Paolo Cremonesi

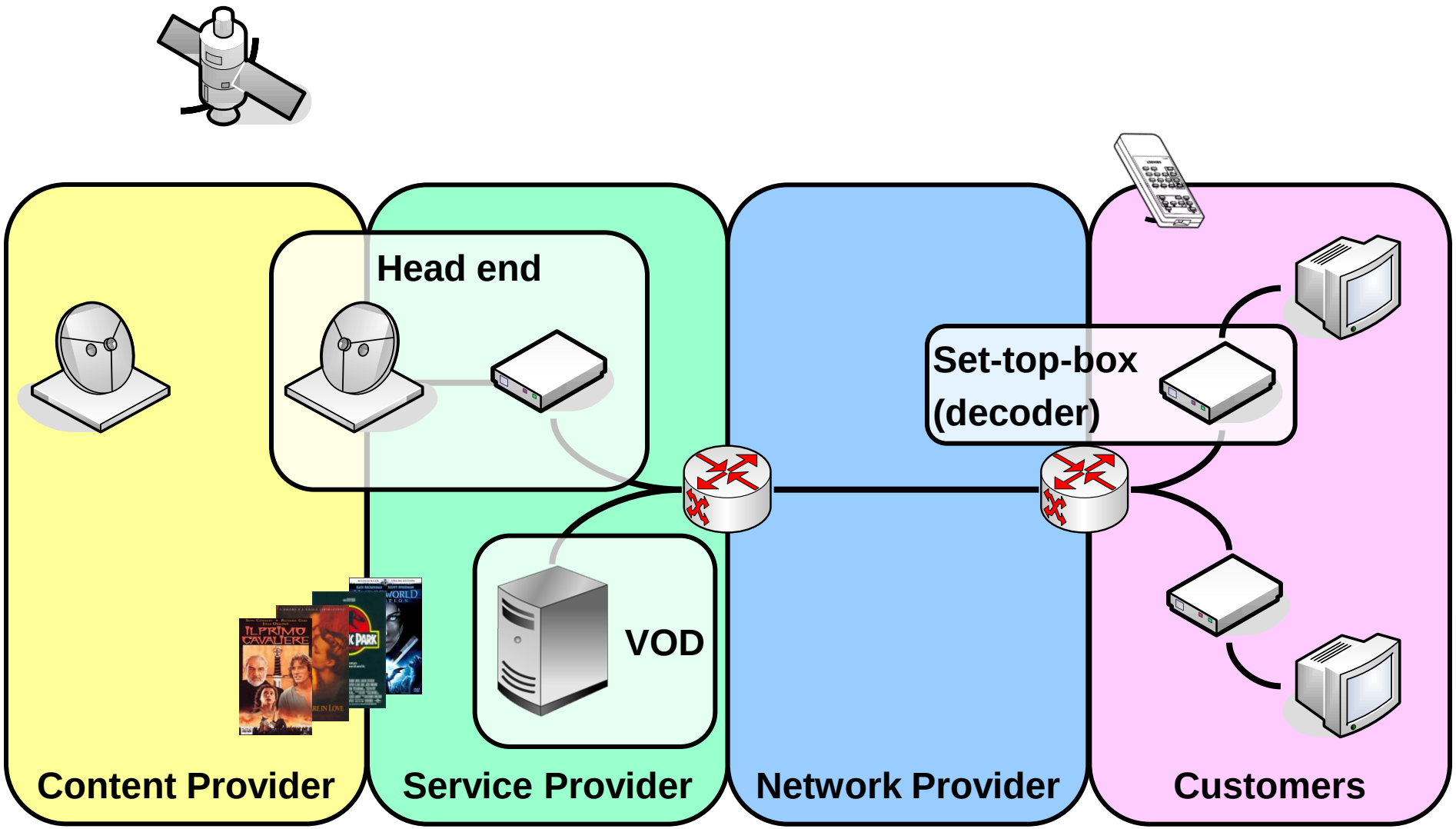
POLITECNICO DI MILANO





IPTV Television

IPTV architecture



IPTV architecture

- IPTV is a video service supplied by a telecom service provider that owns the network infrastructure and controls content distribution over the broadband network for reliable delivery to the consumer (generally to the TV/IP STB).
- Services
  - Broadcast TV (BTV) services which consist in the simultaneous reception by the users of a traditional TV channel, Free-to-air or Pay TV. BTV services are usually implemented using IP multicast protocols.
  - Video On Demand (VOD) services, which consist in viewing multimedia contents made available by the Service Provider, upon request. VOD services are usually implemented using IP unicast protocols.

Actors

- Broadbanders
  - Sky, RAI, Mediaset, La7, ...
- Editors
  - Content providers (WarnerBros, Sony-MGM, ...)
- Telco
  - Vodafone, Tim, Wind, ...

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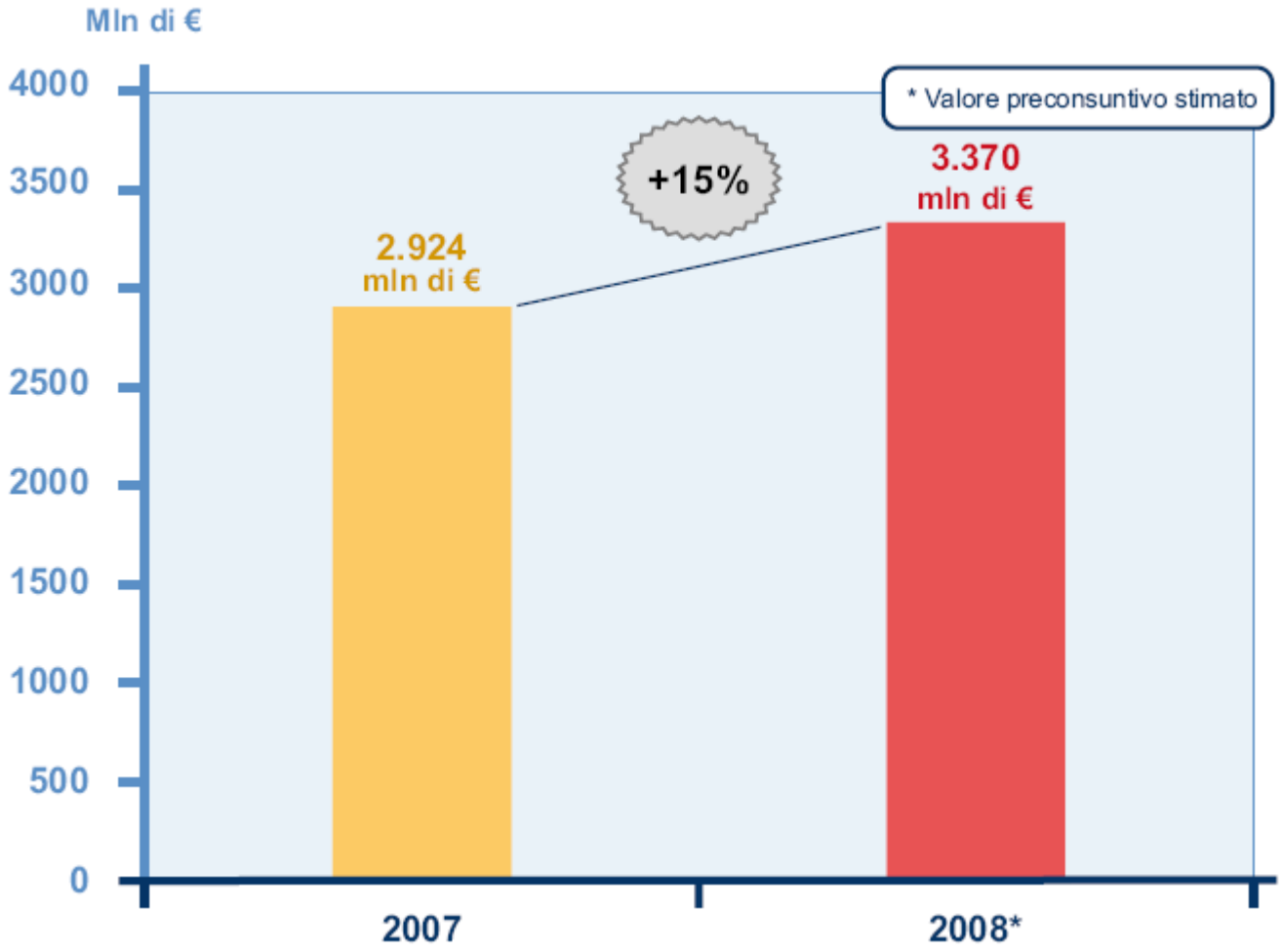
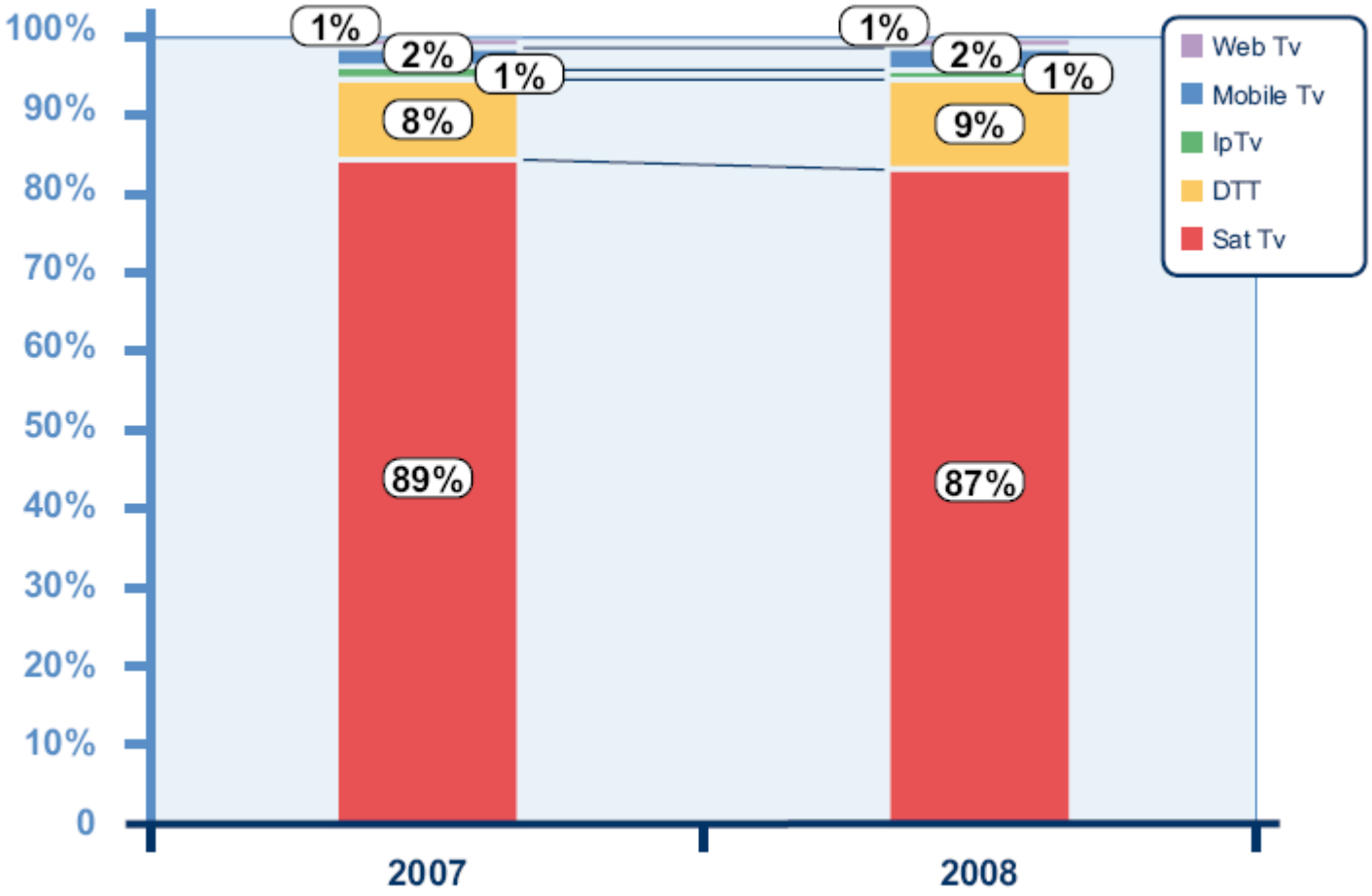
The Italian market: value

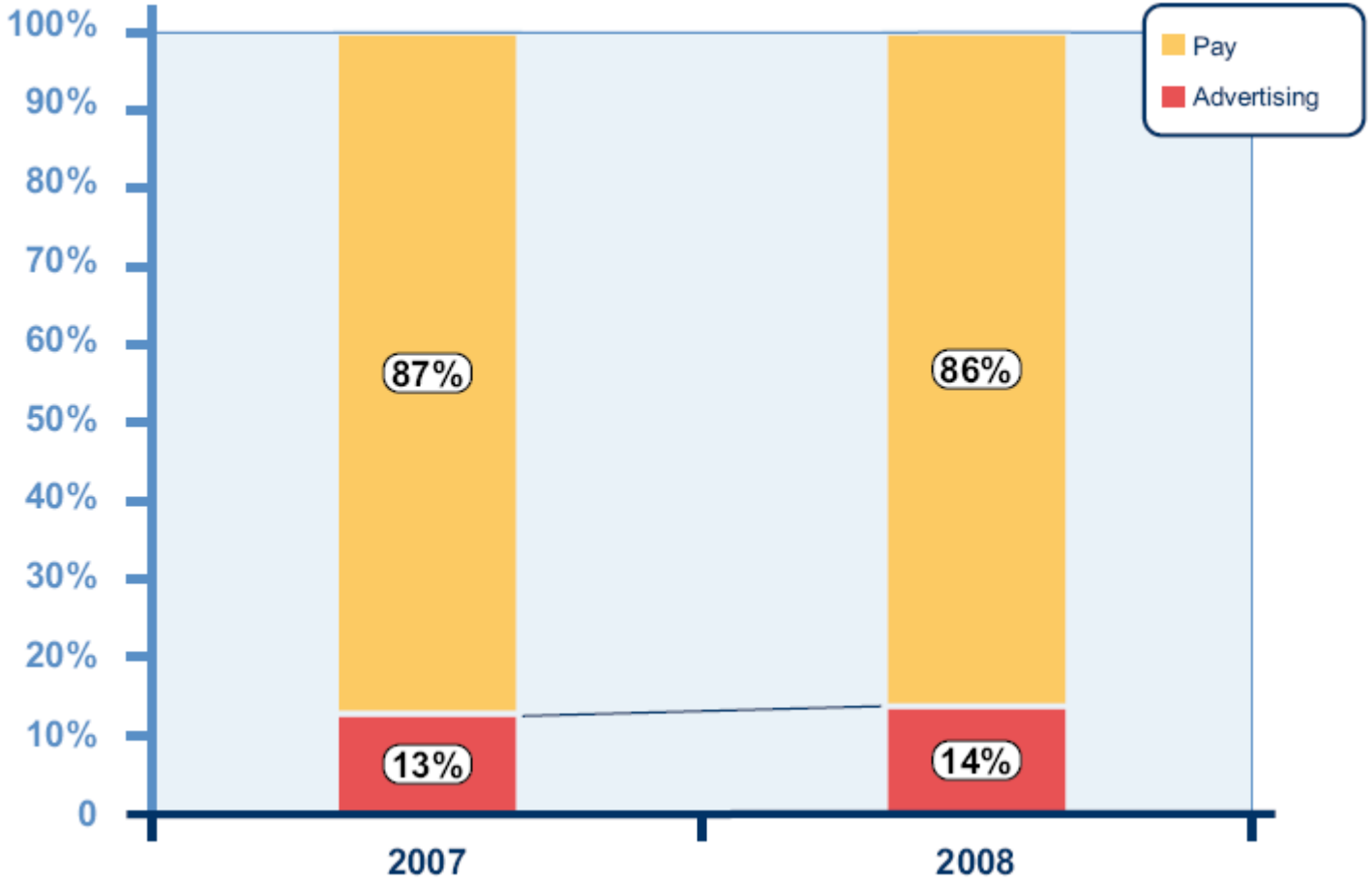
Digital TV market



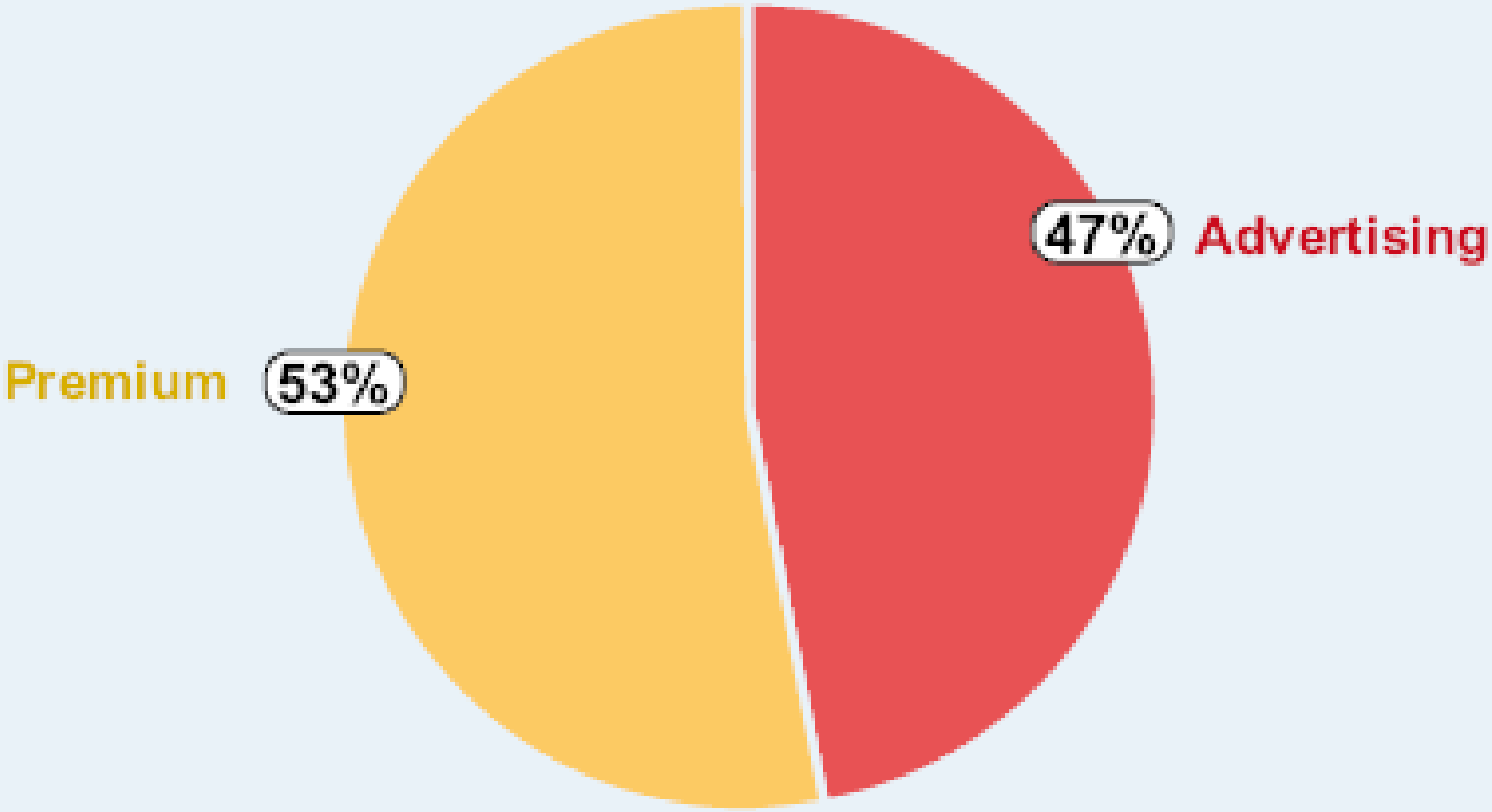
Digital TV market: different platforms



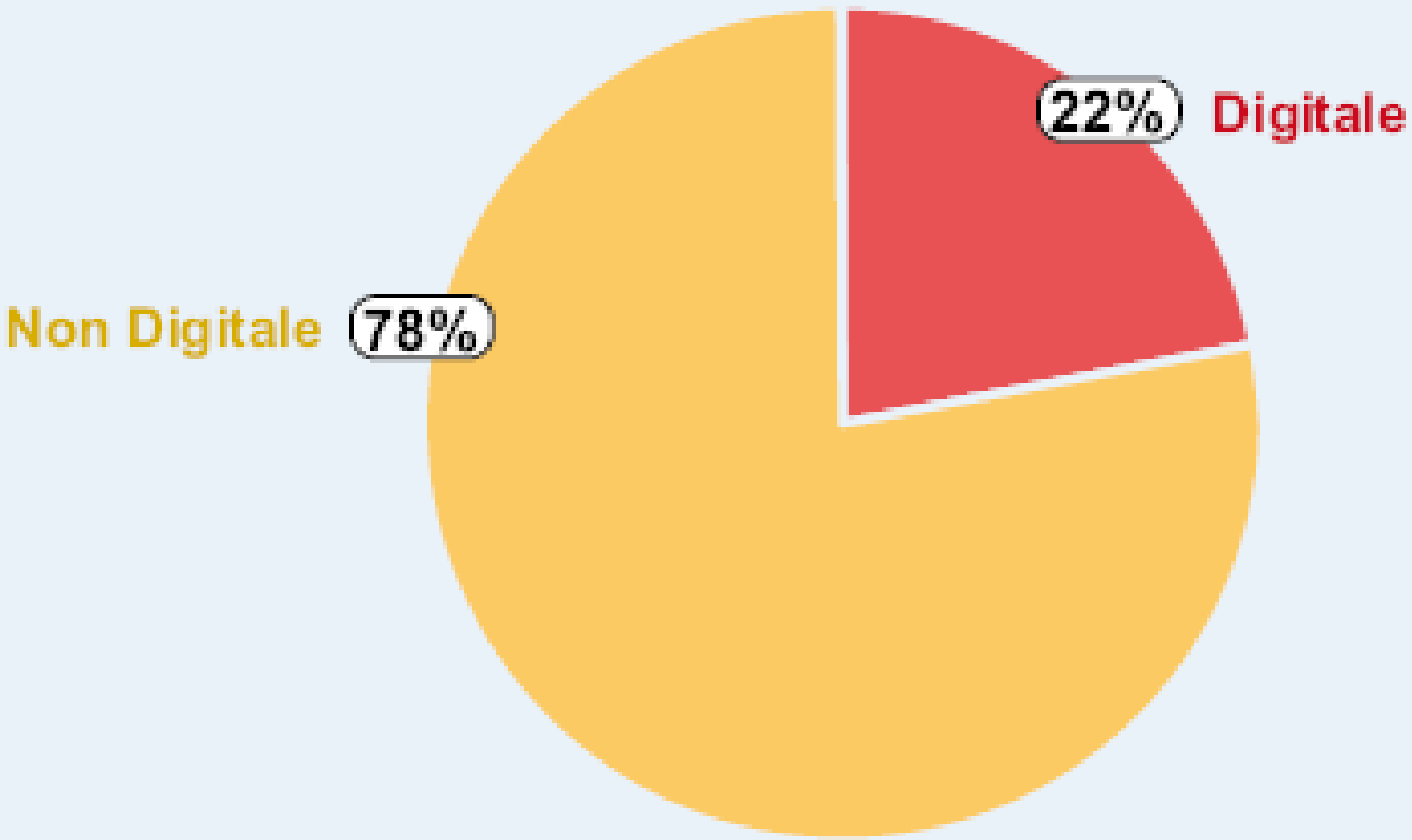
Digital TV market: Advertising vs. Pay



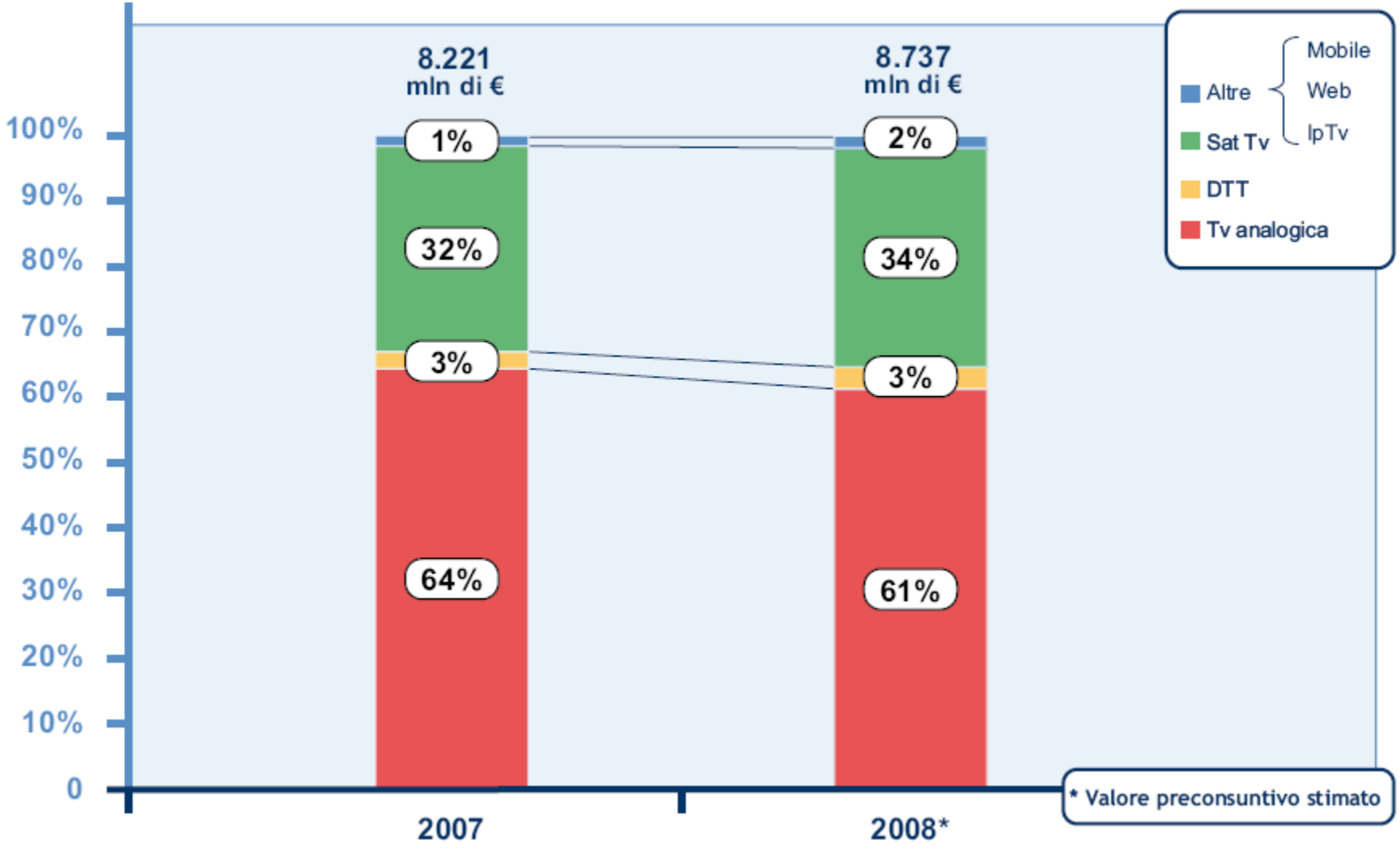
Analog+Digital TV market: Advertising vs. Pay



