Digital Switchover in Broadcasting

A BIPE Consulting Study for the European Commission (DG Information Society)

Annexes :

Part 1: Cost Benefit analysis

Part 2: Spectrum

Part 3: Technological migration

Part 4: Secondary sets

BIPE

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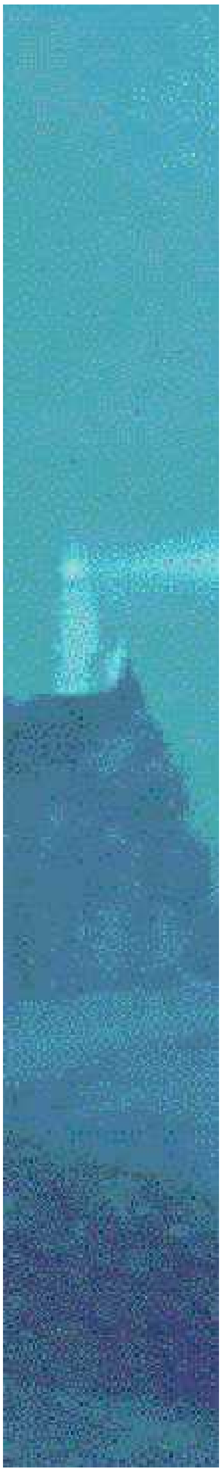

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Part 1 :
Cost Benefit Analysis

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1 Synthesis

- A cost-benefit analysis of a public-policy decision involves establishing the positive or negative impact of the envisaged decision in monetary terms. It enables a user to aggregate *all* of the costs and benefits, regardless of which economic agents are responsible for them directly or indirectly. And it enables us to reason "macro-economically".
- **Two types of decisions have to be taken** by governments within the framework of migration to digital, i.e. concerning **the chosen infrastructure** and **the chosen timing**.

Firstly the chosen infrastructure.

- Should a move be made to digital through the sole use of cable and satellite broadcasting/reception platforms which are *already* being digitised via market forces and which have already found their digital model (**cabsat way**)? In this case, households which currently receive terrestrial television would have to be migrated to cable or satellite reception; the total radio spectrum used today for terrestrial television could be reused for other wireless communication purposes.
- In contrast, should investments be made in digitising terrestrial broadcasting with the prospect of maintaining three modes of television access sustainably (**triple way**)?
- As managers of the radio spectrum, it is up to national Governments to decide whether it is appropriate to continue using UHF/VHF bands for television.
- BIPE has examined the **costs which are specific to each of these regulatory scenarios**: costs of DTH deployment, costs associated with migrating to cabsat, the spectral opportunity cost when VHF-UHF bands continue to be "tied up" and the "competition opportunity cost" when a change is made from three to *two* broadcasting/reception platforms available.
- BIPE has constructed a quantitative model to test and compare the costs of the two scenarios in various market configurations. It appears that the factors determining the optimum choice are: (i) **the initial television landscape** and notably the terrestrial vs. cabsat proportional ratio, (ii) the technical choices (number of multiplexes, coverage, indoor reception or not, etc.), (iii) the political assessment of non-quantified costs or risks (like the competition risks) and (iv) **hypotheses for valuation of the spectrum**. The first and fourth points are clearly those which carry the most weight.
- We have compared the scenarios in **several national contexts**, with a spectrum valuation which we consider prudent of 0.01 euro per Mhz per year and per inhabitant covered. In cabsat dominated countries, the deployment of DTH and tying up frequencies costs much more than migrating terrestrial households to cabsat platforms which are already multichannel and in the process of being digitised (EUR 2,200 million compared with EUR 500 million over 10 years for a medium-sized country).

Inversely, in countries which are predominantly terrestrial today, the cost of total migration to cabsat would be higher than the cost of digitising households which are already terrestrial combined with the spectral opportunity cost (EUR 5,000 million compared with EUR 3,200 million over 10 years).

The questions of regulatory support and the timing of the migration then arise.

- **Will governments have to adopt measures aimed at accelerating the process** (and if yes, which ones) **or should they simply allow market forces to act?** The historical precedents, the presence of chicken-and-egg effects, externalities and co-ordination difficulties lead us to adopt the view that **the process could actually progress more rapidly with government intervention** and that the final expected benefits of digital migration would consequently create an impact *more quickly*.
- Among the final benefits expected, some are linked to the **introduction of digital broadcasting**: (i) additional economic activity (ii) a lowering of barriers and an increase in the level of competition resulting from the existence of three digital networks. Other sought-after benefits arise more from the universal transition to all-digital and the **turn-off of analogue broadcasting**: (i) a drop in broadcasting costs (notably for terrestrial broadcasting), (ii) a release of analogue frequencies which facilitates enhanced use of the spectral resource and even improved fiscal receipts for the community (exclusively with terrestrial broadcasting), (iii) a prevention of the "digital divide", given that universal digital television is seen as a rapid, inexpensive way for everyone to enter the information society.
- These benefits do not always affect the same economic players. We therefore study them separately, although we also have to **aggregate them to try to identify the general interest** which must guide public decision-making.
- Taking steps to achieve these benefits more rapidly also implies **making the necessary investment** in networks and terminal systems **more rapidly**.
- By ensuring that investment (which would have been made in any case) is approved sooner by economic players, a government **is increasing the global cost of migration.** This occurs for two reasons: (i) an added immaturity cost (as the technology is less mature, the equipment is correspondingly more expensive the earlier it is acquired) and an (ii) added financial cost (an investment made today costs more than the same nominal investment spread out over several years due to the interest which this sum could have earned in the meantime). The risks linked to public intervention (competitive distortion and moral hazard risks) have to be added to this cost.
- We therefore need to compare the **effective added cost due to early investment** and the benefit resulting from the **early impact of final benefits**.
- Here again, a quantitative model has enabled us to compare the sum of the measurable benefits (spectral gains and broadcasting cost savings) and the measurable costs (added financial cost resulting from early migration). The most sensitive variables with the most decisive effect on the results are again the initial television landscape and the frequency valuation hypothesis.

- A simulation carried out for a country of 23 million households with 70% made up of analogue households and a Mhz valued at 0.05 euro/year/inhabitant generates a **positive balance (benefits exceeding costs) of approximately EUR 2.3 billion if the migration is completed in three years rather than in ten** (the supposed duration of "natural" migration). This result then has to be rigorously corrected to take account of non-quantified costs and benefits (risks of distortion, added economic activity induced, prevention of the digital divide), but we think that it is possible to avoid distortions by adopting measures which are technologically neutral and platform neutral.
- All other things being equal, if a Mhz is valued at 0, the balance becomes very slightly positive and therefore not significant given the approximations used. **The hypothesis adopted for spectrum valuation is therefore of crucial importance.**
- All other things being equal, if the country's initial profile is varied, it is clear that the fewer the number of remaining analogue households to be converted, the more interesting it is to undertake this early. **Cabsat countries have a greater interest in accelerating migration than others**.
- In a platform-neutral approach, digital migration and the analogue turn-off of all platforms used has been envisaged up to this point. Yet, the most quantifiable and largest benefits essentially derive from *terrestrial* migration/turn-off (analogue terrestrial broadcasting costs, spectral cost/gain). In other words, it is not necessary to assume completed migration on all platforms to be able to achieve these two benefits; **initially, turning off terrestrial analogue broadcasting is enough**. This change of perspective occasionally alters the cost/benefit diagnosis significantly. In the case of a country such as Germany, the cost of migrating *all* of the 90% of viewers in analogue households had been taken into account up to this point; in this new approach, account is only taken of migrating the 8-10% making up analogue *terrestrial* households. As the measured benefits remain the same, the result is much more clearly positive (EUR 5,500 million compared with EUR 2,500 million with optimum timing).

It is possible (and perhaps more realistic) to imagine the public powers intervening to co-ordinate and accelerate terrestrial analogue turn-off, whereas in a *second* phase, market forces could organise overall migration to digital *within* each platform without difficulty.

In the preceding section, no exact assumptions were made as to how the public authorities could accelerate migration. We therefore now need to raise the question of government intervention modalities.

- BIPE has reviewed the **range of different measures imaginable** or envisaged by the public authorities, aimed at accelerating migration towards all-digital plus the turn-off of analogue broadcasting and/or reducing the migration costs borne by consumers.

- Some measures may affect **consumers** (elimination of taxes which helps to absorb some migration costs and the promotion of information campaigns), reception equipment **manufacturers/distributors** (a ban on the sale of reception equipment which is “incompatible” with digital or to achieve a similar effect, compulsory labelling of products concerning their compatibility for digital signals), **television operators** (taxation of use of the spectrum, encouragement for terrestrial analogue broadcasters to migrate and to migrate their viewers to terrestrial, cable or satellite digital) and **other potential users of VHF/UHF frequencies** (encouraging them to reveal their utility via a frequency reservation mechanism would make it possible to measure the economic value of accelerating the process and financing it).
- Finally, other measures essentially would involve sending **political signals** to all of the players concerned to enable them to co-ordinate their acceleration efforts and to optimise their migration cost, thus providing the criteria and an indicative time frame for completing migration, and even an imperative turn-off date. The latter tool is two-edged: if turn-off is imposed against the will of some of the players, any threat must be politically credible: otherwise, the measure will be counterproductive because it adds uncertainty instead of removing it.

Finally, BIPE has focused on one of these measures by analysing the advantages and disadvantages of a <u>compulsory digital tuner</u> measure.

- We think that a measure of this type would be **useful** in the sense that it would produce the sought-for effects: mechanical acceleration of migration by the automatic conversion of all households which replace their TV set (all households would be equipped with at least one digital terminal in 8 years, the average life-span of living-room TV sets).
- We do not think that it is **essential**, to the extent that other solutions exist and, for example, distributing external digital converters could produce almost similar effects.
- Finally, we believe that the **cost/benefit balance is an uncertain factor** here. It depends on (i) the national context (notably the current and future penetration of pay TV) and (ii) the political evaluation of certain effects which are difficult to quantify, such as the **risk that a measure of this type will favour dominant access platforms and free-to-air television** to the detriment of competing platforms and pay TV respectively.
- However, we think that the potential benefits will exceed the slight added cost and the risks attached to a measure of this type in the majority of cases, if steps are nonetheless taken to limit risks of competitive distortion to the greatest degree possible.
- Finally, it must be stressed that this analysis only covers minimum-level integrated digital televisions (IDTVs), i.e. a screen with a “digital tuner” integrated in series. **It cannot be extrapolated to an “extended” IDTV,** which would incorporate various other functions (payTV “module”, memory, built-in API, etc.) and would involve a much more significant added cost.

1.1 Presentation of the costs/benefits tests carried out by BIPE

The different cost/benefit analyses exercises (or “tests”) which were implemented have been set out below.

Test 1: Rationality of tri-platform migration

This test involves comparing (i) the cost/benefit balance of a migration carried out via the *three* platforms (thus inducing digitisation of the terrestrial platform) and (ii) the cost of migration carried out exclusively via the two other *already* digitised platforms (triple way vs. cabsat way).

It should be remembered that as Governments exercise the community’s right of ownership over the radio spectrum, it is *up to them* to decide whether utilisation licences may or may not be allocated for analogue or digital mode television. Thus the ***very* existence of terrestrial television depends on a national political decision**, whereas television broadcasting via satellite is undertaken within a supra-national framework, at least on the transmission side.

Test 2: rationality of accelerated migration relative to “natural” migration (urged switchover vs. sit-back scenario)

This test involves analysing the economic logic of measures aimed at accelerating digital migration. This rationality can be examined in a *private* framework (dealing with one economic player in particular) or a *public* framework (by adopting the point of view of the *entire* public community’s interest).

2a: Private (or “micro-economic”) logic: to what extent and in what conditions could private players be tempted to finance measures aimed at accelerating digital migration? The private players which could implement this type of policy for example include analogue channel broadcasters, who will make substantial savings on broadcasting costs following analogue turn-off on satellite and especially on the terrestrial platform. However, it is also possible to imagine potential new users of frequencies released by a turn-off of analogue terrestrial broadcasting.

2b: Public (or “macro-economic”) logic: to what extent and in what conditions could public authorities be tempted to finance measures aimed at accelerating digital migration because of the expected “macro-economic” or “social” benefits expected from more rapid digital penetration and turn-off than those which would occur spontaneously?

In the two cases (2a or 2b), we will examine the difference between the costs and benefits of a **reference scenario** (which can also be referred to as spontaneous or underlying), in which it is assumed that migration takes a certain number of years, and those associated with the tested **voluntarist scenario**.

Test 3: Rationality of a decision on a "compulsory digital tuner"

In test 2, we have essentially studied the impact, costs and benefits of measures aimed at accelerating migration through action which reduces the migration costs borne by consumers. It is also possible to imagine accelerating the process by making the incorporation of equipment which enables each television set sold to receive digital television signals compulsory[1].

1.2 The main regulatory scenarios to be tested

The main regulatory scenarios identified by BIPE are restated here.

A first path, scenario A, involves using the *terrestrial* broadcasting network as well as the two cable and satellite networks which are already undergoing digitisation. Given that use of the terrestrial mode depends on a public decision and that it consumes a scarce public resource, it is normal to raise questions about the benefits and disadvantages linked to a decision of this type.

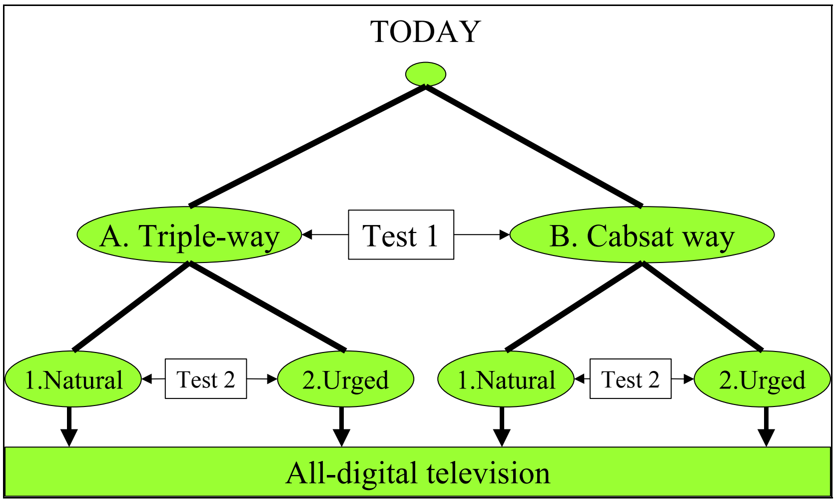
There is a second path, which comprises our scenario B. To move from analogue television to all-digital television, it is possible to migrate viewers to the two networks which are *already* suitable for transporting digital signals in the majority of cases or will become suitable in the near future, i.e. cable and satellite. As such, transponders (transmitters) installed on geo-stationary satellites can equally transport signals modulated in digital mode without a major specific added cost; for their part, cable networks have been largely earmarked for transformation into "broadband" networks and may become supports for high-throughput Internet services, on-demand video and digital television.

It is therefore possible to imagine all households migrating to cable and/or satellite reception over time, in which case, terrestrial broadcasting would be abandoned due to it becoming superfluous. **In this scenario, there would be no introduction of digital terrestrial television**: analogue terrestrial households would migrate to digital cable and/or satellite before a final terrestrial turn off occurs.

Alternative A vs. B will form the subject of Test 1.

[1] This type of measure is currently being studied in the USA and the United Kingdom.

Figure 1: The regulatory scenarios for digital migration



If we now place ourselves in a situation where a political decision to introduce digital terrestrial broadcasting or not to do so has been taken, a second public choice arises, i.e. **the degree of encouragement of migration and its mode**. What are the expected costs and benefits associated with intervention aimed at **accelerating** the rhythm of migration?

Alternative 1 vs. 2 (natural vs. urged switchover) will form the subject of Test 2.

Test 2a will study the relevance of private investment aimed at accelerating migration.

2 The costs of migration

In this section we analyse the main types of costs likely to be borne by the players involved in migration to all-digital television.

All of these costs are not of the same nature. Some are necessary for the "digitisation" of infrastructure and therefore needed for the introduction of digital **broadcasting** (turn-on); others are linked to the migration of digital **reception** equipment and are therefore needed for analogue broadcasting turn-off.

Table 1: The costs of digital migration

No	Cost	Platforms	Who bears these costs (in the first instance) ?
C1	**Digitisation of reception**	Addition or update of aerials or satellite dishes.	Consumer (satellite dish or update of aerial occasionally financed by a pay TV services provider).
C2	**Digitisation of terminals**	Addition of analogue/digital adapters to television sets and video recorders or replacement by "integrated" digital equipment (IDTV). Similar cost on the three platforms.	Consumer (or his pay TV supplier).
C3	**Digitisation of transmission infrastructures**	Updating of existing infrastructure (marginal for satellite, significant for cable and terrestrial).	Network and/or transmission (TSP) operator.
C4	**DTH interference** on cable	Specific to DTH.	Network and/or transmission (TSP) operator.
C5	**Cable interference** on DTH	Specific to digital cable	Cable network operators and/or consumers using these networks
C6	**Risks of competitive distortion**	Risk that the public decisions, if not technologically neutral, could adversely affect certain platforms in a way which may be disproportionate to the sought-for benefits.	Satellite and cable network operators. Broadcasters or operators of pay services which mainly use these networks. Consumers using these networks.
C7	**Risk of industrial failure and moral hazard**	Specific to the platform which is most likely to lead to public intervention: DTH.	Risk of wasted public resources (subsidies, frequencies). Risk of wasted private resources (poorly directed investment).

2.1 Comments on the costs

2.1.1 C1/2 - Reception

Starting with an analogue equipment situation, the consumer has to: (i) upgrade reception equipment (aerial for DTH, satellite dish for direct satellite reception) (cost C1), and (ii) upgrade his receivers via a digital-analogue adapter or a new integrated digital receiver (cost C2)

These costs are specific to each household, even where the former may occasionally be generated at the level of the collective housing unit. They are borne by consumers, or sometimes by their pay TV service provider, who makes the equipment needed to receive digital signals available on hire or gives it away.

