Business Opportunities and Risks from Pay-TV Piracy: The Case of Europe

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ABSTRACT

Pay-TV piracy in Europe is affecting the legal providers of Pay-TV services. This paper describes the main players in the European Pay-TV market, the Conditional Access Systems (CAS) used in the European Union (EU 15), the European Pay-TV piracy market, and the most important technologies used. The paper then discusses the effects of Pay-TV piracy on the CAS providers and Pay-TV service providers followed by some conclusions and an outlook.

Keywords

Pay-TV, Piracy, Conditional Access Systems (CAS), European Union.

TOPIC RELEVANCE

Piracy means illegally accessing copyright-protected content to generate financial profits and reap other non-financial benefits, such as personal prestige. 'Pirates' are unauthorized users of copyrighted works (European Commission 2003b). The fast-growing European Pay-TV market, similar to the rapidly spreading Internet, has promoted the growth of Pay-TV piracy across Europe.

In Italy, for instance, Italmedia Consulting (2002) counted more than 4.1 million households in 2002, but only approximately 1.9 million legally paying Stream and Telepiù subscribers. If illegal Italian viewers were added to Italian legal subscribers in 2001, the Pay-TV share of the Italian TV market would have jumped from 11% to 27%, giving Italy the highest Pay-TV ratio in the EU (Davies 2002c). Within the European Union[1] as a whole, pirate Pay-TV subscriptions were estimated to be about 30% of legal subscriptions at the end of 2003 (Davies 2001; see also European Commission 2003b).
Pay-TV piracy has four main effects on the European Pay-TV industry and the companies within it: (1) It leads to financial losses for the European Pay-TV industry, (2) it substantially damages the image of transmitters and content rights holders (AEPOC 2003), (3) it, reduces the allure and payback of investing in the industry, and (4) it hurts the media economy and its innovation capabilities (European Commission 2003b).
Pay-TV piracy also affects European governments. The European Association for the Protection of Encrypted Works and Services (AEPOC[2], www.aepoc.org) estimates that annual revenues from pirate cards and manipulated set-top-boxes in the EU are at least one billion Euros (AEPOC 2003). Manufacturers of pirate cards pay no taxes at all, and Pay-TV and CAS providers pay lower taxes because of their reduced profits (European Union 2003). The European Parliament (2003) estimated the annual taxation loss to be several million Euros and the annual average job loss to 17,000 jobs across the EU.
Piracy also distorts the markets for audio-visual works because it negatively influences content producers, the cinema industry, and the rental of video tapes and DVDs.

RESEARCH SCOPE AND APPROACH

We analyzed the current Pay-TV piracy situation and its effects, focusing on the following four questions:

1) Who are the key players in the European Pay-TV market and what are the main market characteristics?
2) How do Pay-TV coding systems (Conditional Access Systems, CAS - see also section 4.1) function?

1 The designation 'European Union (EU)' refers to the 'EU 15' (before 2004-05-01).
2 Association Européenne pour la Protection des Œuvres et services Cryptés.

3) Who are the main players in the European market of Pay-TV coding systems and what are the characteristics of this market?
4) Which effects of Pay-TV piracy on CAS providers and on Pay-TV providers can be specified?

The article introduces the main CAS used in the European Union (EU 15 - before the enlargement of the EU on 2004-05-01), the main Pay-TV market players, and the technology essentials underlying CAS evasion. It then briefly analyzes the attractiveness of European Pay-TV piracy (there is significant profit potential) and elaborates on the effects of piracy on CAS and Pay-TV service providers. The paper concludes with recommendations for reducing Pay-TV piracy in the European Union.

The data was collected between December 2003 and February 2004, and consisted of a concentrated literature search and in-depth phone interviews and email exchanges with Pay-TV companies and with the AEPOC, whose members include 35 major players in the European digital TV and telecommunications industry. AEPOC tracks piracy of encrypted works and services and researches legal, organizational, and technological methods for increasing security and protection of CAS (AEPOC 2005). We also attended presentations (Berbinau 2004, Goudsmits 2004, Kuik 2004, Loup 2004, Lowther 2004, Rietkerk 2004, Rossi 2004, van Eijk 2004) given at the 2nd AEPOC Anti-Piracy Symposium in Amsterdam in October 2004, and held follow-up discussions with the speakers to verify the correctness and timeliness of our data.