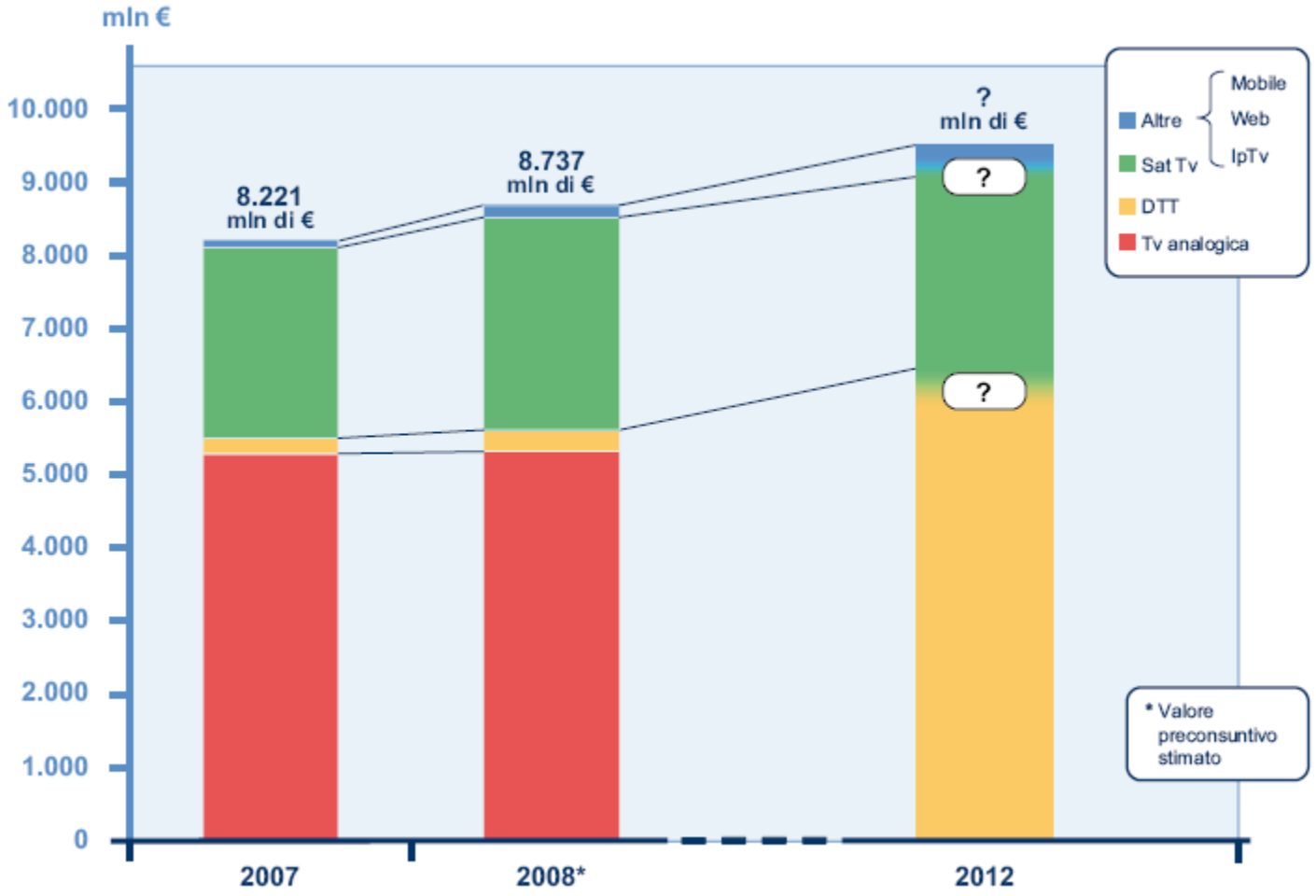
Analog+Digital TV market



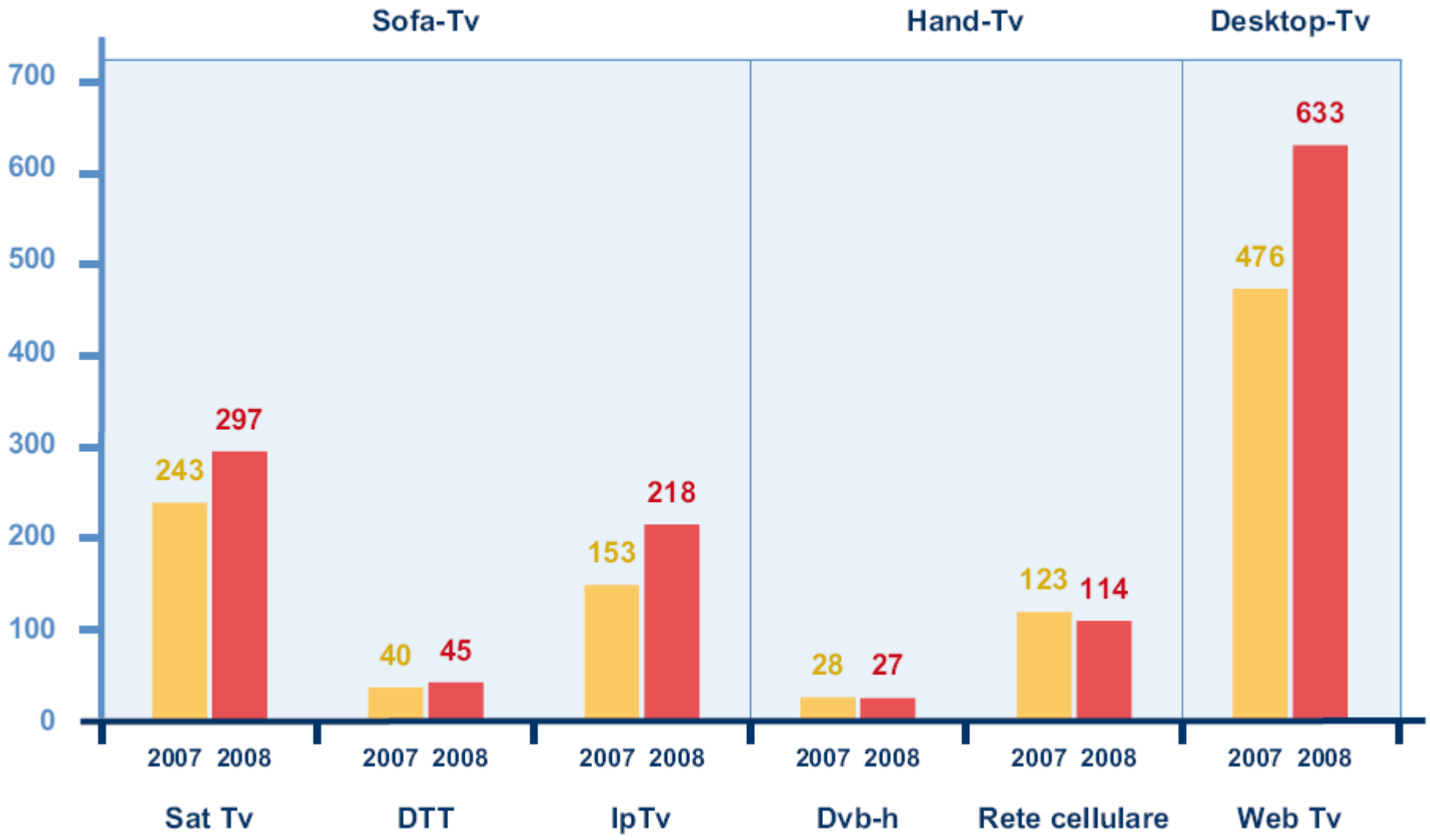
Digital TV market: Analog vs. Digital



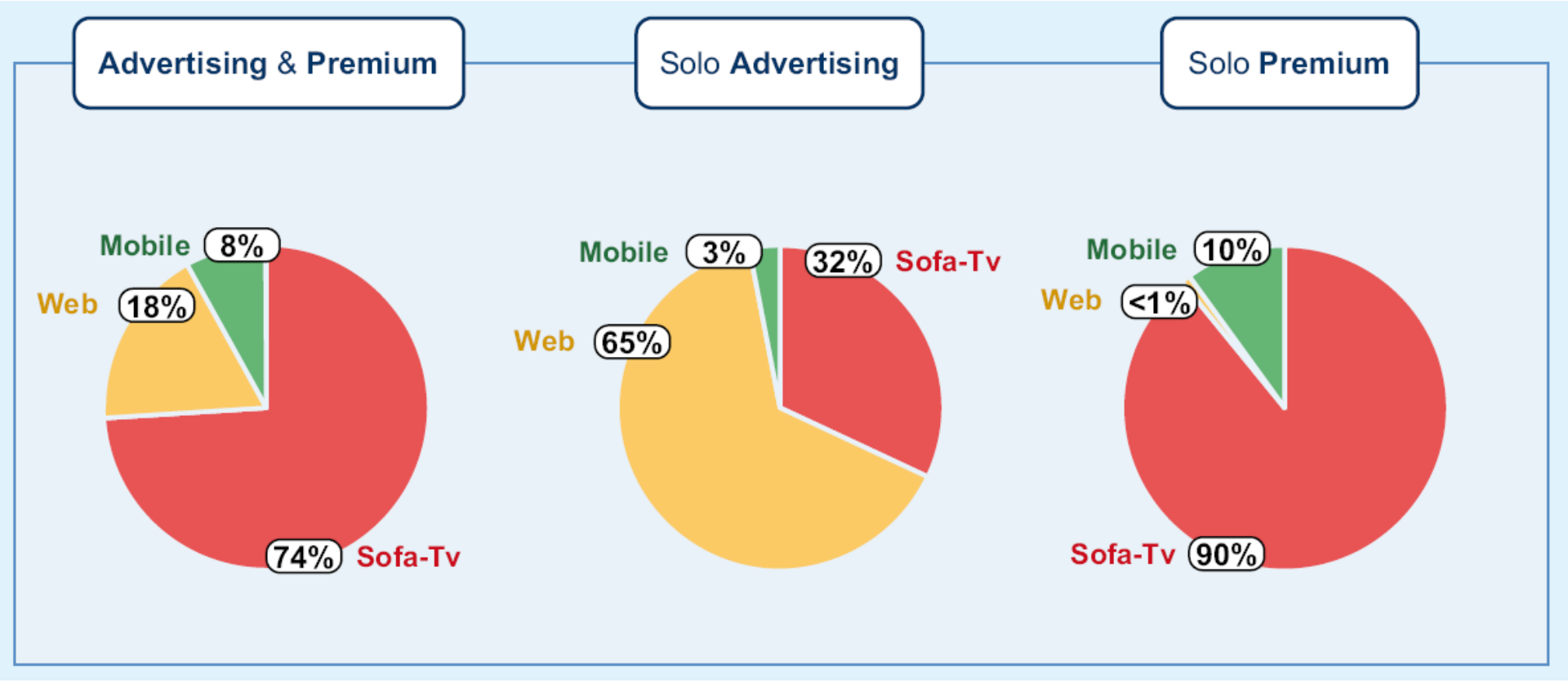
Digital TV market: the future



Digital TV market: different platforms



Digital TV market: different platforms



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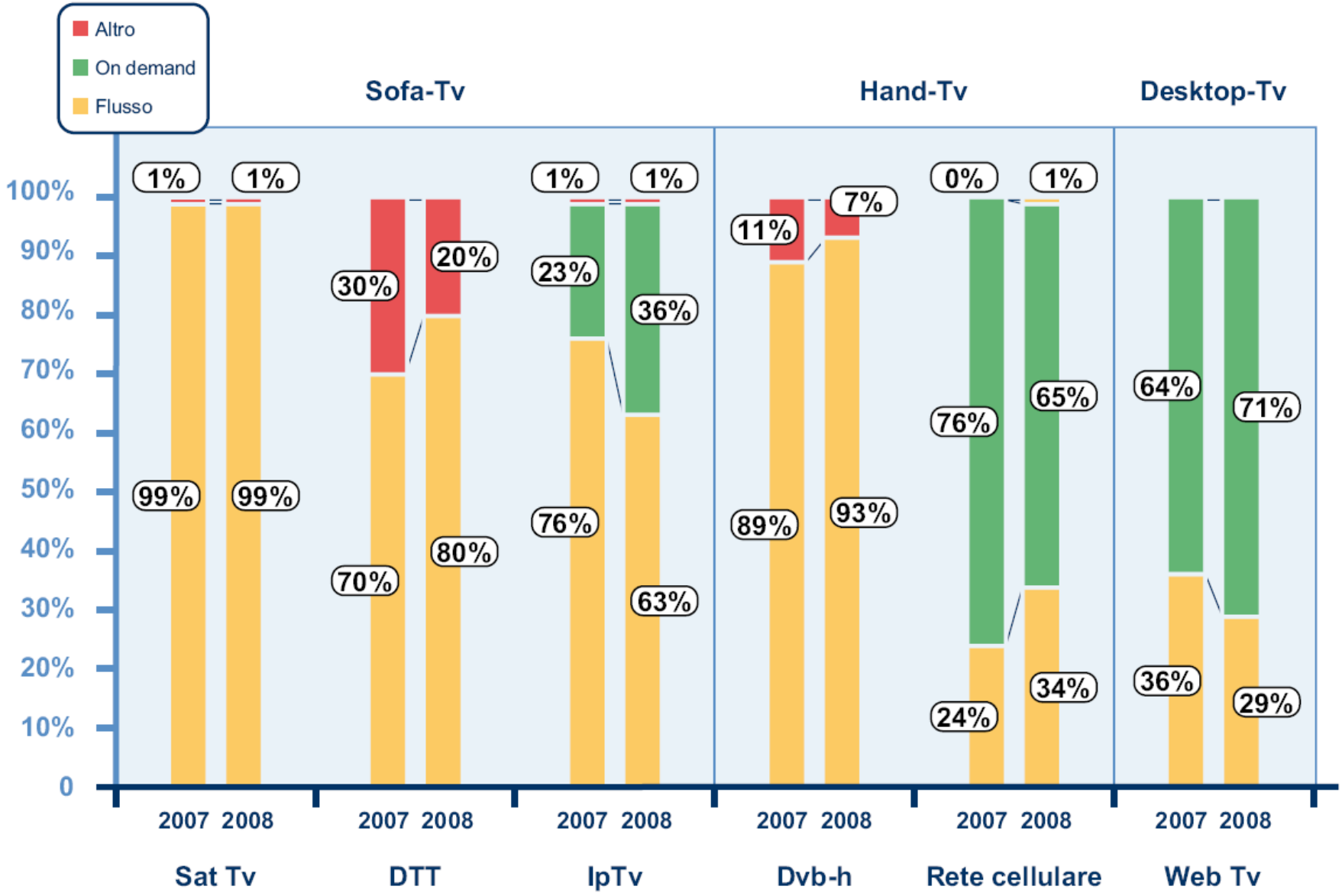
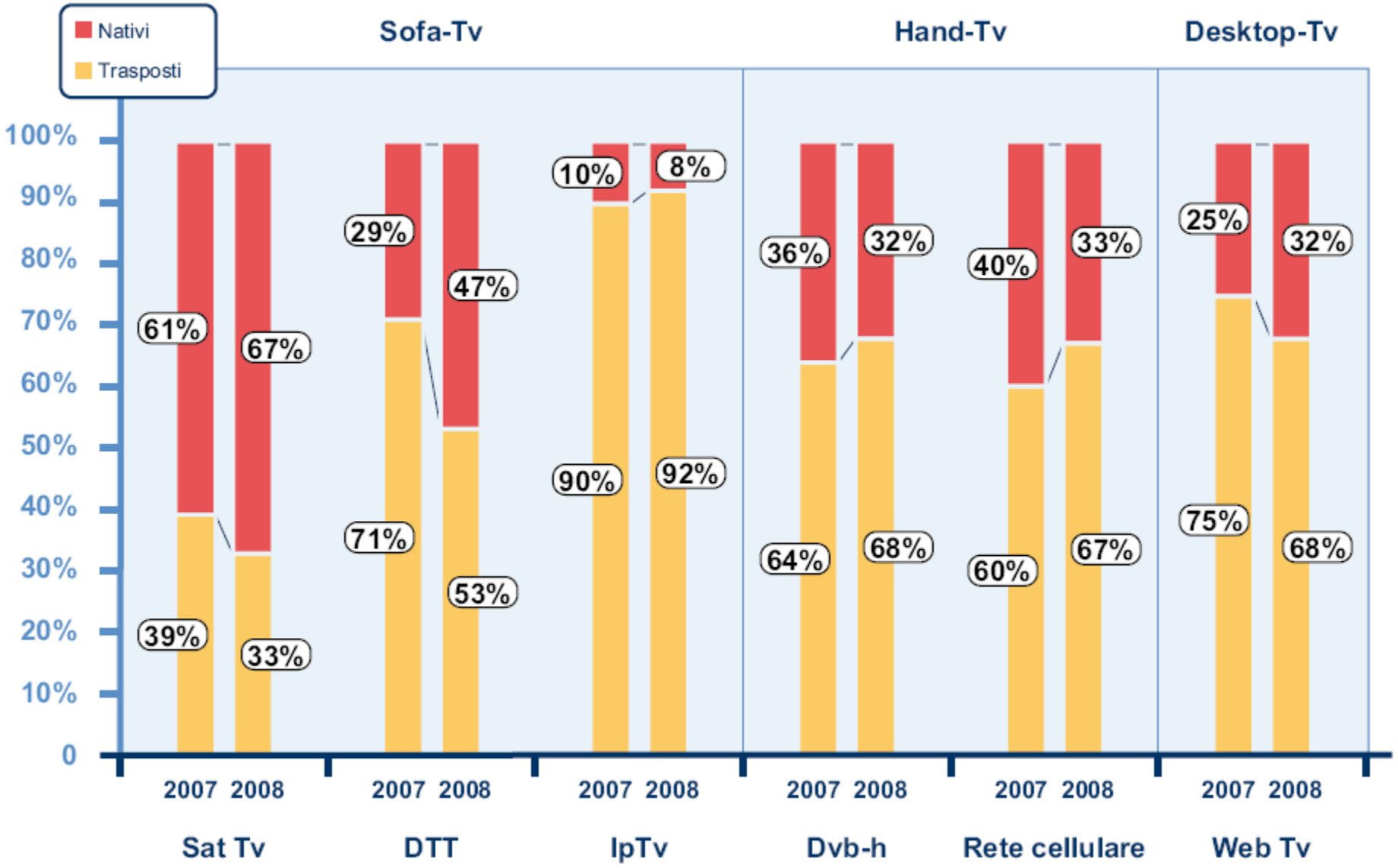
The Italian market: channels

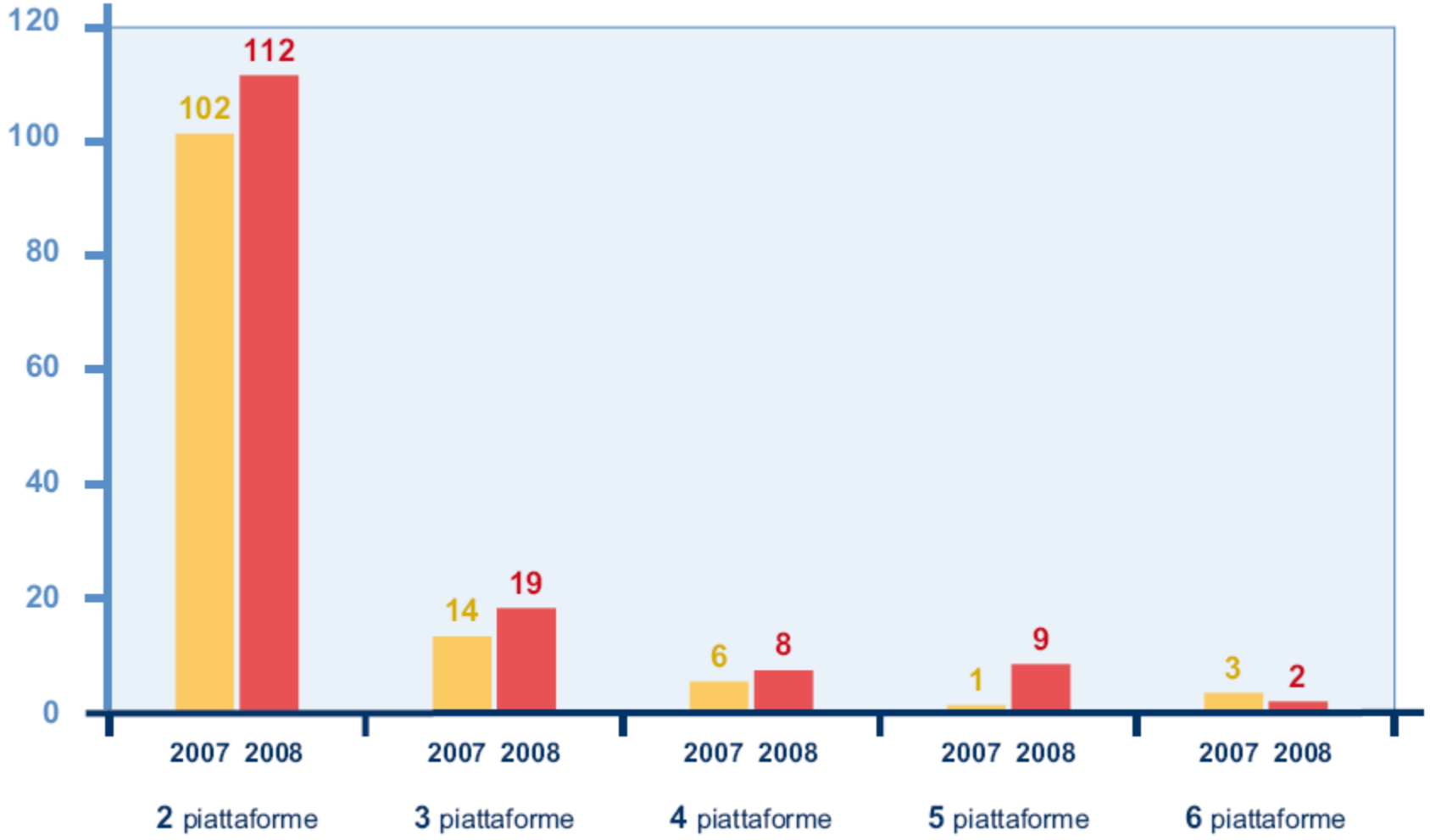
Digital TV: broadcast vs. on-demand channels