2.1.2 C3 – Broadcasting networks

The different networks have to be upgraded (C3) to be able to broadcast signals in digital mode.

In the case of direct satellite broadcasting, the additional investment is marginal. The transponders in service, of which there is a surplus, can change over from analogue to digital broadcasting at a marginal cost.

In the case of terrestrial broadcasting, whereas the majority of broadcasting sites can be used for digital broadcasting (notably if MFN planning is maintained), the transmitters have to be changed and new transmitters have to be added, as no excess broadcasting capacity exists.

While heavier investment is required in the case of cable networks, it will be depreciated on a portfolio of services which is increasingly less limited to television.

This investment will be borne by the network owners and/or operators.

We place ourselves in a framework where the broadcasters have already made the investment needed to *produce* a digital flow. We therefore assume that it does not bear any specific cost a priori within the framework of expansion of digital *reception*.

2.1.3 C4/5 - Interference

Terrestrial digital television can generate interference on cable networks (C4) and vice-versa (C5).

Preventing or treating this interference will represent a cost, whether this is borne by the "polluter" or the "polluted party".

2.1.4 C6- Competitive distortions

If government measures are taken and are not strictly neutral relative to networks and technologies, these measures may have the “collateral” effect of creating a competitive advantage for certain platforms, to the detriment of the others.

2.1.5 C7 – Risk of industrial failure and moral hazard

The risk of moral hazard is also inherent in public intervention itself: some market players (consumers, equipment manufacturers and operators) are actually likely to *anticipate* incentive measures and even to draw up a business plan on the basis of their existence, with the measures in question thus seeming to be necessary *a posteriori*.

Government incentive measures may have the effect of orienting players and investors towards platforms or business models which would not be profitable in the long term, in which case the operators concerned could turn on the Government to force it to *make* the activity sustainable.

3 The benefits of migration

We will not spend time here on the benefits of digital television in general. We focus solely on the **benefits resulting from public choices** concerning the *infrastructure*, *extension* and *timing* strategy for migration.

No one disputes that in the long term everyone will receive television in digital format. Everyone recognises that a process based exclusively on market forces will take a long time. The problem is therefore not substitution per se, but its **pace**. This is because the faster digitisation occurs the faster the analogue turn-off will be implemented and the earlier the benefits of digitisation will be able to spread through society. The level of preference for the present, comparable to the interest rate, will therefore be a key variable in the assessment of private or public policies aimed at influencing the speed and duration of migration.

It is important to remember that some benefits are gained simply by *introducing* digital television (turn-on) and reinforced by the extension of its *reception* (B1, B3), whereas others are solely linked to the *turn-off* of analogue broadcasting (B2, B4).

Table 2: The benefits of digital migration

No	Benefits	Linked to	Platforms	Who benefits? Comments
B1	**Added economic activity** generated by digital television	Turn-on	All	Consumers, providers, t-traders, the entire economy
B2	**Lower broadcasting costs** at the end of the simulcast	Turn-off	True on all platforms. Particularly significant with terrestrial broadcasting, where the analogue transmission costs borne by generalist national channels are very high.	Broadcasters: existing analogue broadcasters (channels, pay TV operators)
B3	**Increased degree of competition** in the multichannel television market	Turn-on	**Specific to the "triple-way" scenario** in which a third multichannel broadcasting platform appears	Consumers (greater choice of access), channel publishers (greater choice of broadcasting networks), multichannel pay TV operators (assuming that they themselves are platform-neutral)
B4	**Spectral gains** Optimisation of radio spectrum management.	Turn-off	True for all platforms but particularly sensitive in the context of terrestrial broadcasting where frequencies are "wasted" in analogue mode and where possible alternative uses are clearly identified.	The entire community (improved use of a scarce public asset) ; potential new users of released frequencies; the State (fiscal receipts derived from the hire of new frequencies and/or newly created economic activities.
B5	**Prevention of the "digital divide"** (=universal access to digital television considered as a means of accelerating the transition to the "information society"	Universality (=turn-off)	True with any platform, but the public decision-makers at the source of this concept tend to prefer the *terrestrial* platform which in the past formed the main support for free-to-air television in the majority of countries.	The entire community. The benefit is only gained if digital reception is universal, which in practice comes down to being able to turn off analogue broadcasting.

4 Measuring the costs and benefits

4.1 Costs

4.1.1 C1 – "Digitising" reception equipment

Transition from terrestrial analogue broadcasting to terrestrial digital broadcasting requires modifications to the stock of antennas. In the UK, approximately 30% of households wishing to subscribe to ONdigital have had to modify their antenna[2].

a) For terrestrial reception

In a collective housing situation, the cost of upgrading collective aerials (modification of the filters), based on the average number of apartments, is estimated at 150 FRF (€23) per household[3]. As regards individual housing units, the average intervention cost is estimated at 250 FRF (€38) per household. In 10% of cases, changing the filters is inadequate and the aerial has to be modified completely at a cost of 1,000 FRF per household (€150).

b) For direct satellite reception (DTH)

In a collective housing arrangement, installation of a satellite dish on the roof of a building plus a demodulator is estimated as costing €1,500 on average[4]. The cost of cabling is estimated at €6,000 on average. The total cost of satellite connection is therefore estimated at €7,500, i.e. €375 per household if an average of 20 apartments per building is assumed.

The cost of a satellite dish for an individual housing unit is estimated at approximately €150.

4.1.2 C2 – Digitisation of receivers

Current televisions are analogue. They can only receive digital signals if they are equipped with an adapter incorporating a digital tuner/demodulator (which can be a terrestrial, cable or satellite tuner) and an MPEG demultiplexer.

On the basis of our meetings and the advertisements published by manufacturers, we can state that simple converters (equipped solely with these two components) could come on the market very soon at posted prices of €150. It is also clear that this price should fall rapidly in the coming years, thanks to technological maturation and economies of scale for DVB equipment achieved at European and global scale.

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[2] Source : CCI interview.

[3] Source : Canal+, SNIDA.

[4] Source : satellite operators interviewed by BIPE.

4.1.3 C3 – Network updating to support digital transmission

In terrestrial broadcasting, the cost is related to (i) the technical choices (that determine whether or not existing masts can be used), (ii) the topography of the country (which determines the number of masts needed), and (iii) the targeted coverage. Factors (i) and (iii) depend on policy decisions. In all countries a decision was made to re-use existing broadcasting sites in MFN (even if it is not necessarily the best *long-term* choice in terms of spectrum efficiency), so that the most critical factor is in fact (iii) i.e. the target coverage.

We have gathered the following indications about the costs.

The combined NTL/CCI investment to roll-out DTH transmitters has been about £150m (€240m), i.e. nearly £2m (€3.2m) per site.

According to our interviews with Teracom, CCI and TDF, the necessary investment to upgrade an existing site in order to support digital transmission is about 3.5 MF or €530,000 per multiplex (for up to 6 digital multiplexes). This amount takes into account: construction, engineering and transmission equipment. This leads to the following examples.

	MF	M€
Upgrade one site for one multiplex	3.5	0.53

	Coverage targeted	Nb of sites needed	Nb of muxes	Cost (M€)
France	70%	90	6	289
France	80%	200	6	641
Sweden	70%	38	4	81
UK	70%	80	6	256

Source : BIPE (PM)

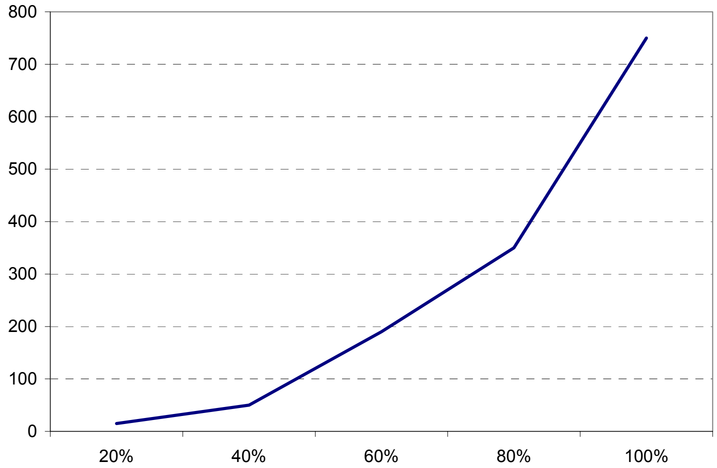
In Italy, RaiWay's Stefano Ciccotti[5] recently stated the following relationship between target coverage and necessary investment. The Ministry of Communications was asked to take it into account before stipulating any coverage for licensees. It was made clear that RaiWay would not bear this investment alone and that at a figure exceeding 80%, public subsidies would become essential (which is a way of saying that the investment could not be privately recouped through any business scenario).

5 Source : Reuters/Inside Digital TV (05/10/2001).

Table 3 : Cost of a DTH network in Italy depending on the target group

Population coverage	Investment in millions of euros
20%	15
40%	50
60%	100
80%	273
96%	750

Figure 2: Cost of a DTH network in Italy depending on the target group



4.1.4 C4/5 – Management of interference costs

While interference in both directions may exist, the main interference to be taken into account is DTH interference on cable networks. In practice, DTH uses the taboo channels which are traditionally used by cable networks because they are not used by analogue terrestrial broadcasting. Initial experience with DTH has revealed problems in the Netherlands, although few problems have been reported in Sweden, Spain or the United Kingdom.

In France, the association of cable operators (AFORM) has estimated that the total cost of adaptation could reach €150m[6] for three million subscribers, i.e. €50 on average per subscriber, although it does not give details of the calculation mode.

There are two ways of avoiding interference: either modify the frequency planning in cable networks or "shield" the cables. The second solution is generally considered less costly and simpler to implement. While installations in buildings are generally shielded, the connection leads used between the wall socket and the television set are sometimes unshielded.

[6] Source : Les Echos, 15/10/2001.

We have retained the hypothesis that 20% of households subscribing to cable are likely to suffer interference and that this can be dealt with by providing a simple replacement shielded connection cable at an average cost of €20.

4.1.5 C6/7 – Risks associated with public intervention

We do not intend to measure this cost in monetary terms. We shall evaluate the net cost/benefit result (excluding systemic risks) and will then ask whether a potential positive balance is qualitatively proportionate to the identified C6/7 risks.

4.2 Benefits

4.2.1 B2 – Saving on broadcasting costs

For one individual channel, digital terrestrial broadcasting will be much cheaper than that in analogue format. However, there is a dual cost between digital turn-in and the analogue turn-off (i.e. during the simulcast period). We therefore need to assess the current analogue broadcasting costs to evaluate the benefits of digital conversion and the potential savings achievable with early turn-off.

In Germany the cost of a nationwide analogue transmission is DM 150m per annum (€76m). As there are three nationwide channels (ARD, ZDF, RTL), and considering that various private stations use terrestrial broadcasting to cover some parts of the country, the current spending on analogue terrestrial broadcasting is about DM 500m (€250m)[7]. According to the Baden-Württemberg State Institute for Communication, the annual cost of broadcasting one channel in stationary analogue mode is DM35m (coverage 99%), whereas it would cost between DM 5m (60% coverage) and DM 25m (95% coverage) in digital with portable indoor reception. Were stationary reception selected, thus making DTH features similar to those of analogue terrestrial broadcasting, the annual costs for 95% coverage would fall to DM 10m. Extrapolated to nationwide transmission, the cost could amount to DM 40-50m (€25m) as against DM 150 (€75m) [8].

In France, we estimate that the six nationwide networks (more than 4,000 transmitters covering 99% of the territory, less for M6, C+ and 5/Arte) pay TDF an average FRF330m per year (€5m), thus making a €300m annual expense.

In Sweden, the three nationwide networks (SVT1, SVT2, TV4) pay a total SEK734m (€76m) a year[9].

In the UK, CCI’s broadcasting revenues in 1999 were $110m. If we add the revenue generated by NTL, we estimate the global cost for 5 nationwide channels at €150m.

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[7] BMWI Launch scenario 2000 (p56).

[8] BMWI Launch scenario 2000 (p56).

[9] Source : Teracom interview.

4.2.2 B3 – Competition

This benefit only occurs in the conceptual framework of test 1. "Triple way" migration presents the advantage of creating a third multichannel broadcasting platform which is available to upstream players (channels, pay TV operators) and downstream players (consumers), whereas the pure and simple disappearance of terrestrial broadcasting would limit the choice and competition relative to the current situation.

There is no doubt that a "triple way" migration offers advantages over the cabsat scenario, which would end up restricting consumer choice in the television area. However, the debate could be widened to include electronic communication and it is worth noting that if television releases the UHF and VHF band (or in any case, cease to be the only service possible on this band by regulatory structure), new multimedia and mobile electronic communication services can be deployed, thus making it possible to licence new operators and to increase possibilities available to content providers and consumers in this domain.

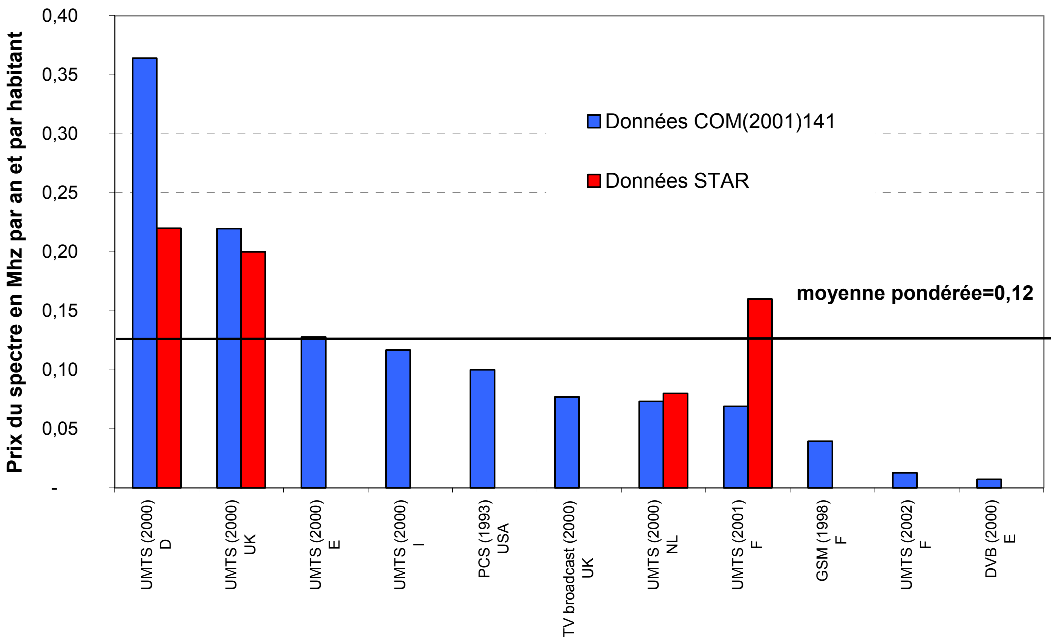
In any case, this potential benefit will not be quantified here.

4.2.3 B4 – Gains in spectrum management

Given that we have to monetarise benefits in order to be able to aggregate them, we will assume that the released frequencies are allocated to the new users and that the revenues derived from this hire correspond to the maximum economic utility.

To obtain references concerning the value of frequencies, we have examined the prices reached historically by Mhz in different auction or hire configurations in Europe and the USA.

Figure 3: Some historical examples of valuations for the use of frequencies



Sources : BIPE (PM) from ANFR, Digitip, ITC, COM(2001)141, STAR

4.2.4 B5 – Preventing the risk of the "digital divide"

Among other things, organised turn-off is the only means of digitising groups which would not be digitised by pure market forces or would only be digitised much later, within a reasonable time frame. This benefit in terms of social cohesion will not be measured here, as it involves an essentially political assessment.

It can be argued that there is a means of preventing the digital divide by **targeted measures** aimed at the groups concerned, rather than via a *global* policy of transferring financing, for example.

5 Test 1: "triple way" or "cabsat way"?

The objective of this section is to analyse the benefits and disadvantages of the "triple way" on the one hand, which involve migrating to digital while keeping digital terrestrial broadcasting and the "cabsat way" on the other. In this latter scenario, it is not necessary to introduce digital terrestrial television; consumers migrate to cable and/or satellite reception platforms which are already being digitised.

Figure 4 : Comparative advantages of the two scenarios in test 1

Triple way

Benefits	Costs
Maintenance of triple access (practicality, choice for the consumer, competition in the transmission market)	Need to upgrade the terrestrial broadcasting network
Partial reuse of existing transmission and reception infrastructure	Limitations on release of the spectrum (opportunity cost)

Cabsat way

Benefits	Costs
Potentially total release of the radio spectrum	Migration to cable or satellite reception for households previously equipped for terrestrial reception
Some consumers access a highly multichannel environment	

5.1 Simulation Zero

We assume an imaginary country with 20 million TV households. 60% of housing units are collective. The buildings contain 20 apartments on average; 12 million households live in 600,000 buildings.

Equipment hypotheses are introduced depending on the housing unit concerned. To simplify, it is assumed that the cabling for the territory has reached maturity and that all households (in collective or individual housing units) in the cabled area are effectively connected to cable. It is assumed that some buildings are equipped for collective satellite reception and that in this case, all of the households in the building have a satellite access.