THE EUROPEAN PAY-TV MARKET

Pay-TV has long been divided into Subscription-TV and Pay-per-View-TV (EBU 1995). For Subscription-TV, the most attractive programs are packaged as monthly subscriptions. For Pay-Per-View-TV, by contrast, individual TV transmissions, usually sporting events, concerts, or blockbuster movies, are sold individually.
The first European Pay-TV provider was Canal+ in France in 1984. In 1989, British Sky Broadcasting (BSkyB) followed in the UK. Until the end of the 1990s, most European Member States had their own country-wide Pay-TV provider. But by 1999, their national quasi-monopolistic positions had become eroded by regulation, standardization, and new market entries. Since then, Europe's national Pay-TV markets have been continually moving toward more competition and more innovative offers using digital technologies, i.e. Pay-Per-View, Video-on-Demand, and online services.
From 1995 to 2001, the number of Pay-TV subscriptions in the EU grew annually by 10%, reaching 68.5 million households in 2001. The growth in investments by European Pay-TV providers mirrored this subscription growth (Wilkinson 2003). In 2004, the European Pay-TV market accounted for more than 150 million households. For 2008, Mayor (2003) forecasts European Pay-TV revenues to reach more than €77 billion.
However, European Pay-TV providers will only realize significant economies of scale and thus high profit margins if the market consolidates. After mergers in Italy and Spain in 2003, others seem to be on the horizon, primarily in France and Scandinavia.

Table 1 summarizes European Pay-TV providers. In some countries, legal constraints, culture, and language barriers limit competition to national companies only (Boucqueau and Verians 2004).

Market	**Pay-TV Provider**	**Main Stockholder**	**Launch**	**Subscribers**	**Minimum Subscription (€/Month)**
Germany	Premiere	Permira (Germany)	1991	2,910,000	5.00
Greece	Nova	Multichoice Hellas (Greece)	1999	223,000	12.30
France	ABSat	AB Group (France)	1995	25,200,000[3]	n/a.

3 Also including Non-Pay-TV as the figures are not separable.

	Canal+	Canal+ Group (France)	1984	4,900,000	28.80
	CanalSatellite	Canal+ Group (France)	1992	2,700,000	11.00
	TPS	TF1 (France)	1996	1,200,000	11.00
Italy	Sky Italia[4]	News Corp. (USA)	2003	2,400,000	22.00
Portugal	TV Cabo	PT-Multimédia (Portugal)	1994	1,400,000	13.49
Scandinavia	Canal Digital	Telenor (Norway)	1997	710,000	20.50
	Viasat	MTG (Sweden)	1991	600,000	13.29
Spain	Canal+	Sogecable (Spain)	1990	1,930,000	24.97
	Digital+[5]	Sogecable (Spain)	2003	1,800,000	22.00
UK	BSkyB	News Corp. (USA)	1989	7,200,000	20.20

Table 1 Pay-TV Providers in the EU 15
(Sources: New Media Markets; Cable Satellite Europe; Report ABSat 2004, Report Canal+ Group 2004, Report MTG 2003, Report News Corp. 2004, Report Premiere 2004, Report PT-Multimédia 2004, Report Sogecable 2004, Report Telenor 2004; own calculations)

Several Pay-TV providers have reported losses for the past few years due to rising costs for content, competition with other Pay-TV providers on the national market, and falling revenues caused by Pay-TV piracy (Bajon 2002). Furthermore, in countries with strong free-to-air offerings, such as Germany, Pay-TV providers face strong competition. Recently, Pay-TV providers have concentrated on intensifying their business relationships with their 'good' customers and thus increasing their Average Revenue Per User (ARPU). Table 2 shows the ARPU figures for selected Pay-TV providers during 2000 to 2003.

