Television
and
the radio-frequency spectrum

Walid Sami,
Union Européenne de Radio-Télévision (UER)

Abstract:
Television has changed along with technology, especially during the past two decades. Watching television used to be a group activity but has now become, especially for young adults, an individual form of consumption via personal, connected devices. Diverse contents are now offered, and viewers select what they want to watch, and where and when they do so. They have at their fingertips a slue of channels of transmission and business models that have benefitted from the growth of the Internet via landline or wireless connections. Under pressure, landline transmission has already lost much of the radio-frequency spectrum reserved for it. Nevertheless, the consumption of linear contents on a television set that receives for free Hertzian signals has apparently not declined. This is an argument for maintaining and even improving a platform based on land lines in order to adapt to new uses.

This article tracks major trends in television with regard to: viewing patterns, broadcasting, distribution, the contents offered, business models and regulations. What impact have these trends, many of which are listed in the table, had on radio frequencies for television, in particular for broadcasting?[1]

Table 1:
Trends in television

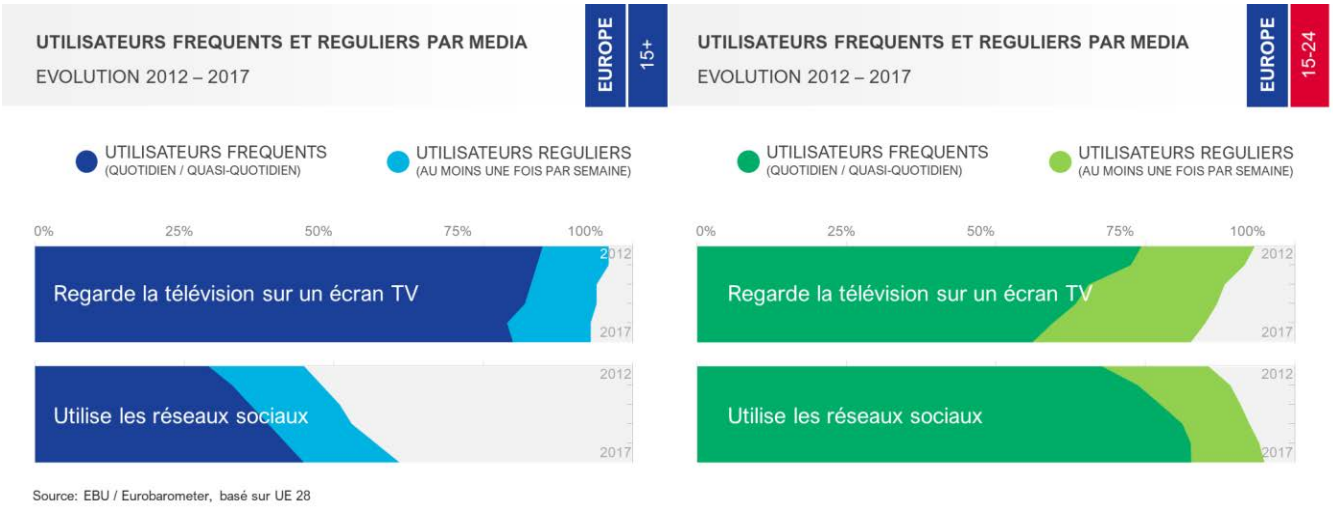
	1960-1990	*1990-2000*	*2000-2010*	*2010-2020*
Viewing medium	One TV set per household	Several sets per household. Large screens (16x9) on the market.	Improvement of the fixed TV set (flat screens, HD, sound). More portable and mobile sets. Individual viewing.	The fixed TV set stands its ground and improves (UHD, connected). iPad, and television on tablets and mobile phones.
Means of transmission and distribution	Analog terrestrial (over-the-air), cable and satellite.	Analog terrestrial, cable and satellite plus digital cable, satellite and the start of digital terrestrial .	Terrestrial, cable and satellite, analog as well as digital. Television via the Internet in development.	Terrestrial, cable and satellite TV, analog as well as digital, plus digital TV via the Internet. Given the rapid development of mobile networks (3G and 4G), television via the Internet on mobile devices.
Contents and business models	"Linear" programming. A few national (public and commercial) broadcasting networks. Business models: "for free" or "for pay".	"Linear" programming. More broadcasters, mostly commercial.	A "nonlinear" offer of online video on demand. User-made contents (Facebook, YouTube, etc.).	Subscription-based video on demand (SVOD) from global operators (such as Netflix). A proliferation of user-made contents.
Regulation	Contents regulated by governments. Frequencies managed by national broadcasters.	Contents subject to the regulatory authorities that oversee the media. Frequencies subject to the regulatory authorities that oversee the radio-frequency spectrum.	Same as the previous period but, in addition, regulation is extended to the Internet.	Same as the previous period.
Frequencies for broadcasting on the airwaves	A moderate use and abundance of frequencies. Regional agreements and plans (ST61 and GE89).	Intensive use. Regional agreement (Chester 97).	Regional agreement and plan (GE06). Loss of the 800 MHz bandwidth.	Agreements and plans for Africa and the Middle East. Loss of the 700 MHz bandwidth.