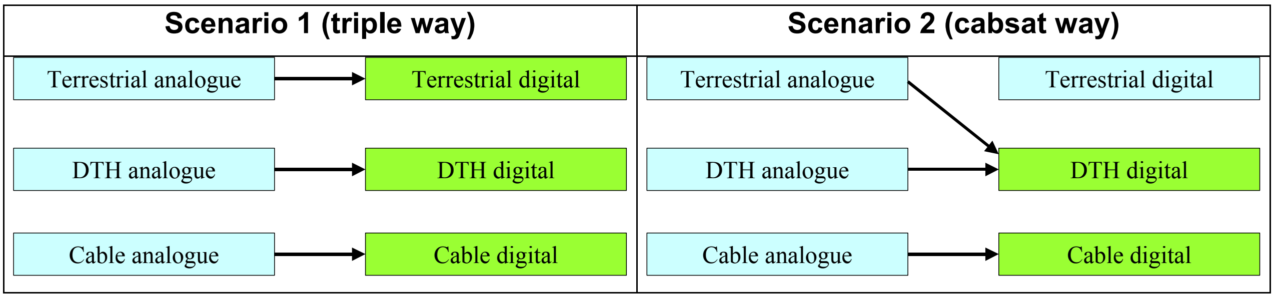
It is taken for granted that in the collective environment the breakdown of buildings and households among satellite, terrestrial and cable access amounts to 10%, 40% and 50%. It is assumed that this breakdown is 30%, 50% and 20% in individual housing units.

It is also hypothesised that all of the investments examined here can be depreciated over 10 years.

5.1.1 Costs of the triple way scenario

We examine the specific costs inherent in scenario 1 (triple way). In this scenario, each household continues to use the reception platform to which it is connected. In particular, terrestrial households change over to digital terrestrial.

Figure 5: Platform migration in the two scenarios



It is assumed that 50% of aerials have to be modified and 10% changed completely in the collective housing environment. 216,000 buildings located in the DTH coverage area and previously equipped with a collective aerial are concerned. The total cost is EUR 116 million (a). In the individual environment, the proportions of antennas to be modified or changed are set at 25% and 10%. The total cost is EUR 70 million (b).

Collective aerials	
% of aerials needed to be upgraded	50%
Cost per household (€)	23
% of aerials needed to be changed	10%
Cost per household (€)	154
Number of buildings concerned	216 000
Total cost (M€)	**116**

Individual aerials	
% of aerials needed to be upgraded	25%
Cost per household (€)	38
% of aerials needed to be changed	10%
Cost per household (€)	154
Number of households concerned	2 800 000
Total cost (M€)	**70**

Prevention or treatment of interference in cable households requires the replacement of non-protected leads by shielded leads (costing €20) in the case of 25% of connected households. As 7,200,000 households are concerned the cost is €36m (c).

We assume a simulcast of identical duration in both scenarios, but in scenario 1 digital terrestrial broadcasting survives analogue turn-off, whereas in scenario 2 terrestrial broadcasting itself is turned off along with analogue terrestrial. It is therefore possible to view the deployment of digital terrestrial broadcasting as an added cost specific to scenario 1.

According to our research, the investment needed to install a digital transmitter at an existing site is €0.5m per multiplex and per site on average. As the cost of coverage is exponential in terms of reaching the last %, and other broadcasting networks are available, we have hypothesised that coverage of the population is voluntarily limited to 85% (90% of the collective housing sector and 70% of the individual housing sector). It is hypothesised that this coverage is reached with approximately 100 transmission sites. Finally, it is assumed that six digital multiplexes are deployed. The total cost of investment is therefore 0.5*100*6= €300m. Furthermore, we assume an operating cost of 4.5 K€ per year, per mux and per site, thus generating an added 4.5*6*100= €2.7m annually. The total cost of broadcasting the six multiplexes over 10 years (which taking account of depreciation of the investment) is therefore €300+€27=€327m (d).

It is hypothesised that previously terrestrial households located *outside* the reception area are equipped for satellite reception (if they are outside the DTH area, they are probably outside the major urban zones and therefore also outside the cabled areas). This adds approximately €180m for equipping collective housing and €180m (f) for individual houses.

Finally, the adaptation of frequency plans needed at the introduction of DTH costs approximately €3m per site, i.e. approximately €305m for the national territory (g).

The total for the deployment and operating costs (a to g) therefore amounts to 116+70+36+327+180+180+305 **= EUR 1,214 million for 10 years (A)**.

5.1.2 Costs of scenario 2 (cabsat way)

As a very important preliminary hypothesis, it is assumed that in terms of broadcasting, cable and DTH platforms are made suitable to broadcast digitally spontaneously, independently of any public decision[10]. **These investments (noted as E) will occur *regardless of* the migration scenario** (with or without terrestrial) favoured by the public authorities; **they consequently do not have to be taken into account in a comparative view**.

As a second hypothesis, it is assumed that all of the households previously connected terrestrially are equipped with satellite reception devices (collective or individual). This device is actually more economical than migration to cable. This is very clear for households located outside cabled areas (a local network would have to be deployed), and it would be almost equivalent where it is assumed there is a need to link up households in cabled areas which had not been connected up to that point. In any case, it has been hypothesised that all households in cabled areas have *already* been linked up.

In the collective housing sector, the installation of an antenna and a demodulator costs about 1.5 K€ and cabling the building costs 6 K€ on average. 240,000 housing blocks are equipped at an average cost of 7.5 K€, and a total cost of €1800m (i).

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[10] In fact, from the point of view of DTH, the cost of updating satellite transponders to broadcast digitally is marginal. From the cable side, it is noted that the majority of European cable networks are in the processing of being upgraded to high-throughput to act as supports for multiservice broadband strategies; by doing this they become all the more usable for digital TV broadcasting.

Furthermore, 4 million individual houses are equipped at an average cost of €150 and a total cost of €600m (j).

Households connected to cable remain connected to cable. Households which were previously DTH remain DTH.

The total for redeployment costs to satellite (i+j) therefore amounts to €1800+€600 **=€2400m (B)**.

5.1.3 Comparison of the cost/benefit balances

It is necessary to add **the benefit which may be derived from releasing radio frequencies** (a criterion in which the two scenarios differ significantly) in the two scenarios to the costs of (re)deploying networks. In the triple way scenario with 6 DTH multiplexes in MFN, each multiplex mobilises 6 8-Mhz channels, i.e. 48 Mhz. 6*48=288 Mhz. Of the 360 Mhz in the UHF band only 72 Mhz could be released. Their reuse creates further difficulties as the free frequencies make up a “gruyère” cheese in MFN mode[11]. In the cabsat scenario, *all* of the broadcast spectrum is released through the structure involved. The lower quantity (and the lower “quality”) of the released spectrum comprise an **opportunity cost** for the triple way option relative to the other option.

The triple way option with 6 multiplexes would therefore release 72 Mhz and the cabsat option 360 Mhz. The difference is 288 Mhz. If an attempt is made to monetise this difference, it is useful to seek historical references. BIPE has observed that valuations from different paying allocation procedures during the period 1995-2001 in Europe and the USA have led to an average price expressed in Mhz per year and per inhabitant, of approximately EUR 0.08[12].

However, it is necessary to be very prudent relative to these historical precedents and to remember that if new frequencies were made available to wireless telecommunication services operators (mobile telephony, wireless local loop, etc.) they would be added to frequencies which have already been purchased and used. In economic theory, this additional supply set against constant demand would lead to a reduction in prices[13]. It would thus be possible to study the macro-economic impact of a global drop in the costs of using the radio spectrum. However, we will be content here with hypothesising on the revenues corresponding to the frequencies released by the transition to digital television.

If an average valuation of EUR 0.01 is taken over a period of 10 years, we obtain an opportunity cost **(C)** of 288*0.01*20*2.5*10**=€1,440m**[14].

[11] The transition to SFN after turn off would make it possible to avoid this disadvantage, but would itself represent a sizeable cost in some countries.

[12] After excluding extreme valuations occurring in very specific conditions (UMTS UK and UMTS Germany).

[13] Another way of saying it would be to consider that the Mhz which remain tied up or are released in scenario 1 are *marginal* Mhz which consequently which only have a lower economic value than the *first* Mhz released in the UHF band.

[14] 288 Mhz at €0.01 per Mhz, multiplied by 50 million inhabitants (20 million households multiplied by 2.5 individuals per household), multiplied by 10 years.

Figure 6: Comparison of the costs of each scenario in test 1

Triple way	**Cabsat way**
DTH deployment (A1) + migration of analogue terrestrial households to DTH (DTH area) or cabsat (outside DTH area) (A2) = **(A)**	Migration of all *terrestrial* households to cabsat **(B)**
Spectral opportunity cost **(C)**	Competition/diversity opportunity cost **(D)**
Cabsat digitisation **(E)**	Cabsat digitisation **(E)**

If the elements in the previous table are replaced by calculated values, term E which is present in each side is neutralised and we obtain the following table where it is possible to measure (monetarise) three of the four other elements (A, B, C, D).

Triple way	**Cabsat way**
A=€1214m	B=€2400m
C=€1440m	COMPETITION/DIVERSITY OPPORTUNITY COST **(D)**
Total : €2654m	**Total : €2400m + D**

The total for the costs of scenario 1 (triple way) is €2654, representing an amount which is greater by approximately 10% (€250m) than the cost of deploying scenario 2 (cabsat way), €2400m, although it is in the *same range as regards size*.

a) The cost of abandoning terrestrial (D)

At this point, account has to be taken of the fact that scenario 2 also includes an **opportunity cost,** corresponding to the fact that **a move is made from three TV broadcasting platforms to two platforms only.** This **reduces users' choices, reduces the diversity of the options available to them and potentially degrades the competitive position** of users (consumers on the one hand and content providers on the other) relative to the position of intermediaries, i.e. network operators and transmission service providers. This is particularly applicable, as the terrestrial platform has characteristics which the two other platforms do *not* have, i.e. essentially interior, portable and even mobile reception.

We will not venture here to *measure* this opportunity cost of scenario 2 **(D)**, which corresponds symmetrically to a benefit specific to scenario 1. Nonetheless, we can state that **this cost is probably much more significant in countries where *one* of the cabsat platforms is already heavily dominant** (as cable is in the Netherlands), rather than in countries where cable and satellite are together dominant and almost balanced (such as in Nordic countries).

For example, the Netherlands is de facto a mono-platform country, at least as regards main TV access. Satellite is subject to major restrictions and has difficulty competing in view of the installed base of cable connections. Scenario 1 therefore leads us here to move from one to two multichannel digital platforms available to players, whereas scenario 2 maintains the mono-platform environment. Having a choice instead of a compulsory access improves the Dutch consumer's well-being. Furthermore, even in countries where the three platforms are already used, some consumers see their effective choice opportunities reduced for various reasons[15]. In this context, the existence of DTH would extend their choice.

The objection could be raised that the level of competition and choice **does not depend on the number of *technical platforms*** available to players. This is true in theory, but in practice today, households connected to cable often only have one possible commercial contact partner for accessing pay TV (the cable operator itself), whereas one or two pay TV operators per satellite control the market depending on the country concerned (and the trend is towards concentration via merger).

The result of this situation is that in order to prevent reduced consumer well-being a reduction in the number of platforms used for television should be correlated by measures aimed at **reinforcing the consumer's real opportunities for choice,** both (i) **among technical access platforms** (struggle against unwarranted restrictions on satellite access) and (ii) ***within* the same technical platform**, among service providers (interoperability of conditional access systems, and even partial "unbundling" of cable, etc.).

If such measures were taken, it would be possible to neglect the risk of reduced competition (D) in scenario 2.

b) Conclusion

Given the hypotheses in this zero simulation, to decide rigorously whether regulatory scenario 1 is more or less expensive than scenario 2 it would be necessary to know whether having three broadcasting platforms instead of two comprises a benefit of more or less than €250m for the commercial players. If this benefit is viewed as greater than €250m in a given national context, the opportunity cost in option 2 (cabsat) becomes higher than that in option 1 (triple way) and favouring option 1 (triple way) becomes of interest.

However, as the difference before factor is minor and because factor D can be neutralised by targeted measures, we believe that the result of the zero simulation is an **equivalence of the two options** in terms of the cost/benefit balance.

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[15] Restrictions linked to co-ownership or urban planning in an urban and/or collective habitat, absence of cable networks in the rural area.

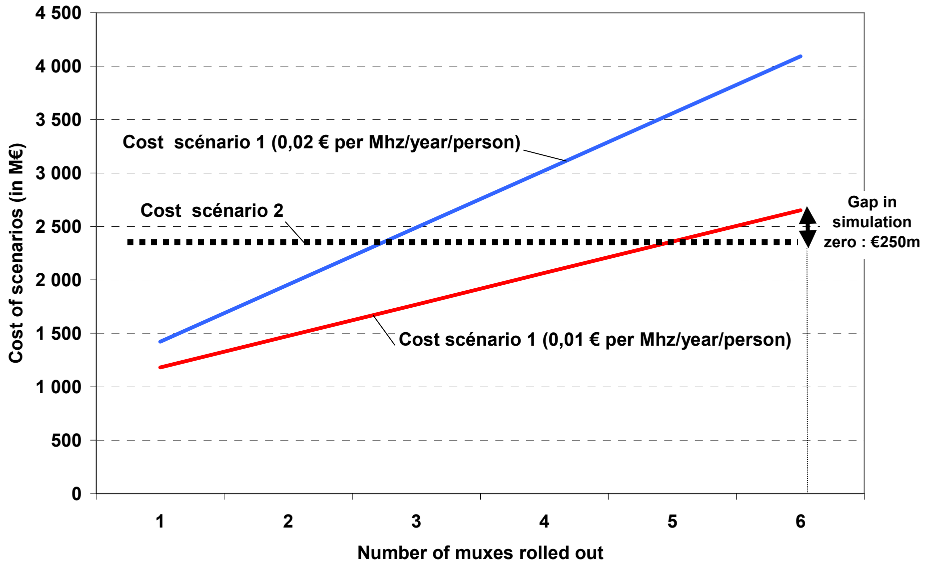
5.1.4 Sensitivity of the variables

The most sensitive hypothesis in this simulation is the one associated with spectrum valuation. If 0.02 had been chosen instead of EUR 0.01 per Mhz/year/inhabitant, the opportunity cost would have doubled to reach €2880m, whereas the total cost of option 1 would have exceeded €4000m.

The **number of multiplexes** launched in DTH also determines the quantity of spectrum which continues to be tied up and the opportunity cost of scenario 1. Thus, *minimum* DTH which would involve transmitting the 5 to 7 channels previously available in analogue terrestrial digitally would only require the deployment of a single multiplex and would only occupy 48 Mhz, representing an opportunity cost of €240m with the 0.01 hypothesis. Each additional mux represents an opportunity cost C of €240m, while simultaneously increasing the deployment/broadcasting costs (d).

The following figure examines the cost of scenario 1 depending on the number of multiplexes deployed (1 to 6) and the average valuation of Mhz over 10 years with all other things equal. The figure recapitulates the level of cost measured (excluding the cost of reducing the choice) in scenario 2 in order to display the equivalence points. For example, for 6 multiplexes and EUR 0.01 (hypotheses in the zero simulation, where we are very close to the point of equivalence between the two scenarios).

Figure 7: Costs of option 1 vs. 2 depending on the number of multiplexes and the value of the Mhz



Source: BIPE

5.2 Other simulations

We have carried out the following three simulations, differentiating among them solely on the basis of the original level of penetration of cabsat reception:

- Cabsat countries: 90% of accesses by cable or satellite
- Terrestrial countries: 90% of accesses via terrestrial reception
- Average country: 50% of terrestrial accesses, 50% of cable or satellite accesses (situation corresponding to the weighted average of national situations in the Union, or with the Union considered as a single territory)

All of the other hypotheses remain those of the zero simulation (in particular a Mhz valued at 0.01 € and 6 multiplexes launched).

5.2.1 "Cabsat" countries (10% of terrestrial reception)

As there are few analogue terrestrial households, the reception upgrade costs are low, but the cost of option 1 is slightly higher (796 compared with 570) due to the fixed costs of deploying the DTH network (independent of the number of households affected by this mode of reception). If the spectral opportunity cost of scenario 1 (€1440m) is added, option 1 becomes much more expensive than option 2 (total cabsat migration and terrestrial turn-off): 2236 compared with 570.

Conclusion: in countries with a strongly cabsat profile (such as Germany), it is more interesting to migrate via platforms which are *already* dominant than to introduce DTH, notably if the released spectrum is valued, and as long as the opportunity cost which could reside in restricting the technological/competitive range is neglected or neutralised.

5.2.2 "Terrestrial" countries (terrestrial reception rate of 90%)

In option 1 (DTH) the cost of migration increases little relative to the preceding simulation as it is partially made up of fixed costs and the variable cost is low (mostly a simple *adaptation* of installed reception equipment): it moves to €1754m.

In option 2 on the other hand, the cost of converting reception increases very significantly as 90% of households have to be equipped with a completely new reception installation: it moves to €5130m. If the spectral opportunity cost (which remains at €1440m) is added, we obtain an option 2 cost which is higher than that of option 1 by €2,000m (5130 compared with 3194).

Conclusion: in countries where terrestrial reception predominates (such as Italy), the DTH option is the least expensive as the cost of general re-equipment with satellite reception devices (B) is higher than the total costs of migrating to DTH plus the incorporation of the spectral opportunity cost (A+C). The Mhz released would have to be valued at EUR 0.025 instead of EUR 0.01 for the spectral opportunity cost to increase sufficiently to counterbalance option 2. In other words, the value of the Mhz would have to exceed € 0.025 per year per inhabitant in order for the recoverable spectrum to be worth the trouble of migrating to cabsat television.