Pay-TV Provider	**ARPU (€/Month)**						
	2000	Δ	**2001**	Δ	**2002**	Δ	**2003**
BSkyB	37.40	+ 16.2%	43.46	+2.9%	44.71	- 1.0 %	44.02
Canal Digital	28.50	- 2.1%	27.90		n/a		n/a
Canal+ France	26.00	+ 7.7%	28.00	+ 1.1%	28.30	- 7.1%	26.30
CanalSatellite	27.50	+ 4.0%	28.60	- 3.8%	27.50		n/a
Premiere	n/a		24.99	+ 0.8%	25.20	+ 13.3%	28.55
Sogecable	38.00	- 3.2%	36.80	+ 10.7%	40.75	+ 2.0%	41.55
TPS	n/a		n/a		n/a		37.10
TV Cabo	17.50	+ 4.0%	18.20	+ 4.4%	19.00	+ 4.2%	19.80
Viasat	44.40	+ 34.0%	59.50	+ 9.1%	64.90	+ 4.4%	67.75

Table 2 ARPUs of European Pay-TV providers from 2000 to 2003
(Sources: Report Canal+ Group 2001, Report Canal+ Group 2003, Report News Corp. 2001, Report News Corp. 2003, Report Premiere 2001, Report Premiere 2003, Report Sogecable 2001, Report Sogecable 2003, Report Telenor 2001, Report Telenor 2003; own calculations)

PAY-TV CONDITIONAL ACCESS SYSTEMS

Technical Considerations

4 In 2003, Stream and Telepiù fused to Sky Italia.
5 In 2003, Vía Digital and Canal Satélite Digital became Digital +.

Conditional Access Systems (CAS) prevent uncontrolled access to Pay-TV content by encoding TV signals (Jain, Joshi, Mitra 2002). They only give access to users who have special access information, generally a decoding key.
The logical CAS architecture (see Figure 1) can be divided into two essential components: the head-end architecture and the set-top-box architecture (for a more detailed technical description, see, for instance, de Santis and Soriente 2004).
The head-end architecture describes the equipment used by the Pay-TV providers, while the set-top-box architecture describes the hardware used by Pay-TV viewers to decode content. To evade payment, Pay-TV pirates generally manipulate the set-top-box architecture, particularly the smart card and the set-top-box itself.
The set-top-box has two logical components: the conditional access module, into which the smart card is inserted, and the modules that receive and decode transmitted content.

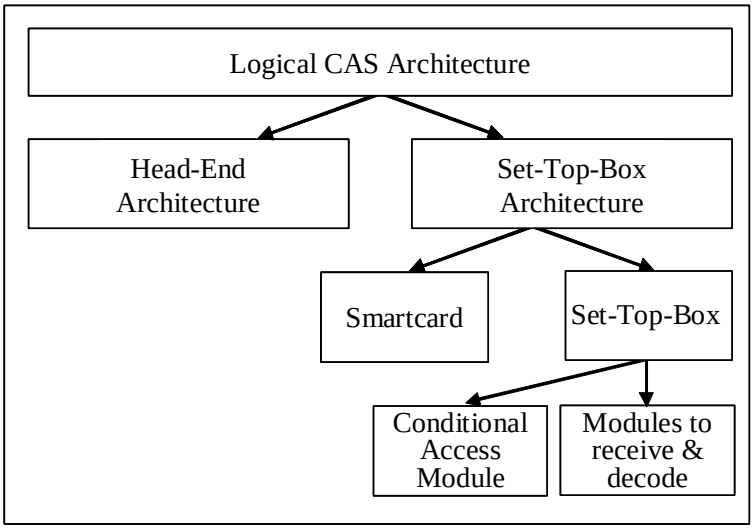

Figure 1 Logical CAS Architecture (After: Boucqueau, Verians 2004)

The connection between the conditional access module and the smart card is the most difficult to protect against piracy; therefore, Pay-TV providers have resorted to frequently changing the decoding key used by their set-top boxes to reduce piracy (Motorola 2002).

Different set-top boxes have different data interfaces. Those with an *integrated* common interface are CAS-independent, which means they can be operated with smart cards from different CAS providers (Jain, Joshi and Mitra 2002). On the other hand, set-top-boxes without an integrated common interface only support a specific preloaded CAS, called Unicrypt. These boxes do not have a conditional access module. While these boxes are less flexible, some set-top box producers still use them because they are simpler and less costly to produce (Boucqueau and Verians 2004). Other set-top box producers (such as Motorola) include both in some set-top boxes, for maximum flexibility.
Overall, though, CAS security is higher with set-top boxes that use a conditional access module because they offer more electronic countermeasures options (EBU 1995). However, this superior security has higher CAS costs (Motorola 2002).
Most Pay-TV providers grant legal access to their encrypted Pay-TV programs by requiring that the smart card, the set-top-box and the conditional access module (if included) all provide authorization. Without such mutual authorization, a computer with hacking software can simulate a set-top box and operate it with an original or modified smart card (Pits Security 2000).