Digital TV broadcast: direct vs. indirect channels



Digital TV broadcast: platforms per channel



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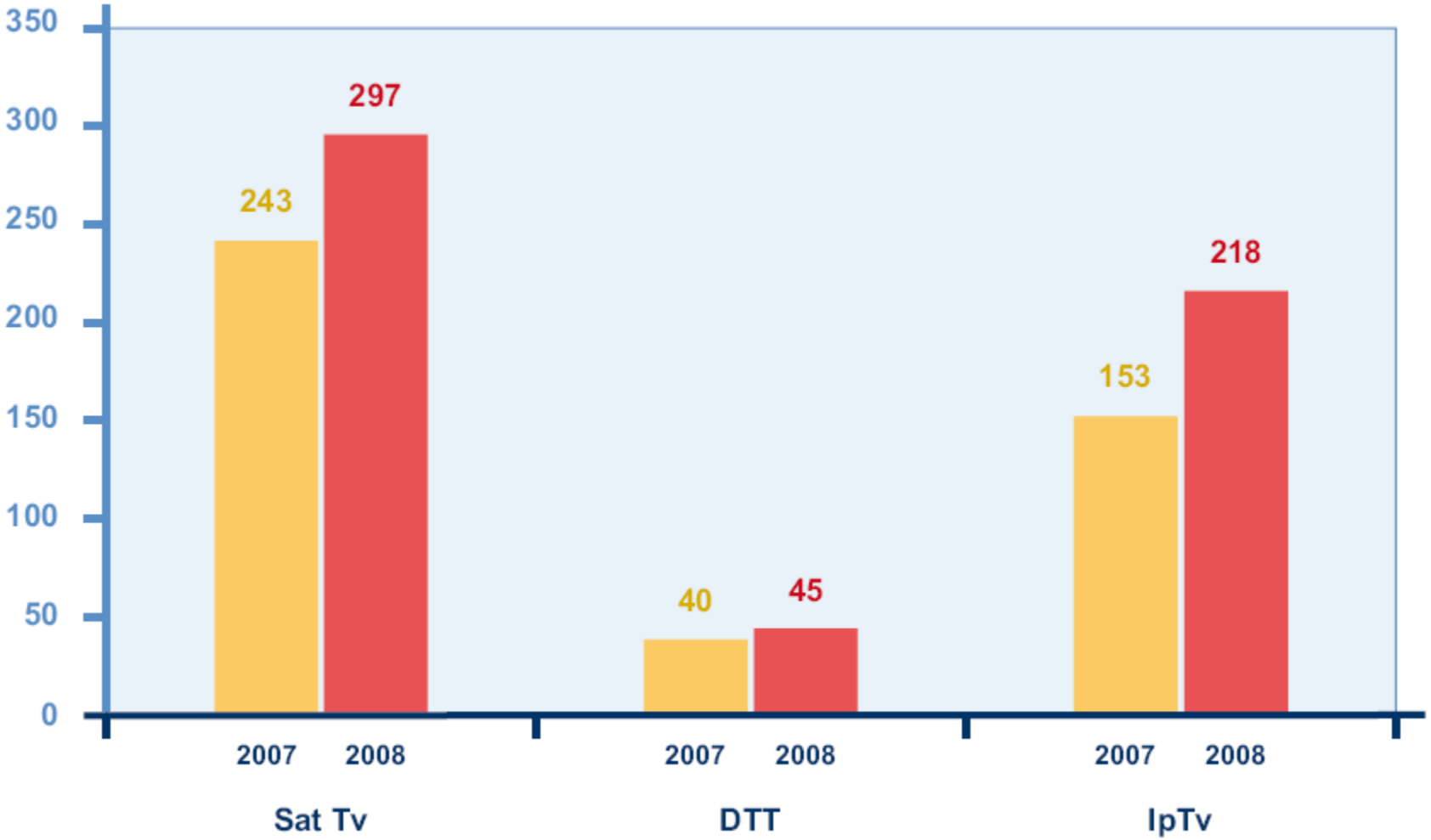
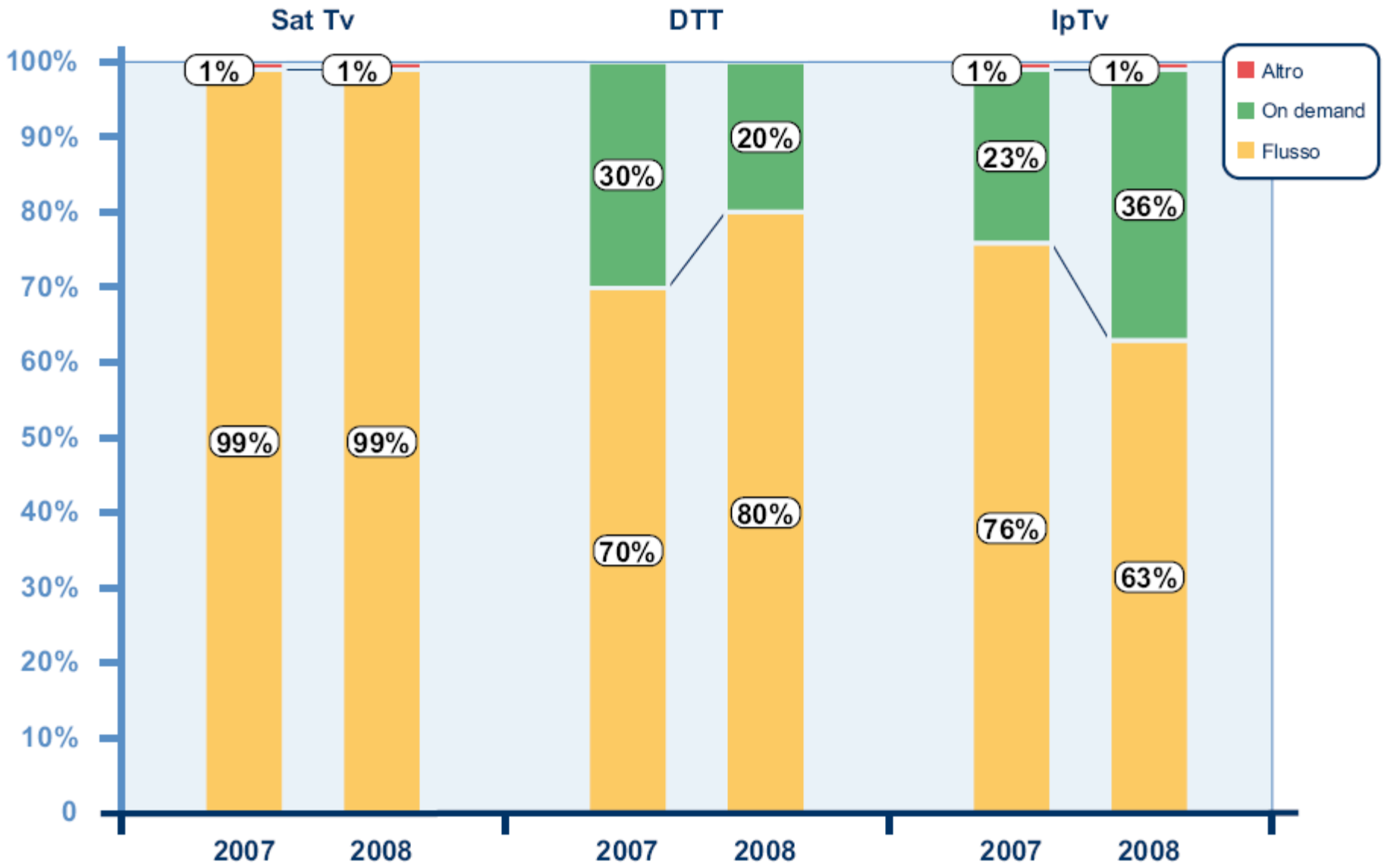
Sofa TV:
Satellite, Digital TV, IPTV

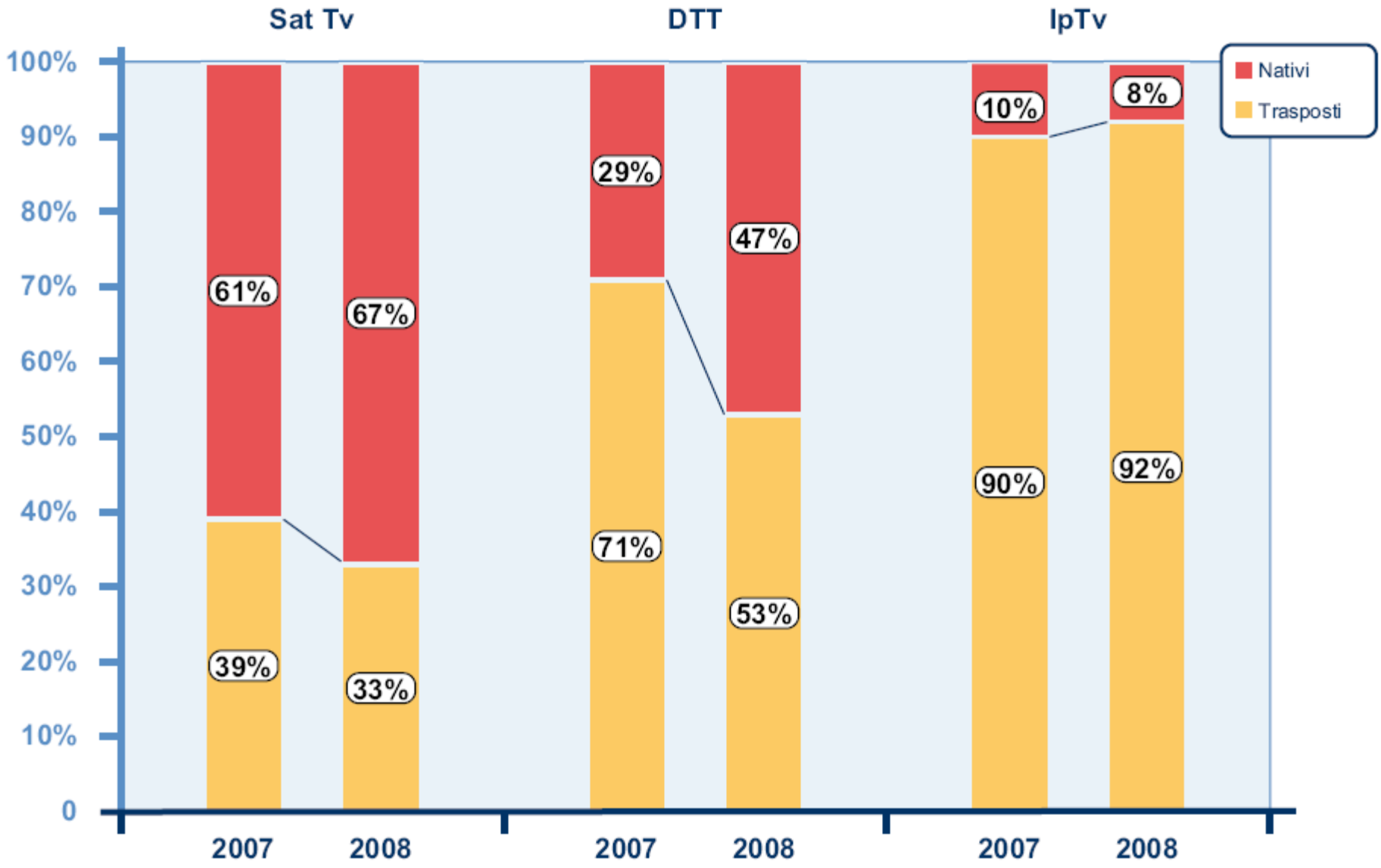
Sofa TV: number of channels



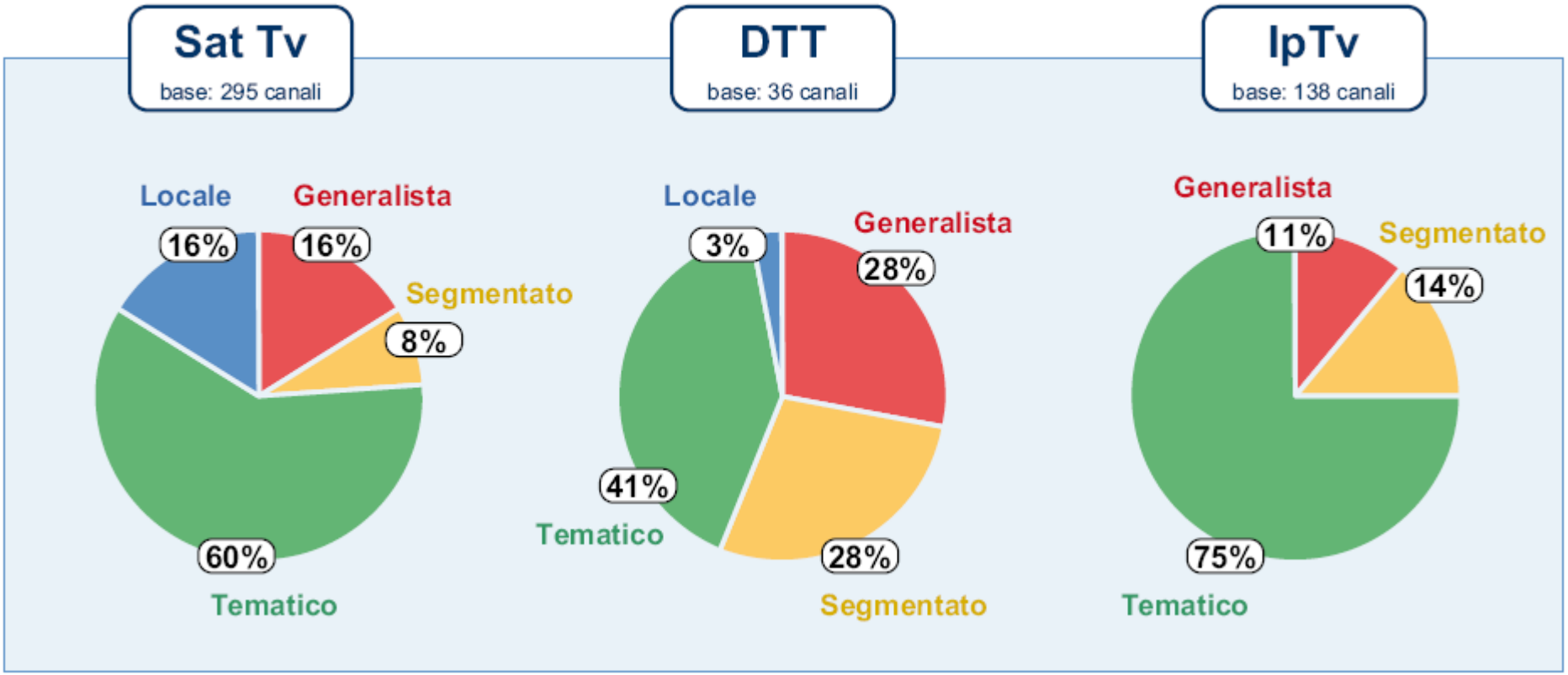
Sofa TV: broadcast vs. on-demand channels



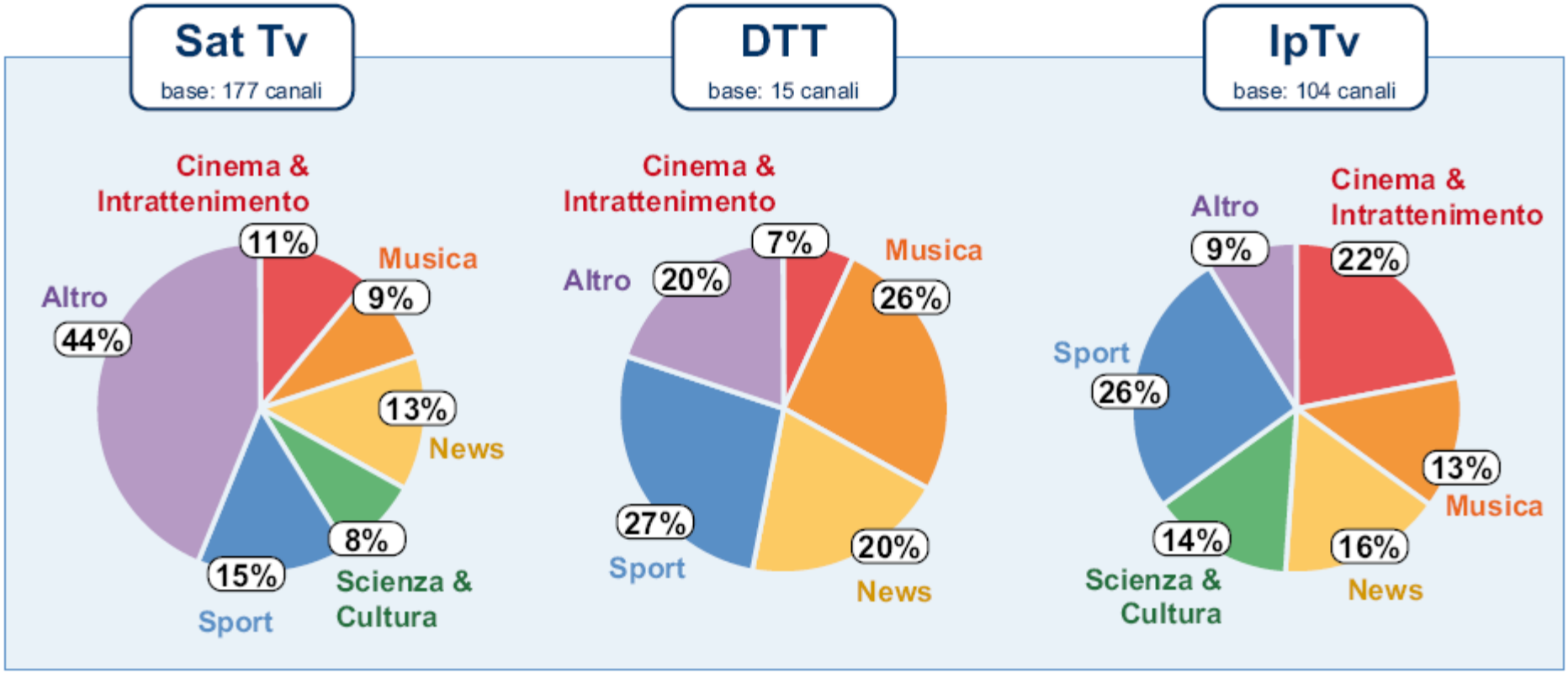
Sofa TV broadcast channels: direct vs. indirect



