it has finished recording).

The ability for users to select specific content to view is also beneficial for IPTV service providers, as they can optimise the bandwidth utilisation on their networks by sending one-to-one signals instead of one-to-many. Finally, IP-based transmission allows users to access IPTV content and services from any device that is connected to a telecoms data network: as well as being able to view IPTV content from a smart home TV set, it can be accessed for instance on mobile devices via a mobile data connection. Therefore, IPTV transmission offers users greater flexibility than legacy broadcast transmission platforms.

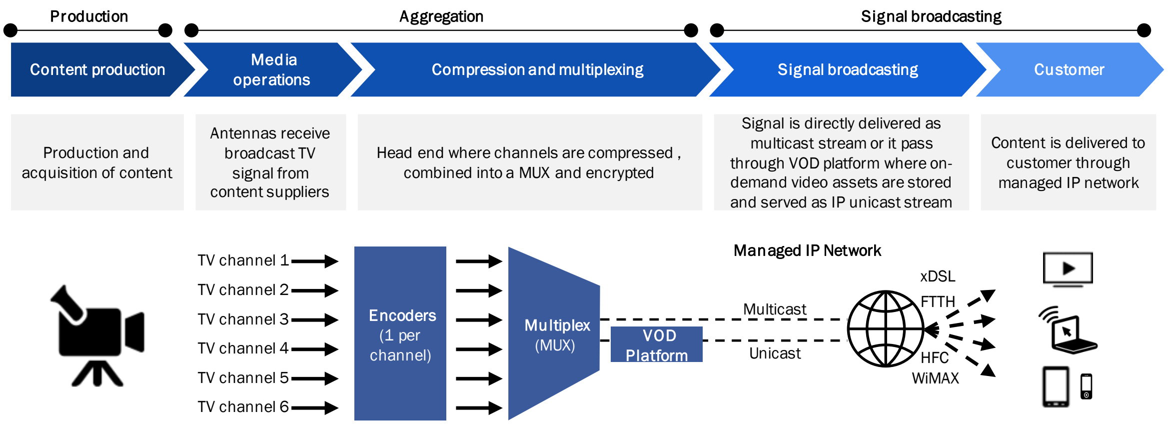
However, because IPTV relies on broadband connection performance (which is subject to variations in throughput, latency etc.), service quality is heavily dependent on the internet access that is available to individual end users. The viability of IPTV services can therefore be limited in countries with older telecoms access networks.

The diversity of technologies and expertise involved in this sector have caused a convergence of the broadcast and telecoms industries and many telecoms operators have begun to offer IPTV services.

This transformation has led to the emergence of 'triple play', where a provider offers a single subscription that includes a combination of voice, video and data services[8].

Value chain

Figure 3.7: IPTV value chain [Source: Analysys Mason, 2019]



There are two options for the architecture of an IPTV transmission platform:

- In a **centralised architecture** model, all the TV content is stored in centralised servers without requiring any comprehensive content distribution scheme. This type of architecture is typically used by small video-on-demand (VOD) services providers.
- In a **distributed architecture** model, centralised servers are integrated with the distribution infrastructure. This requires sophisticated content distribution technologies to support effective delivery of content over the service provider's network. This concept is also known as Content Delivery Networks (CDN[9]).

The production stage of the IPTV value chain is similar to the other transmission platforms, while the other stages present some significant differences as the content is delivered over the Internet.

- **Aggregation** – This stage is the same whether the IPTV provider produces in-house content or not, and it involves two different forms of infrastructure:
  - Head end, where the (linear) TV content is compressed, encoded and encrypted in the form of IP multicast streams, a technology used to broadcast IP datagrams[10] to the receiving devices using only one transmission.

8 There are also 4P services that typically include mobile services as well.

9 A content delivery network can be owned by the same IPTV operator or a specialised company that owns network equipment and servers located around the world to store content closer to the end user to improve the user experience and reduce transmission costs.

10 Message sent over the internet carrying user data (in this case, audio and video content).

  - Advertising, live TV streaming and VOD servers and platforms, which can be part of the central unit or located separately. The VOD platform is where on-demand video content is stored and provided as IP unicast streams, a transmission method to send a signal point-to-point, when subscribers request a specific content.