European CAS Market

Table 3 shows the different European CAS encoding schemes their providers, their main customers (Pay-TV providers), and the respective market shares of each scheme, based on number of smart cards and/or set-top-boxes in use. All the CAS encoding schemes in Table 3 use the architecture described earlier, with a smart card and a set-top box.

CAS	CAS Provider	Main Customers / Pay-TV Providers	Market Share
@Sky crypt	Neotion (France)	Free-XTV	n/a
Conax	Conax (Norway)	Canal Digital	1%
CryptoWorks	Philips CryptoTec (Netherlands)	Cyfra+	1%
Irdeto	Irdeto Access (Netherlands)	Nova, Sky Italia	9%
MediaGuard	Canal+ Technologies (France)	ABSat, Canal+, CanalSatellite, Cyfra+, Digital+, Sky Italia	16%
Nagravision	Nagravision (Switzerland)	Premiere, TV Cabo	28%
Viaccess	Viaccess (France)	ABSat, Canal+, CanalSatellite, TPS, Viasat	5%
VideoGuard	NDS (Great Britain)	BSkyB, Sky Italia, Viasat	33%

Table 3 Encoding schemes and providers in the European CAS market
(Sources: European Commission, Boucqueau/Verians 2004, own calculations)

Until the end of 2002, national CAS providers had a monopoly in their own country. The Pay-TV providers only used their national CAS provider. For instance, from 2001 until 2003, Premiere (Germany's Pay-TV provider) used Germany's CAS provider, Betacrypt (BetaResearch, www.betaresearch.de; now: comvenient, www.comvenient.com). However, since 2003, the continuing piracy problems have decreased the loyalty of Pay-TV providers to their CAS providers (Thomson 2003), so the European CAS providers have expanded their offerings internationally. Table 4 shows the CAS migrations of European Pay-TV providers in 2003.

Pay-TV Provider	Old CAS	New CAS	Details
Premiere (Germany)	Betacrypt 2	Nagravision	The customer base was migrated to Nagravision due to the high piracy level.
Telepiù (Italy)	MediaGuard	VideoGuard	Within the scope of the merger of Telepiù and Stream to the new Italian Pay-TV provider Sky Italia the subscribers of Telepiù were migrated to VideoGuard.
Viasat (Scandinavia)	Viaccess	VideoGuard	Due to piracy problems the customer base was migrated to VideoGuard and the set-top-box software was updated.

Table 4 CAS migrations of European Pay-TV providers in 2003
(Sources: Davies 2002d, Davies 2003, Wynn 2003)

PAY-TV PIRACY MARKET IN THE EU

Different Pirate Groups

We distinguish three groups of Pay-TV pirates: (1) Professional pirates, (2) local manufacturers of pirate cards, and (3) home industry pirates.

Professional pirates use sophisticated technical equipment and produce large quantities of pirate cards, which. they produce and sell in a highly professional manner using profit-oriented processes (European Commission 2003b).

Local manufacturers, on the other hand, use far less industrial production methods, but they still cause damage to the Pay-TV industry. They either produce pirate cards from scratch or use commercially available blank smart cards and 'do-it-yourself hardware', e.g., Season Interfaces[6] (European Commission 2003b). Manuals for manipulating smart cards, for building

6 Season Interfaces replace the smartcard in the conditional access module. The Pay-TV smartcard connected with a Personal Computer can be emulated by means of special software.

programming devices, and the decoding keys can be downloaded from the Internet (European Commission 2003b). The URLs are deemed illegal, so they are changed frequently; but they continue to exist.
Besides selling pirate cards, local manufacturer pirates generate profit by selling blank smart cards, programming devices, or complete satellite-reception systems that include pirate cards. Moreover, organized crime often uses local manufacturers as distribution channels for professionally manufactured pirate cards (European Commission 2003b).
Home industry pirates crack coding systems mainly for their own pleasure or as an intellectual challenge. Technically experienced Pay-TV viewers act as hobby pirates, using the same hardware as professional pirates and exploiting information from hacker websites. These self-made pirate cards are used in the pirate's own living room or sold or offered free in small quantities to friends, neighbors, and colleagues. In return, hobby pirates usually receive pirated copies of software, music CDs, or DVDs (European Commission 2003b). As long as they do not publish or sell their approach, they have a minimum effect on the industry.
With the exception of some professionals, pirates depend on private hacker websites to obtain keys, evasion hardware and software, and manuals. These hacker websites - without commercial support - provide the main exchange point for the many players and thus are the Achilles' heel of most non-professional piracy trades (European Commission 2003b).