[1] This article has been translated from French by Noal Mellott (Omaha Beach, France). The translation into English has, with the editor's approval, completed a few bibliographical references. All websites were consulted in November 2020.

From family to individual viewing patterns

Between 2012 and 2017, “traditional” television viewing decreased moderately as many Europeans over the age of 15 shifted toward the social networks. This trend is stronger among 15-24 year-olds (*cf*. Figure 1).

Figure 1: Users of television and social networks in the EU-28 of persons over the age of 15 (on the left) and of 15-24 year-olds (on the right)



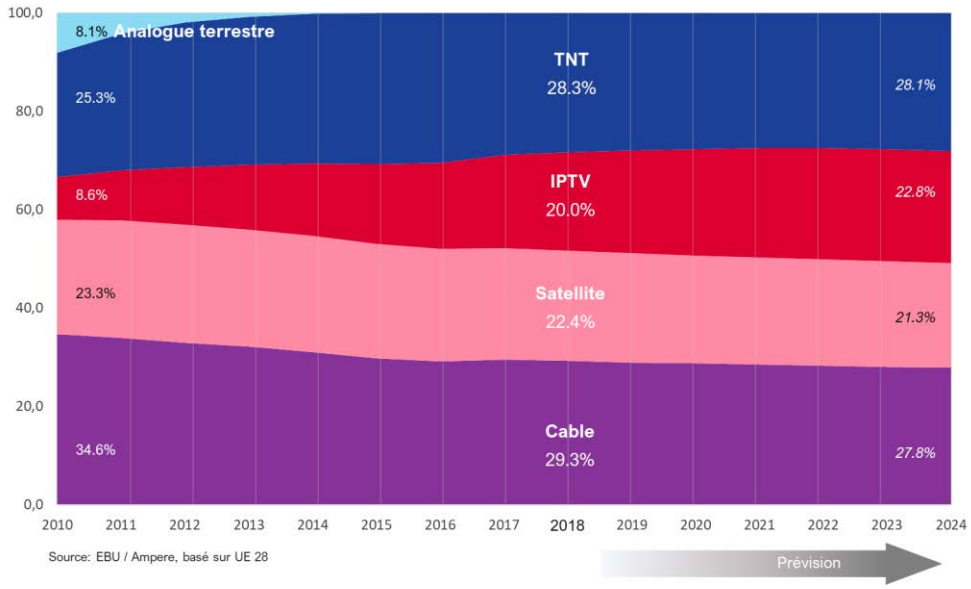
Source: EBU / Eurobarometer, basé sur UE 28

Multiple means of transmission and distribution

Broadcasting on the airwaves was the first way television programs were distributed. Powerful transmitting stations covered zones as large as possible, and relay stations were installed to make up for white spots. Then came, in chronological order: cable TV, which was rolled out more slowly and at a higher cost than broadcasting; satellite TV; a “higher” version of broadcasting that covered zones spanning several countries; and recently, IP-TV, a form of distribution using the Internet Protocol via wirelines or wireless connections (Wi-Fi, 4G). Around the turn of the millennium, broadcasting, cable and satellite TV all shifted from analog to digital technology, which offers better quality, a larger capacity and more features.

Figure 2 presents changes in the principal TV set used by households. The percentages are averages; they smooth out quite wide variations. Digital terrestrial television (TNT), for instance, varies from a few percent in Belgium to more than 75% in Greece. When the household has a second TV set, the percentage of TNT increases.