- **Signal distribution** – Content is delivered from the head end to the end-user premises via the telecoms data access network, which is based on one of a range of different network access architectures and technologies such as digital subscriber line (DSL) over copper or Ethernet over fibre to the home (FTTH).

Technology

IPTV is based on packet transmission, where packets of information are transmitted to end users over an IP network. Unlike traditional TV content broadcast services, where the signal is sent by one sender to all receivers (broadcast), IPTV uses both unicast and multicast transmission platforms:

- **Unicast** refers to communication that only involves one sender and one receiver, where each piece of content is sent from one point (the source) to another point (the destination). This technology is typically used for VOD services, allowing subscribers to play, pause, stop and replay content, without affecting the content that is viewed by other customers of the same VOD provider. In IPTV, the same TV programme can be delivered to several users using unicast transmission only if they are directly connected to the media platform.

- **Multicast** refers to the sending of information from a single source to a selected group of devices. In the specific case of IPTV, an IP multicast group needs to be defined for each TV channel, so that its content is only sent to the specified IP addresses. Users can access their network device only when they want to watch the specific channel.

Multicast is much more efficient than unicast, as it enables the same packet of information to be delivered to many users at the same time, whereas unicast can transmit to only one recipient. However, multicast is a more complex process, due to the effort required to remove or add users to particular groups. Multicast is typically used to broadcast linear content, as all the content is delivered the whole user base of the groups, whereas unicast is used to deliver niche or low audience content.

Sending individual data streams (unicast streaming) to many users can result in a high load in the backbone network of the IPTV providers. For this reason, content delivery networks (CDNs) are typically used to guarantee an adequate QoS.

3.1.5 OTT

Overview

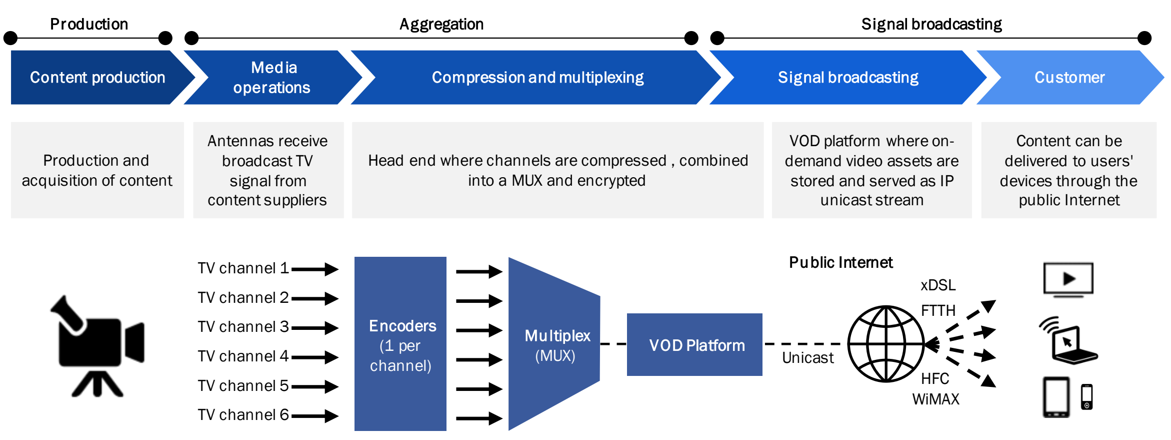
OTT services fall within the category of *unmanaged* internet services, as they deliver content via the public internet without operating or leasing any network capacity; as the services operate 'over the top' of an ISP network. The ISP is neither responsible for nor has control over copyright, viewing abilities or redistribution of content that is delivered to end-user devices. Consequently, there is no need for OTT service providers to have any business affiliation with the ISP. OTT service providers are therefore free from the burden of owning their own delivery infrastructure.