Market Situation

Pay-TV piracy significantly affects the various players offering legal Pay-TV. With an average pirate subscription ratio of about 30% of legal Pay-TV subscriptions in the EU (Davies 2001) and about 33 million Pay-TV customers, one can assume that about 10 million pirate cards are in use throughout the EU. According to the European Parliament (2003), the sale of products for committing piracy of CDs, DVDs, Pay-TV, and Pay-per-view TV in the EU rose 900% between 1998 and 2001. Organized Pay-TV pirating groups generate a sales volume of up to USD one million annually (Boucqueau and Verians 2004). Table 5 indicates prices and the number of pirate smart cards of selected Pay-TV providers.

Pay-TV market	Pay-TV provider	Price of Pirate Smartcards	Number of Pirate Smartcards	Piracy Ratio of Legal Subscriptions
Germany	Premiere	€20.00 – 60.00	1,500,000	52%
Italy	Sky Italia	€28.90 – 43.30	1-2 Mill.	83 – 125%[7]
Scandinavia	Viasat	€20.00 – 60.00	250,000	25%
Spain	Sogecable	€30.00 – 90.00	100,000 - 300,000	6 – 17%

Table 5 Prices and numbers of piracy smart cards of selected European Pay-TV providers
(Sources: Davies 2001, Davies 2002d, Sellgren 2002, Wynn 2003, own calculations)

The piracy market is characterized by high demand for piracy products, high profit margins on piracy products, and lack of fear of legal consequence on behalf of the pirating manufacturers and consumers (Nagravision 2003). Therefore, directive 98/84/EC by the European Commission in 1998 (European Commission 1998) aimed to strengthen the rights of the European Union Pay-TV industry and right holders as well as increase the effectiveness of counter-measures. Davies (2001), however, believes the Directive contributes to relocating the criminal activity rather than removing it. For example, an increasing number of the websites for pirate cards now originate from Eastern Europe or Africa.
Even though new security solutions make decoding of Pay-TV encoding more expensive and complex, experts assume the never-ending battle between the Pay-TV industry and Pay-TV pirates will continue (European Commission 2003b, Boucqueau and Verians 2004, Wynn 2002b).

Technical Approaches to Circumventing Pay-TV CAS

Pay-TV CAS schemes are cracked mainly by taking advantage of the implementation errors in smart cards, errors in conditional access modules, and weak CAS security protocols (Goudsmits 2004). Moreover, numerous web pages and virtual communities describe, in detail, how to decode CAS encryption and obtain decoding keys. Programming hard- and software, as well as blank smart card, can be acquired legally (European Commission 2003b). These are used to build pirating equipment. Taking these into account, creative Pay-TV pirates have discovered various ways to evade CAS's security safeguards (see Table 6).

7 More than 4.1 million HH in 2002 compared to approximately 1.9 million legally paying Stream and Telepiù subscribers.

Accessory	Description
Modified Original Smart card (MOSC)	Modifying a deactivated or expired original smart card of Pay-TV provider with programming device and appropriate software, so that entire program offers can be decoded. Needed equipment: Set-top box, computer, original smart card, programming device, special software, and decoding key.
Digital Pirate Smart card (DPSC)	Making Pay-TV card out of a legal blank smart card with specific programming device and appropriate software. Needed equipment: Set-top box, computer, blank smart card, programming device, special software, and decoding key.
Season Interface	Using a PC to emulate the interface by means of special emulator software; no smartcard required. Needed equipment: Set-top box, computer/paddle/ Personal Digital Assistant (PDA), Season Interface, special emulator software, and decoding key.
Universal CAS (UCAS)	Pentacrypt or similar software loaded by Magic Module Programmer on chip (manufactured by company SIDSA, www.sidsa.es) of UCAS set-top box or UCAS conditional access module emulating up to six different conditional access systems at a time. Needed equipment: UCAS set-top box /Set-top box with common interface and UCAS conditional access module, computer, if necessary, pirate card, if necessary, programming device, special software, and decoding key.
FreeCAM	Emulating Pay-TV card by manipulating conditional access module with special software; Pay-TV card then becomes unnecessary. Needed equipment: Set-top box with common interface, computer, conditional access module, special software, and decoding key.
DVB Card	Decoding Pay-TV program by modifying the Pay-TV card operating software using a PC; no smart card, no common interface, and no conditional access module necessary. Needed equipment: DVB card, computer, freeware as a substitute for the card operating software with special driver file, and decoding key.