Figure 2: The principal TV set in a household (% of households in the EU-28)



Terrestrial TV seems to be standing its ground opposite competing forms of distribution. Some of the reasons for this are that: TNT is for free; consumers find it simple to use; public TV stations are legally obligated to provide universal, for-free reception. Other reasons have to do with national sovereignty and resilience in case of natural catastrophes. Furthermore, TNT stations, when for-free reception is geographically restricted, eventually pay less for the rights to transmit programs (sports).

To satisfy the new TV viewing patterns that have evolved along with the viewing media (in particular reception on mobile devices), new forms of technology for distributing terrestrial television are being developed along the lines of the technology used for mobile networks (EBU 2018, RATKAJ 2019).

An exploding supply and the quest for business models

On account of the explosion of contents, the race to attract an audience is intense. A supply of programs “on demand” is competing with traditional, “linear” programming.

As a consequence, several business models are in competition:

- on the one side, the for-free model financed by a fee (or tax in the case of French public TV) or by advertisements (commercial stations); and, more recently, online over-the-top (OTT) contents, including contents uploaded by the public.
- on the other side, the for-pay models financed by the sale of contents on demand (video on demand, VOD, is available on the Internet and via cable stations) or by a monthly subscription for access either to a group of stations (content packages via cable or satellite TV or IP-TV) or to a set of contents (*e.g.*, Canal+ in France and, more recently, Netflix, Amazon…).

The multiplication of for-pay TV is forcing users to make a choice but is also boosting for-free offers (STEWART *et al*. 2019). IP-TV and subscription-based video on demand (SVOD) are increasingly chosen to the detriment of cable subscriptions.

Adapting regulations

Given the spectacular upsurge in using the Internet to post and exchange audiovisual contents, regulatory tools are undergoing adaptation, in particular at the EU level. The EU's Audiovisual Media Services Directive (AVMSD) addresses questions related to contents. More recently, two directives have been issued on copyright law in the Digital Single Market and on the contracts for supplying digital contents and services.[2]

The obligations related to the production of audiovisual contents in Europe tend to be applied independently of the means of transmission and platform of distribution. They are stronger for on-demand contents (30% compared with 50% for "linear" contents).

Radio frequencies: "Doing more with less"

Between the 1950s and 1970s, terrestrial television was the biggest consumer of radio frequencies. The broadcasting of images, sounds and color with analog modulations took up bandwidth — a TV program could occupy up to 8 MHz. As a result, broadcasting stations geographically close to each other had to use different frequencies to avoid interference. In a country like France, this meant that from six to eight channels (48-64 MHz) had to be used for an analog broadcast of a single program. Frequencies thus had to be managed in coordination with neighboring lands. To avoid the "first come, first to take" principle, regional conferences organized by the ITU allotted channels fairly to broadcasters. The Stockholm agreement (ST61) was adopted in 1961 for the European zone; the Geneva agreement (GE89), in 1989 for the African zone; and, the Geneva agreement (GE06), in 2006 on digital television and radio services in the ITU's Region 1, which includes Europe, Africa, the Middle East and part of Asia. These plans provide for channels occupying several frequencies: band I, 47-68 MHz (not included in the GE06 plan), band III, 174-230 MHz, and bands IV and V 470-862 MHZ. In all, 469 MHz were devoted to television broadcasting services, approximately 47% of the spectrum below 1 GHz. In Europe, this allowed from seven to nine analog channels to file plans for using these 469 MHz.

Digital transmission developed in the 1990s and was rolled out during the 2000s: TNT in line with the DVB-T standard, which was launched in France in 2005. Six programs could instead of one be transmitted on a single channel of 8 MHz with the quality of the sound and images being at least as good as in analog transmission.

In parallel, the rapid growth of 3G and 4G mobile services during the first decade of the millennium produced a need for frequencies in the bands below 1 GHz. The 900 MHz band was already being used for 2G digital mobile services (GSM). The propagation of electromagnetic waves in this part of the spectrum allows for new networks with extended coverage but fewer sites than in the case of higher frequency bands, which offer more capacity for coverage (especially in urban areas).

WRC-07, the ITU's world radiocommunication conference in 2007, decided to reallocate the upper part of the UHF band (790-862 MHz) from television to international mobile telecommunications (IMT). This so-called "800 MHz band" represented the "first digital dividend". A second one was in the pipeline. Many countries in Europe were able to put up with this loss of the 800 MHz band for television insofar as this band's upper part was not intensely used. Nonetheless, several countries had to make arrangements for financing the reassignment of frequencies so as to free the band and solve problems of interference with TV reception in surrounding areas (because of signals emitted for mobile services from antennas).