OTT media content is delivered over the public internet without going through traditional platforms such as cable TV or DTH. As with IPTV services, content can be accessed by any device which is connected to an internet access network (e.g. a mobile phone with a data subscription), which is not possible with cable TV or DTH. In addition, OTT users have the flexibility to decide when and where to watch the content offered, unlike the traditional concept linear or real-time TV.

Because OTT network operators deliver their content through the public internet, they incur lower infrastructure costs than DTT network operators. However, one disadvantage of using the public internet is that OTT services are vulnerable to long buffering times and low speeds (problems which do not affect managed services such as IPTV or cable TV[11]). In addition, it is possible for ISPs to restrict end users' access to OTT services (e.g. by introducing monthly caps on data usage).

Value chain

Figure 3.8: OTT value chain [Source: Analysys Mason, 2019]



The main difference between this value chain and those for other broadcasting transmission platforms is that OTT providers are not involved in the infrastructure that is used for service delivery,

11 Live OTT services experience an additional latency of 30-45 seconds that is significantly higher than IPTV, CATV (4-5 seconds) and DTT (few hundreds of milliseconds). This is the result of the storage and packaging processes applied to ensure a smooth viewing experience to end-users [source: Analysys Mason Research]

for which responsibility lies exclusively with consumers' ISPs. OTT value chain differs from other transmission platforms' value chains mainly in these two phases:

- **Aggregation** – OTT content is transferred from studios to the head-end, where the different forms of content are aggregated into the OTT service portfolio (including channels). The content is then stored on the VOD platform and made available as IP unicast streams when customers select them.
- **Signal broadcast** – OTT providers do not directly transmit the signals to users' digital receivers. Users can request the required content to the OTT provider and receive it on demand. In some cases, OTT can guarantee higher quality than a service completely delivered on the public Internet, through agreements with local CDNs.

Technology

There are two variations of OTT delivery models:

- Basic service: OTT service providers can deliver content over the public internet without any form of control of it, exposing the content to reliability issues, delays and bandwidth limitations.
- Hybrid solution: OTT service providers can develop hybrid solutions, in conjunction with CDN operators to deliver higher-quality content to customers. Because CDNs can manage their own networks, they can guarantee QoS standards until the access network and consequently content is less exposed to public Internet related issues.

3.1.6 Comparison of TV transmission platforms

Even though all TV transmission platforms deliver similar content, they require different infrastructure and exhibit different characteristics. In Figure 3.9 below, TV transmission platforms are compared by analysing the following aspects:

- **Coverage** – DTH is the only platform that can deliver wide coverage in most locations, via a single satellite. In contrast, cable TV, IPTV and OTT coverage depends on the deployment of wireline broadband networks. DTT represents an intermediate option which enables substantial population coverage to be achieved with just a few transmitters. However, universal coverage of DTT would require a non-linear increase in transmitters in order to serve areas with adverse geographical conditions (such as mountains).
- **Capacity** – DTT is the transmission platform with the lowest channel capacity, due to constraints related to spectrum availability. In contrast, cable TV can carry many channels – as can DTH (provided there are enough transponders[12] on the satellite). The capacity of IPTV and

12 A satellite transponder for DTH is typically a device that receives radio signal in a frequency band, amplifies it and transmits it on another frequency (e.g. Ku band, as noted earlier) without any other modification of the received signal.

OTT is potentially unlimited but can also place significant transport demand on the supporting networks and require capacity optimisation techniques.

- **Content availability** – Due to spectrum limitations, DTT delivers a limited number of channels and is more typically used to deliver FTA[13] content. Other transmission platforms such as DTH, IPTV/OTT or cable TV typically offer a larger amount of content, including both FTA (available on DTT) and premium content.

- **Interactivity and ICT development** – Transmission platforms based on wireline technologies (i.e. cable TV, IPTV and OTT) are typically able to offer a wide range of interactive services. In contrast, the lack of a return channel on DTT and DTH (unless integrated with a broadband connection) means that these platforms offer limited or no interactive services.