Table 6 Technical possibilities for illegally decoding CAS encryption
(Source: Pits Security 2000)

While expired and programmable smart cards used to be for sale on the Internet (Davies 2001), to the best of our knowledge, in 2004 dealers no longer publicly sell pirate cards or piracy software on the Internet. However, blank smart cards and programming devices, such as UCAS set-top boxes, season interfaces, and multi-conditional access modules for decoding several different CAS are still on the market (Boucqueau and Verians 2004).

ATTRACTIVENESS OF THE PAY-TV PIRACY MARKET

The high profit margins of Pay-TV attract pirates. Some piracy product dealers sell €8,000 to €16,000 worth of products in one day (Boucqueau and Verians 2004). Skillful pirates even bill viewers a monthly fee of approximately €16, providing them updated decoding keys (Boucqueau and Verians 2004). But to avoid having to pay dealers each time the decoding key changes, some savvy viewers acquire a programming device and other evasion hardware and software to maintain their own system (Boucqueau and Verians 2004).

By comparing legal subscription fees to pirate card production costs, we estimate that pirate card manufacturers have a margin of more than 30% during the first year of an annual subscription (see Table 7). These manufacturers achieve a positive cash flow if they sell only eight pirate cards, for €30 each. If, on the other hand, they simply sell a card, not a

subscription for updating the decoding keys, then they only need to sell two pirate cards to amortize their production costs. Purchases of the pirate cards save 88% of a subscription cost if pirate card owners update the decoding keys themselves.

Pay-TV provider and subscription fee		**Production of single pirate card**	
Premiere Super	€28.00	Programmer Infinity USB	€39.00
(Blockbusters & Sport events)	(per month)	Smartcard ATMega 161 PCB	€1.00
		Software (free download)	€0.00
		Subscription for current	€16.00
		decoding keys	(per month)
Costs/year	€336.00	Costs in the first year	€232.00

Table 7 Average subscription fees and production costs of single pirate card for first subscription year including purchase of programming device and smartcard (Source: own calculations)

Pirates sell programmable blank smart cards, such as the FunCard PCB, for €2.50 up to €19.95, achieving an average margin of almost 360%.

Despite high profit margins for Pay-TV marketers, and lower 'subscription' rates for consumers, pirate products do have disadvantages as well.

Illegal Pay-TV consumers often encounter program interruptions as a decoding key change; they need an update to capture the signal again. These interruptions might encourage formerly illegal viewers to legally subscribe to avoid the complicated and expensive process of obtaining regular updates (Boucqueau and Verians 2004).

Finally, the interaction between Pay-TV providers and set-top boxes is becoming increasingly automated as interactive TV services spread. It may render Pay-TV piracy less attractive because the Pay-TV providers can identify pirate cards or pirate set-top-boxes faster and more easily. Consequently, pirates may switch to non-interactive offerings. Assuming limited attractiveness of such content, pirate Pay-TV providers may retire from the market in the short to medium term (Boucqueau and Verians 2004).

ECONOMIC EFFECTS OF PAY-TV PIRACY

Pay-TV piracy redirects revenues of Pay-TV providers to Pay-TV pirates. Moreover, revenues to writers, screenwriters, artists, actors, musicians, and other content producers are reduced by piracy.

Economic Effects on CAS providers

Pay-TV piracy requires CAS providers to invest substantially in integrating complex anti-piracy mechanisms into their system and continually upgrading their system's general security (European Union 2003). These companies employ, on average, ten experts (Boucqueau and Verians 2004) for investigation, observation, legal prosecution, analysis of piracy activities, and development of counter measures and smart card technology. Maintaining technical security alone requires annual investments of approximately €5 to €10 million per provider (Boucqueau and Verians 2004).

The demand for illegal UCAS set-top boxes, which can be easily manipulated, is increasing in the consumer market (Mueller 2004). To avoid decreasing their licensing fees, CAS providers are integrating their systems into the set-top boxes. The average annual loss to CAS providers from piracy amounts to 5% of their total revenues, depending, of course, on the number of subscribers who manipulate their smart cards (Boucqueau and Verians 2004).