5.2.3 “Average” European country

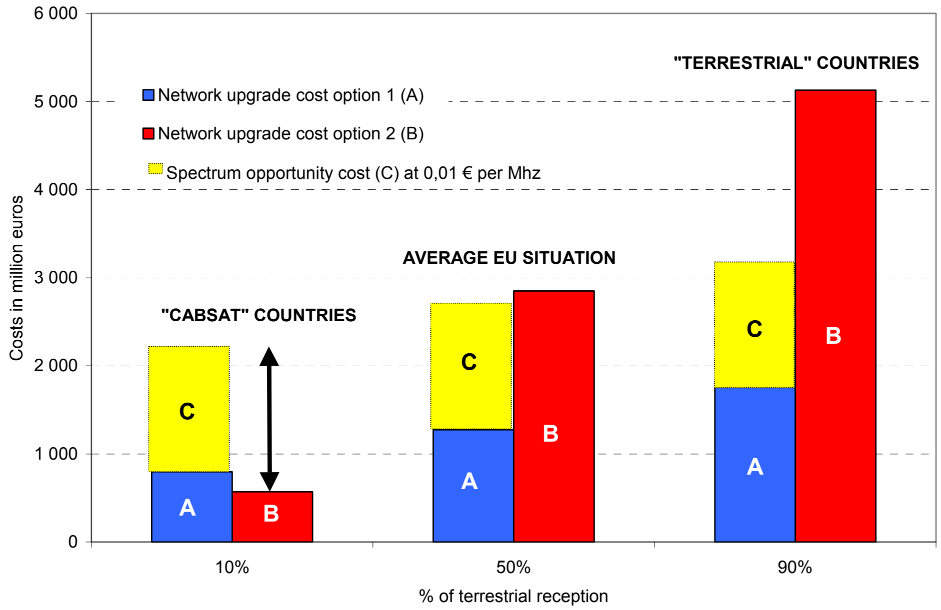
Finally, if we take the reception landscape of an average EU country (50% of terrestrial reception), we find ourselves in a situation where A+C balances out B almost perfectly. The two options appear to be equivalent in terms of cost.

Figure 8: Simulations depending on the initial audiovisual landscape (1)

	"Cabsat" country	Average	"Terrestrial" country
Terrestrial broadcasting	10%	50%	90%
Network costs in option 1 (A)	796	1 275	1 754
Spectrum opportunity cost in option 1 (C)	1 440	1 440	1 440
Total cost of option 1 (A+C)	2 236	2 715	3 194
Total cost of option 2 (B)	570	2 850	5 130
Difference	**1 666**	**-135**	**-1 936**

Source : BIPE

Figure 9 : Simulations depending on the initial audiovisual landscape (2)



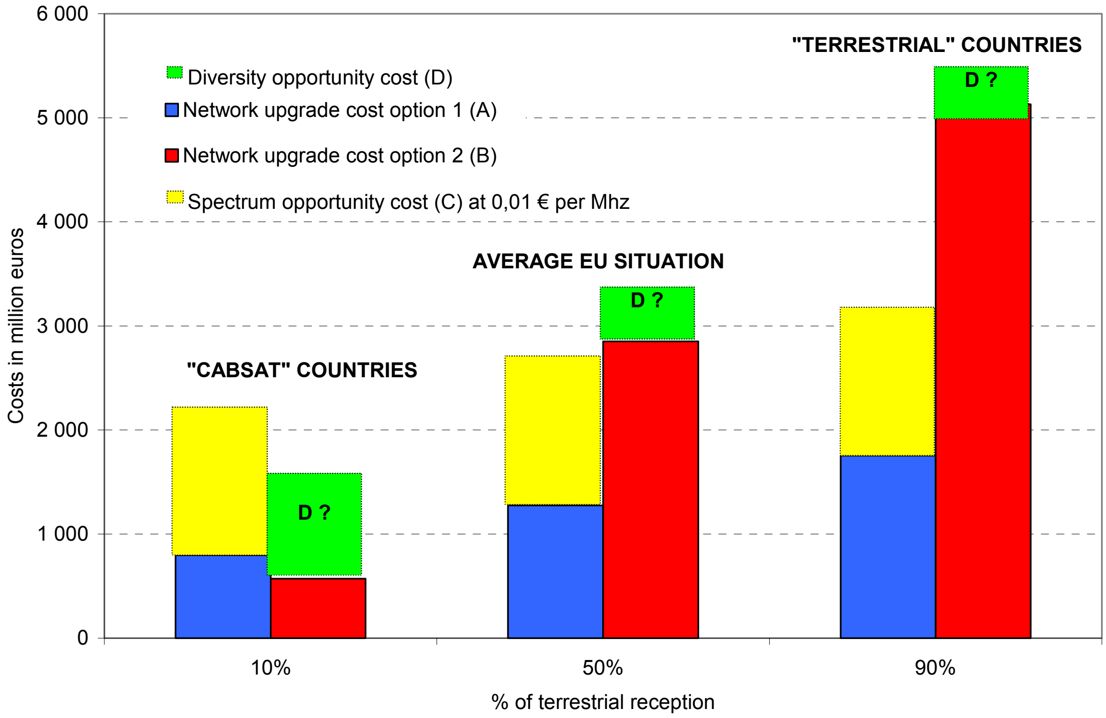
5.2.4 Taking account of the competitive opportunity cost

If we now try to take account of the *fourth* element which has not been measured**, the competitive and diversity opportunity cost (D)**, it is added to the cost in option 2.

As option 2 is already more expensive than option 1 in “terrestrial” countries, taking this effect into account would only emphasise the gap noticed.

In cabsat countries, in contrast, we are free to imagine that with cost D being added to conversion costs B, the total for option 2 (B+D) could counter-balance the total in option 1 (A+C). In other words, the disadvantages of only having two broadcasting platforms instead of three could offset the benefits from spectral gains. However, we think that this may only be true in an extreme case when a single platform is already very heavily dominant in the market (the case of cable in Benelux). In all of the other cases, we can imagine that a cable + satellite landscape would be enough to create adequate competition in the access market and if a market for mobile television exists some day, UHF frequencies placed on the market can be purchased by specialist operators.

Figure 10: Simulations depending on the initial audiovisual landscape – 2 (with D effect)



5.3 Test 1: synthesis and conclusion

Migration to all digital television will occur in any case via cable and satellite platforms as a result of simple market forces.

The national public authorities, notably as managers of the radio spectrum resource, play a special role in determining the mode and degree of use of VHF-UHF frequencies for television. It is up to them to determine to what extent terrestrial broadcasting should continue to be used in a world where digital multichannel television will be available via cable and satellite, *in any case*.

Public decision-makers therefore have a choice between two major options. On the one hand, encouraging the introduction of digital multiplexes in terrestrial broadcasting, then turning off analogue terrestrial broadcasting and then releasing a section of the UHF band for other uses. On the other hand, encouraging migration to cable and satellite reception platforms (and even the accelerated digitisation of these platforms in a second stage) leading to the turn-off of terrestrial broadcasting itself and the release of the entire UHF band.

BIPE has identified four types of costs for the different options and has measured three of these.

Option 1 requires network costs (upgrading of terrestrial broadcasting infrastructure and of reception equipment - A) and incorporates an opportunity cost (C) to the extent that a smaller quantity of spectrum would be released. Option 2 does not take account of the investment needed to allow the transport of digital signals as it is assumed that these investments are already being made in any case by private players. Option 2 also requires upgrade costs (migration of reception equipment, essentially to DTH – B); it also incorporates an opportunity cost (D) relative to diversity and competition, corresponding to the fact that some users would only have two broadcasting and access networks (at maximum), instead of the three today.

The figure below recapitulates the factors which determine the scale of these costs in a given national context. They essentially derive from:

the initial reception conditions,

political technical choices (number of terrestrial digital multiplexes introduced),

political choices (importance assigned to the diversity of access media),

the hypothesis selected for a future valuation of radio frequencies likely to be released. This latter factor is both the most uncertain and the most determining.

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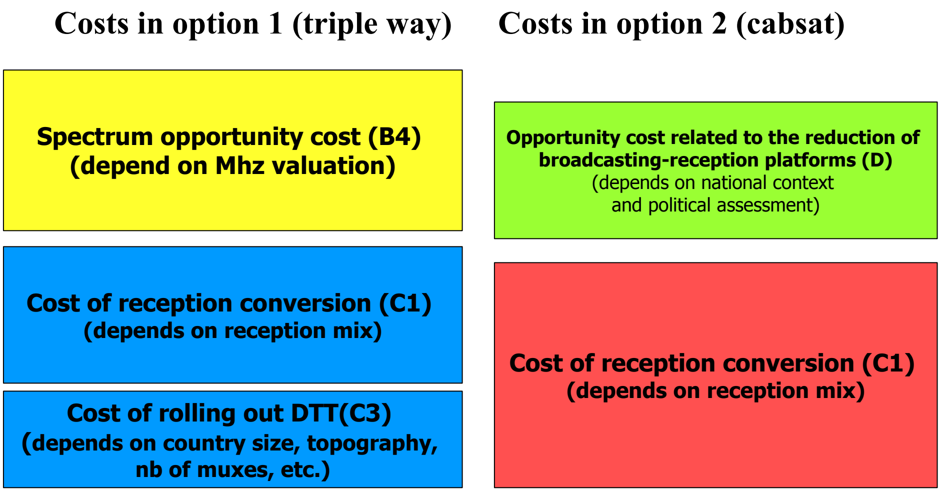
Figure 11: Main costs involved in the two options



The simulations carried out by BIPE, at a price per Mhz which we consider prudent (at EUR 0.01 per Mhz per year per inhabitant covered) illustrates the fact that:

(i) **Option 1 (triple way, maintenance of terrestrial) is more expensive in cabsat reception countries** than option 2 (all cabsat), with the redeployment costs (A and B) being equal and the spectral opportunity cost (C), thus driving up the cost of option 1 significantly.

(ii) **Option 2 is significantly more expensive in terrestrial landscape countries**, notably because it requires the conversion of a large installed base of reception equipment. Taking account of this factor can only reinforce this gap.

(iii) In countries with balanced reception, option 1 (A+C) reaches the same cost level as option 2 (B). Factor D could then decide between them.

(iv) Taking account of the unmeasured factor D could re-balance the two costs in cabsat countries in certain cases, notably when one of the two platforms dominates the other and the all-cabsat option would contribute to emphasising this monopoly. But even in this configuration, we believe that appropriate targeted measures guaranteeing genuine competition in access supply to the consumer could neutralise this risk.

6 Test 2: Accelerate digital migration or not?

6.1 Test 2a : private financing of analogue turn-off

6.1.1 Objectives

This section studies **the potential interest for broadcasters of financing the acceleration of reception migration so that analogue broadcasting during simulcast could be terminated as quickly as possible and savings on broadcasting costs could be achieved**. For broadcasters, the most direct means of accelerating the process would involve contributing to reducing migration costs for viewers, e.g. by financing some of the converter costs.

Here we study the turn-off of analogue *terrestrial* television to a greater extent than migration to digital television. Placing ourselves "**in the broadcaster's position"**, the simple termination of analogue terrestrial reception rather than digital migration is what is important for an ability to halt analogue terrestrial broadcasting.

Indirectly, however, a wish to turn off analogue terrestrial television can only have a driving effect on the pace of adoption of digital television, as households leaving analogue terrestrial broadcasting find themselves using either DTH, cable or satellite, platforms which are *already* digitised or are rapidly being digitised.

It would also have been possible to model a broadcaster's incentive to have analogue *satellite* broadcasting halted to save on broadcasting costs, but the exercise is of less interest given that the broadcasting costs in question are approximately ten times less. The meetings held by BIPE show that neither private FTA broadcasters nor public broadcasters are really worried about the EUR 4 to 5 million per year which pan-European analogue broadcasting costs (in comparison, national analogue terrestrial broadcasting costs EUR 20 to 50 million per year, depending on the country's size and topography). The second reason why we therefore preferred to concentrate on terrestrial broadcasting here is the spectral stakes associated with this type of broadcasting.

6.1.2 Zero simulation

We have adopted the following hypotheses.

- Cable and satellite are the only platforms offering highly multichannel television and the number of channels accessible remains a major component for a large proportion of consumers. This intrinsic "superiority" of cabsat platforms should lead to an (already observed) transfer from terrestrial reception to cabsat reception cabs, at least in countries where this latter mode is currently underdeveloped. Each year, this natural movement reduces the number of households "to be converted" before terrestrial analogue broadcasting can be turned off.
- We estimate the annual cost of terrestrial analogue broadcasting (typically €200 to €300m annually for a large country and 5 to 6 national channels).

- We adopt the reference hypothesis of a "natural" or spontaneous migration ("sit-back" scenario) which would take about 10 years (the time frame often selected by national planners).
- We adopt the hypothesis of an average initial price for converters (e.g. €150, the price announced by different manufacturers for the 2002 period) and we assume a regular fall in this price (e.g. 10% per year during the period). We suppose that a cable or satellite terrestrial digital converter costs approximately the same price.
- We take a discount rate of 5% of future monetary flows.

In the zero simulation, we take an imaginary country resembling Germany with 31 million TV households of whom 9% have a terrestrial access.

Once digital terrestrial television is introduced, each year of simulcast represents a cumulative cost, which we assume to be linear for simplification purposes (as analogue terrestrial broadcasting technology is mature enough, we do not assume any significant gains in productivity).

The costs of converting the remaining terrestrial households falls constantly and geometrically for two reasons:

- The number of terrestrial households falls from year to year
- The price of conversion equipment also drops.

If a subsidy for converters were organised in year 1 in order to facilitate the turn-off of analogue terrestrial broadcasting, the cost of the operation (financing 2.5 converters in terrestrial households with 3 million households at a price of €150 per converter, €40 for the cost of an antenna) would amount to €1270m, to which it would be necessary to add €250m for the cost of simulcasting for a year, representing €1520m in total.

If the same operation took place in year 10 for example, there would only be 1.3 million households to convert, and as the price of converters would have dropped dramatically in the meantime, the price of conversion would only amount to €211m (€148m at present value). In contrast, the cost of the simulcast for 10 years would amount to €1,612m at present value. The total cost would therefore amount to €148+€1,612=1,750m. Turn-off in year 1 would therefore cost approximately €239m less in year 1 than in year 10, representing a saving of more than approximately 15%.

It seems that in a national context of this type, **it would be in the interest of broadcasters to federate in order to ensure that migration occurs *before* the ten-year milestone, even if this means contributing financially to the migration costs borne by consumers**. We actually assume that neither private free-to-air generalist broadcasters nor public broadcasters can allow themselves to turn off a channel while a significant share of their viewers are not in a position to continue to access the programmes. If it is assumed that they will have to do so one day or another, the sooner seems the better choice. Even if it were imagined that the residual analogue terrestrial viewers were to finance their migration themselves in year 10 before turn off or the State were to do this, it would still be in broadcasters' interest to obtain more rapid progress. **The optimum timing is actually turn-off in year 3, which makes it possible to save €303m over turn off in year 10.**

SIMULATION ZERO

Hypothesis

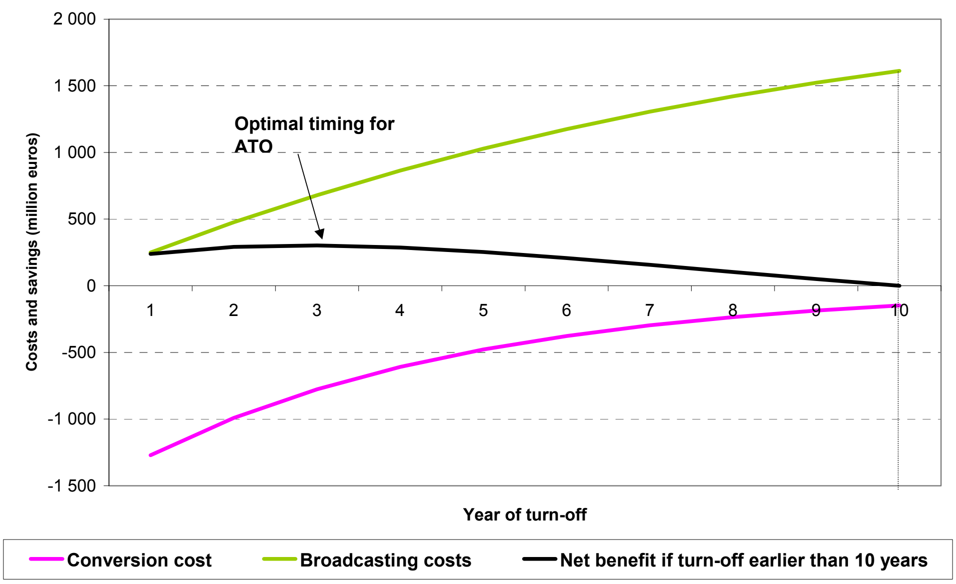
	%	Nb
Initial number of terrestrial homes	9%	3,06
Cabsat homes	91%	30,94
Total TV homes	100%	34

Natural switch rate to cabsat	7%
Natural switch rate to DTT	1%
STB price decrease per year	12%
Initial converter price (€)	150
Global analogue broadcasting costs (M€)	250
Number of receivers to convert before turn-off	2,5
Cost of reception upgrade per home (aerial/dish) (€)	40
Discount rate	5%

Results

Year of turn-off	Conversion cost	Broadcasting costs	Net benefit if turn-off earlier than 10 years
1	-1 270	250	239
2	-992	476	291
3	-776	680	303
4	-608	864	287
5	-478	1 028	253
6	-376	1 175	208
7	-297	1 306	157
8	-234	1 421	104
9	-186	1 523	51
10	-148	1 612	0

Graph

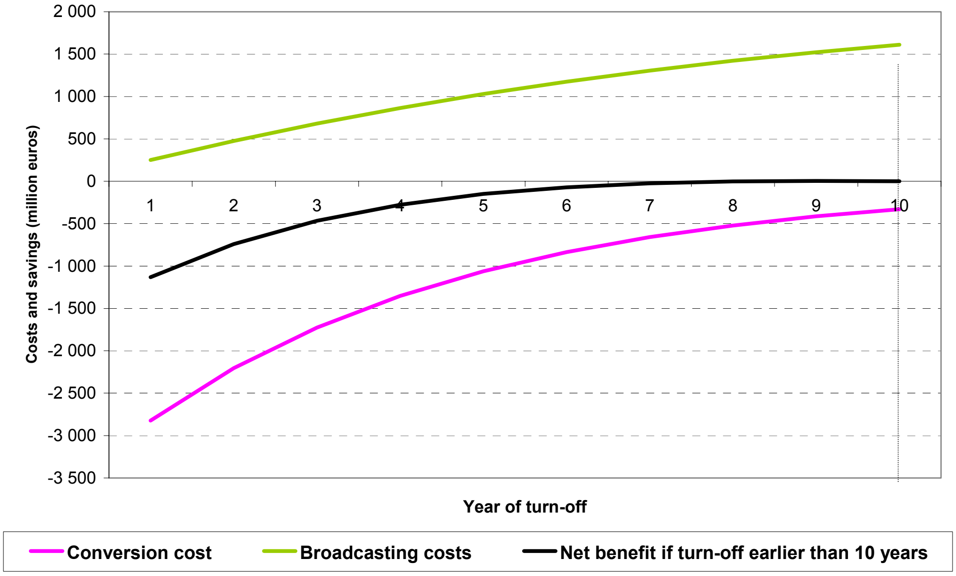


6.1.3 Other simulations

We have tried to test the sensitivity of different hypotheses and notably the hypothesis of the level of analogue terrestrial households, while keeping all of the other hypotheses unchanged.