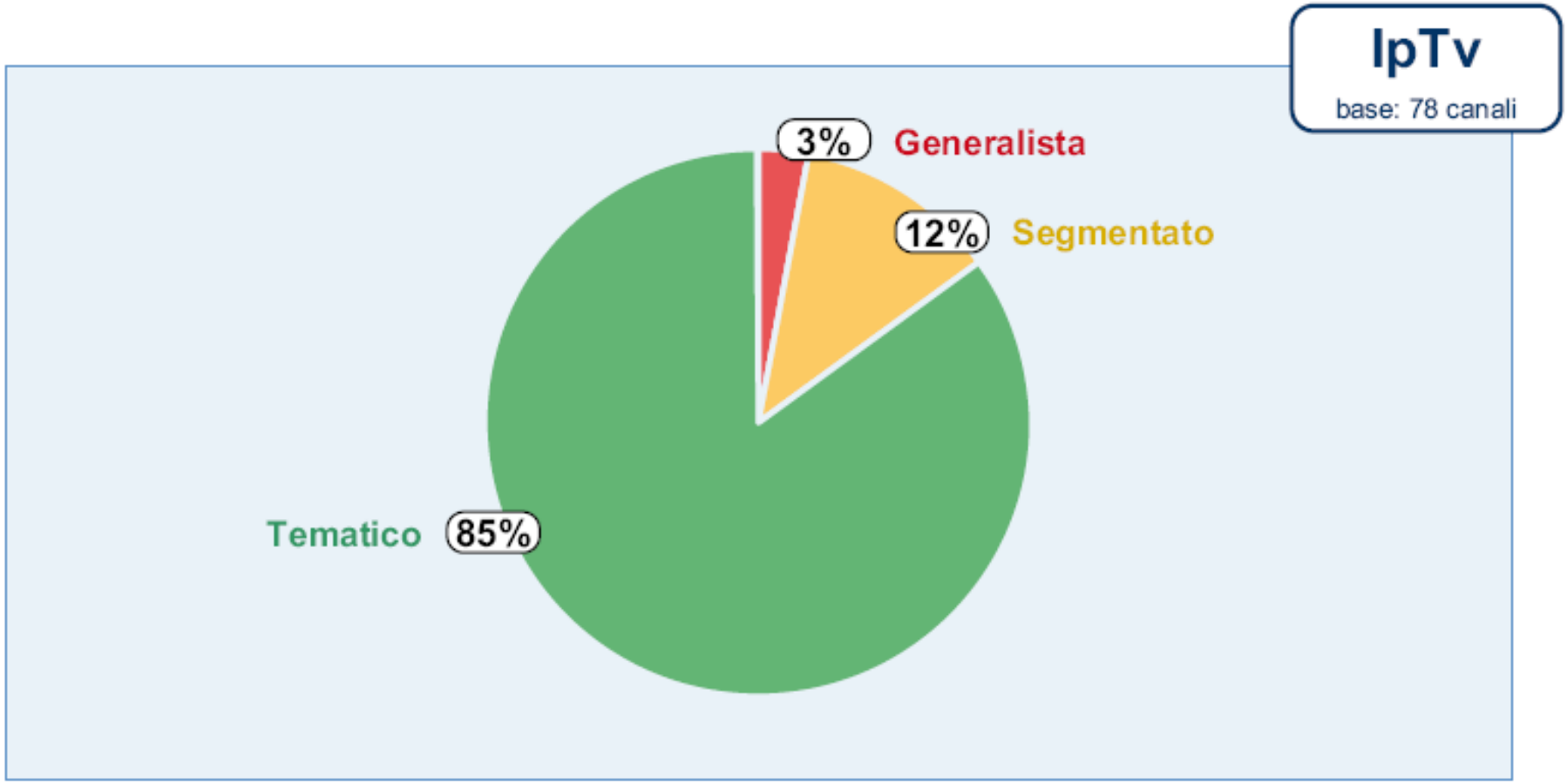
Sofa TV: broadcast channels



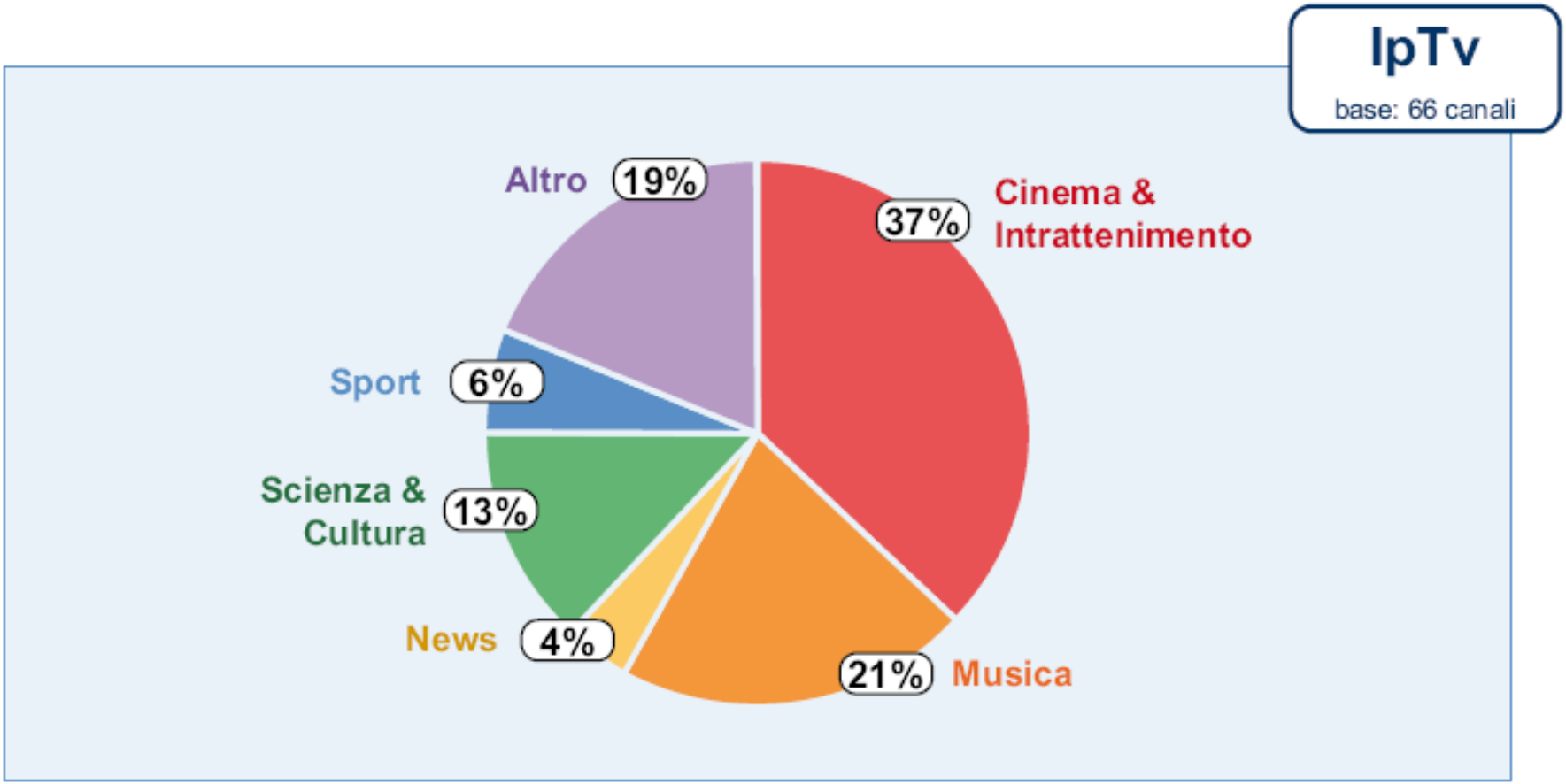
Sofa TV: broadcast thematic channels



Sofa TV: on-demand channels



Sofa TV: on-demand thematic channels



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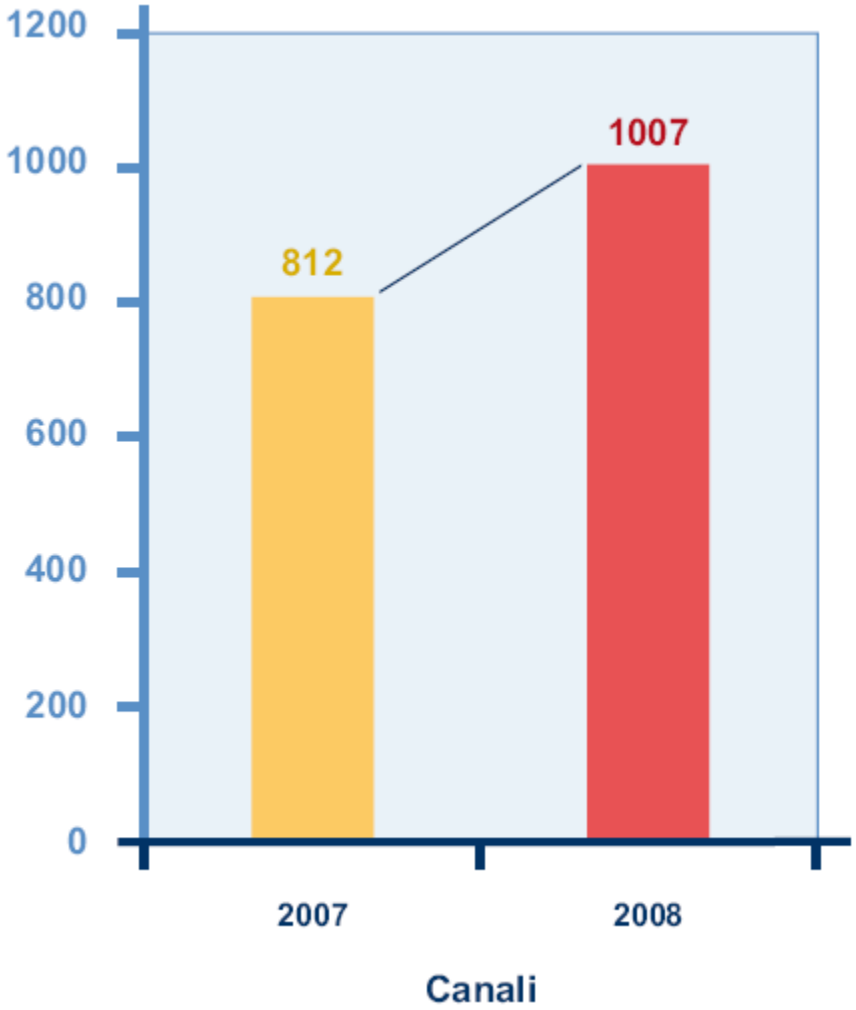
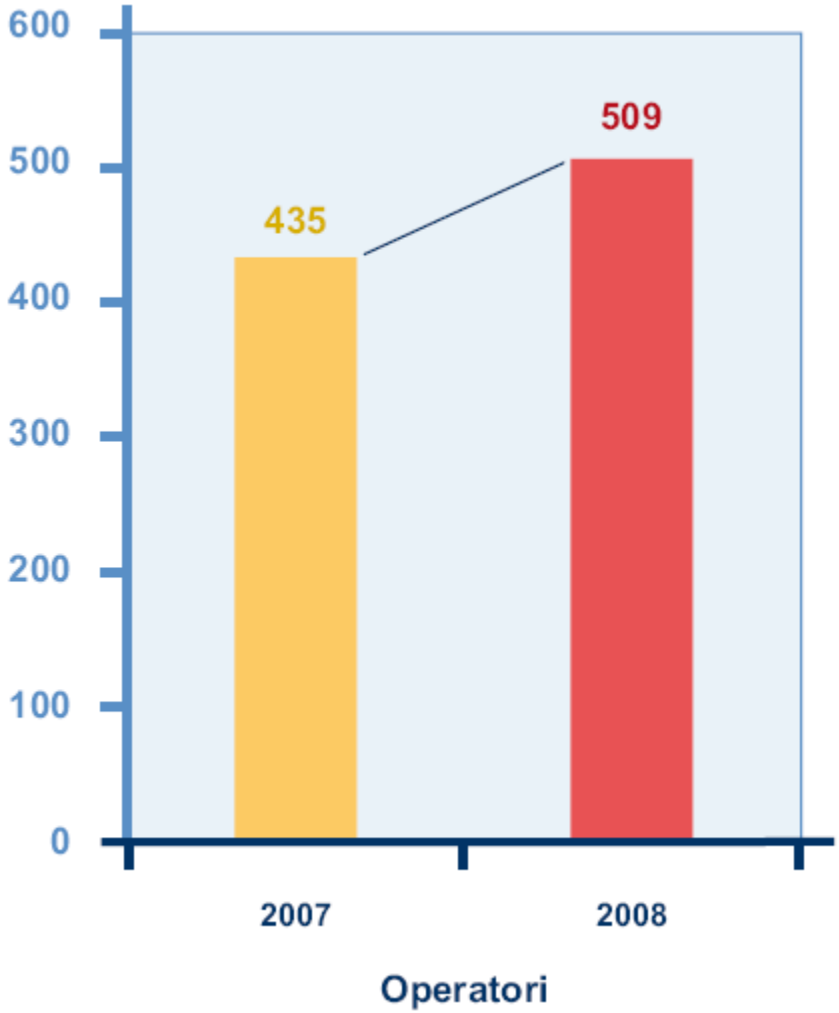
Desktop TV: Web TV