- **Cost of customer premises equipment (CPE)** – DTH involves the highest costs for consumers, as it requires the installation of external antennas and an STB. Cable TV and IPTV only require the purchase of an STB (with or without installation costs) plus an existing broadband connection. OTT does not typically require a STB rather the content is accessed via an application, in addition to the device on which the content is to be watched[14]. In terms of CPE cost, the best platform is DTT as it only requires the purchase of a television set.

Figure 3.9: Comparison of features of TV transmission platforms [Source: Analysys Mason, 2019]

Feature	DTT	DTH	Cable TV	IPTV	OTT
Geographical coverage	◕	●	◑	◑	◑
Capacity	◔	◕	●	◑	◑
Content availability	◑	●	●	●	●
Interactivity	◔	◔	◕	●	●
CPE cost[15]	●	◔	◕	◕	◕
Reception means	Wireless	Wireless	Wireline	Wireline	Wireline

Key:

● Positive for the transmission platform

○ Negative for the transmission platform

13 See Section 2.3 for an explanation of the FTA business model.

14 In some older TV sets that do not support applications (i.e. non-smart TV sets), a plug-in device such a Chromecast may be required.

15 The lowest CPE cost is assigned the highest value in Figure 3.9

3.2 Radio

Below we describe the main platforms used for transmission of radio broadcasting services, i.e.:

- analogue radio: amplitude modulation (AM) and frequency modulation (FM)
- digital audio broadcasting (DAB) radio
- internet radio (IR)

3.2.1 Analogue radio - FM and AM radio

Overview

There are two main types of analogue radio transmission platforms depending on the modulation[16] method:

- **AM**– the radio carrier wave's amplitude is varied by the modulation signal
- **FM** – the radio carrier wave's frequency is varied by the modulation signal.

AM and FM transmission platform radio are used exclusively to deliver linear audio channels.

AM technology was the first audio radio transmission method developed and it is still broadcast worldwide. AM transmission platforms can use long wave (153–279kHz), medium wave (531–1602kHz) or short wave (2.3–26.1MHz).

FM has also a worldwide presence and it has slowly replaced AM in many regions. FM radio is usually broadcast in the 87.5–108.0MHz frequency range. AM and FM radio signals are transmitted by large transmitter sites[17] and delivered to end users' receiver devices.

AM has a 30kHz bandwidth requirement that is lower than the band used for FM channels, 180kHz. AM can therefore carry less information, which translates into a lower sound quality. Other features of FM which have driven the widespread adoption of FM around the world include a low level of interference between FM radio stations that are near one another, well-defined service areas for transmitters, and negligible interaction with small to medium-sized indoor objects. These features guarantee high-quality sound with low interference, provided there are no topographic obstacles.

By contrast, FM signal strength has a higher negative correlation to long distance between the receiving and the transmitting devices, when compared to AM.

As a result of the development and increasing coverage of DAB services (see Section 3.2.2 below), some European countries are currently switching off FM. For instance, Norway already completed this process in 2017 whereas Switzerland plans to complete it by 2024.