If we select 20% of analogue terrestrial households at start-up instead of 9%, the conversion cost would be so high that it would not be profitable to attempt to anticipate the changeover. A similar value is obtained for any value over 20%

Figure 12 : Results with 20% of initial terrestrial analogue households



The enclosed table shows the result of 16 simulations, tried with 4 overall terrestrial broadcasting cost levels and 4 levels of initial terrestrial populations.

Table 4: Relevance of acceleration depending on the households to be migrated and broadcasting costs

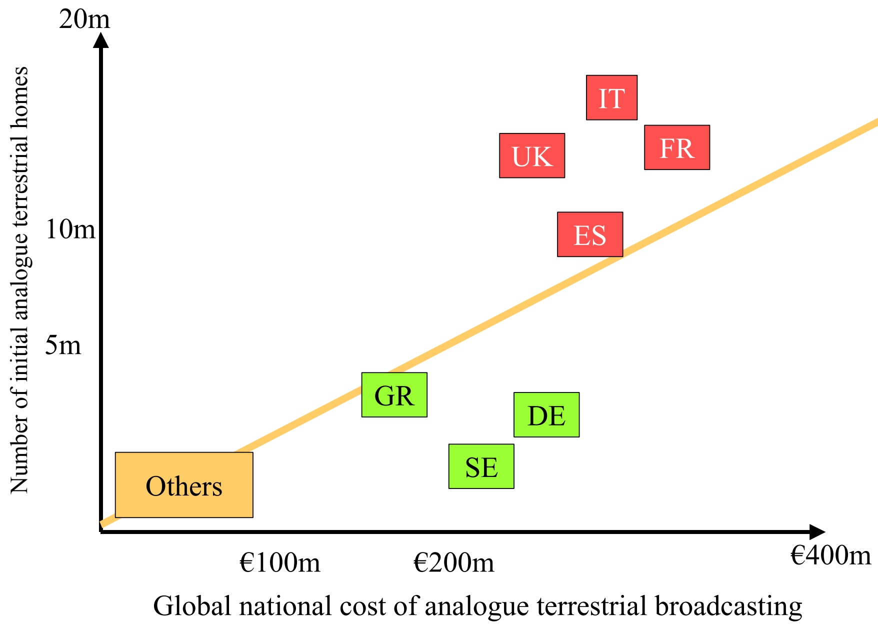
		Terrestrial homes initially (m)			
		2	5	10	15
Analogue broadcasting cost (m€)	100	6 years, €25m	No sense	No sense	No sense
	200	2 years, €356m	No sense	No sense	No sense
	300	1 year, €900m	5 years, €160m	No sense	No sense
	400	1 year, €1445m	3 years, €463m	8 years, €11m	No sense

Colour code

(green)	Positive
(yellow)	Barely positive
(red)	Negative

We indicate where the main European countries are positioned in this framework in the following graph. The countries shown in red are those positioned on the side of the trade-off line where it is not in the interest of analogue terrestrial broadcasters to accelerate migration to reduce their broadcasting costs. The countries in green are those where the low terrestrial population and the rather substantial broadcasting cost make acceleration conceivable[16]. The other countries are located somewhere in the orange zone (small countries, low terrestrial population, low broadcasting costs) where the optimum situation is more difficult to identify but where the amounts at stake in any case are substantially smaller.

Figure 13: Appropriateness of private acceleration 2a in some European countries



Conclusion

Seeking to reduce the duration of terrestrial simulcast by financing consumer migration costs (conversion of reception) with the aim of saving transmission costs **only** makes sense for the broadcaster if (i) the initial number of terrestrial households is low (because the country is small or the proportion of terrestrial broadcasting is low) and/or (ii) the overall cost of analogue terrestrial broadcasting is high (due to the number of channels broadcast or the characteristics of the national territory).

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[16] Digicast BV has published a document in which the German situation is specifically envisaged, and which has also inspired us here. Digicast, an STB integrator, showed that subsidising German broadcasters to broadcast STB would effectively be profitable for them in the medium term. While we share this vision, we think in contrast that few European countries are likely to find themselves in the same situation. Sweden is probably among these; this accounts for the initiative by the public broadcaster SVT, which has stated that it is ready to finance some of the conversion costs which would be necessary to accelerate analogue terrestrial turn-off (“ Sweden ending analogue by 2003?” Advanced-television.com, October 2001)..

6.1.4 Practical limits of this approach

Even in a situation where we find an economic logic for terrestrial broadcasters to finance accelerated conversion, we have observed that **no steps have been taken in this direction**. We can see four types of reasons which explain this.

(i) As all broadcasters would benefit from conversion of analogue households which would enable them to turn off analogue broadcasting sooner in a given country, none of them is likely to take this step itself *alone*. Establishing an agreement and a consortium involving all of the channels is therefore an implementation condition which is difficult to achieve. More generally, as they are aware that it may be in the interest of other players (such as the Government itself) to make such investment, broadcasters tend to *wait* until someone else takes the first step so that they can subsequently benefit (**the "free rider" syndrome**).

(ii) The **technology** has not been mature enough up to now to envisage converters at less than €150.

(iii) In certain countries such as France or Spain, **it is not in the interest of commercial terrestrial broadcasters to promote migration to DTH**, which for them could mean sharing the advertising market with a larger number of competitors. The savings which they could make on analogue broadcasting costs appear obviously much lower than their oligopoly rent in the advertising market from their point of view.

(iv) **Public broadcasters do not have a clear incentive to reduce their costs**. They cannot be certain that if they reduce their broadcasting costs, the savings thereby achieved could be *reallocated* to other uses and would not lead to a *reduction* in overall funding.

For all of these reasons, and *even though* an initiative of this type would be profitable micro-economically, it seems difficult to implement. It only seems likely in countries where the initial conditions make the operation inexpensive and where the number of terrestrial broadcasters is low enough to ensure they can reach an agreement on dividing up the effort involved (Sweden).

It seems more probable that the transmission cost benefit will be consolidated with *other* benefits and either taken over by the State or within **a migration financing fund, which would receive contributions from *all* players interested in accelerating migration and turn-off.**

6.2 Test 2b : Public intervention to accelerate migration

Macro-economically, it is considered that the investment needed to ensure migration and analogue turn-off will be made *regardless of what happens*. Symmetrically, the benefits of all-digital and analogue turn-off will appear sooner or later.

Public intervention therefore only changes the *timing or* scheduling of investment and flows of benefits.

A comparison has to be made for the algebraic total of:

(i) the cost to the community of making the necessary investment *earlier* than would have been the case in a "natural" reference scenario, along with the risks inherent in public intervention,

(ii) benefits resulting from *earlier* enjoyment of the final benefits expected (B1, 2, 4, 5, along with B3 in the framework of migration incorporating a terrestrial component).

First of all, we examine the effect of financing the cost of migrating consumers (C1+C2). This financing can take the form of a tax or exceptional incentive linked to digital reception equipment (reimbursement, lower VAT, lower fee); it may be organised via public or dedicated funds. At this stage, we do not make any assumptions concerning the financial transfer technique used.

Table 5: Flow of investment and benefits linked to early migration

Year	Event	Costs (investment)	Flow of benefits
1	First year of migration		
p	Forced financed turn-off	- **Macro-economic added cost of early financing C1+C2** (corresponds to added cost for immaturity + financial cost)	
p+1	First year of benefits		- Increase in activities linked to all-digital (B1) - **Broadcasting savings (B2)** - **Gains (revenues) from released spectrum (B4)** - Increased competition (B3) (only in a "triple-way")
p+2			- Idem
n	Reference year (turn off at the end of this year, when there are fewer than 5% of analogue viewers, for example)		- Idem
n+1	First year of benefits in the reference scenario		
	Without timing	- Risks of bureaucratic failure (C6/7)	- Avoidance of digital divide (B5)

In this flow of costs and benefits, we only **measure** the cost of the initial investment (function of C1+C2) and the benefits B2 and B4. This does not mean that we do not take account of the existence of other costs/risks and benefits. We simply take account of them qualitatively.

6.2.1 Simulation Zero

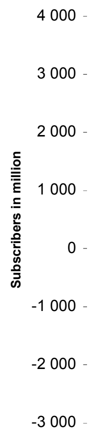
This section aims to present the simulation model. The values taken as hypotheses in this section *do not prejudge* hypotheses which could later be adopted as median by BIPE[17].

For example, let us take an **imaginary country** of 23 million TV households (hypothesis C), with approximately 57.5 million inhabitants (D=2,5*C), and an initial rate of 70% of analogue households (A). Here, we have data similar to a country such as France, the United Kingdom or Italy.

All of the hypotheses and parameters are presented in the following table. The boxes containing primary hypotheses are indicated in blue (or light grey). The other boxes are deduced from the primary boxes.

Table 6: hypotheses in simulation zero

		%	Nb
A	Initial number of analogue homes	70%	16,1
B	Cabsat homes	30%	6,9
C	Total TV homes	100%	23
D	Total population	57,5	
E	Interest rate (time discount)	5%	
F	Natural switch rate to cabsat	10%	
G	Natural switch rate to DTT	5%	
H	Total natural switch rate to DTV	15%	
I	Initial converter price (€)	150	
J	STB price decrease per year	10%	
K	Number of receivers to convert before turn-off	2,5	
L	Fixed cost of digital reception upgrade per home (dish/aerial) (€)	40	
M	Global analogue broadcasting costs (M€)	250	
N	Bandwith released after analogue turn-off (in Mhz)	100	
O	Initial bandwidth price (in € per Mhz*year*inhabitant)	0,05	
P	Annual revenue out of leased frequencies year one (M€)	288	
Q	Annual increase	10%	
R	Years of simulcast in reference scenario (n)	10	

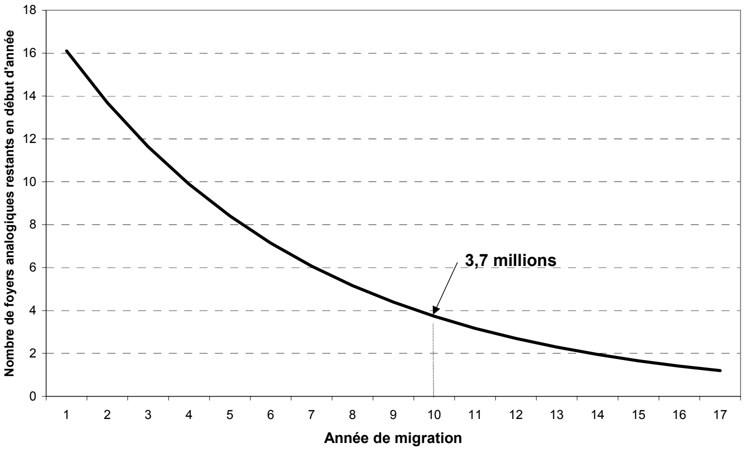


We hypothesise that under the simple effect of market forces, 15% of analogue households will change over to digital each year (hypothesis H), of which 10% will move to cabsat and 5% to DTH (although the destination of the ex-analogue users is an indifferent factor at present).

[17] Furthermore, the results presented here derive from cost hypotheses which can obviously be contested. It is appropriate to differentiate between the simulation model on the one hand and the set of hypotheses which are subject to it on the other. The tool developed by BIPE makes it possible to test an infinite number of hypotheses.

This hypothesis is adopted on the basis of recent trends which push viewers towards multichannel television and premium television which tends to turn out to be digital and pay TV. The intrinsic advantages of digital television naturally push consumers towards making this choice. At this point, we do not make assumptions concerning the proportion of consumers who have moved to digital via pay TV or by purchasing a digital receiver within the context of replacing their television set. Finally, we adopt the simplifying hypothesis that the household that has moved to digital migrates *all* of its receivers in one step.

Figure 14: Natural erosion of analogue households



We would move from 16 to 3.7 million analogue households (i.e. approximately 16% of households) between year 1 and year 10.

An assumption is made concerning an initial price for digital converters in year 1 (hyp I), e.g. EUR 150, and a reduction rate in this price over the period (hyp J), e.g. 10%. It is also assumed that the total number of converters needed (i.e. equipment which has to be migrated) is 2.7 per household (hyp K).

Whatever the moment selected, regardless of the player who pays for or finances the process, the receivers in these few percent of analogue households will have to be converted at the time of turn-off.

For example, if it was decided to finance the migration of the last 16% during year 10, it would cost EUR 772 million in year 10 at current STB prices, which at discounted value amounts to €497m in year 1. We have assumed a constant discount rate over the period (hyp E), e.g. 5%.

In the meantime, the 12.3 million other households will have either financed migration of their equipment themselves (purchase of an STB) or subscribed to a pay television package and their provider will have then supplied them with a decoder. In this latter case, we can still consider that they are financing their migration themselves as the pay TV operator earns a return on its investment in decoders or satellite dishes through the subscription figure which it invoices (although we reiterate that this does not matter, as we are not interested in *who* pays in the first instance).

In the first year, for example, it will be necessary to finance the migration of approximately 2.3 million households, which each have 2.7 receivers, i.e. 6.2 million receivers at a fixed cost of EUR 50 per household, which is assumed to be constant over the period (hyp L), plus an average current price of EUR 150 per receiver. The total invoice is approximately €1100m. In contrast, 1.5 million households migrate at the time when the price of converters has fallen to €109 on average in the fourth year ; the cost is now only €512m at contemporary value or €442m at current value. In a reference scenario where final conversion would occur during year 10, the cumulative discounted sum of the investment flows would amount to €3.934m.

At present, we are interested in the **savings which can be made on transmission costs**. Analogue turn-off for all platforms would make it possible to terminate the analogue terrestrial broadcasting which continues during the simulcast. This is the B2 benefit. We have made a hypothesis concerning the global cost of analogue transmission in our imaginary country (hyp M), for example €250m, which is assumed to be constant over the period. If analogue terrestrial broadcasting could be stopped at the end of year 8, instead of year 10, the community would save two years of broadcasting at €250m per year, i.e. €161m+€169m=€330m in discounted value.

In terms of benefits, it is also (strongly) assumed that the frequencies released through the turn off of analogue broadcasting (essentially terrestrial) can be re-allocated immediately and that the community draws an income from this (in the form of tax of a utilisation fee) from the first year.

We assume the volume of frequencies released (hyp N) e.g. 100 Mhz, (which is quarter of the UHF-VHF band currently reserved for terrestrial broadcasting). 100 Mhz actually corresponds to the quantity of spectrum which could be released at the top-end of the UHF band at the turn-off of the 5 analogue networks and if 6 digital multiplexes in MFN are retained. This figure reflects a situation which is relatively close to the position in several European countries.

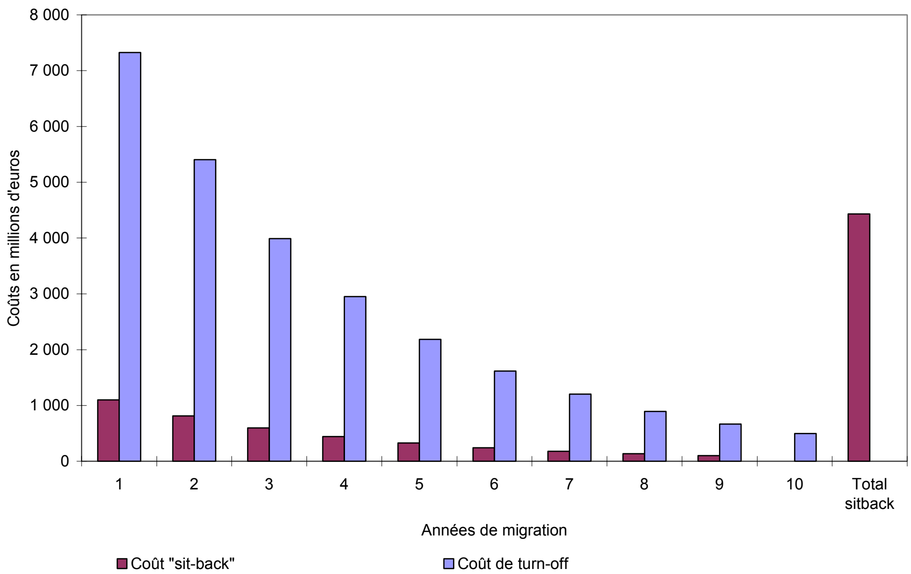
It is assumed that a **revenue is derived from using these frequencies** during the first year (hyp O) expressed in Mhz per inhabitant and per year. The market value of a frequency is actually a function of the income on conceivable services and therefore of the population pool covered. For example, we assume a revenue of EUR 0.05 per Mhz per year and per inhabitant for the first year, which would represent € 288 m in year 1 for 100 Mhz and a population of 57 million people. This figure of €0.05 per Mhz and per year is in the low average of valuations derived from sales of the spectrum in recent years in various western countries[18]. It is assumed that the wireless services on which the social value and revenue derived from use of the frequencies comprises a significantly developing market whose annual growth rate over the period amounts to 10% (hyp Q).

It is also necessary to **examine the investment needed** to ensure that the community can benefit from these two incomes as soon as possible in order to evaluate the conditions in which this collective investment would be profitable and advisable at macro-economic level.

[18] See the table on the price of the spectrum in the Spectrum section of the report.