Desktop TV: overview

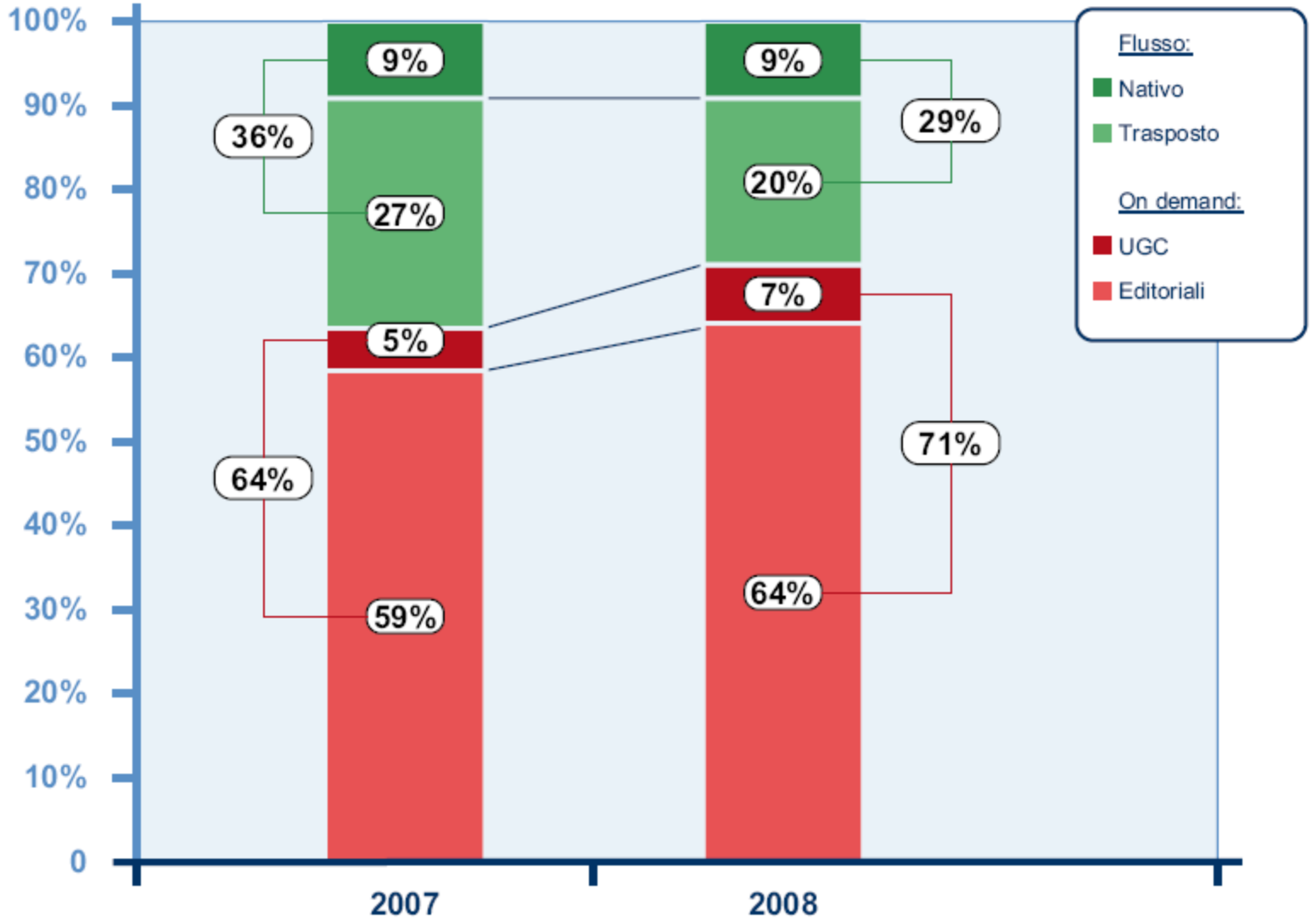


Canali

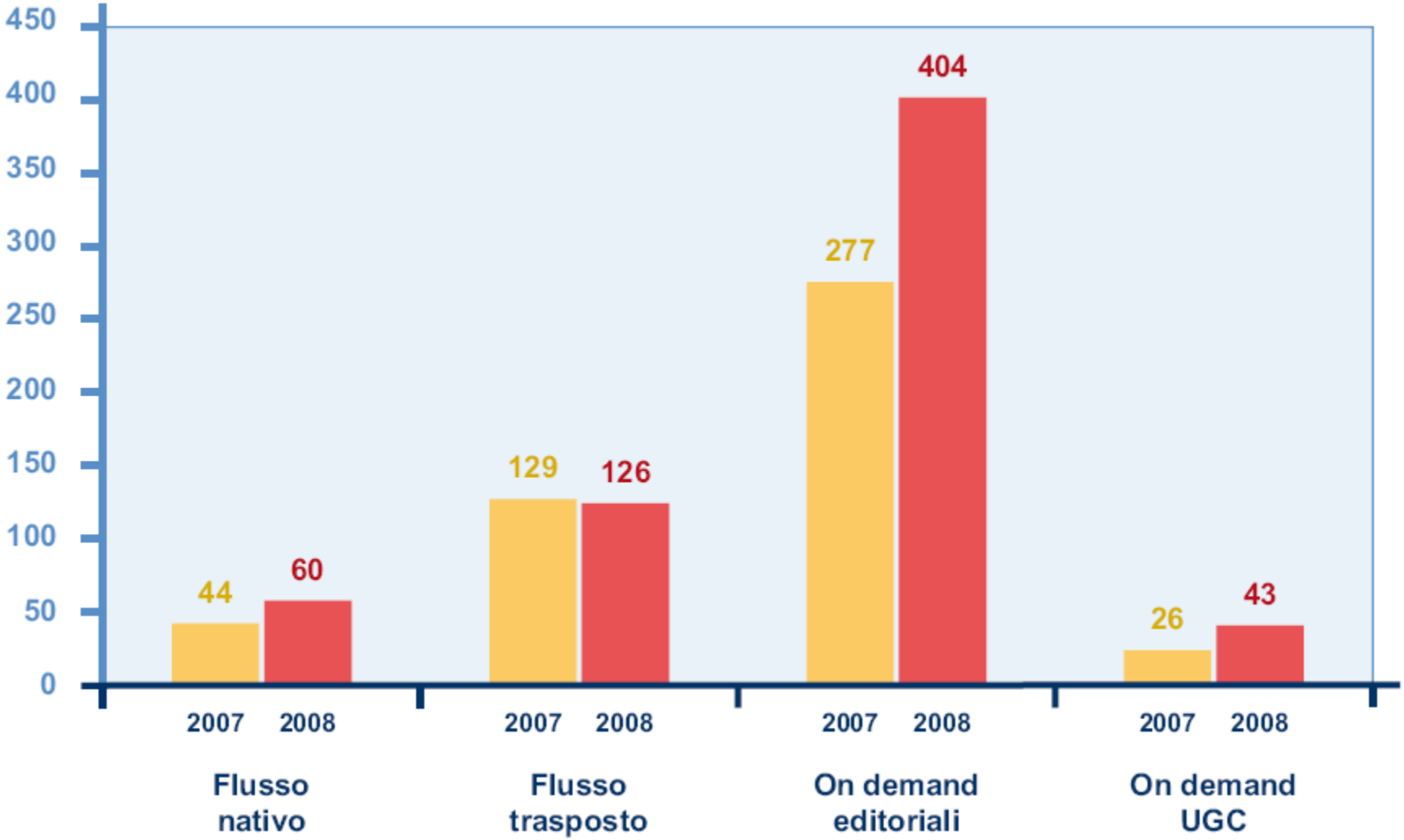


Operatori

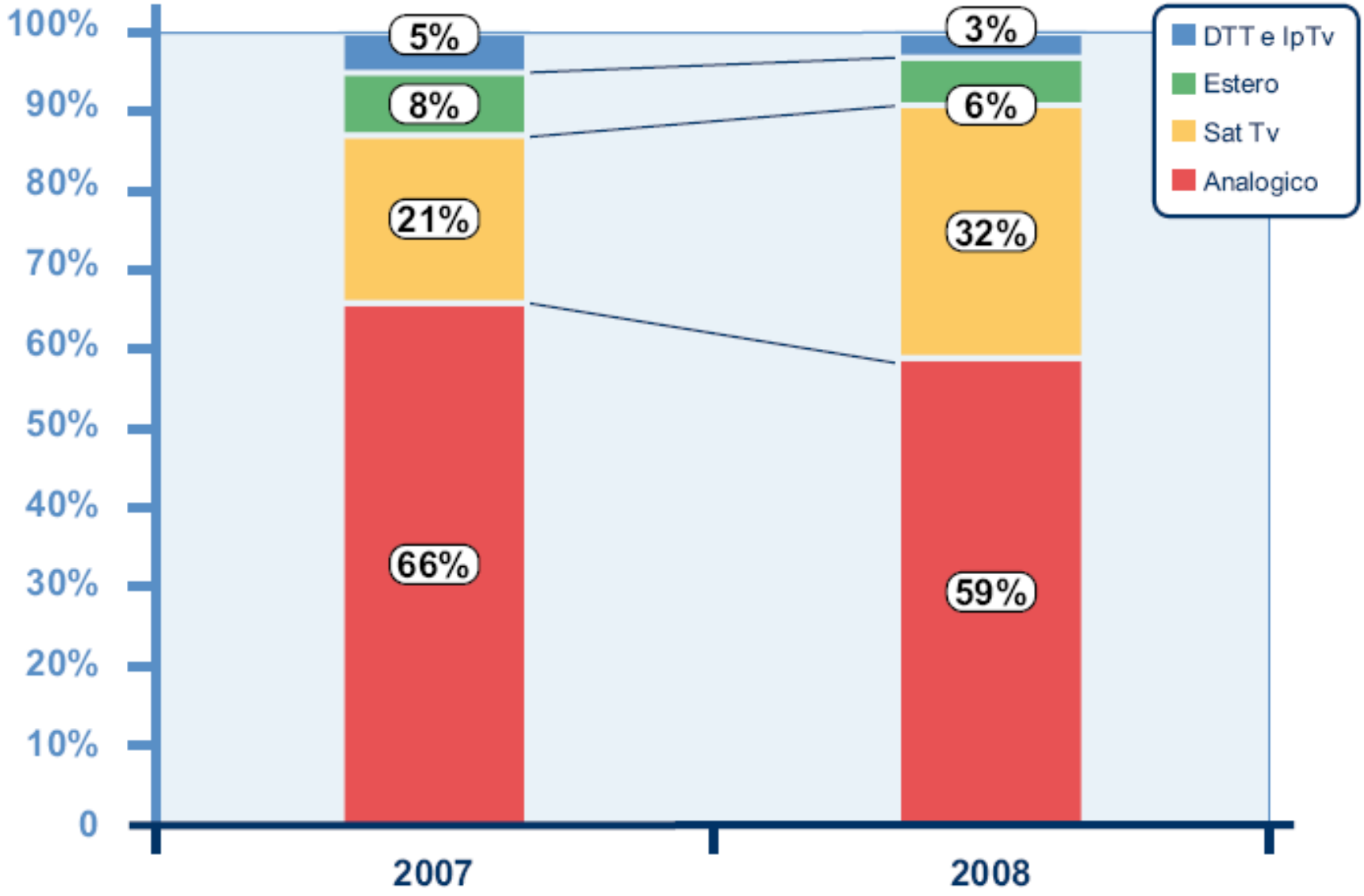
Desktop TV: broadcast vs. on-demand



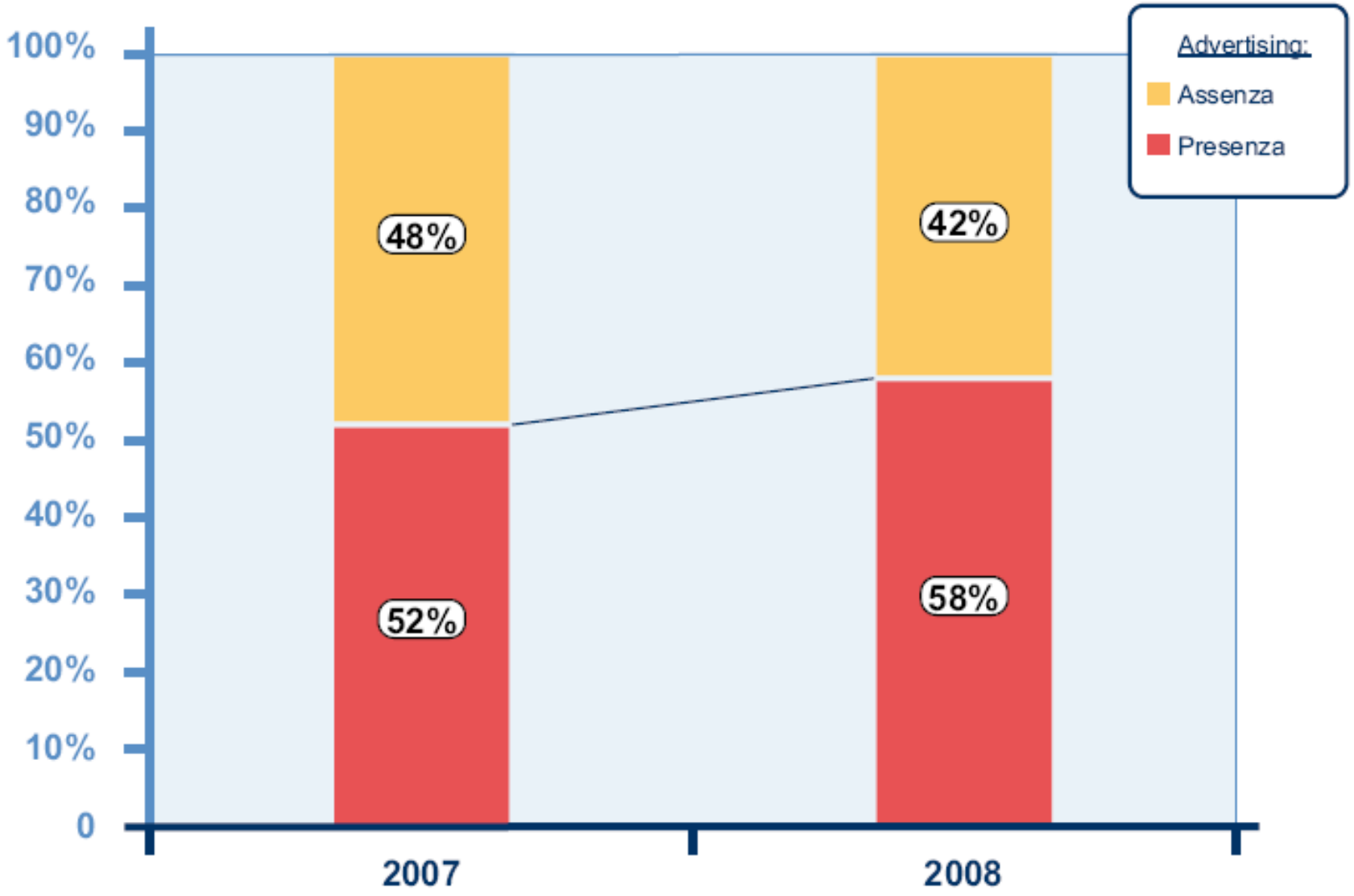
Desktop TV: content generation



Desktop TV: source of indirect channels



Desktop TV: advertising



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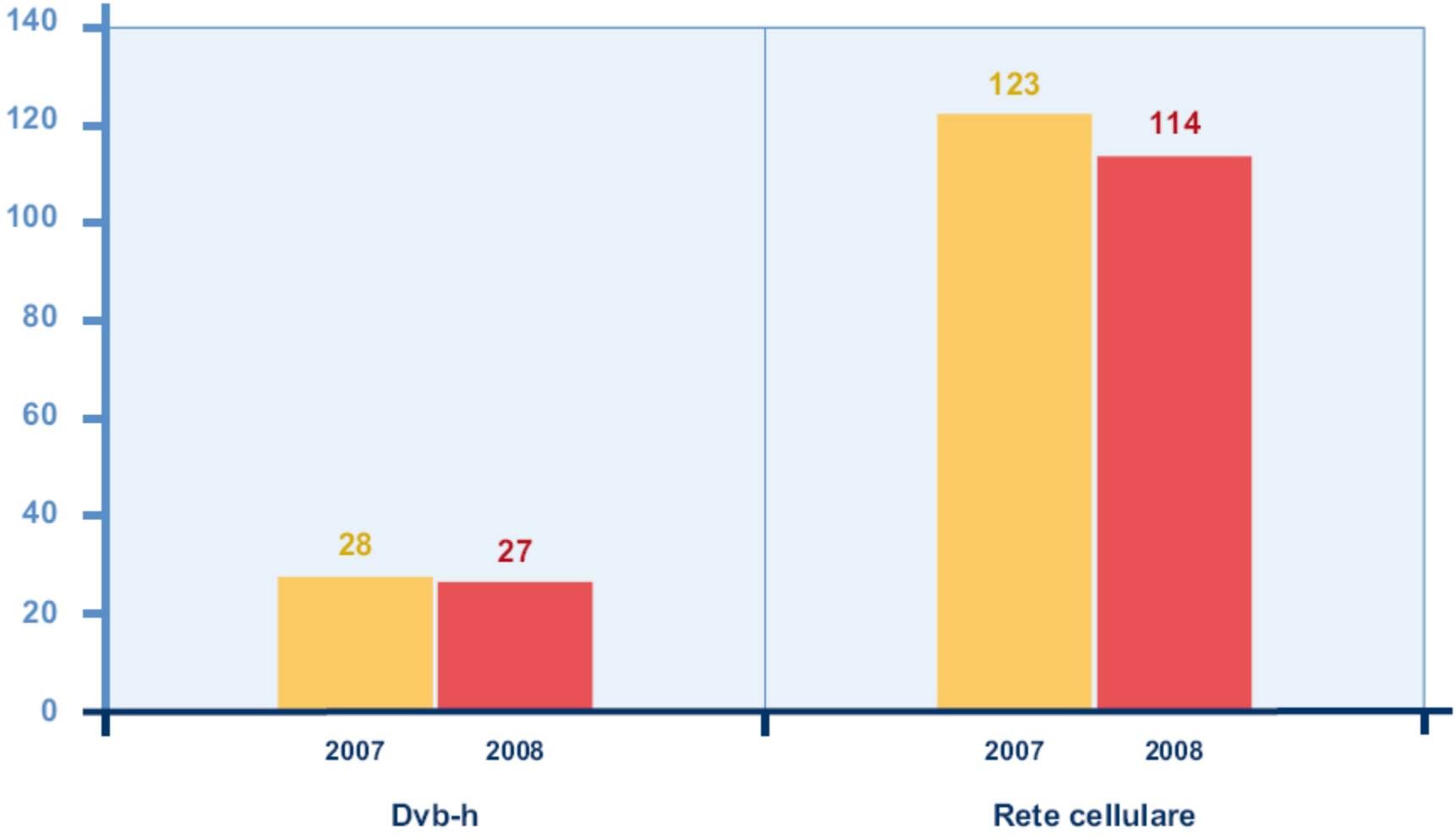
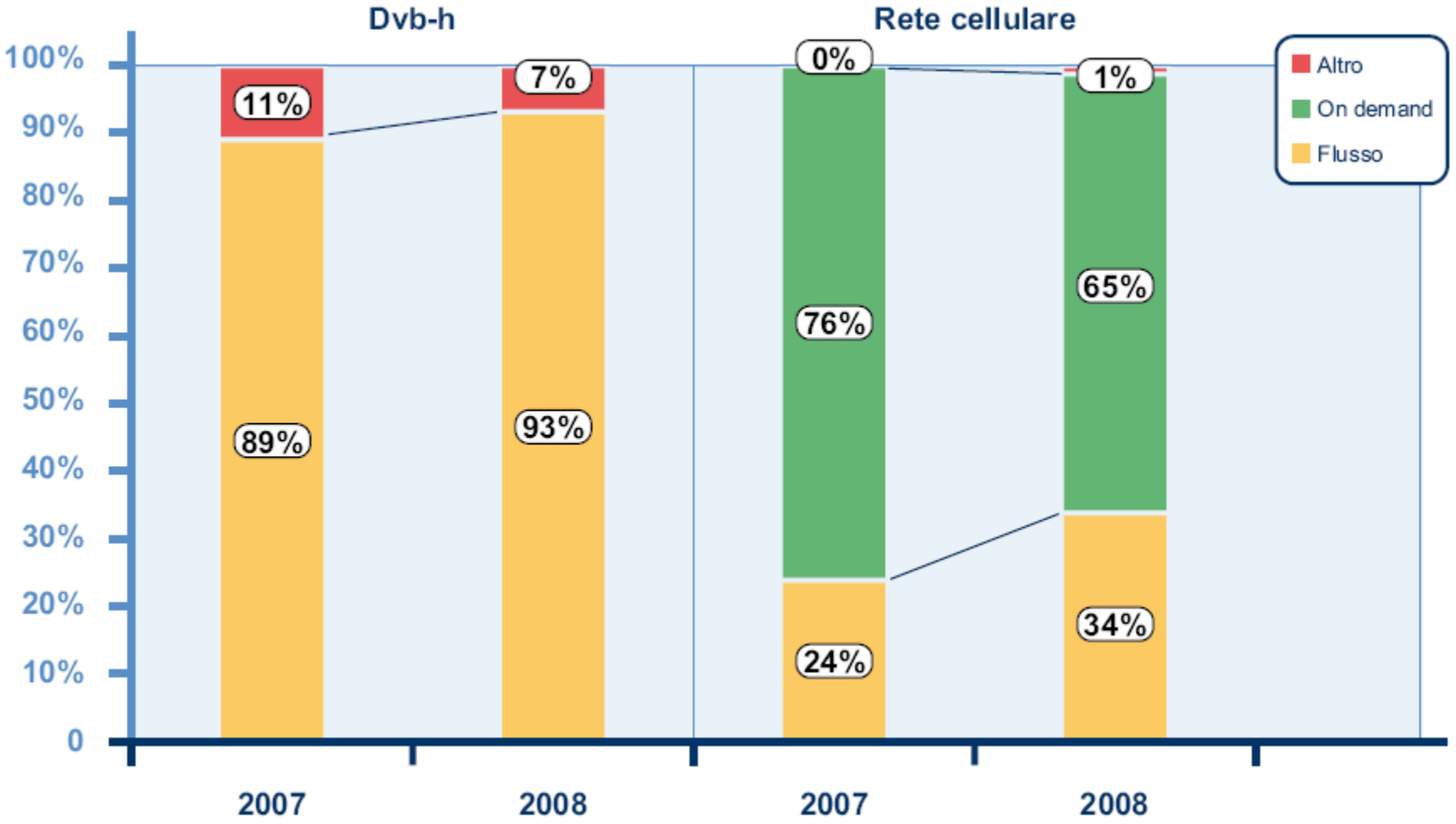
Hand TV:
DVB-H, UMTS

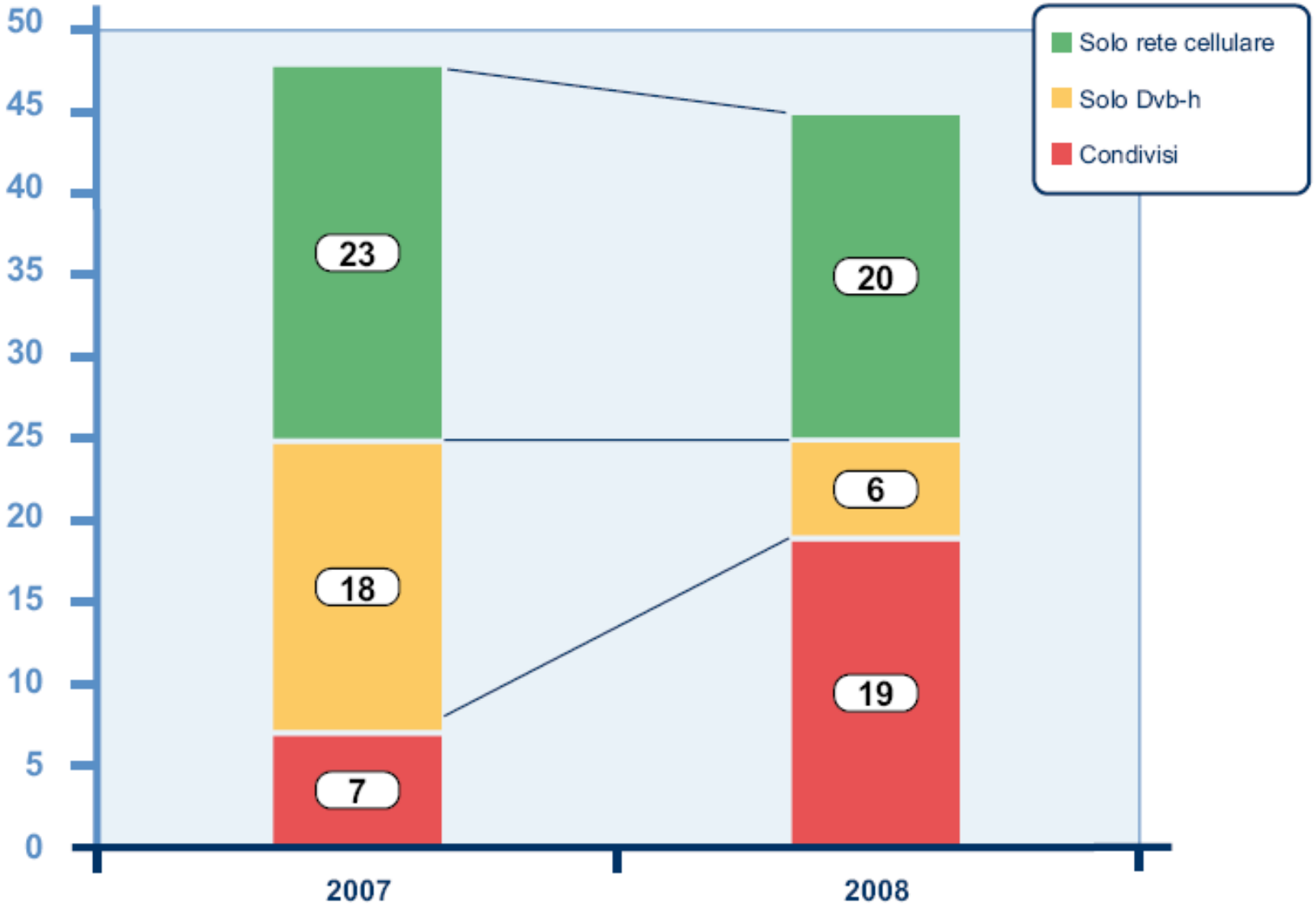
Hand TV: DVB-H vs. UMTS



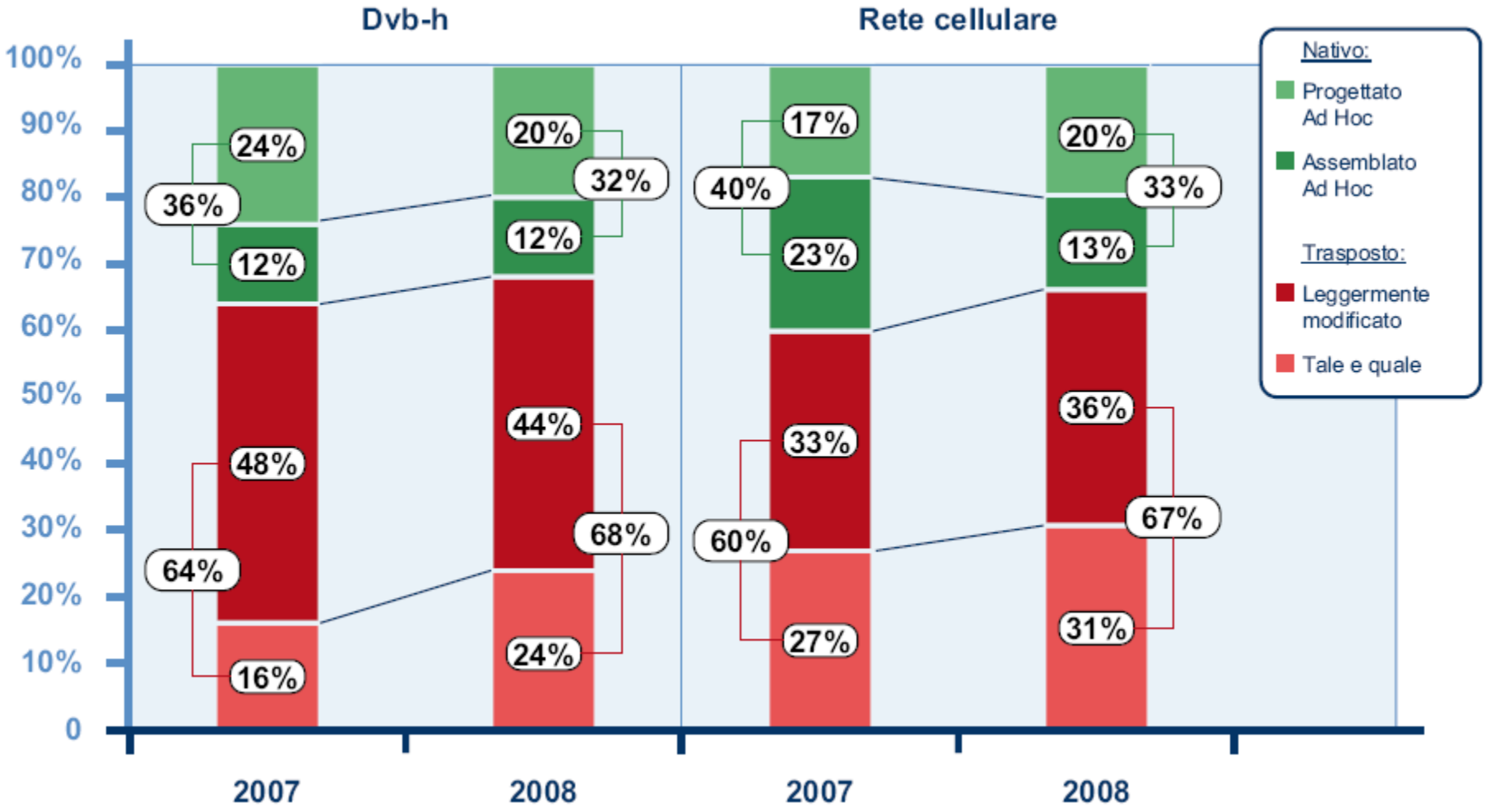
Hand TV: broadcast vs. on-demand



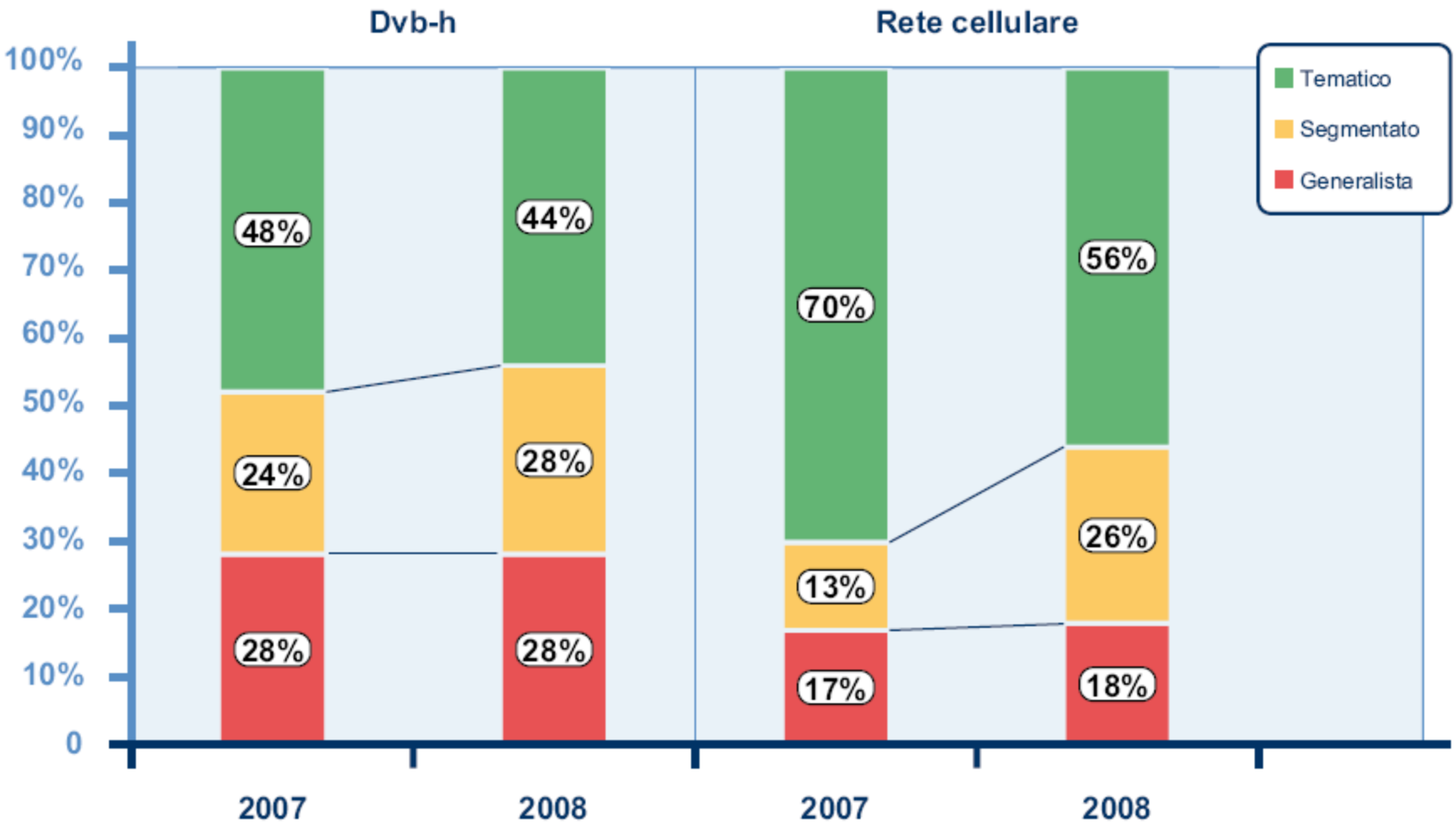
Hand TV: broadcast channels



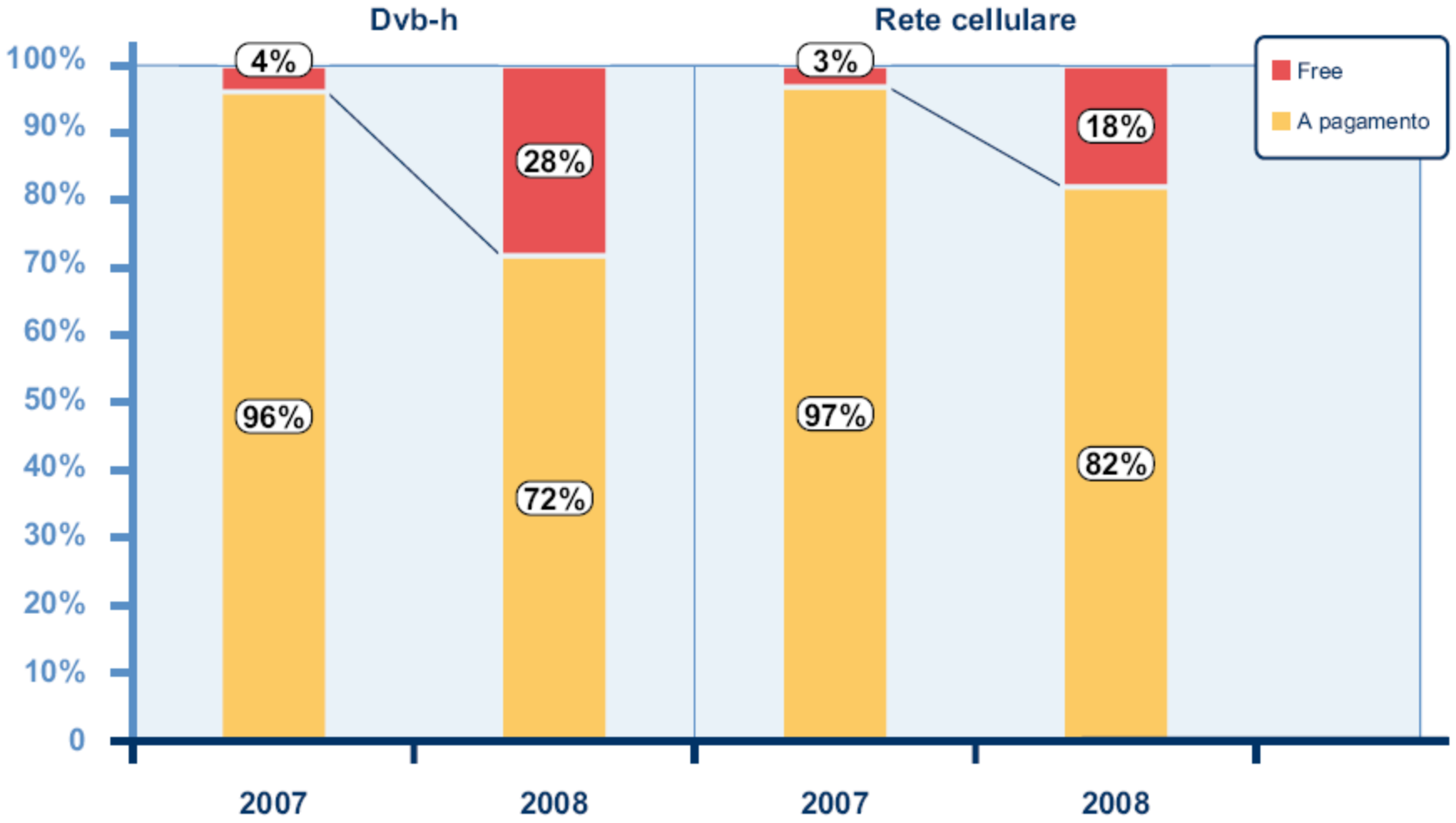
Hand TV broadcast channels: direct vs. indirect



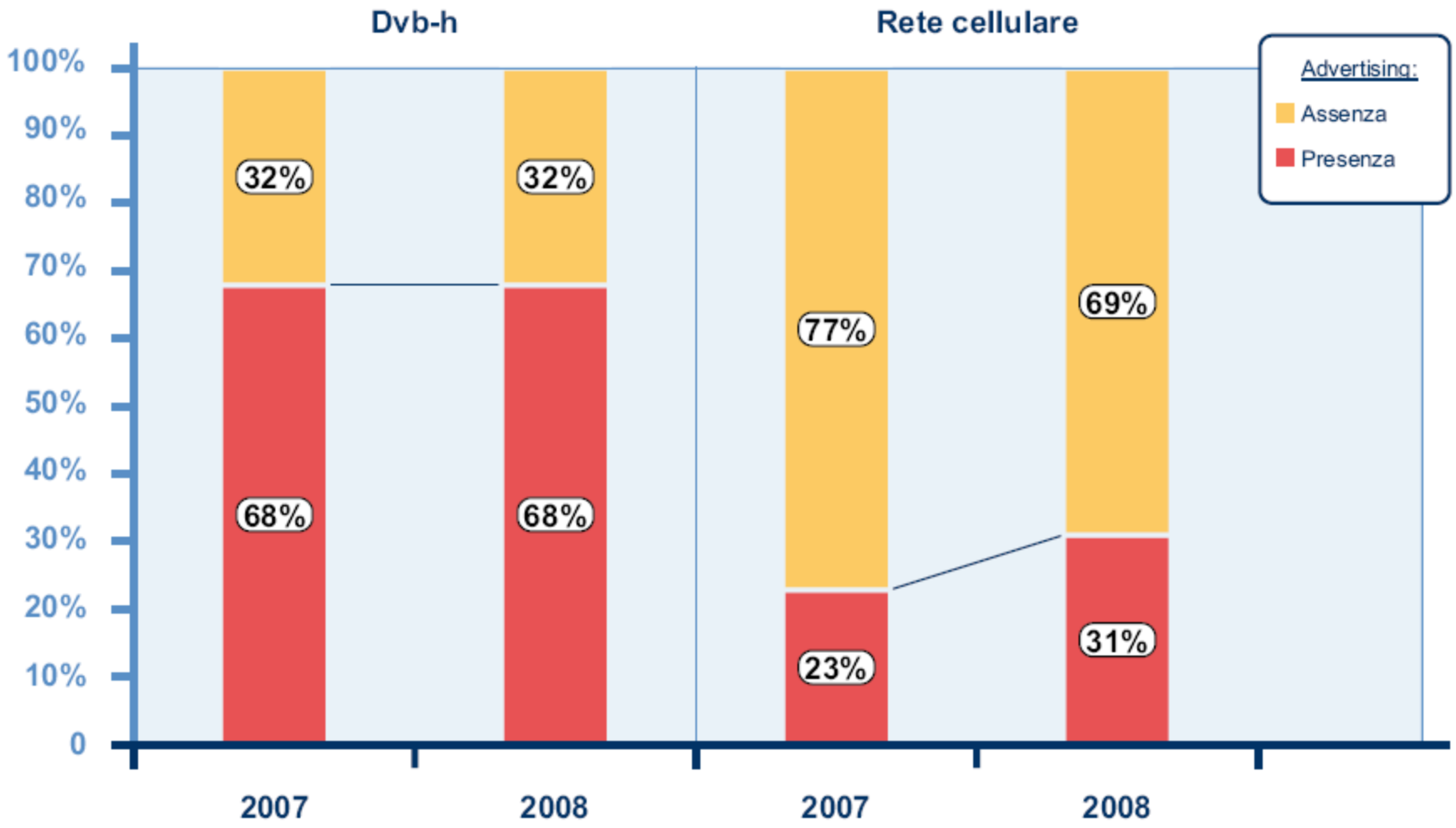
Hand TV broadcast channels: content type