[2] Respectively: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=LEGISSUM%3Aam0005, https://www.europarl.europa.eu/doceo/document/TA-8-2019-0231_EN.html & https://www.europarl.europa.eu/doceo/document/TA-8-2019-0232_EN.html.

At WRC-12, pressure from the regions of Asia-Pacific and sub-Saharan Africa led to the allocation to IMT services of a second slice of the spectrum that was being used for broadcasting. This so-called "700 MHz band" lies just below the first: 694-790 MHz. This is the second digital dividend. This allocation went into effect at the time of WRC-15 in 2015.

This new loss has had more impact on European broadcasters. During the 2010s, TV audiences had rising expectations for high definition television (TVHD), which was already available via satellite and cable, and was being adopted by program producers. Broadcasting in HD requires more than the double of the passband compared with "standard" broadcasting (ITU-R 2016). The switch to HD thus needed more bandwidth at a time when a second part of the spectrum had just been reallocated away from television services. Technological advances in compression and encoding (MPEG4, Moving Picture Encoding Group; and HEVC, High Efficiency Video Coding) and modulation (DVB-T2, Digital Video Broadcasting – Terrestrial) might be solutions but at the cost of substantial investments by broadcasters and sometimes even by viewers (who might have to adapt their TV sets). An EU decision in 2017 recognized the effort consented by broadcasters for gradually freeing the 700 MHz band by 2020 (or even later in some countries). The intent is for the 470-790 MHz frequency band to be used till at least 2030 for terrestrial broadcasting (including for-free television) and wireless microphones.[3]

Over an eight-year period, the share of the spectrum allocated to terrestrial television services has been reduced by 168 MHz. Besides this reduction, television has to stop using band I (VHF 47-68 MHz) because of the higher noise level inherent on this part of the spectrum and the bulky receiving and emitting antennas. Several European countries, including France, have retained band III (VHF 174-230 MHZ) for digital terrestrial radio based on the DAB+ standard. In all, the spectrum for terrestrial television has been reduced by 245 MHz — more than half of the 469 MHz previously available.

A new attempt at WRC-15, coming from North America and supported by some Middle Eastern counties, was made to allocate an additional slice (the "600 MHz band") to IMT services. Though unsuccessful, it did put the question of the reallocation of the 470-694 MHz band in the ITU's Region 1 on the agenda for WRC-23. In the meantime, studies will have to be made of needs and of the possibilities of spectrum sharing. WRC-19 reaffirmed this decision.

Conclusion

Television has evolved along with changes in technology and their impact on viewers' habits, even more so over the past two decades. The use of radio frequencies by television, especially terrestrial television, has changed significantly during this period. Despite being deprived of more than half of the spectrum to which it previously had access, terrestrial television is still the principal mode of reception in more than a third of European households. Its access to the spectrum still depends on many factors, the major ones being:

- the evolution of viewer demand (types of programs: for-free or for-pay, linear or on-demand; a fixed TV set or mobile viewing);
- technological changes in the methods of broadcasting and distribution so as to adapt to new (individual and mobile) viewing patterns;
- changes in this band and the strategies of distributers; and
- the positions eventually adopted by governments about how to handle the needs of television and mobile radio communications in the frequencies below 1 GHz.

[3] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017D0899

References

RATKAJ D. (2019) “5G: What it is and what it might become”, *Tech-i*, 39, pp. 10-11.

EBU [European Broadcasting Union] (2018) “Trials tests and projects relating to 4G/5G broadcast supported by European PSB”, *Technical Report*, TR044, July, 22p., available via https://tech.ebu.ch/docs/techreports/tr044.pdf.

STEWART D., CASEY M. & WIGGINGTON C. (2019) “My antennae are tingling: Terrestrial TV’s surprising staying power”, *TMT Predictions 2020*, 10 December, available at https://www2.deloitte.com/us/en/insights/industry/technology/technology-media-and-telecom-predictions/2020/antenna-tv-growth.html.

ITU-R (2016) “Requirements for the implementation of digital terrestrial television broadcasting networks”, *Handbook on Digital Terrestrial Television Broadcasting Networks and Systems Implementation* (Geneva, CH: International Telecommunication Union).