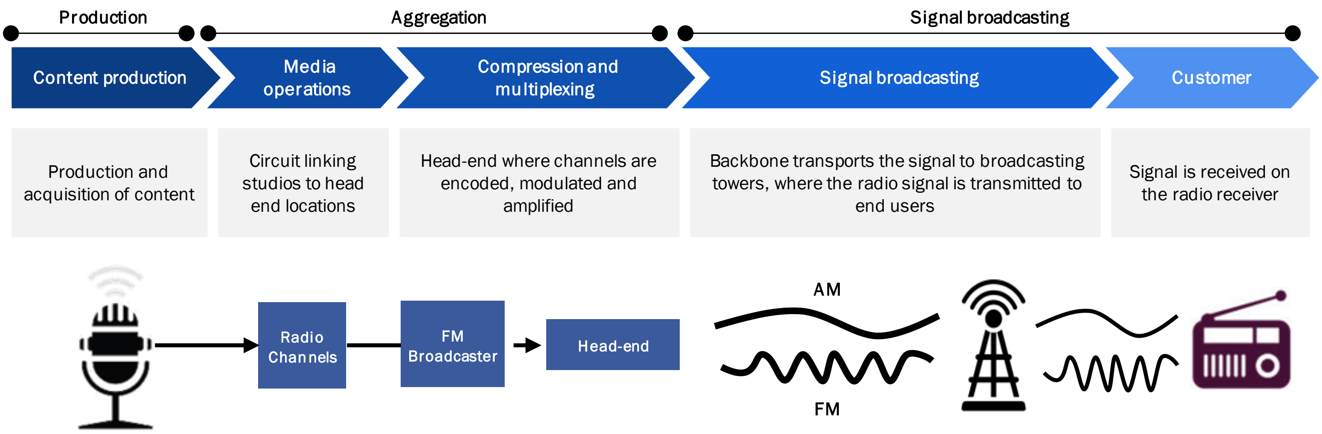
---

16 Process of varying one or more properties of a "carrier signal" with another signal (modulating signal) that contains the information to be transmitted.

17 Large transmitter sites which typically generate between 50kW and 250kW of power

Value chain

Figure 3.10: AM/FM radio platform value chain [Source: Analysys Mason, 2019]



AM and FM have a very similar value chain, with the only difference of how the signals are modulated[18]. This value chain has many common processes with the TV value chains with only few significant differences in the signal broadcasting phase. In this stage, amplified radio frequencies are delivered from the head-end to radio broadcasting towers, from where they are broadcast to the end-user devices in the form of electromagnetic waves (i.e. radio waves).

A significant difference in terms of broadcasting networks can be found in that radio receivers typically have omnidirectional[19] antennas, making it more feasible for broadcasters to set-up their own radio transmission stations than DTT stations (otherwise the DTT end user would need several antennas pointing in different directions if the various MUX were transmitted from different sites). However, some broadcasters outsource their transmission to broadcast network operators (BNO) since they have the best infrastructures and can provide relevant services, e.g. power assurance, security and management of electromagnetic frequency emissions.

Technology

AM and FM are both proven technologies whose worldwide diffusion has been favoured by the high availability and low cost of their receiver devices. AM has coverage of hundreds of kilometres while FM has a lower range (not more than 35–40km). This is because the frequencies which are used for FM radio in most countries (87.5–108.0MHz) do not usually propagate beyond the horizon. In addition, FM signals can be blocked by topographic obstacles.

More recent FM devices are integrated with radio data systems (RDS), communication protocols which allow the integration of small digital information to FM signal. The main objective of RDS is to improve FM receivers' functionalities and to make them more user friendly by adding some

18 Transmission sites can be different for AM and FM radios.

19 Antenna which radiates and receives equal radio power in all directions perpendicular to an axis.

additional functions, such as programme identification, programme service name display and tuning for portable and car radios.

3.2.2 DAB or DAB+

Overview

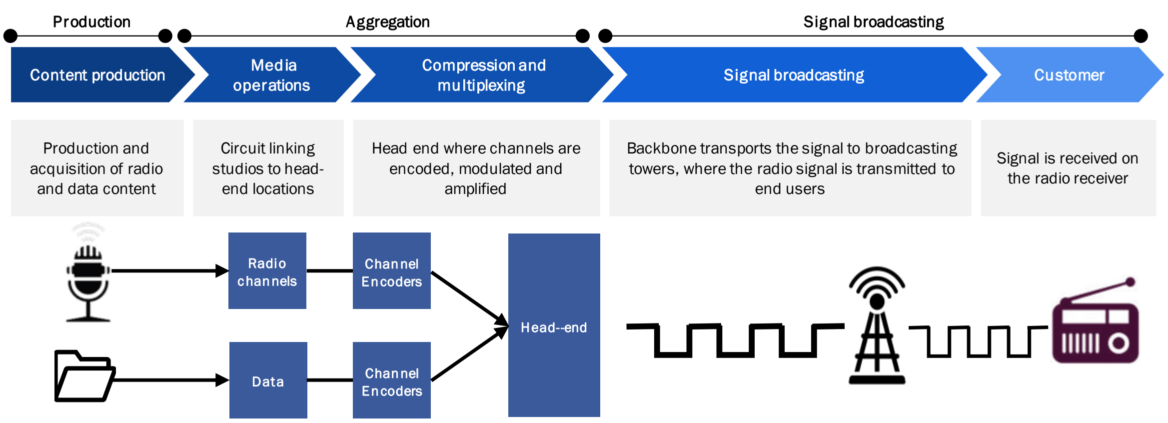
DAB is a digital radio standard developed by EUREKA, a European consortium, with the aim of providing an alternative to AM and FM. Unlike these legacy radio broadcasting platforms, DAB allows different sound programmes to be grouped and broadcast through a single radio-frequency channel in a similar way as a MUX for DTT compared to analogue TV channels. The superior spectral efficiency of the DAB standard means that radio network operators can increase the number of radio stations they transmit without overloading the radio waves, potentially providing enough space for hundreds of music stations.