Indirectly, CAS providers also suffer losses from piracy when they gain a bad reputation, and hence lose their customers (that is, the Pay-TV providers) (Boucqueau and Verians 2004). To keep these customers, most CAS providers now offer anti-piracy insurance, where they agree to exchange all smart cards for free if those cards have been hacked by pirates. For example, the company Irdeto (www.irdetoaccess.com) offers a regular exchange of its current generation of smart cards every twelve to eighteen months, so that in case of piracy, only the cards of the hacked generation must be swapped (Thomson 2003). Without such insurance, Pay-TV providers themselves must bear the cost of swapping their smart cards.

Economic Effects on Pay-TV providers

According to Boucqueau and Verians (2004), Pay-TV piracy leads to lower average subscription rates and annually falling Pay-TV revenues. Some Pay-TV providers have seen their revenues decrease by €10s of millions. This drop is not only caused by having fewer subscribers but also by pirate viewers replacing premium subscriptions with cheaper basic packages, which they then enhance with illegally bought premium content (European Commission 2003b).

As a result of the decreasing profitability, Pay-TV providers' invest less in program content (Nagravision 2003), close

channels, or postpone planned premium channels (Wynn 2002a). Piracy thus threatens program and service quality due to the revenue losses and costs increases along the Pay-TV value chain (Nagravision 2003).

If CAS providers cannot reduce piracy to an acceptable level using technical anti-piracy measures, the only option left to Pay-TV providers is to regularly swap smart cards or even upgrade entire systems. Obviously, both measures significantly increase their operating costs: Swapping one rented set-top box costs about €11. Exchanging or upgrading a smart card costs €0.04 to €0.20 per month. Moreover, personalizing smart cards (i.e. connections with individually subscribed Pay-TV channels with personalized access for end-consumers) costs about €10. Another €10 have to be taken into account as investment costs for the smart card itself. For example, a swap of smartcards for one million subscribers would amount to some €20 million altogether (Davies 2002b).

Also, large swap actions may cause compatibility problems with existing smart cards and the set-top box. Furthermore, viewers who legally subscribe to basic TV services and, on top of this, illegally receive premium services, may quit completely when they are notified of the upcoming card swap (Davies 2002a). Hence, due to the high costs, many Pay-TV providers continue to use their systems, which they know have been hacked, without exchanging smart cards (Boucqueau and Verians 2004).

CONCLUSIONS AND OUTLOOK

At present, Pay-TV consumers decide between a cheaper, illegal pirate card and a more expensive, legal monthly subscription. New sophisticated security solutions implemented by CAS providers make piracy more expensive and thus less attractive. Apart from such new security solutions, the increase in interactive services could lead naturally to less piracy. By the interaction of each set-top-box with the Pay-TV provider, pirate cards or –set-top-boxes can be identified faster and easier. So, pirates are obliged to change their offer into a non-interactive one (Boucqueau and Verians 2004). Due to the less attractiveness of the non-interactive content, pirates could sell their products only at a very low, non-profitable price. In the long run, this could lead to a withdrawal from the piracy market. But as most CAS architectures and technologies are designed for one-way satellite broadcast; they would have to be enhanced to handle two-way communications.

Global cooperation in the Pay-TV industry, among the legal bodies, and technical laboratories may also significantly reduce Pay-TV piracy. High subscription prices keep many potential customers from buying a Pay-TV package and make it interesting to receive the program illegal but free of charge. Finally, a higher percentage of legally paying Pay-TV subscribers can lead to decreasing subscription prices, which, in turn, could draw more people into legal subscriptions.

Overall, market developments are leading in the right direction. Since 2002, mergers and integrations in the European CAS market have impaired the relationships between national Pay-TV providers and their respective CAS providers. Foreign entrants have arrived on the European CAS market with new technologies and services, leading to lasting competition on the market. If smartcards and set-top-boxes were sold or rented only by Pay-TV providers, piracy would become more difficult because of better monitoring possibilities (Boucqueau and Verians 2004). As long as piracy equipment like programmable smartcards and set-top-boxes can be bought without restrictions, piracy will continue. However, most likely, the combat against Pay-TV piracy will never end.

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