In a "reference" (or "sit-back") scenario the population migrates "at its own pace". The current discount spending corresponding to the acquisition of converters at the contemporary price is indicated in red in the graph below. It can be seen that it decreases strongly year after year, with the drop in the number of households migrating and particularly the drop in the price of converters. In the case of turn-off organised in year 10, the total cost of migrating reception ("total sit-back") would have been the total of annual discounted spending from year 1 to year 9 (approximately €3900m), *plus* the cost of migrating the leftover analogue households during year 10 (approximately €497m), representing a total discounted value of €4,400m.

Figure 15: Costs of migration to digital reception (1)



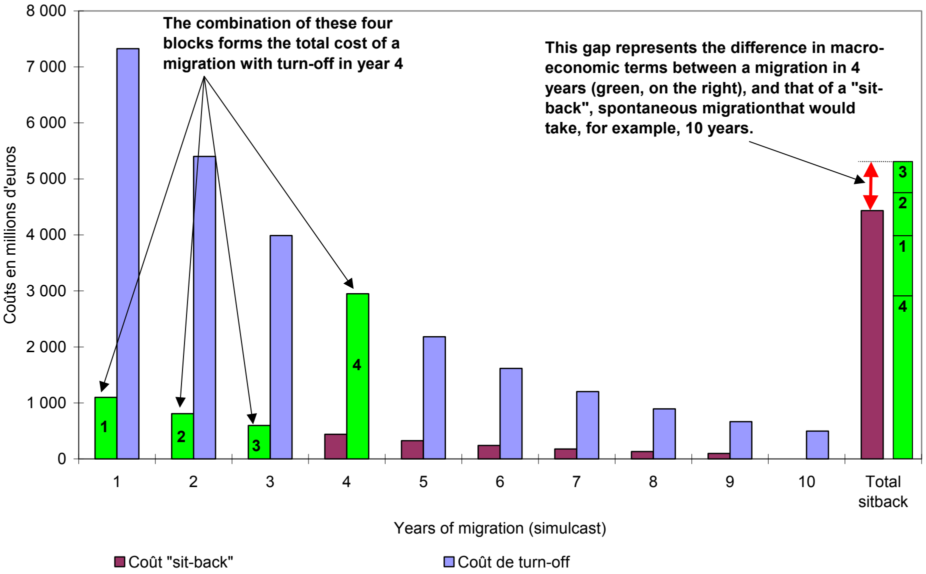
If on the other hand it is decided to finance conversion earlier, this means migrating the total remaining analogue households at the start of the year at the contemporary converter cost. In year 4 for example, this cost would be €2949m. Thus, the total macro-economic cost of turn off at the end of year 4 would be the discounted spontaneous expenditure of years 1, 2 and 3, *plus* the discounted expenditure associated with converting the remainder in year 4. The corresponding amounts have been identified in green in the following figure. The total for these sums is represented to the right of graph 2 below.

In a macro-economic approach, we have to take *sole* account of the ***cost differential*** between the cost of "sit-back" migration (which here is assumed as lasting 10 years) and the cost of accelerated, forced and financed migration (which is concluded here during year 4). This differential or "added cost" is represented by a red arrow in the graph below. Whereas the actual figure for total investment is taken into account for the analysis of the relevance of private financing (2a), account is only taken here of the cost *differential* between the public intervention scenario and a reference scenario with no intervention.

This differential arises from two components:

- The **"added immaturity cost"**: accelerated migration will lead to investment in technology in a less mature phase where the equipment is more expensive
- The **"added financial cost"**: macro-economically, the investment is made by the community earlier than normally would have been the case, with this sole timing differential representing a financial cost (the opportunity cost corresponding to the interest which could have been earned in the meantime if the same sums had been spent later).

Figure 16: Costs of migration to digital reception (2)



Two methodological clarifications

- It would have been possible to take account of the fact that where it is assumed that the public authorities intervene to cause early massive migration, the average price of equipment would automatically be *lower* than would have been the case without this intervention. This occurs for two reasons: (i) an effect of scale which enables manufacturers to reduce their production costs; (ii) the negotiating power of a macro-purchaser. However, it is also possible to imagine that various "bureaucratic failures" would mean that prices do not fall significantly and that the manufacturers simply pocket the corresponding rent differential. We therefore adopt the hypothesis that **these effects neutralise each other**.
- The financing *method* and the *announcement effects* linked to turn off are not neutral for the process. For example, if the Government announces turn off in year n in year p and announces that converters will be financed as of year n-1 (or for the last 15% of analogue households), spontaneous equipment of households between p and n-1 will be lower than would have been the case without this announcement, as some consumers will prefer to wait. We can then add that *even* in the absence of an announcement about financing, some consumers will be likely to anticipate it from the time when turn-off is planned. We shall not take account of this type of effect in order to make the simplification needed in this type of modelling.

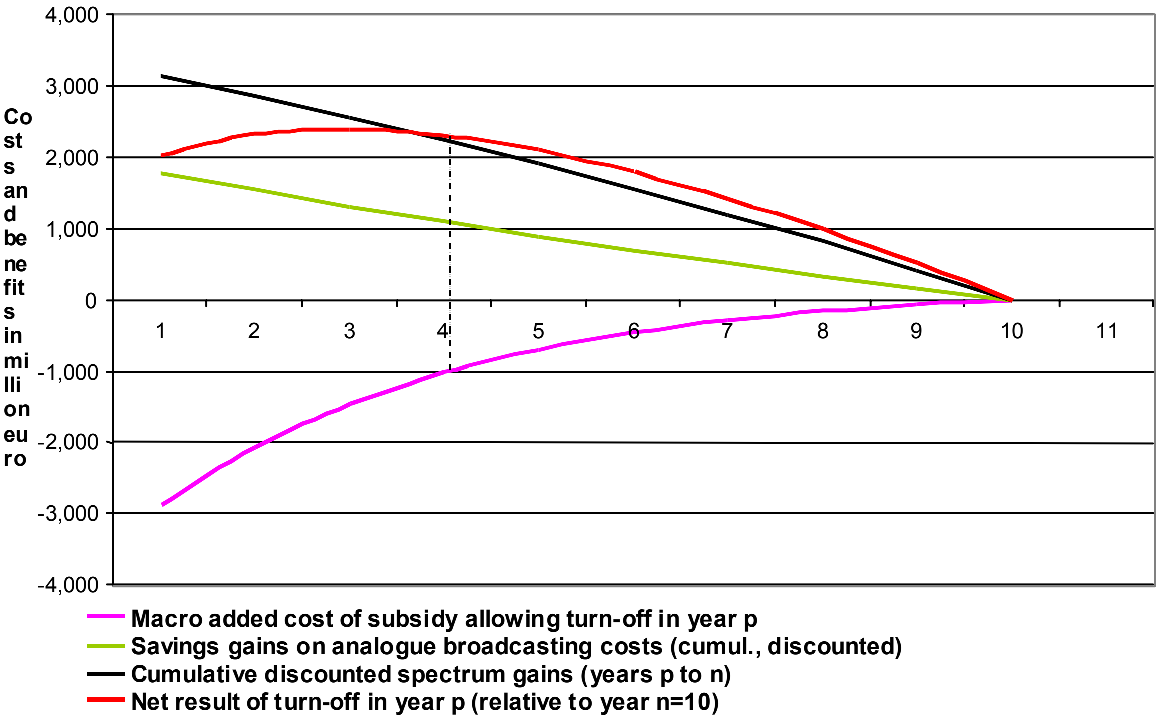
We have therefore now identified **two tangible benefits** (gaining years of extra revenue flows derived from savings in broadcasting costs and services generated by the released frequencies), **and an investment** to be approved (the added macro-economic cost corresponding to the inter-temporal financial transfer used to force early turn-off).

This investment and these expected flows of benefits now have to be compared, which we do in the following table and figure.

Figure 17: Results of the zero simulation

	A	B	C	D = B + C + A
Year of early turn-off p	Macro added cost of transfer allowing turn off in year p	Savings gains on analogue broadcasting costs (cumulated, discounted)	Cumulative discounted spectrum gains (years p to n)	Net result of turn-off in year p (relative to year n=10)
Turn-off year	Public Investment	Broadcast Savings	Spectrum Gains	Net Result
1	-2,894	1,777	3,139	2,022
2	-2,069	1,539	2,852	2,321
3	-1,466	1,312	2,551	2,396
4	-1,025	1,096	2,235	2,307
5	-701	890	1,904	2,094
6	-464	695	1,558	1,789
7	-290	508	1,195	1,413
8	-163	330	815	983
9	-69	161	417	509
N=10	0	0	0	0

Figure 18: Graph of the zero simulation



With the hypotheses selected in the zero simulation, **the benefits resulting from early shutdown of analogue broadcasting largely exceed the investment cost needed to cause this shutdown**. However, it would be wrong to think that “the sooner we turn off, the more we gain”, as the optimum is actually found in year 3 : two years of spontaneous migration, then forced financed conversion of the leftover analogue households during the third year.

For example, if we look at what happens in year 4, we see that the added cost of forced migration is approximately –1 billion euros, whereas the spectrum gains and savings on analogue broadcasting reach +2.2 and +1.1**. The net result of the investment is therefore +2.3 billion euros, relative to the situation if turn-off had only occurred in year 10**.

This differential surplus naturally declines as we approach the reference date and in year 10 it is zero by definition.

Figure 19: Costs and benefits resulting from financing the costs associated with migrating analogue consumers

Costs	Benefits
Macro added cost of early conversion	Flows of savings on analogue broadcasting
Risks inherent in public intervention	Revenue flows derived from the early release of frequencies
	Benefits drawn from the increase in economic activity
	Social benefits derived from universal digital conversion

At this point, it is necessary to remember that up to now we have *only* measured *one part* of the costs and benefits identified in the procedure.

The general inequation whose sense we have to define is actually :

Total costs <> Total benefits ?

Which (in our notation) produces :

[f(C1+C2) + C6/7] <> [f(B2) + f(B4) + B1 + B5][19]

[19] The costs and benefits which do not appear in this inequation are only relevant within the conceptual framework of test 1 (“ triple-way” vs. “cabsat way”). It is pointed out that C3 (cost of updating networks) has not been included here because the level 2 tests assume that the networks are constructed so that it is possible to focus solely on the costs of migrating in terms of reception. C4 and C5 are not included either as these are costs corresponding to interference between networks and that these are almost independent of the timing of migration. Finally B3, the specific benefit of the consumer withdrawn from a third multichannel platform also only enters into account when the “triple-way” and “cabsat way” migration choices are being compared.

Exercise 2b has enabled us to **quantify several components in the inequation**.

Assuming that we retain the set of hypotheses from the zero simulation and take the forced turn-off year which appears optimum to us (3 or 4), we have:

$$[\ 1 + C6/7_{(4)}\ ] <> [\ 1.1 + 2.2 + B1_{(4)} + B5_{(4)}\ ]$$

$$\text{or} \quad C6/7 <> (1.1 + 2.2 - 1) + (B1_{(4)} + B5_{(4)})$$

$$\text{or} \quad C6/7 <> 2.3 + (B1_{(4)} + B5_{(4)})$$

It is therefore then necessary to estimate whether the **unmeasured risks of "bureaucratic failure"** (competitive distortion, moral hazard, etc.) could be greater or smaller than the unmeasured benefits arising from accelerated entry into the all-digital TV economy (B1), *plus* the expected benefits in terms of social cohesion (B5), *plus* EUR 2.3 billion in *measured* benefits.

The risks of a distortion of the natural operation of markets are acceptable to the extent that (i) they appear to be **proportional** to the expected benefits (ii) they are a "**necessary** evil" for achieving the target benefits insofar as there are no ***alternative*** solutions for reaching them.

The risks of competitive distortion are low here to the extent that we have assumed "platform-neutral" financing: with the public player organising or offsetting the financing of receiver conversion in the same way *regardless* of the household's initial or final mode of access.

6.2.2 Other simulations tested – Sensitivity of different variables

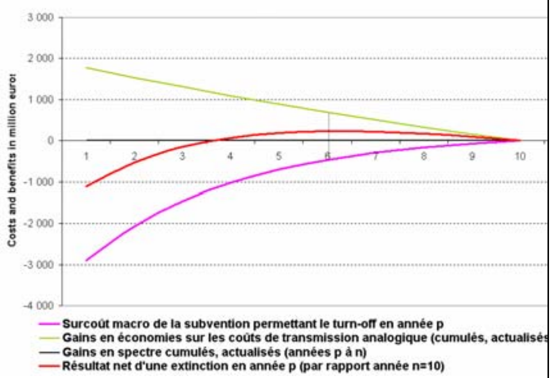
If all of the other components are kept unchanged and an absence of solvent demand for the releasable Mhz is assumed (i.e. the income derived from the released 100 Mhz is zero), we obtain a negative balance over the first three years and a slightly positive balance subsequently. As the maximum positive surplus observed is under €250m, it becomes much more difficult to assert that the operation will remain positive once the unmeasured costs and benefits are taken into account.

Figure 20: Simulation without spectral benefits

Hypotheses

		%	Nb
A	Initial number of analogue homes	70%	16,1
B	Digital homes	30%	6,9
C	Total TV homes	100%	23
D	Total population	57,5	
E	Interest rate (time discount)	5%	
F	Natural switch rate to cabsat	10%	
G	Natural switch rate to DTT	5%	
H	Total natural switch rate to pay DTV	15%	
I	Initial converter price (€)	150	
J	STB price decrease per year	10%	
K	Number of receivers to convert per home	2,7	
L	Fixed cost of digital reception upgrade per home (dish/aerial)	50	
M	Global analogue broadcasting costs (M€)	250	
N	Bandwith released after analogue turn-off (in Mhz)	100	
O	Initial bandwidth price (in € per Mhz*year*inhabitant)	0	
P	Annual revenue out of leased frequencies year one (M€)	0	
Q	Annual increase	10%	
R	Years of simulcast in reference scenario (n)	10	

Result



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The valuation of the releasable spectrum is therefore a decisive variable for the cost/benefit calculation. While historical precedents have produced valuations from EUR 0.02 to 0.25 per Mhz and per inhabitant, we believe it seems unrealistic to test values exceeding 0.10 for several reasons:

- Because the valuations in the years 1995-2000 were made in particular context of financial bullishness in the telecoms sector.
- Because the auction mechanisms established led to overpayment in certain cases.
- Because it has been observed that some governments have since started to agree to negotiate these prices downwards or to transfer the payment to a tax on the turnover generated, while adopting the view that prospective revenues would today no longer make it possible to amortise the fixed price payable initially.
- Because, as telecommunications operators have *already* purchased an access right to these frequencies, their willingness to pay again and their ability to mobilise capital is much lower today. This is all the more applicable if it is accepted that the frequencies in question are not absolutely vital for the development of business.

Figure 21: Balance depending on a hypothesis of valuation of the spectrum

Valuation of released spectrum in € per Mhz per inhab	**Maximum positive balance in M€**
0	+231
0.01	+570
0.02	+951
0.05	+2396
0.10	+5170

If we retain a hypothesis of 0.05 and assume zero development over the period (instead of 10%), the balance remains positive over the entire period, with an optimum of approximately €1.5 billion.

Figure 22: Simulation without an increase in spectral benefits

Hypotheses

		%	Nb
A	Initial number of analogue homes	70%	16,1
B	Digital homes	30%	6,9
C	Total TV homes	100%	23
D	Total population	57,5	
E	Interest rate (time discount)	5%	
F	Natural switch rate to cabsat	10%	
G	Natural switch rate to DTT	5%	
H	Total natural switch rate to pay DTV	15%	
I	Initial converter price (€)	150	
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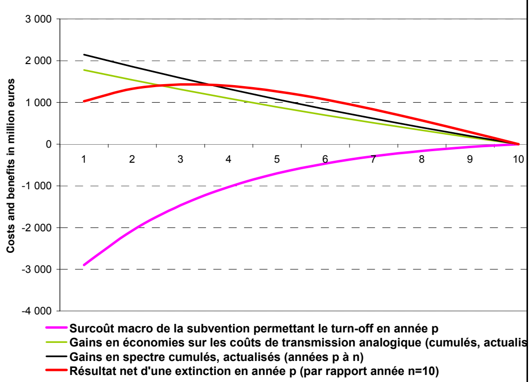
K	Number of receivers to convert per home	2,7	
L	Fixed cost of digital reception upgrade per home (dish/aerial)	50	
M	Global analogue broadcasting costs (M€)	250	
N	Bandwith released after analogue turn-off (in Mhz)	100	
O	Initial bandwidth price (in € per Mhz*year*inhabitant)	0,05	
P	Annual revenue out of leased frequencies year one (M€)	288	
Q	Annual increase	0%	
R	Years of simulcast in reference scenario (n)	10	

Result



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The mobile telecommunications market in the Union

The telecommunications services market in the European Union currently represents approximately EUR 200 billion per year, with annual growth of 12%. Mobile communications, which consume radio frequencies accounted for approximately 30% of this market in 2000, i.e. EUR 60 billion, recording a growth rate of 38%[20]. As the population pool of our imaginary country is approximately 15% of the EU figure, we have to assume a mobile telecommunications services market worth about EUR 10 billion annually here. A cost of €288m per year would therefore represent approximately 3% of the current market.

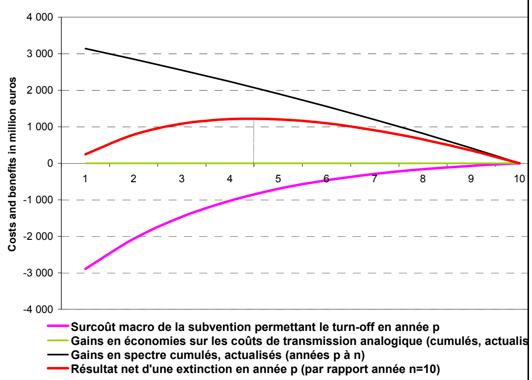
If we now take an assumed spectral valuation of 0.05 again with 10% growth per year and we test the **sensitivity of the "cost of analogue broadcasting" variable**, it can be seen that even a zero value does not degrade the positive balance completely. This is obviously due to the fact that with 0.05 the spectral gains are very much greater than the broadcasting gains and are sufficient themselves to balance out costs.