The above-mentioned features provide DAB listeners with the advantages of high sound quality (comparable to CDs), a reduction in the need for retuning of car radios, and error-free data transmission.

By the end of 2018, 475 million people were covered by a DAB radio signal. Except for Australia, where DAB has also been adopted as the standard radio device for in-car use by some manufacturers, the only established DAB markets are in Europe. However, while some European countries such as Norway are completing analogue radio switch-off, and in many countries analogue and digital standards co-exist. Kordia, the New Zealand government-owned broadcast and telecommunications company, conducted DAB trials in New Zealand between 2006 and 2018. The Minister of Broadcasting, Communications and Digital Media considered that the case for adopting DAB was not strong enough, but the Government must still communicate its final decision on DAB implementation.

Value chain

Figure 3.11: DAB value chain [Source: Analysys Mason, 2019]



The main difference between DAB and analogue radio transmission platform's value chain is that in DAB several radio channels are aggregated in one single channel during the multiplexing process. Another difference is that DAB can carry significantly more information than analogue radio and that in the first stages of DAB there are two separate streams for sound and data, which are then aggregated in one single channel during the multiplexing process. After the DAB signal has been modulated, it is transported to radio broadcasting towers, from where radio antennas broadcast it to end users.

Technology

The ITU's standardisation body has allocated DAB to Band III (174–240MHz) and L-band (1.452–1.492GHz) frequencies.

DAB's high spectral efficiency offers two main advantages:

- It is well regarded by governments that wish to move traffic from low frequencies, which are in greatest demand (e.g. for mobile telecoms) due to their highest coverage and capacity.
- It allows radio network operators to offer a higher-quality sound service, including additional integrated data.

DAB+ is an updated variant of DAB technology which provides more efficient encoding by using a higher efficiency audio codec, i.e. HE-AAC v2[20] instead of MP2[21]. Whereas FM radio can transmit 8 channels within 1.6MHz of bandwidth, a DAB MUX provides between 9 and 12 channels, and a DAB+ MUX can transmit 18 radio stations using 1.536MHz of spectrum. The higher channel capacity of DAB+ relative to other transmission platforms, requiring less spectrum to transmit not only audio, as AM and FM, but also data content. Moreover, the audio channels broadcast over DAB have also a higher sound quality than over FM radio.

On the other hand, DAB/DAB+ receivers are more expensive, as they are based on more complex technology, which requires costly components such as host processors and modems, when compared to analogue ones.

3.2.3 IR

Overview

IR is a radio broadcast transmission platform where content is delivered through the Internet rather than wirelessly as in conventional radio terrestrial platforms (AM and FM), or radio digital platforms (DAB/DAB). IR is the radio equivalent of OTT for TV broadcasting. IR has significantly reduced the barriers to public transmission, allowing small stations to enter the market, and consequently

[20] High-Efficiency Advanced Audio Coding – version 2

[21] MP2, also known as MPEG-2, is a standard for digital audio coding

widening the choice of service providers for end users. Moreover, IR stations are not subject to any geographical limitation and can potentially reach a global audience.