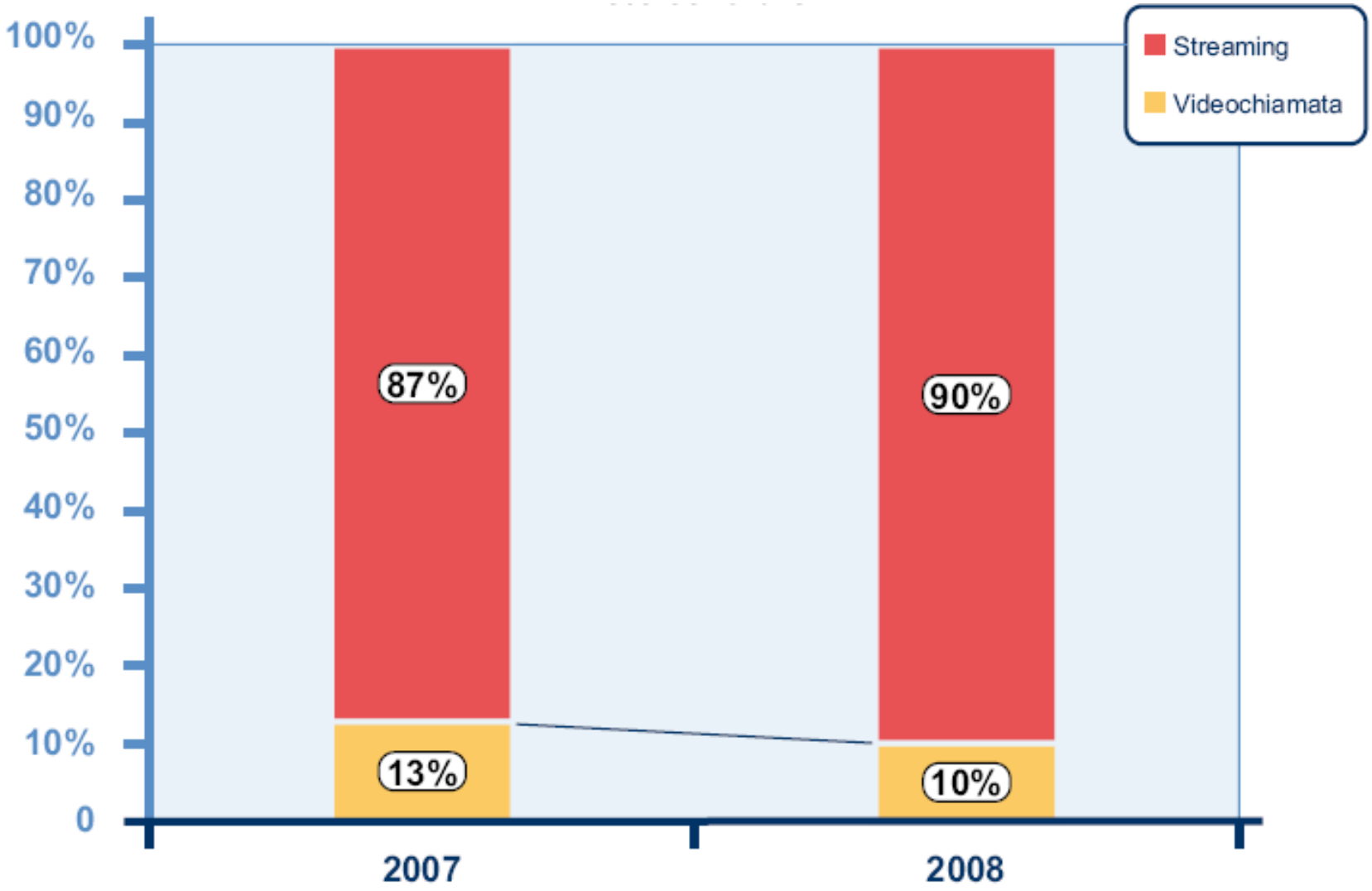
Hand TV broadcast channels: pay vs. free



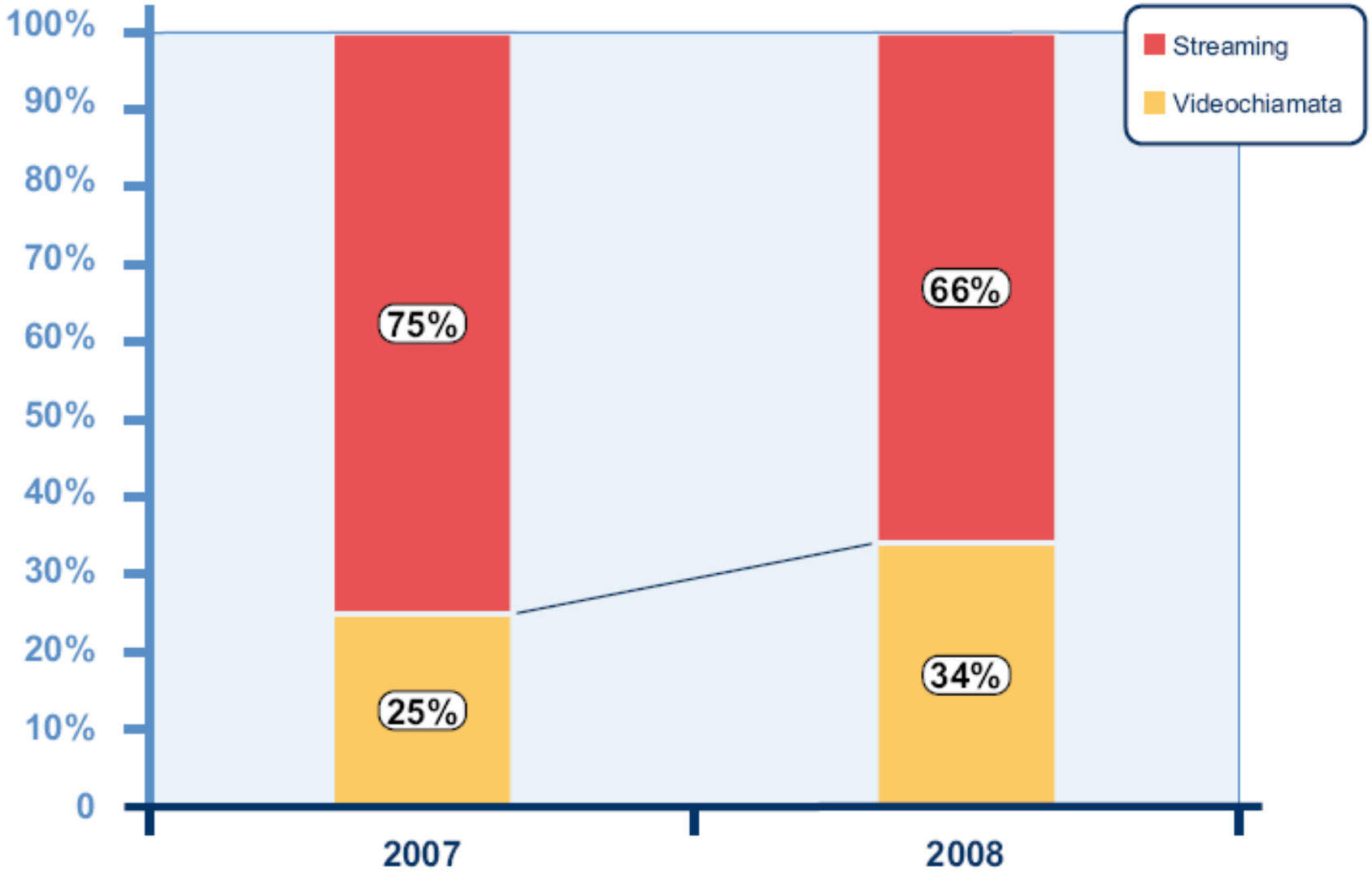
Hand TV broadcast channels: advertising



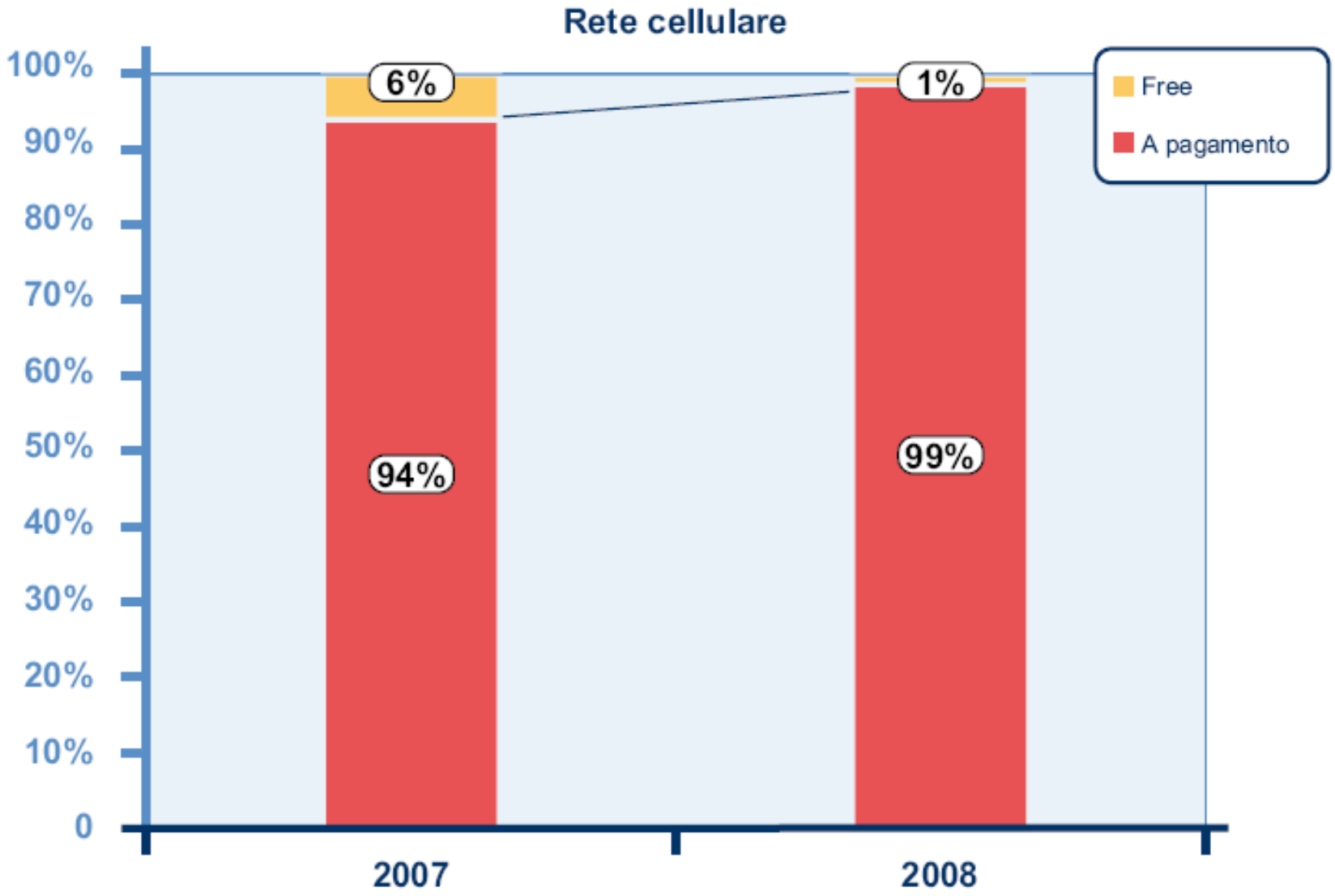
Hand TV broadcast channels: UMTS technology



Hand TV on-demand channels: UMTS technology



Hand TV on-demand channels: pay vs. free



Television classification

Analogue	Digital

Analogue television systems

- Several components
  - technical parameters for the **broadcast signal**
  - system for **encoding color**
  - system for **encoding audio**

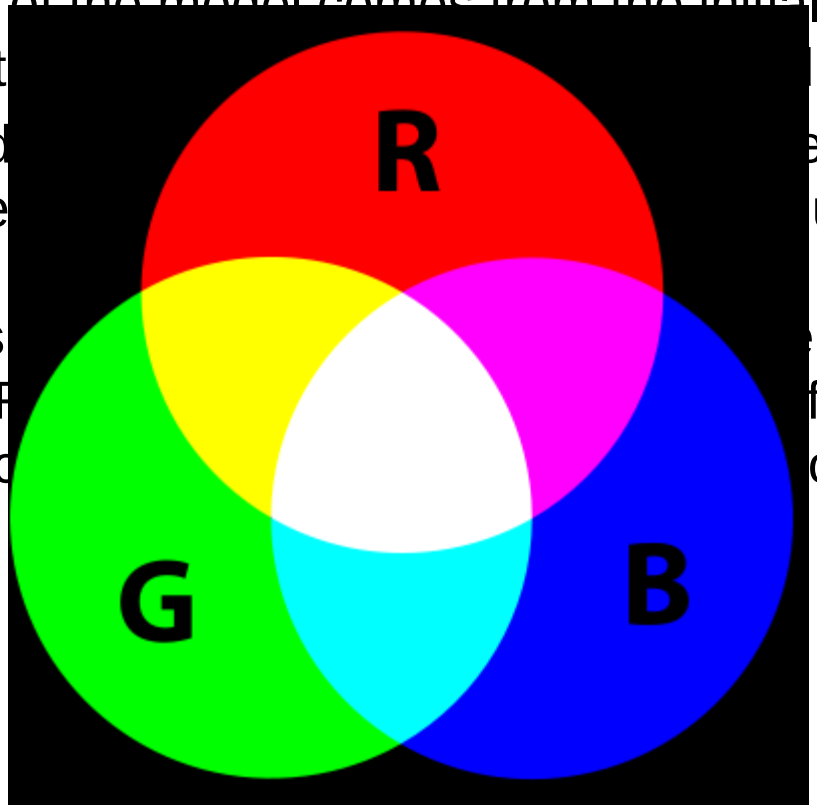
- PAL
- NTSC
- SECAM

Frames

- The monochrome image seen by a camera (the luminance component of a color image) is divided into horizontal scan lines, some number of which make up a single image or frame
- A monochrome image is theoretically continuous, and thus unlimited in horizontal resolution, but to make television practical a limit had to be placed on the bandwidth of the television signal, which puts an ultimate limit on the horizontal resolution possible.
- All current analogue television systems are **interlaced**
  - alternate rows of the frame are transmitted in sequence, followed by the remaining rows in their sequence.
  - Each half of the frame is called a field, and the rate at which fields are transmitted is one of the fundamental parameters of a video system
  - It is related to the frequency at which the electric power grid operates, to avoid flicker resulting from the beat between the television screen deflection system and nearby mains generated magnetic fields.
  - All digital, or "fixed pixel", displays have progressive scanning and must deinterlace an interlaced source.
  - Use of inexpensive deinterlacing hardware is a typical difference between lower- vs. higher-priced flat panel displays (PDP, LCD, etc.).
- All movies and other filmed material shot at 24 frames per second must be transferred to video frame rates in order to prevent severe motion jitter effects.
- Typically, for 25 frame/s formats (countries with 50 Hz mains supply), the content is sped up, while a techniques known as "3:2 pulldown" is used for 30 frame/s formats (countries with 60 Hz mains supply) to match the film frames to the video frames without speeding up the play back

Color models: RGB

- The RGB color model is an additive color model in which red, green, and blue light are added together in various ways to reproduce a broad array of colors
- The name of the model comes from the initials of the three addit blue
- RGB is a d erent devices de ue differently, phosphors individual R facturer to manufac over time



Color models: RGB

- To form a color with RGB, three colored light beams (one red, one green, and one blue) must be superimposed (for example by emission from a black screen, or by reflection from a white screen). Each of the three beams is called a component of that color, and each of them can have an arbitrary intensity, from fully off to fully on, in the mixture.
- The RGB color model is additive in the sense that the three light beams are added together, and their light spectra add, wavelength for wavelength, to make the final color's spectrum.[1][2]
- Zero intensity for each component gives the darkest color (no light, considered the black), and full intensity of each gives a white; the quality of this white depends on the nature of the primary light sources, but if they are properly balanced, the result is a neutral white matching the system's white point. When the intensities for all the components are the same, the result is a shade of gray, darker or lighter depending on the intensity. When the intensities are different, the result is a colorized hue, more or less saturated depending on the difference of the strongest and weakest of the intensities of the primary colors employed.
- When one of the components has the strongest intensity, the color is a hue near this primary color (reddish, greenish, or bluish), and when two components have the same strongest intensity, then the color is a hue of a secondary color (a shade of cyan, magenta or yellow). A secondary color is formed by the sum of two primary colors of equal intensity: cyan is green+blue, magenta is red+blue, and yellow is red+green. Every secondary color is the complement of one primary color; when a primary and its complementary secondary color are added together, the result is white: cyan complements red, magenta complements green, and yellow complements blue.
- The RGB color model itself does not define what is meant by red, green, and blue colorimetrically, and so the results of mixing them are not specified as absolute, but relative to the primary colors. When the exact chromaticities of the red, green, and blue primaries are defined, the color model then becomes an absolute color space, such as sRGB or Adobe RGB; see RGB color spaces for more details
- A color space in which colors are unambiguous, that is, where the interpretations of colors in the space are colorimetrically defined without reference to external factors

Gamma correction

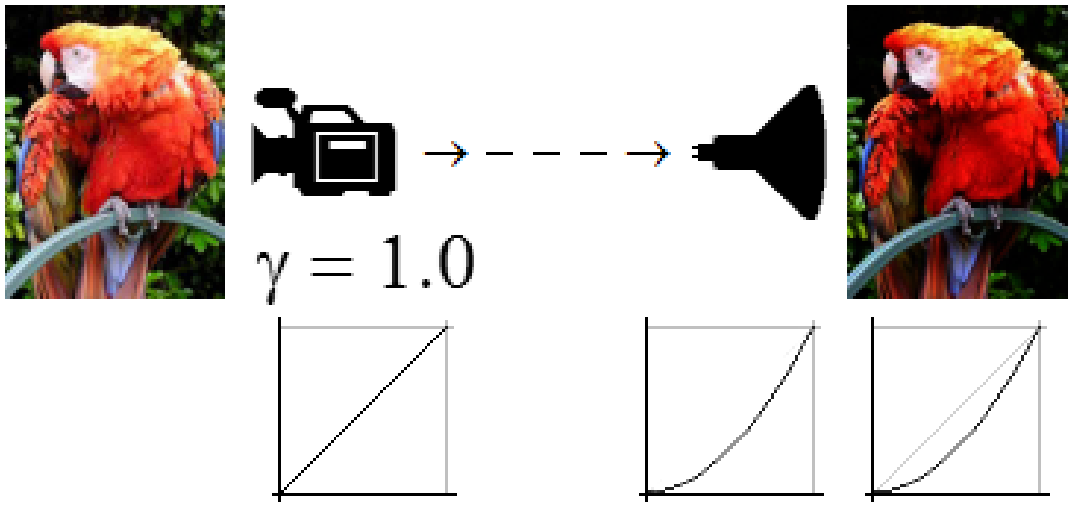
- A cathode ray tube (CRT), for example, converts a video signal to light in a nonlinear way, because the electron gun's intensity (brightness) as a function of applied video voltage is nonlinear. The light intensity I is related to the source voltage VS according to

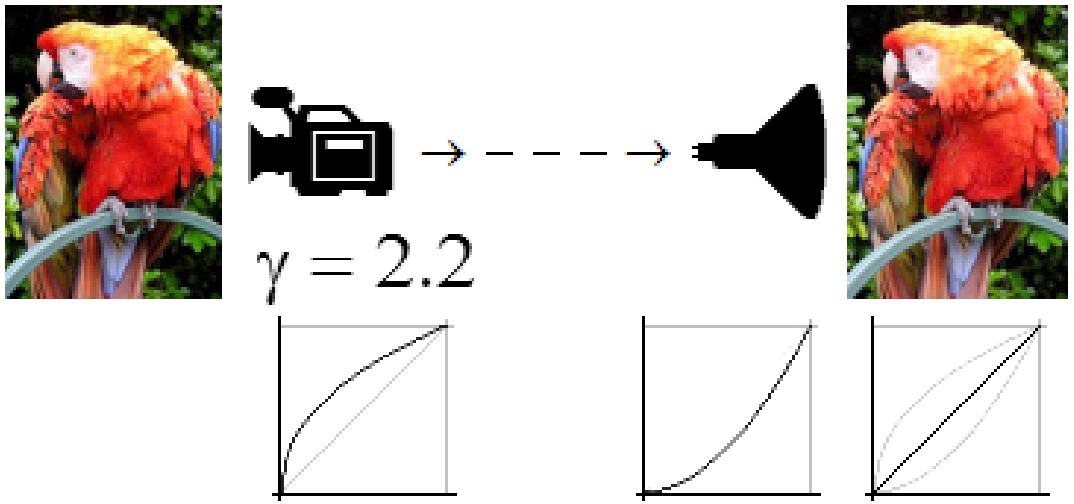
$$I / V_S$$

- where γ is the Greek letter gamma. For a computer CRT, γ is about 2.2. By coincidence, this results in the perceptually homogeneous scale as shown in the diagram on the top of this section.
- For simplicity, consider the example of a monochrome CRT. In this case, when a video signal of 0.5 (representing mid-gray) is fed to the display, the intensity or brightness is about 0.22 (resulting in a dark gray). Pure black (0.0) and pure white (1.0) are the only shades that are unaffected by gamma.
- To compensate for this effect, the inverse transfer function (gamma correction) is sometimes applied to the video signal so that the end-to-end response is linear. In other words, the transmitted signal is deliberately distorted so that, after it has been distorted again by the display device, the viewer sees the correct brightness. The inverse of the function above is:
- where VC is the corrected voltage and VS is the source voltage, for example from an image sensor that converts photocharge linearly to a voltage. In our CRT example 1/γ is 1/2.2 or 0.45.
- A color CRT receives three video signals (red, green and blue) and in general each color has its own value of gamma, denoted γR, γG or γB. However, in simple display systems, a single value of γ is used for all three colors.