Figure 23: Simulation without transmission cost savings

Hypotheses

		%	Nb
A	Initial number of analogue homes	70%	16,1
B	Digital homes	30%	6,9
C	Total TV homes	100%	23
D	Total population	57,5	
E	Interest rate (time discount)	5%	
F	Natural switch rate to cabsat	10%	
G	Natural switch rate to DTT	5%	
H	Total natural switch rate to pay DTV	15%	
I	Initial converter price (€)	150	
J	STB price decrease per year	10%	
K	Number of receivers to convert per home	2,7	
L	Fixed cost of digital reception upgrade per home (dish/aerial)	50	
M	Global analogue broadcasting costs (M€)	0	
N	Bandwith released after analogue turn-off (in Mhz)	100	
O	Initial bandwidth price (in € per Mhz*year*inhabitant)	0,05	
P	Annual revenue out of leased frequencies year one (M€)	288	
Q	Annual increase	10%	
R	Years of simulcast in reference scenario (n)	10	

Result



If we now take the zero spectral benefits (0.05) and broadcasting (250) hypotheses again and test the **sensitivity of the cost hypotheses**, we can for example assume that the average initial price of converters is €250 and no longer €150 (which is approximately the current price of converters in the market) and that this price falls 30% per year over the period instead of 10%. With these significantly less favourable hypotheses, we can see that the result is negative if an attempt is made to turn off at the end of year 1 or 2, but remains very positive beyond these points. It may appear paradoxical that a more dramatic drop in converter costs creates a less favourable context, but this is nonetheless the case because if converters drop more dramatically it is less in our interest to turn off early, because turning off early then represents a comparatively greater added cost.

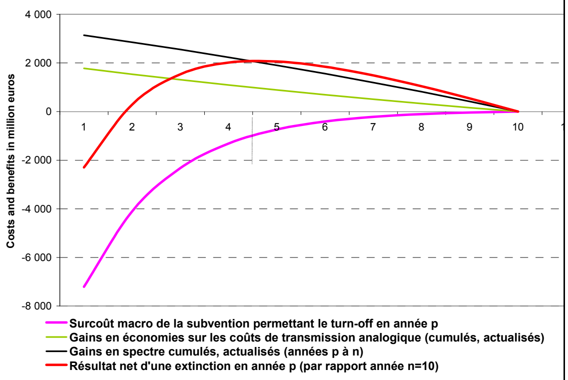
[20] Source : Communication dated 20 March 2001 on 3G mobile communications - COM(2001)141.

Figure 24 : Sensitivity of the hypothesis concerning the cost of converters (C2)

Hypotheses

		%	Nb
A	Initial number of analogue homes	70%	16,1
B	Digital homes	30%	6,9
C	Total TV homes	100%	23
D	Total population	57,5	
E	Interest rate (time discount)	5%	
F	Natural switch rate to cabsat	10%	
G	Natural switch rate to DTT	5%	
H	Total natural switch rate to pay DTV	15%	
I	Initial converter price (€)	250	
J	STB price decrease per year	30%	
K	Number of receivers to convert per home	2,7	
L	Fixed cost of digital reception upgrade per home (dish/aerial)	50	
M	Global analogue broadcasting costs (M€)	250	
N	Bandwith released after analogue turn-off (in Mhz)	100	
O	Initial bandwidth price (in € per Mhz*year*inhabitant)	0,05	
P	Annual revenue out of leased frequencies year one (M€)	288	
Q	Annual increase	10%	
R	Years of simulcast in reference scenario (n)	10	

Result



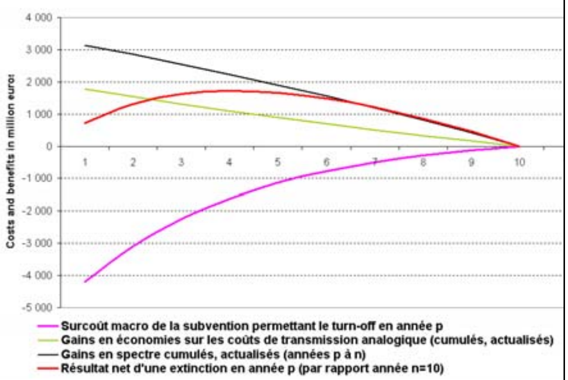
Hypothesis N (fixed cost of adapting reception), corresponding to either the adaptation of a aerial for DTH, or the purchase-installation of a satellite dish, does not appear to be a very sensitive variable as this cost is not likely to develop dramatically over time. Assigned a value of 500 (instead of 50 in the zero simulation), the balance remains positive.

Figure 25: Sensitivity of the hypothesis on the cost of adapting reception (C1)

Hypotheses

		%	Nb
A	Initial number of analogue homes	70%	16,1
B	Digital homes	30%	6,9
C	Total TV homes	100%	23
D	Total population	57,5	
E	Interest rate (time discount)	5%	
F	Natural switch rate to cabsat	10%	
G	Natural switch rate to DTT	5%	
H	Total natural switch rate to pay DTV	15%	
I	Initial converter price (€)	150	
J	STB price decrease per year	10%	
K	Number of receivers to convert per home	2,7	
L	Fixed cost of digital reception upgrade per home (dish/aerial)	500	
M	Global analogue broadcasting costs (M€)	250	
N	Bandwith released after analogue turn-off (in Mhz)	100	
O	Initial bandwidth price (in € per Mhz*year*inhabitant)	0,05	
P	Annual revenue out of leased frequencies year one (M€)	288	
Q	Annual increase	10%	
R	Years of simulcast in reference scenario (n)	10	

Result



If we now take the median hypotheses and test the **sensitivity of the hypothesis on the interest rate** and discounting, it emerges that:

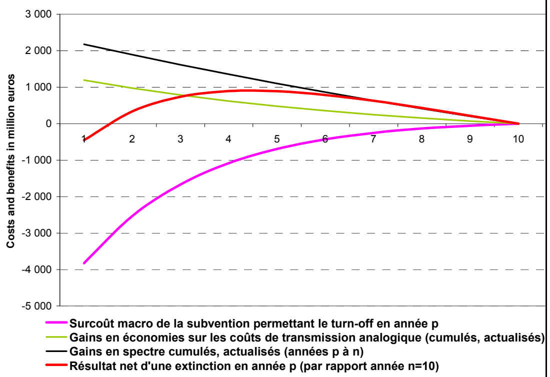
- The balance is much more substantially positive with an interest rate of 0% (instead of 5%).
- With a higher interest rate, for example 15% (instead of 5%), the lower value of future benefits present relative to the initial investment makes the operation much less positive, with a maximum positive balance of €800m instead of €2.5b. However, **the balance remains positive**.

Figure 26: Sensitivity of the hypothesis concerning the discount rate

Hypotheses

		%	Nb
A	Initial number of analogue homes	70%	16,1
B	Digital homes	30%	6,9
C	Total TV homes	100%	23
D	Total population	57,5	
E	Interest rate (time discount)	15%	
F	Natural switch rate to cabsat	10%	
G	Natural switch rate to DTT	5%	
H	Total natural switch rate to pay DTV	15%	
I	Initial converter price (€)	150	
J	STB price decrease per year	10%	
K	Number of receivers to convert per home	2,7	
L	Fixed cost of digital reception upgrade per home (dish/aerial)	50	
M	Global analogue broadcasting costs (M€)	250	
N	Bandwith released after analogue turn-off (in Mhz)	100	
O	Initial bandwidth price (in € per Mhz*year*inhabitant)	0,05	
P	Annual revenue out of leased frequencies year one (M€)	287,5	
Q	Annual increase	10%	
R	Years of simulcast in reference scenario (n)	10	

Result



6.2.3 Territorial simulations

After testing the sensitivity of different hypotheses, we present the results of simulations obtained from sets of hypotheses matching different types of EU countries in this section.

a) *Large predominantly terrestrial countries (UK, France, Italy, Spain)*

The **zero simulation applies** overall, as the imaginary country selected resembles these countries.

b) *Large predominantly cabsat countries*

The smaller the number of initial analogue households, the more the operation is profitable macro-economically. For example, if we take a country the size of Germany (33 million TV households, 82 million inhabitants), it can be seen that converting 20% of households would yield approximately EUR 5 billion at optimum timing, whereas converting 90% would only yield EUR 2.5 billion. The reason is simple: the (added) cost of conversion increases the with the size of the population to be converted whereas for their part, the expected benefits of turn-off remain constant.

Figure 27: Cost/benefit result depending on the remaining users to be converted

INITIAL PERCENTAGE OF ANALOGUE (OR ANALOGUE TERRESTRIAL) HOUSEHOLDS	MAXIMUM NET RESULT
10%	5,500
20%	5,000
50%	3,500
70%	3,000
90%	2,500

6.2.4 Digital conversion or terrestrial turn-off?

Up to now it was assumed that all households would be migrated to digital. However, to obtain the B2 (broadcasting savings) and B4 (spectrum gains) benefits alone, it is *only* necessary to migrate *terrestrial* households and not *all* households.

It would therefore be possible to consider a public decision aimed solely at turning off analogue terrestrial broadcasting and no longer digitising all accesses. This would mean equipping all analogue terrestrial households so that they could move to DTH, to cable (it does not matter where this is digital or analogue) or to satellite (digital or analogue).

Three components are now altered relative to the costs/benefits table envisaged in the previous scenario: the added macro-economic conversion cost is reduced significantly; the macro-economic benefits derived from the extra activity are slightly reduced because an all-digital situation is not created (although it does remain all-multichannel); finally, the social benefits expected from all digital (reduced risk of the digital divide) are not achieved at this stage.

In this case, it is necessary to consider the initial *terrestrial* population and its remainder year after year instead of the initial *analogue* population and its remainder year after year.

Thus, if we take the case of Germany again, it is no longer necessary to consider 90% of households to be converted to digital, but 10% of households to be converted to… any platform other than analogue terrestrial. Thus, for identical measured benefits, the cost is much lower and the positive balance is much greater, as it reaches €5,500 m in this instance.

However, it should be remembered that the same things are not being measured

In the first case (digital migration) the measured positive balance (€2,500) does not take account of the macro-economic benefits derived from accelerating multi-platform digital migration. These possible benefits therefore have to be added.

In the second case (analogue terrestrial turn-off), the measured positive balance (€5,500) represents all benefits, as the impact on the overall digitisation of the country is low (but not zero). There is less to add.

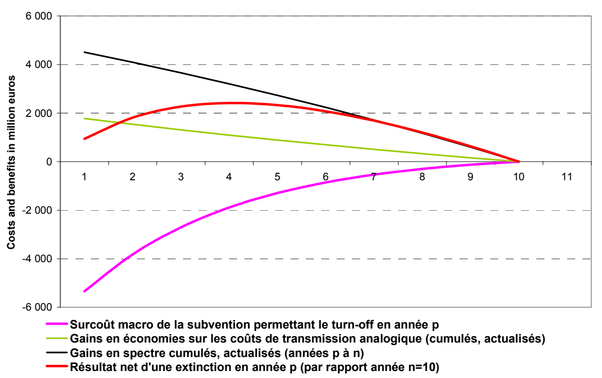
Figure 28: Costs and benefits of early *terrestrial* turn-off

Costs	Benefits
Macro added cost of early conversion (-)	Flow of savings from analogue transmission
Risks inherent in public intervention	Revenue flow arising from the early release of frequencies
	Benefits derived from increase in economic activity (-)
	Social benefits derived from universal digital conversion (-)

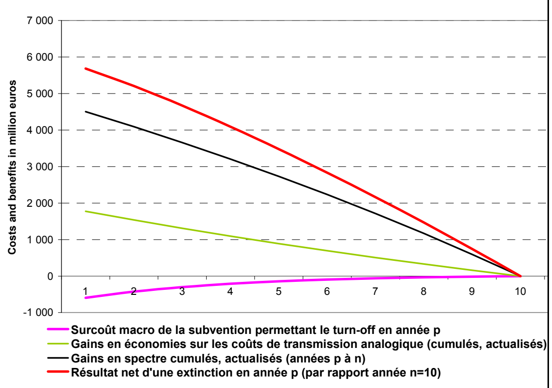
The enclosed figure shows the difference for a given country (in this instance Germany), depending on whether the interest of accelerating digital migration is measured overall or whether account is only taken of the acceleration of the halt in analogue terrestrial broadcasting.

Figure 29 : Digital conversion or terrestrial turn-off?

Digital conversion of 90% of households

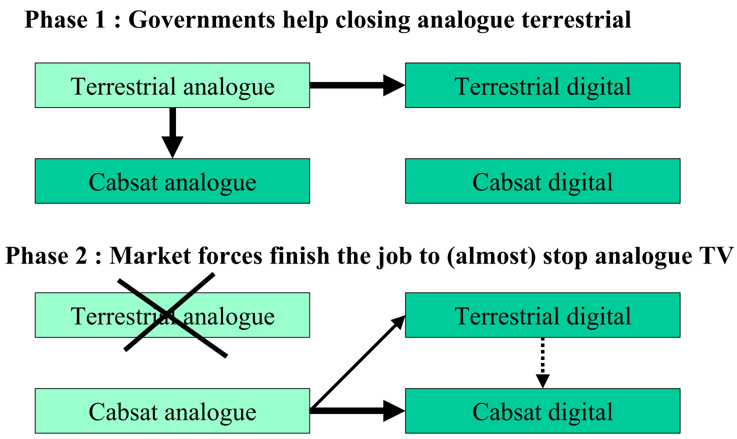


Terrestrial turn-off of 10% of households



It can be seen that it is possible (and probably more realistic) to imagine that the public authorities will intervene to co-ordinate and accelerate analogue terrestrial turn-off, whereas in a second phase, market forces could organise overall migration to digital within each platform without difficulty.

Figure 30: Regulatory intervention solely for the first phase of digital migration



6.2.5 Pan-European simulation

This simulation exercise can be carried out again on the scale of an imaginary country which has the size and characteristics of the European Union.

According to the European Commission report on the application of Telecom Directives, the values for the entire Union (plus Norway and Switzerland) are as follows:

- Households at the end of 2001: 155 million
- TV households at the end of 2001: 152 million
- Population at the end of 2000: 388 million[21]
- Terrestrial households only: 47% or 71 million (cable or satellite household: 53% or 81 million)
- Digital households: 18% (analogue households : 82%), i.e. 27 million

If we add the hypothesis that the annual cost of analogue terrestrial broadcasting amounts to approximately €1,500 per year in the EU, we obtain the following results:

- Early digital conversion provides a positive balance culminating in approximately EUR 14 billion.
- Early turn-off of analogue terrestrial broadcasting is much less costly for identical measured results. The maximum balance is therefore higher (approximately 19 billion).

[21] Source: INED.

Figure 31: Early digital conversion in the European Union

Hypotheses

		%	Nb
A	Initial number of analogue homes	82%	124,64
B	Digital homes	18%	27,36
C	Total TV homes	100%	152
D	Total population	380	
E	Interest rate (time discount)	5%	
F	Natural switch rate to cabsat	10%	
G	Natural switch rate to DTT	5%	
H	Total natural switch rate to DTV	15%	
I	Initial converter price (€)	150	
J	STB price decrease per year	10%	
K	Number of receivers to convert per home	2,7	
L	Fixed cost of digital reception upgrade per home (dish/aerial)	50	
M	Global analogue broadcasting costs (M€)	1500	
N	Bandwith released after analogue turn-off (in Mhz)	100	
O	Initial bandwidth price (in € per Mhz*year*inhabitant)	0,05	
P	Annual revenue out of leased frequencies year one (M€)	1900	
Q	Annual increase	10%	
R	Years of simulcast in reference scenario (n)	10	

Results

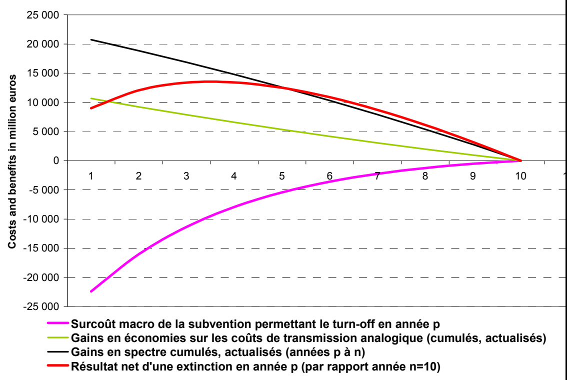
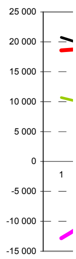


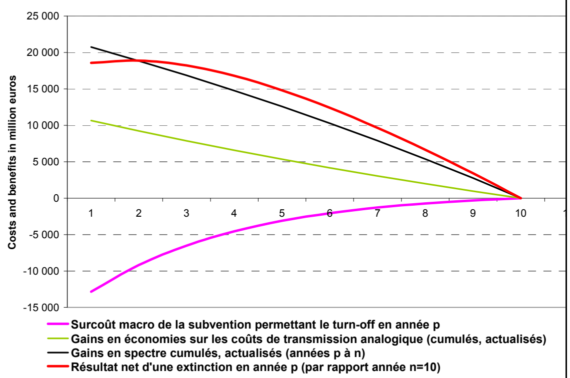
Figure 32 : Analogue terrestrial turn-off in the European Union

Hypotheses

		%	Nb
A	Initial number of analogue terrestrial homes	47%	71,44
B	Non-terrestrial homes	53%	80,56
C	Total TV homes	100%	152
D	Total population	380	
E	Interest rate (time discount)	5%	
F	Natural switch rate to cabsat	10%	
G	Natural switch rate to DTT	5%	
H	Total natural switch rate from analogue terrestrial	15%	
I	Initial converter price (€)	150	
J	STB price decrease per year	10%	
K	Number of receivers to convert per home	2,7	
L	Fixed cost of digital reception upgrade per home (dish/aerial) (€)	50	
M	Global analogue broadcasting costs (M€)	1500	
N	Bandwith released after analogue turn-off (in Mhz)	100	
O	Initial bandwidth price (in € per Mhz*year*inhabitant)	0,05	
P	Annual revenue out of leased frequencies year one (M€)	1900	
Q	Annual increase	10%	
R	Years of simulcast in reference scenario (n)	10	



Results



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7 Test 3: Hypothesis of the compulsory "digital tuner"

One of the regulatory measures currently envisaged by Governments in order to accelerate digital migration and analogue turn-off is an obligation solely to sell televisions with an ability to **receive digital signals**, which would require the integration of a **digital tuner and a demultiplexer** in each television set sold.