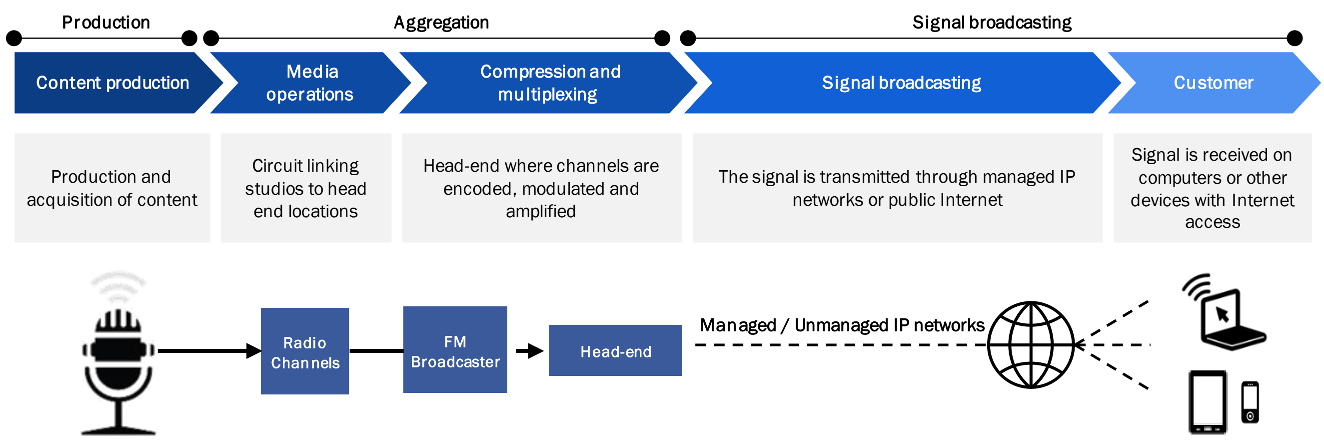
As for OTT, end-users can benefit from a higher grade of personalisation with the opportunity to select a radio station which is playing a specific song or to generate a virtual station schedule according to their preferences. In addition, many traditional broadcasters also offer an on-demand service, allowing listeners to play archived contents previously broadcasted via conventional channels also for off-line listening.

Even though IR has a potentially global audience, it still lags behind conventional radio transmission platforms in term of take-up. This results from IR's low compatibility with mobile and in-car listening as it requires a reliable internet signal that is not guaranteed in all the locations and due to the limited number of cars with an integrated internet access.

IR has a higher quality compared to analogue and digital radio due to the application of more modern audio codec technologies such as WMA[22] and AAC+[23] and also the ability to provide customers with up to 320kbit/s quality.

Value chain

Figure 3.12: IR value chain [Source: Analysys Mason, 2019]



The IR value chain is very similar to IPTV or OTT value chains depending on whether the content is delivered through managed IP networks or on the public Internet. This is also the main difference with other conventional radio transmission platforms' value chains where content is delivered via wireless platforms.

22 Windows Media Audio

23 Advanced Audio Coding

Technology

IRs are affected by the same drawbacks of OTT depending whether it is delivered through managed IP networks or public Internet. However, IR streaming services benefit from low variability in bandwidth demands and low bandwidth requirement for an acceptable quality service when compared to video streaming services, as audio content involves lower data volumes.

Annex A Main players in New Zealand's TV broadcast market

Figure A.1 below lists main the main TV broadcast players in New Zealand by platform, content type and business model.

Figure A.1: Main players in New Zealand's TV broadcast market [Source: Analysys Mason, 2019]

Name	Platform					Content type		Business model		
	DTT	DTH	Cable TV	IPTV	OTT	Linear	On demand	FTA	Subscription	PPV
Sky TV		X			X	X	X		X	X
Neon (Sky)					X		X		X	
Fan Pass (Sky)					X		X		X	
Vodafone (former Telstra Saturn)			X	X	X		X		X	
Lightbox (Spark)					X		X		X	X
Spark Sport					X		X		X	X
Netflix					X		X		X	
Disney Plus					X		X		X	
Google Play Film & TV					X		X			X
Prime Video					X		X		X	X
TVNZ	X	X	X	X		X	X	X		
Mediaworks	X	X	X	X		X	X	X		