$$V_C / V_S^{(1=\gamma)}$$

Gamma correction



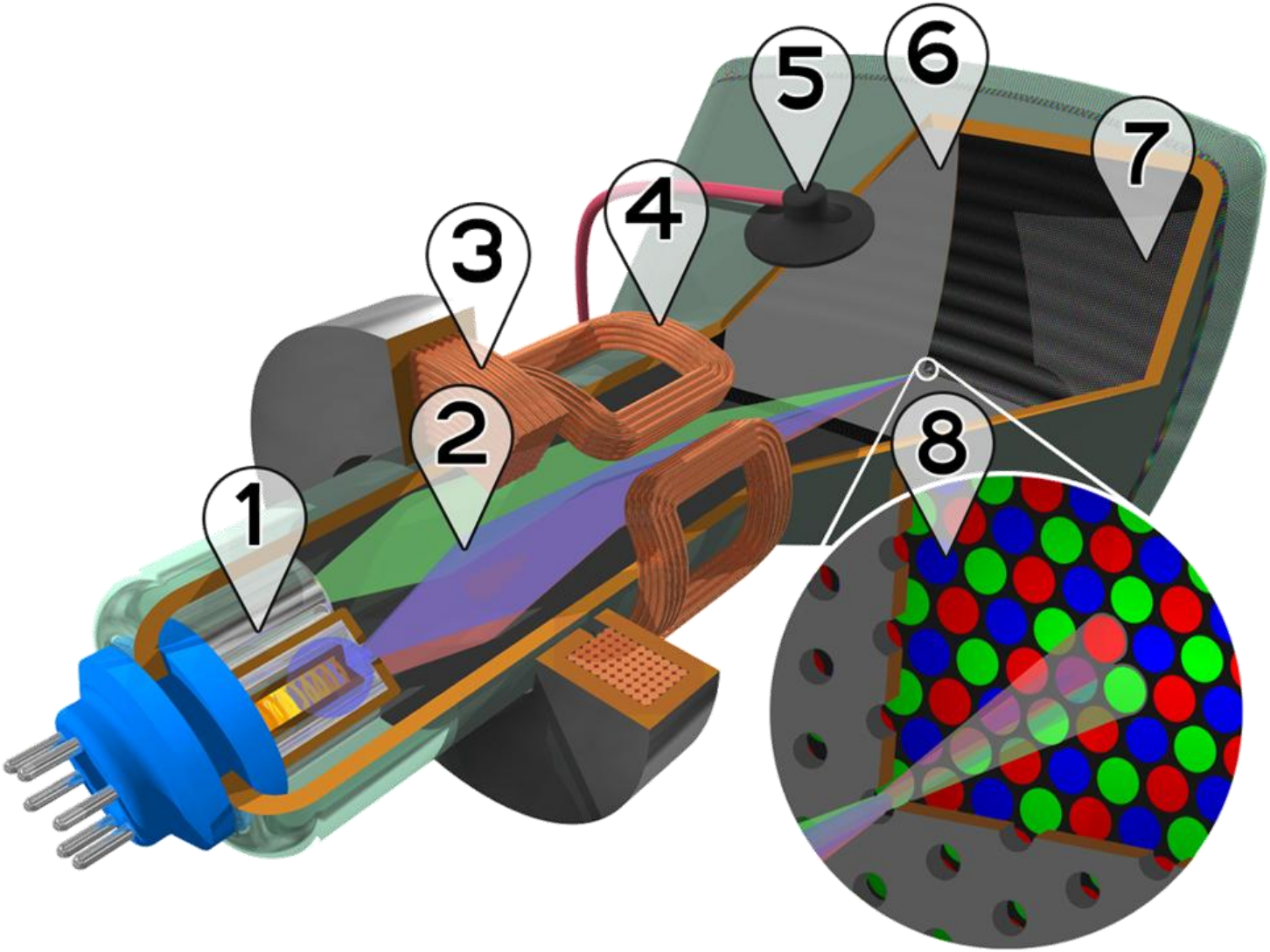


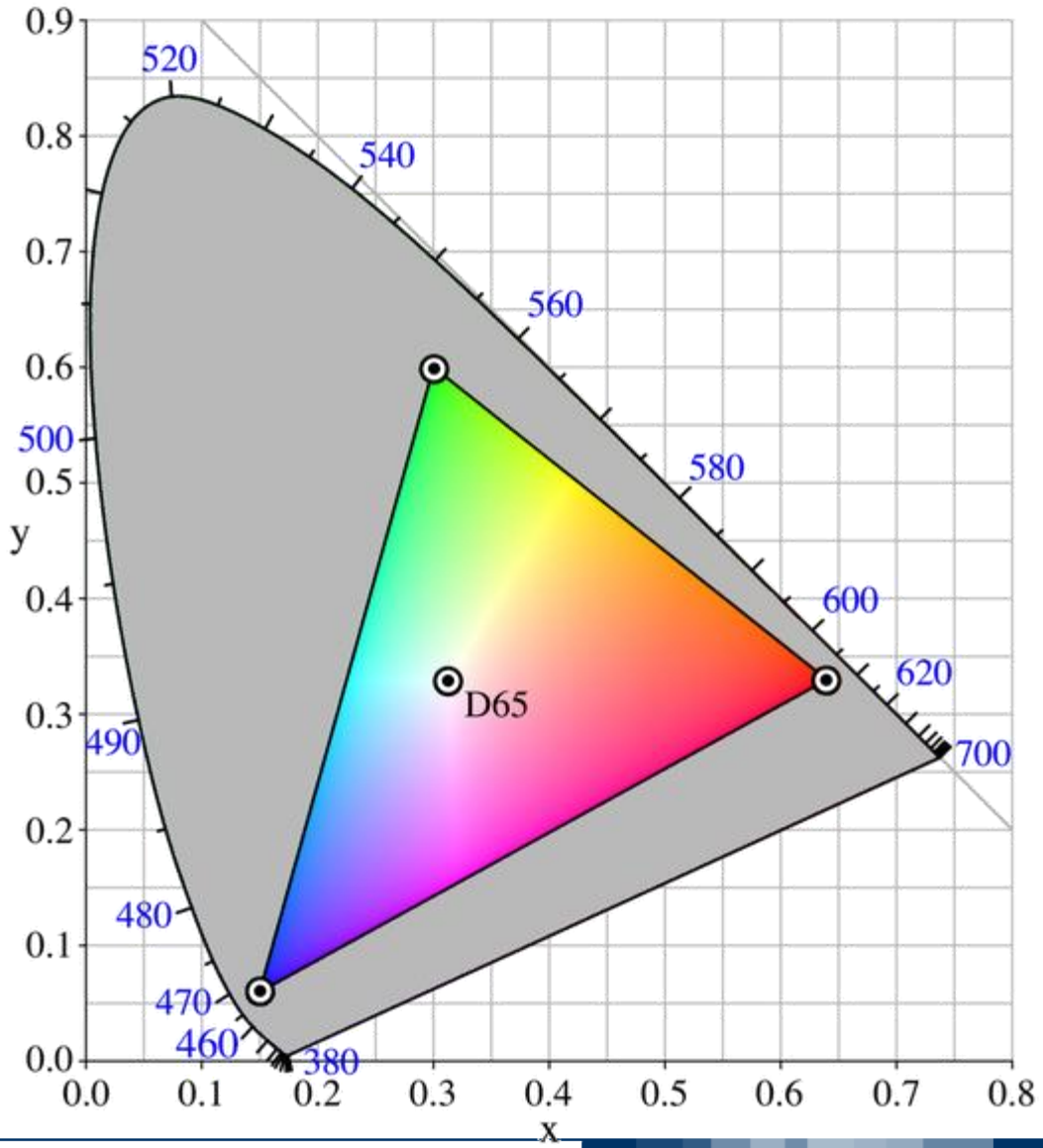
Systems with linear and gamma-corrected cameras.

The dashes in the middle represent the storage and transmission of image signals or data files

The three curves represent input–output functions of the camera, the display, and the overall system, respectively

Cathode ray tube




0.9
0.8
0.7
0.6
500
0.5
y
0.4
0.3
490
0.2
480
0.1
470
460
0.0
520
540
560
580
600
620
700
380
D65
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
x

- In classic cathode ray tube (CRT) devices, the brightness of a given point over the phosphorescent screen due to the impact of accelerated electrons is not proportional to the voltage applied to electrons in their RGB electron guns, but to an expansive function of that voltage. The amount of this deviation is known as its gamma value (γ), the argument for a power law function, which closely describes this behavior. A linear response is given by a gamma value of 1.0, but actual CRT nonlinearities have a gamma value around 2.0 to 2.5.

Relative luminance

- Y = 0.2126 R + 0.7152 G + 0.0722 B

$$Y = 0.299R + 0.587G + 0.114B$$

$$U = \frac{B - Y}{2.03}$$

$$V = \frac{R - Y}{1.14}$$

- Interlaced scan refers to one of two common methods for "painting" a video image on an electronic display screen (the second is progressive scan) by scanning or displaying each line or row of pixels. This technique uses two fields to create a frame. One field contains all the odd lines in the image, the other contains all the even lines of the image. A PAL based television display, for example, scans 50 fields every second (25 odd and 25 even). The two sets of 25 fields work together to create a full frame every 1/25th of a second, resulting in a display of 25 frames per second
- The afterglow of the phosphor of CRTs, in combination with the persistence of vision results in two fields being perceived as a continuous image which allows the viewing of full horizontal detail with half the bandwidth that would be required for a full progressive scan while maintaining the necessary CRT refresh rate to prevent flicker.

- Flicker is visible fading between cycles displayed on video displays, especially the refresh interval on cathode ray tube (CRT) based computer screens. Flicker occurs on CRTs when they are driven at a low refresh rate, allowing the screen's phosphors to lose their excitation (afterglow) between sweeps of the electron gun. A similar effect occurs in PDPs during their refresh cycles.

- For example, if a CRT computer monitor's vertical refresh rate is set to 60 Hz, most monitors will produce a visible "flickering" effect, unless they use phosphor with long afterglow. Most people find that refresh rates of 70-90 Hz and above enable flicker-free viewing on CRTs. Use of refresh rates above 120 Hz is uncommon, as they provide little noticeable flicker reduction and limit available resolution.

- Since the shutters used in liquid crystal displays for each pixel stay at a steady opacity, they do not flicker, even when the image is refreshed. The backlights of such displays do flicker, but typically operate in the range of 150-250 Hz.

Frame rates

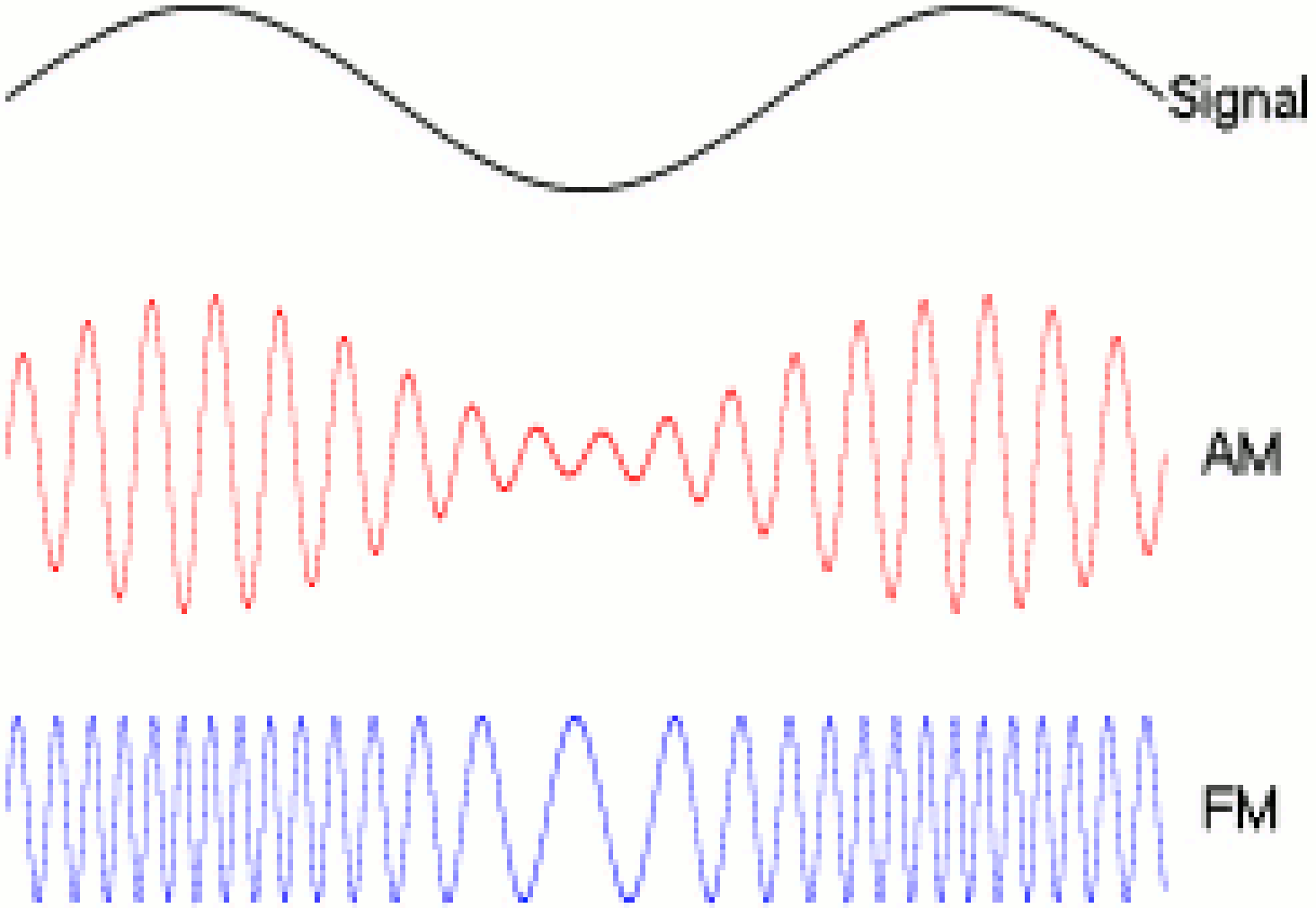
- 60i (actually 59.94, or 60 x 1000/1001 to be more precise; 60 interlaced fields = 29.97 frames) is the standard video field rate per second that has been used for NTSC television since 1941
  - When NTSC color was introduced, the older rate of 60 fields per second was reduced by a factor of 1000/1001 to avoid interference between the chroma subcarrier and the broadcast sound carrier
- 50i (50 interlaced fields = 25 frames) is the standard video field rate per second for PAL and SECAM television
- 30p, or 30-frame progressive, is a noninterlaced format and produces video at 30 frames per second. This frame rate became popular in the 1980s, with the popularity of music videos.
- The 24p frame rate is also a noninterlaced format. Used in “old” film movies
- 25p is a video format which runs twenty-five progressive frames per second. This framerate is derived from the PAL television standard of 50i (or 50 interlaced fields per second). While 25p captures only half the motion that normal 50i PAL registers, it yields a higher vertical resolution on moving subjects. It is also better suited to progressive-scan output (e.g. on LCD displays, computer monitors and projectors) because the interlacing is absent.
- 50p and 60p is a progressive format used in high-end HDTV systems. While it is not technically part of the ATSC or DVB broadcast standards, it is rapidly gaining ground in the areas of set-top boxes and video recordings

- The horizontal retrace is accounted for in the time allotted to each scan line, but the vertical retrace is accounted for as phantom lines which are never displayed but which are included in the number of lines per frame defined for each video system. Since the electron beam must be turned off in any case, the result is gaps in the television signal, which can be used to transmit other information, such as test signals or color identification signals
- Broadcasters later developed mechanisms to transmit digital information on the phantom lines, used mostly for teletext and closed captioning

Modulation

- Given all of these parameters, the result is a mostly-continuous analogue signal which can be modulated onto a radio-frequency carrier and transmitted through an antenna. All analogue television systems use vestigial sideband modulation, a form of amplitude modulation in which one sideband is partially removed. This reduces the bandwidth of the transmitted signal, enabling narrower channels to be used.

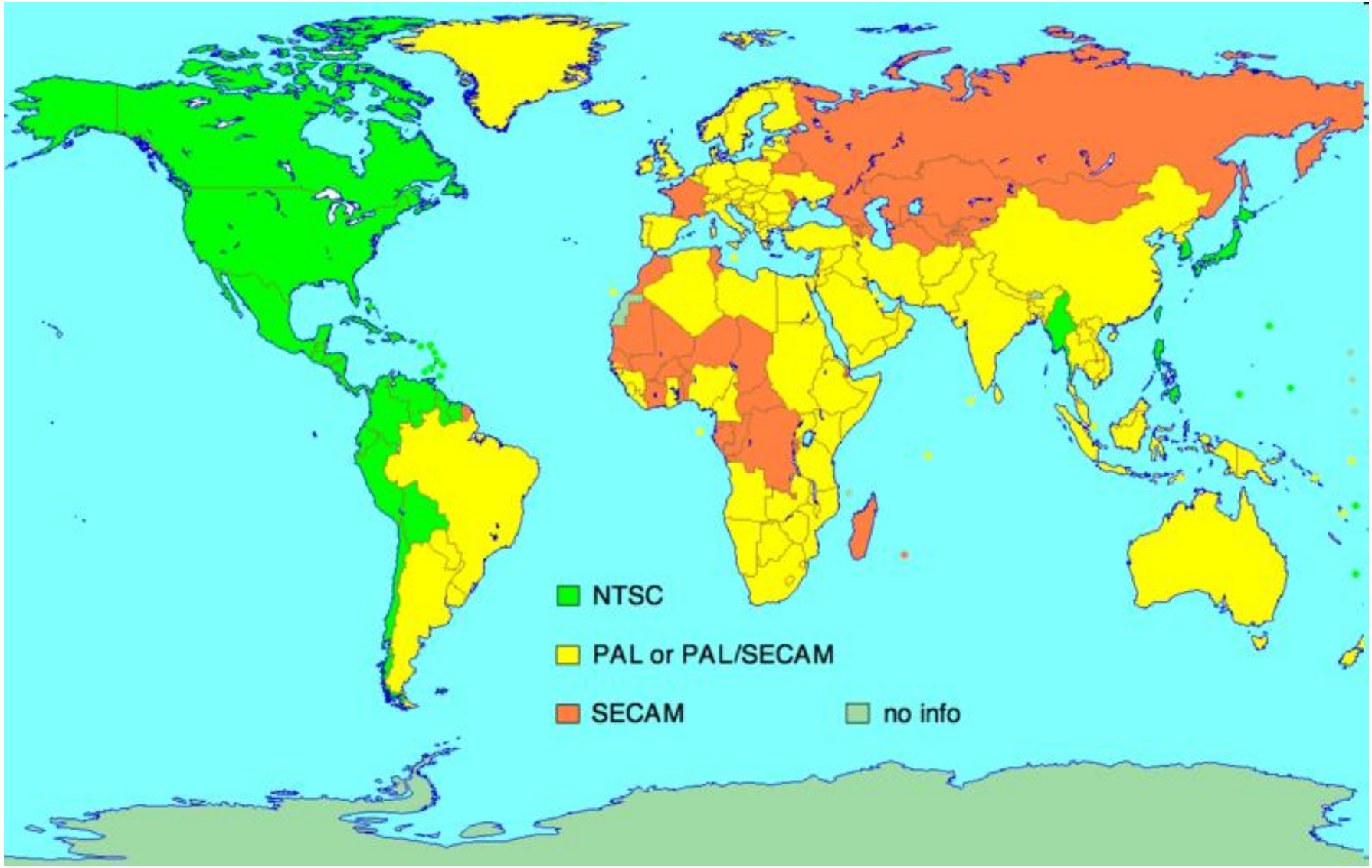
Modulation



Audio

- In analogue television, the sound portion of a broadcast is invariably modulated separately from the video. Most commonly, the audio and video are combined at the transmitter before being presented to the antenna, but in some cases separate aural and visual antennas can be used. In almost all cases, standard wideband frequency modulation is used for the standard monaural audio
- Stereo, or more generally multi-channel, audio is encoded using a number of schemes which are usually independent of the video system.

Analogue Television Standards



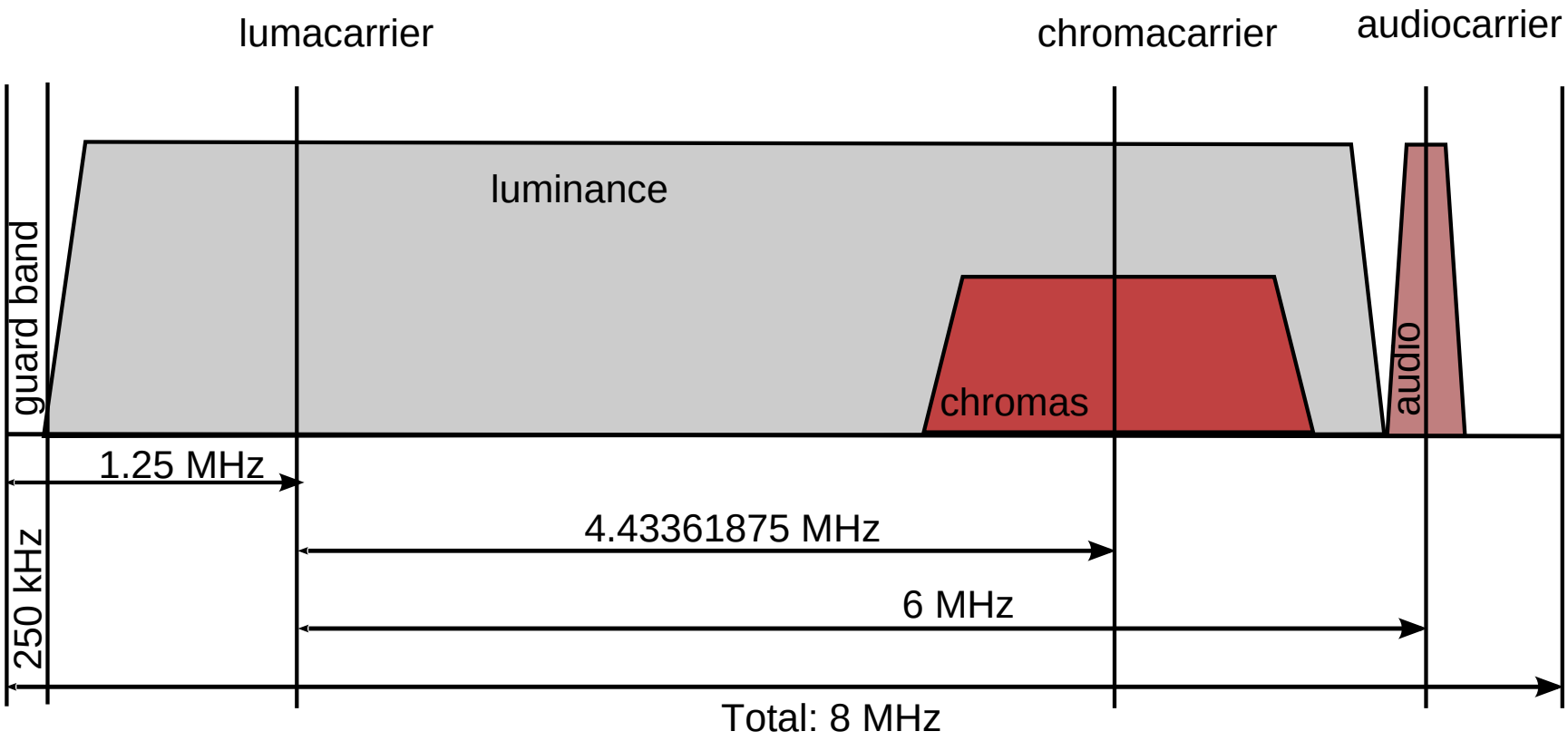
Standard di partenza

	risoluzione (linee)	frequenza immagini (fps)	scansione	rapporto d'aspetto
A	? x377	25	interlacciata	4:3
B	768x576	25	interlacciata	4:3
B'		25	interlacciata	4:3
C		25	interlacciata	4:3
D		25	interlacciata	4:3
D'		25	interlacciata	4:3
E	? x755	25	interlacciata	4:3
F		25	interlacciata	4:3
G	768x576	25	interlacciata	4:3
H		25	interlacciata	4:3
J		30	interlacciata	4:3
L		25	interlacciata	4:3
M	648x486	30	interlacciata	4:3
N		25	interlacciata	4:3

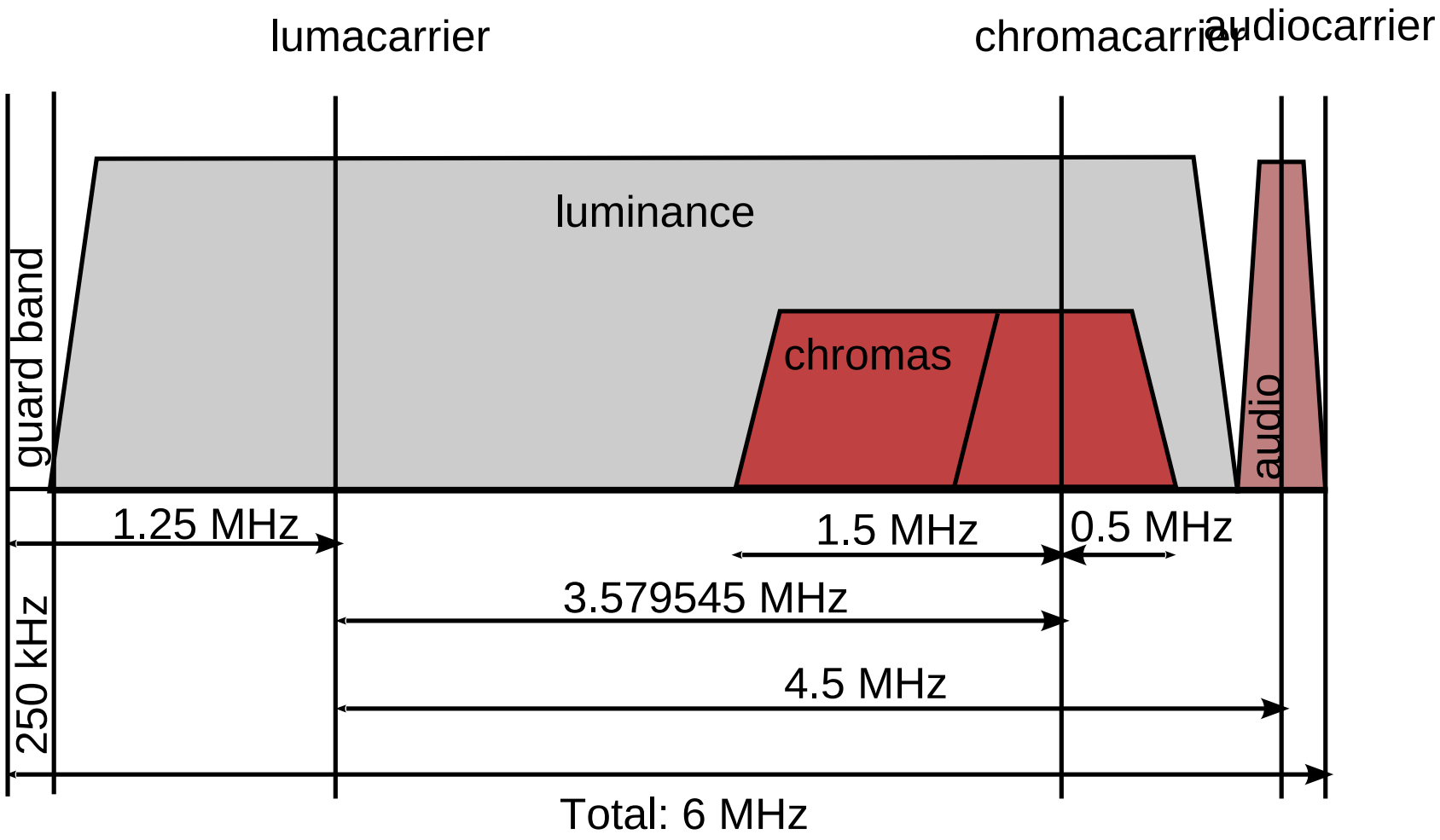
Standard di partenza

Nome standard	Linee	Frequenza verticale (Hz)	Ampiezza banda canale (MHz)	Ampiezza video (MHz)	Modulazione video	Modul. audio	Portante audio (MHz)
A	405	50	5	3	AM (positiva)	AM	-3,5
B	625	50	7	5	AM (negativa)	FM	+5,5
B'	625	50	8	5	AM (negativa)	FM	+5,5
C	625	50	7	5	AM (positiva)	AM	+5,5
D	625	50	8	6	AM (negativa)	FM	+6,5
D'	625	50	8	5	AM (negativa)	FM	+6,5
E	819	50	14	10	AM (positiva)	AM	
F	819	50	7	5	AM (positiva)	AM	
G	625	50	8	5	AM (negativa)	FM	+5,5
H	625	50	8	5	AM (negativa)	FM	+5,5
J	525	60	6	4,2	AM (negativa)	FM	+4,5
L	625	50	8	6	AM (positiva)	AM	+6,5
M	525	60	6	4,2	AM (negativa)	FM	+4,5
N	625	50	6	4,2	AM (negativa)	FM	+4,5

PAL

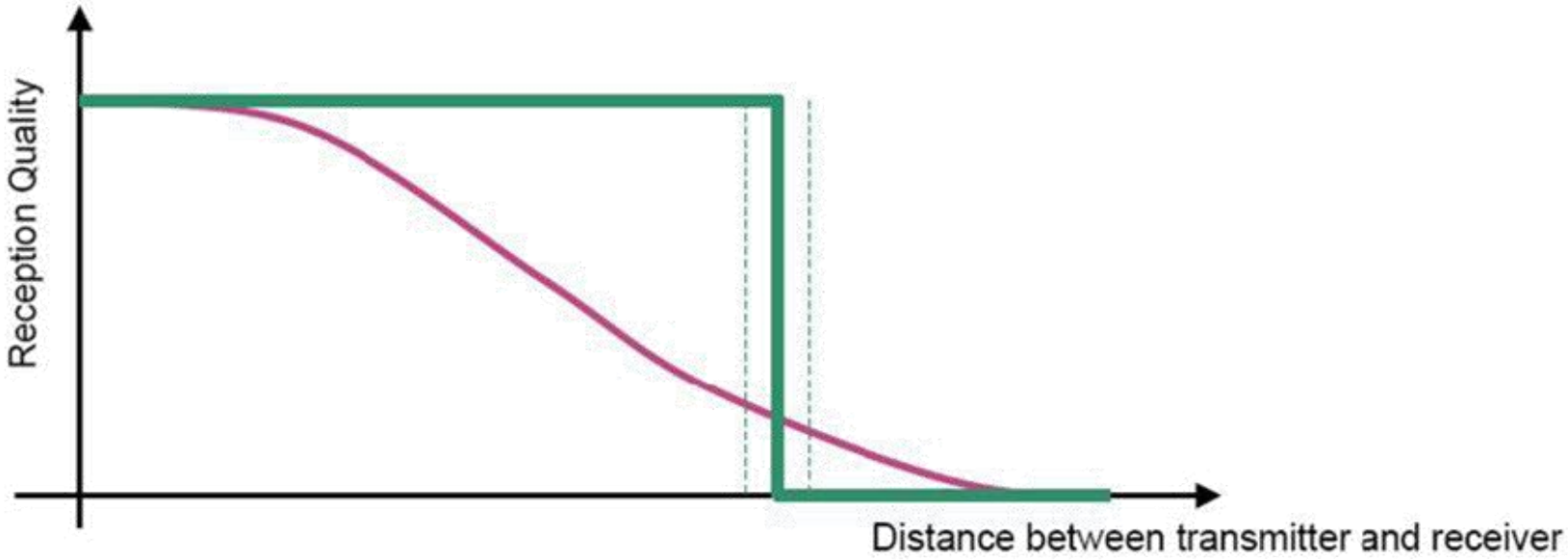

lumacarrier
chromacarrier
audiocarrier
luminance
guard band
chromas
audio
1.25 MHz
4.43361875 MHz
6 MHz
250 kHz
Total: 8 MHz

NTSC


lumacarrier
chromacarrier
audiocarrier
luminance
chromas
audio
guard band
1.25 MHz
1.5 MHz
0.5 MHz
3.579545 MHz
4.5 MHz
250 kHz
Total: 6 MHz

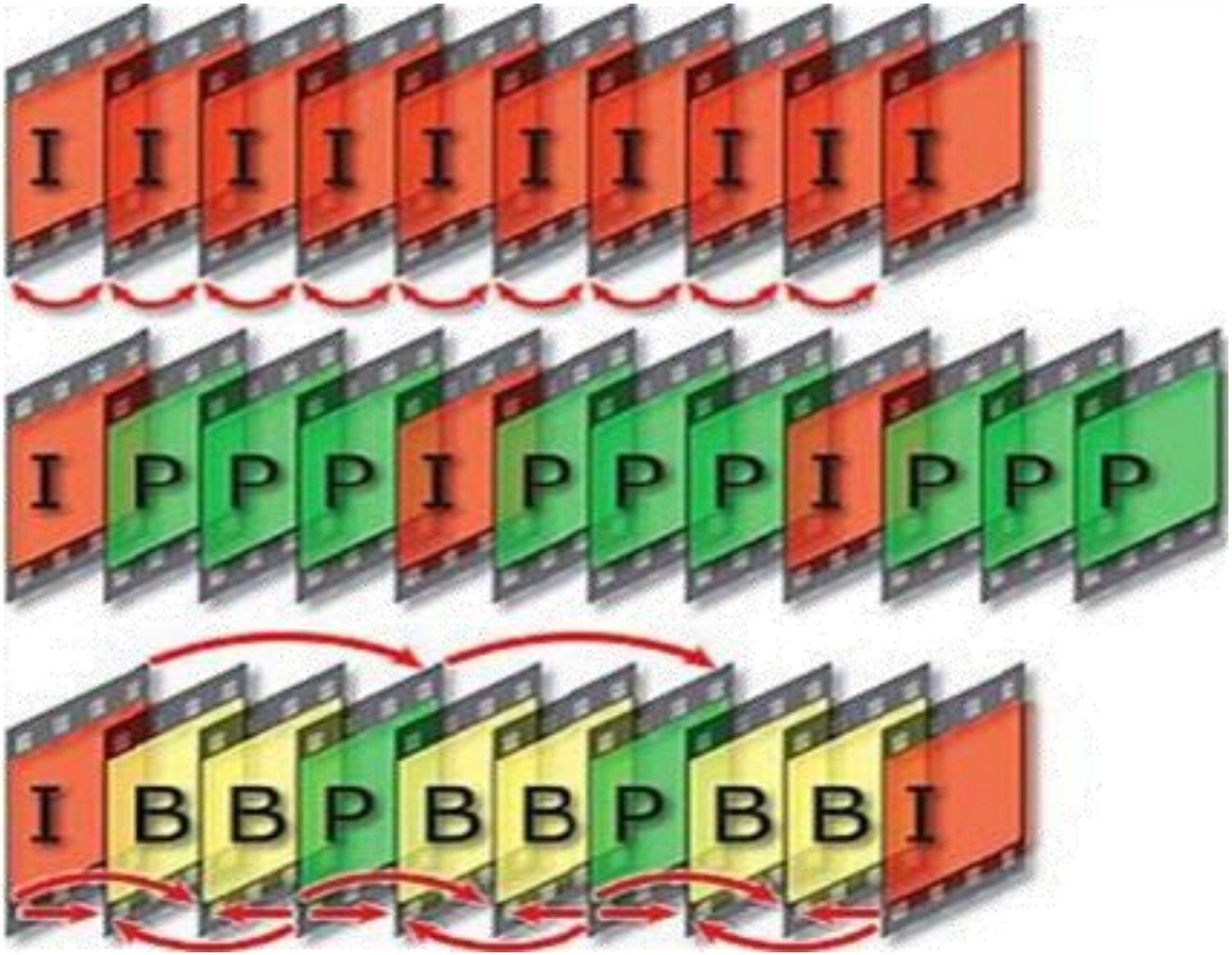
PAL

	PAL B	PAL G, H	PAL I	PAL M	PAL D	PAL N	PAL Nc
Transmission Band	VHF	UHF	UHF/VHF	UHF/VHF	UHF/VHF	UHF/VHF	UHF/VHF
Lines/Fields	625/50	625/50	625/50	525/60	625/50	625/50	625/50
Video Bandwidth	5.0 MHz	5.0 MHz	5.5 MHz	4.2 MHz	6.0 MHz	5.0 MHz	4.2 MHz
Sound Carrier	5.5 MHz	5.5 MHz	6.0 MHz	4.5 MHz	6.5 MHz	5.5 MHz	4.5 MHz
Channel Bandwidth	7 MHz	8 MHz	8 MHz	6 MHz	8 MHz	6 MHz	6 MHz



Analogue TV
The reception quality directly depending on the field strength. With growing distance the reception quality continuously decreases.

DVB-T
The transition from covered to not covered area is very sharp. The position can slightly vary according to atmospherical (weather) changes.


I I I I I I I I I I
I P P P I P P P I P P P
I B B P B B P B B I


(5) Music Channel 5
LIVE
Music: In concert
Options
NOKIA
N77
(2) Sports Channel 2
LIVE
Sport: Player penalty
Options
NOKIA
N77
SAMSUNG

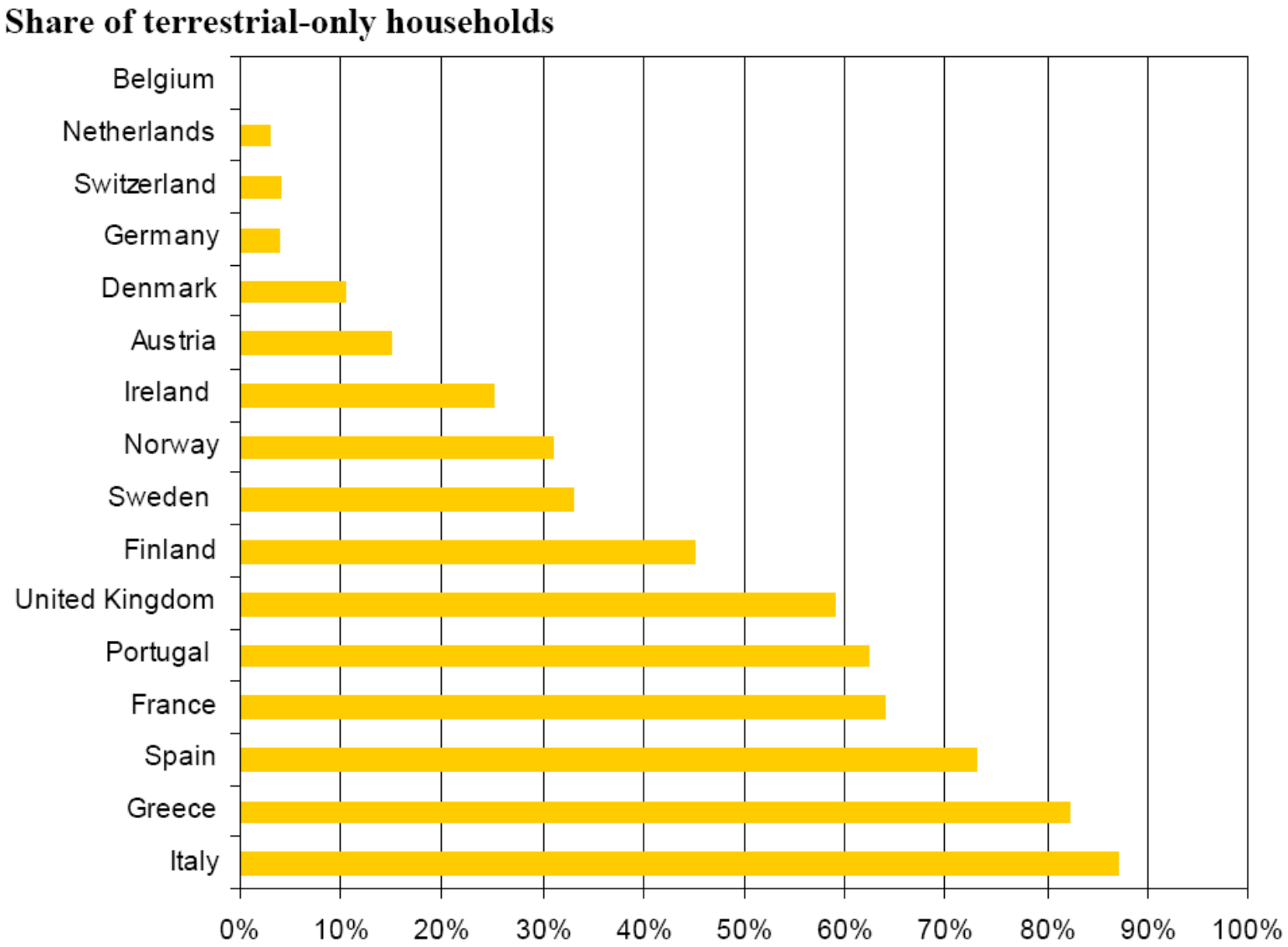
DVB over IP

UMTS vs. DVB-H

- DVB-H pros
  - broadcast
  - quality
- DVB-H cons
  - no video-on-demand

- UMTS pros
  - video-on-demand
  - usable on any mobile phone without any additional receiver
- UMTS cons
  - radio frequency bandwidth saturation when transmitting (especially broadcasting but also unicasting) to several users

Analogue switch-off (ASO) on the terrestrial platform



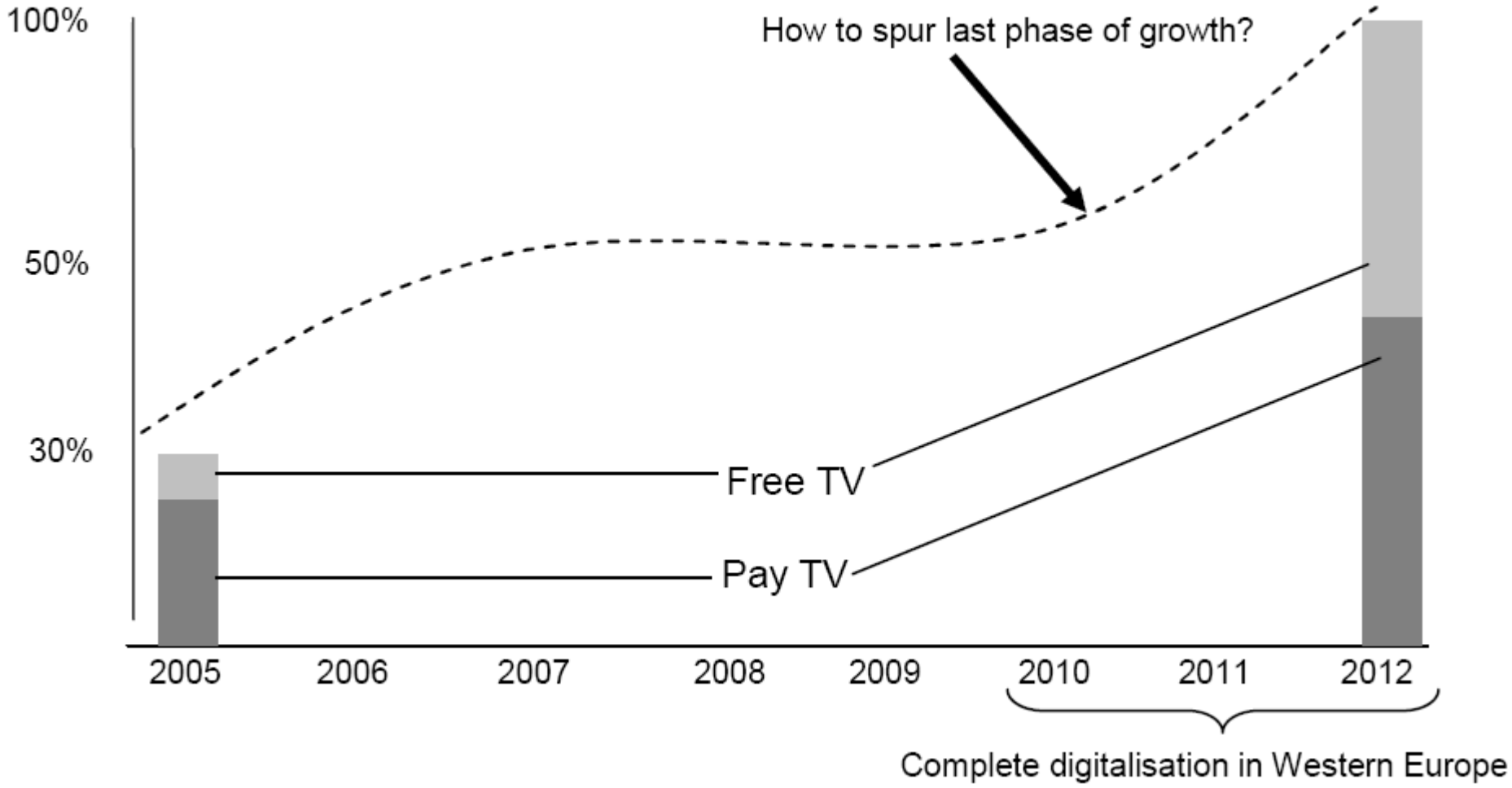
estimate of DTT penetration

Country	DTT Penetration (end 2005)	Years since full DTT launch (50% population coverage)
United Kingdom	25%	7
Sweden	14%	6
Spain	5%	4
Finland	25% (mid 2005)	4
Italy	16%	2
Germany	8% (varies by region)	2
The Netherlands	2%	2
France	6%	<1

Country	DTT population coverage of at least 1 multiplex (end 2005)
United Kingdom	80%
Sweden	93%
Spain	80%
Finland	99.9%
Germany	60%
The Netherlands	50%
Italy	70%
France	50%

Country	DTT launch	ASO date	Status of ASO date
United Kingdom	1998	2012	Firm
Sweden	1999	2008	Obligatory
Spain	2000	2010	Target
Finland	2001	2007	Obligatory
Switzerland	2001 (commercial DTT services)	2008	Firm
Germany	2002	2009	Firm
Belgium	2002	2012	Target
The Netherlands	2003	2007	Firm
Italy	2003	2012	Target
France	2005	2011	Target
Malta	2005	2010	Target
Czech Republic	2005	2010	Target
Denmark	2006	2009	Obligatory
Lithuania	2006	2012	Target
Greece	2006	2012	Target
Slovenia	2006	2011	Target
Austria	2006	2010	Firm
Estonia	2006	2012	Target
Norway	2007	2009	Obligatory

	ASO date (official or estimated)	Expected range
Fast Track		
Finland	2007	2006 - 2008
Sweden	2008	
The Netherlands	2007	
Germany	2008	
Middle term		
Belgium	2010	2009 - 2011
Norway	2009	
Denmark	2009	
Switzerland	2008	
Austria	2010	
Last		
Italy	2012	2012 - 2015
United Kingdom	2012	
France	2011	
Spain	2010	
Portugal	2012	
Greece	2015	


100%
50%
30%
How to spur last phase of growth?
Free TV
Pay TV
2005
2006
2007
2008
2009
2010
2011
2012
Complete digitalisation in Western Europe

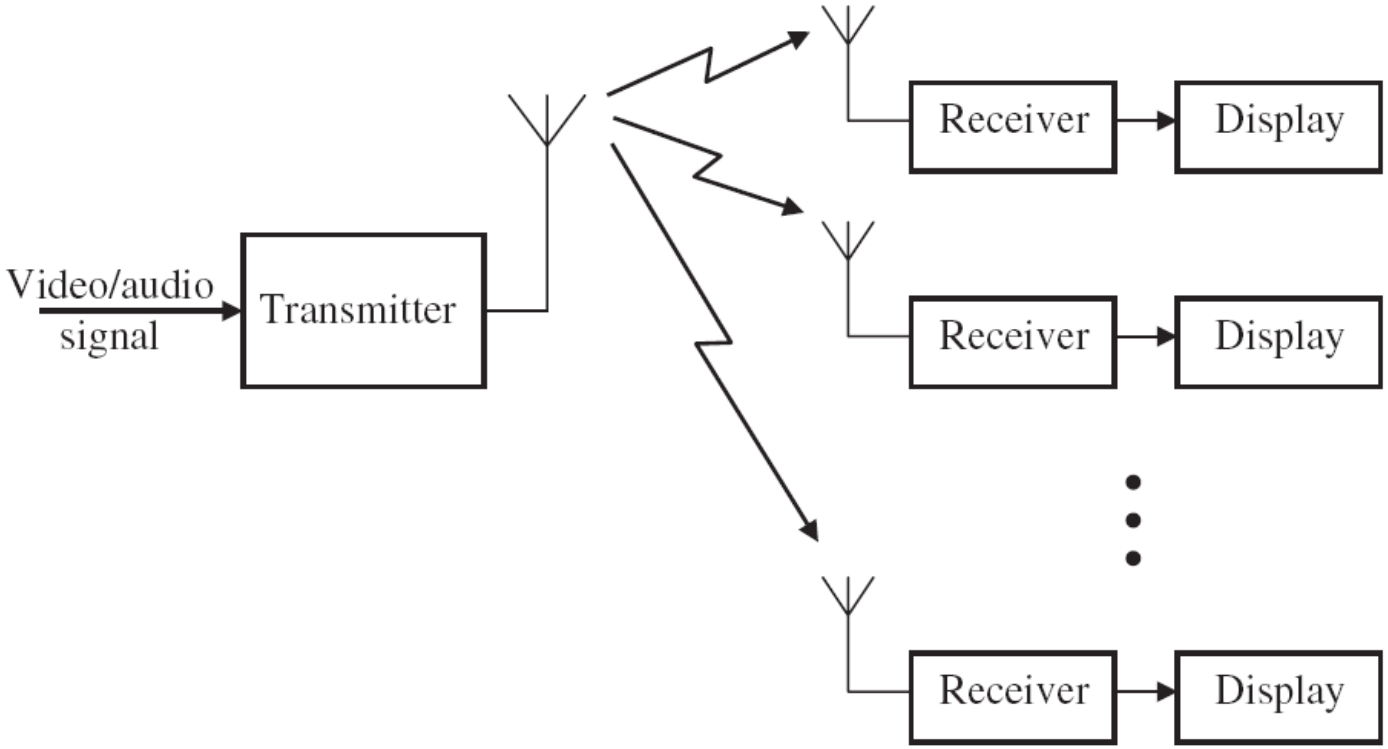


Figure 1.1 Simplex structure of terrestrial broadcast television.

- The vertical resolution is usually 576 lines for 25 Hz systems and 480 lines for 30 Hz systems.
- In addition to the displayed lines, a number of other lines of data are transmitted.
- These are intended to provide time for the scan in a cathode ray tube to return from the bottom right of the display at the end of one picture to the top left of the display at the beginning of the next picture. The inclusion of these non displayed lines brings the total number of lines per picture to 625 for 25 Hz systems and 525 for 30 Hz systems. The time in which these nondisplayed lines are transmitted is known as the vertical blanking interval (VBI).
- There is 52 µs time for the active image on each scan line (PAL).
  - Usual vertical resolution in Western Europe is 520 pixels (767 if you want square pixels)
    (PAL B,G,H)
  - Usual vertical resolution with NTSC is 441 pixels