At a minimum, integrated digital TV or IDTV describes a television set equipped with a "digital tuner". In certain cases, IDTV can incorporate other functions such as an interface which makes it possible to insert a conditional access module, a hard disk and a modem. In this section, unless specified otherwise, we focus our analysis on a minimum-configuration IDTV, which is equipped solely with a digital tuner.

This sections aims to provide responses to the following questions:

- What would the **efficiency** of such a measure be?
- What is the **need** for this measure, knowing that a spontaneous development of the market could produce similar effects to those sought after?
- What would be the "macro-economic" **relevance** of a measure of this type which would result from a cost/benefit analysis?

BIPE believes that a measure which makes the presence of "digital tuners" in marketed television sets compulsory would create major impacts, notably as regards the speed of digitising all receivers in households. The possible disadvantages of a measure of this type (distortion in favour of free-to-air television and a theoretical limit on consumer choice) are of much less consequence in our view than the benefits arising from a significantly shortened migration period.

7.1 Efficiency of the measure

a) Effect of replacing televisions

All other things being equal, it is clear that **a measure which makes the presence of a digital tuner in televisions compulsory can only increase the speed of penetration of digital television in households** which have not subscribed to pay TV (for their part, the main televisions in pay TV households will be "digitised" via the decoder provided by the pay TV operator).

Let us take the example of an imaginary country of 20 million TV households, where pay TV penetration is 20% at the start of the period. Thus, there are 16 million households which only receive free-to-air television ("free-to-air households" or "FTA households").

We assume that televisions currently have a lifetime of approximately 8.3 years on average, which means that approximately 12% of the television sets will be replaced each year. 12% of 16 million main television sets in FTA households are replaced each year, i.e. approximately two million televisions.

If all receivers sold were digital, it would take 8 years for all FTA households to be "digitised". At the other extreme, if only 5% of new receivers were digital, approximately 100,000 would be sold annually to FTA households. At this pace and if we also assume that the level of pay TV households reaches 50% after ten years, the stock of digital receivers among the main equipment owned by FTA households would reach 800,000. This means that only 8% of FTA households (54% of households in total) would have an access to digital television. The following table indicates the stock migration speeds achieved depending on the proportion of digital receivers among annual sales

Table 8: Digitisation of the stock of receivers by IDTVs under the sole effect of replacement

Proportion of IDTVs in annual sales	**5%**	**25%**	**50%**	**100%**
Level of FTA households digitised after 10 years	8%	40%	80%	100%
Level of households digitised after 10 years	54%	70%	90%	100%
Number of years required to reach 100%	160 years	30 years	14 years	8 years

NB This table does not take account of receivers and households "digitised" by external converters.

The same calculation can be undertaken for **secondary receivers**. However, it should be noted that secondary televisions probably have a longer life-span than main televisions and are more generally low-end goods (in this respect, they would be more sensitive to an added cost). Thus, whatever spontaneous migration rate hypothesis adopted for the main TV set, it is appropriate to adopt a more pessimistic assumption for the *second* TV set. If for example, it is assumed that the rate of spontaneous migration for the main TV set is 50%, it could only be 25% for the second TV set. At this rate, it would take only 14 years for 100% of households to gain access to digital television, but **20 to 30 years would be required for *all* receivers to be digitised**, depending on the scale of the recovery of the main television which becomes the secondary receiver when the main TV set is changed.

While we are interested in the number of "digitised" households (i.e. with at least one access to digital TV) within the perspective of migrating reception to digital television (switchover), **we are interested in this second level within a perspective where the sought-after collective benefit arises from the turn-off of analogue broadcasting**, as it inconceivable politically for analogue broadcasting to halt where the majority of secondary TV sets are still digital[22].

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[22] However, the most complete and clear criterion for analogue turn-off (the three English tests) only considers the "digitisation" of households (at least one digitised television set) and not the conversion of *all* receivers in the household.

b) *Effect of external converters*

For the moment, we have only envisaged two modes of migration to digital reception: (i) transition to pay TV (which automatically induces a transparent transition to digital, at least for the main TV set) and (ii) replacement of analogue television sets by digital receivers at the time of natural renewal. It is also necessary to take account of a third path, the purchase of converters by FTA households so that they can receive digital broadcasts on their working analogue televisions.

What might the scale of this phenomenon be?

We shall take the same imaginary country as previously, with the same level of pay TV consumers and assume that IDTVs are not sold at all. If it is assumed that 5% of remaining analogue receivers are equipped with a converter each year, 55% of FTA households will possess a “digital” receiver after ten years. If on the other hand, the spontaneous equipment rate amounts to 10%, almost all (87%) FTA households will possess a digital receiver after ten years.

Table 9: Digitisation of the stock of receivers through the acquisition of external converters

Annual level of equipment of main analogue receivers with external converters	**5%**	**10%**	**15%**
Level of FTA households digitised after 10 years	55%	87%	100%
Level of households digitised after 10 years	77%	93%	100%

NB This table does not take account of sales of integrated digital televisions (or these are assumed to be zero).

We see that, taken separately, the measure to impose a compulsory digital tuner or conversion of the analogue stock by spontaneous purchase of external converters may **lead to similar effects**, depending on the assumptions concerning the success of converters which are favoured. The first lesson is therefore that an obligation to acquire a digital tuner **is not the *only* way** of hoping to convert households and of converting receivers within short time frames.

c) *The two paths partially compete with each other*

Furthermore, these two ways of “digitising” receivers and households **partially compete with each other in their effects**, to such a degree that we have to **choose** between them to a certain extent.

A measure which makes the "digital tuner" compulsory would make external converters less attractive for two reasons.

- One group of consumers in a renewal situation, who otherwise would have selected a modular digital reception option (analogue receiver + converter) will *no longer* have this opportunity.
- a **waiting effect**: consumers with an analogue receiver close to the end of its lifetime would be discouraged from buying a converter, *knowing that* as their next television *will have to be* digital, the external converter bought in the meantime would become useless one or two years later.

Thus, the success of simple converters in the market *cannot* be the same, depending on whether we assume or do not assume a regulatory measure to impose a "compulsory digital tuner".

Two alternative scenarios thus emerge when the coherent hypotheses are combined:

- **Scenario 1 (sit-back):** no compulsory digital tuner, low sales of IDTVs (e.g. 25% in a terrestrial country) and a conversion rate via external converters at a given pace (e.g. 10% per year in a terrestrial country)
- **Scenario 2 (regulatory intervention)** : compulsory digital tuner and a level of spontaneous conversion *lower* than in scenario 1 (e.g. 5% in a terrestrial country)

We also have to apply these two scenarios to two types of environment.

- In countries with a terrestrial tradition, the range of free-to-air programmes is small and not very diverse, particularly with analogue terrestrial reception. As a result, pay TV can expand to reach 50% of households, for example. An external converter or an integrated digital television may enable households which refuse to subscribe to receive more free-to-air channels terrestrially or by satellite and therefore represents a real consumer benefit.
- In countries with a cable-satellite tradition, the range of free-to-air programmes or those available via basic access is sizeable. As a result, pay TV has a more limited potential and FTA or basic households only derive a minor consumer benefit from transition to digital. The level of spontaneous migration to digital reception by FTA or basic households will be much lower in such countries which are already multichannel.

Our calculations show that in terrestrial countries an IDTV adoption rate at 25% combined with an annual converter equipment rate of 10% makes it possible to ensure total household digitisation in 7.5 years, which is very slightly longer than it would take with the compulsory digital tuner accompanied by an external conversion rate of 5% (5.5 years). The two regulatory scenarios are therefore almost equivalent in terms of their impact on households' speed of access to digital, but it is conceivable that the gap is greater as regards total digitisation of household receivers (we shall deal with this again later).

In cable and multichannel countries, where the attractiveness of IDTVs and converters can be assumed to be much lower, it would be necessary to count approximately 25 years for household migration and much longer for the migration of all receivers. In this instance, an compulsory digital tuner measure would produce a real difference because it would only take 7 years to "digitise" households and receivers.

Table 7: Speed of migration according to scenarios and contexts

	Terrestrial countries	Multichannel cabsat countries
Pay TV at start of period	20%	5%
Pay TV after 10 years	50%	25%
Scenario 1		
IDTV rate	25%	10%
Converter rate	10%	5%
FTA digital households: +10 years	100%	66%
Total duration of migration	7.5 years	Approx. 25 years
Digital households after 10 years	100%	75%
Scenario 2		
IDTV rate	100%	100%
Converter rate	5%	2%
Digital households after 10 years	100%	100%
Total duration of migration	5.5 years	7 years
Digital households after 10 years	100%	100%

d) Price effect

Up to now, we have neglected the impact of an obligation measure on costs, prices and (subject to consumer price-elasticity) sales.

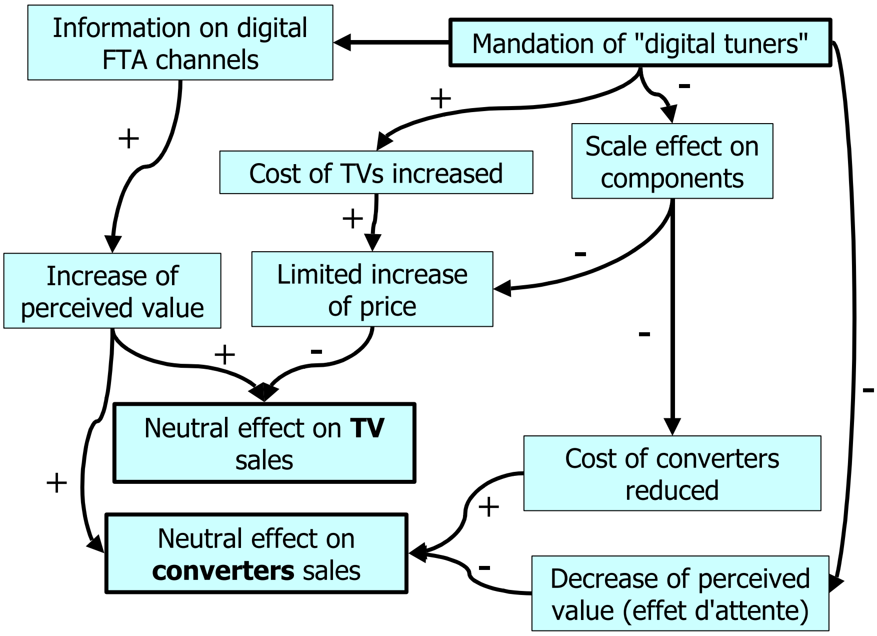
A measure which made digital tuners compulsory would end up **increasing the cost of manufacturing televisions**, although this **added cost would be limited by an effect of scale leading to a drop in the cost of components**. It is also possible to imagine that manufacturers or distributors would reduce their margins slightly to maintain their sales.

In our view, this slight added value could be **compensated for by an increase in the practical value perceived** by the consumer (image quality, possibility of accessing free-to-air channels accessible in digital), notably if an **information campaign** is mounted in parallel to explain the existence of free-to-air digital reception. In total, the impact on sales could be small. This quality effect offsetting the value effect would mainly come into play in terrestrial countries. Once again, the majority of households are *already* multichannel in cabsat countries.

Furthermore, the drop in component prices generated by the volume effect on televisions will have the effect of reducing the cost and price of converters. This could make it possible to offset the loss of attractiveness of converters due to the waiting effect described above, thus leading to an overall neutral effect on sales of converters.

We have not *measured* these effects resulting from price elasticity and the perceived practical value, but we assume that these effects in an opposing direction are of similar dimensions and that it is possible to assume that they balance each other out. Finally, neither sales of televisions nor even sales of converters would be heavily negatively affected by a measure making a digital tuner compulsory in televisions and generating an added cost, if it remains low (as we believe it will).

Figure 33: The obligation to have a digital tuner may be *neutral on sales* of televisions, but also converters



e) *Focus on secondary receivers*

This measure would lead to an added manufacturing cost for all televisions. The problem is less the added cost as such (approximately 50 euros in manufacturing costs and 80 to 100 euros as the selling price) than its **fixed** nature, which is independent of the cost of the receiver. Thus, 80 euros on a low-end terminal is proportionally much greater than on a top-end terminal, as the following table shows.

	Low-end	Medium range	Top-end
Anal. TV price	200	500	1000
Extra cost for digital adapt	80	80	80
Extra	40%	16%	8%

The following dilemmas arise from this fixed-cost characteristic:

- Making a digital tuner compulsory on high-end televisions serves little purpose as (i) the majority of options are integrated in any case in this price range and (ii) the added cost is proportionally minimal.

- Making the digital tuner compulsory on entry-level terminals (the category including almost all *secondary* TV sets) could generate a more substantial cost supplement which would either lead to a drop in sales in this category or to a reduction in manufacturers' and retailers' margins. However, this disadvantage would not be *intrinsic* to the "compulsory" path, as the price of external converters is also once again independent of the price of its associated receiver.

7.2 Character of the necessity of the measure

The advocates of a measure of this type start from two principles:

(i) Migration of digital reception has to be rapid for general interest reasons;

(ii) Dissemination of free-to-air digital television reception equipment which would occur under the impact of market forces alone will be (too) slow relative to what is desirable.

The problem associated with the second point is that **this pessimistic prediction is based on an analysis of the recent past which probably cannot be extrapolated** into the future. It should be remembered that the very low sales of IDTVs and digital converters during the first three years in the United Kingdom[23] occurred in a **very unfavourable 1998-2001 context**:

- few and still very expensive products available;
- distributors and manufacturers anxious to "surf" first on the success of DVD, 16/9 and digital subscriptions, before investing their resources in educating the public about a new product concept;
- few new free-to-air channels available in digital mode;
- a low level of information on free-to-air channels and even on the existence of a free digital access mode;
- a low level of information on the topic of analogue turn-off and the required adaptation of receivers by then
- a windfall effect caused by Sky and ITV Digital promotional drives on decoders, which provisionally diverted households who otherwise would have had recourse to digital reception from this medium;

As a result, **conditions can only improve as of now**:

- a slowdown in migration to pay TV and promotion of the service (maturation, saturation, a leader anxious to return to a financial balance now that its leadership seems to be definitively established) ;
- improved level of information on free-to-air digital;
- a trend towards a greater awareness of image quality (notably linked to the strong development of DVD and 16/9 for the past three years) ;

[23] Sales of IDTV in UK : 1999 30K, 2000 100K, 2001 180K compared with six million television sets (3%).

It therefore appears **premature** to conclude today that consumers and providers do not want and will never want IDTV or converters and to decide that *as a result* the obligation to have a digital tuner is *essential* for migration to occur at what is considered a satisfactory pace.

7.2.1 Precedents and analogies

In the history of electronics, some innovations have become disseminated spontaneously because they provided the user with a greater value. He was consequently prepared to pay more for new equipment and/or replace his equipment earlier than he would have done without the appearance of this innovation. This was the case with colour television. There was no point in banning the sale of black and white TV sets, given the success of colour sets. Nonetheless, it took approximately 20 years for all households to be equipped with a colour television and even longer for black and white receivers to disappear.

At the start of the 1980s, **the Scart plug** was made compulsory on French televisions. This standard interface allowed inexpensive universal connection to market video-recorders without requiring an adapter. The added cost was passed on to prices but the economies of scale achieved due to the obligation measure rendered this added cost minimal and did not lead to a shrinking of the television set market. Macro-economically, households wishing to own a video recorder (which moved from 0% to approximately 70% today) benefited from the measure, whereas the others incurred a slight added cost without a useful offsetting benefit for them. The video-recorder market benefited from the measure and therefore the sales and hire market. Prices dropped in these markets. Video-recorders and home video therefore became more accessible to consumers who a priori would not have been interested. The added cost generated by the Scart plug paid for by households thus corresponded in a way to compulsory insurance taken out: if the consumer decided to acquire a video-recorder during his television's life-span he would be able to connect it without incurring an added cost at the time.

It was easier to ensure the general use of an appliance like the Scart plug than a digital tuner for a simple reason: the Scart plug benefited the video-recorder market. Thus, manufacturers and retailers were able to recover the investment made to make the Scart plug almost universal (industrial investment, possible lower margin to avoid passing on the cost of the interface fully in the selling price) from the video-recorder market. Nothing like this applies to the digital tuner, which will essentially benefit providers of free-to-air digital channels. It is precisely the *external* nature of the benefits generated by the progress of digital penetration and by the possibility of turn off which does not allow the players in the TV set market to internalise these effects spontaneously and which may justify a "compulsory tuner" type intervention.

7.3 Sector players facing the measure[24]

The various players in the consumer electronics sector have spoken of the opportunities linked to integrated digital televisions with BIPE.

According to Thomson Multimédia, the modular model should assert itself in the long term through a separation of the screen interface from the electronics section (hard disk, recorder, reader, decoder(s)). However, it should be noted that modular HiFi systems account for a small segment of the overall market in the sound sector. TMM believes that, as the life-span of STBs (approximately four years) is half that of televisions, this may cause a problem in the case of integrated functions. However, if the integration is limited to the analogue tuner (without a conditional access module or built-in intelligence), the risk of obsolescence will be more limited. Finally, TMM points out that the pay TV decoder distribution model is extremely different in the US from in Europe. In this “sharing” model, pay TV operators subsidise the availability of STBs in retail outlets, where they are bought by the subscribers. Thus, the operator does not have to look after the management of a stock of decoders.

Philips Consumer Electronics UK believes that IDTV will be the dominant solution for converting FTA households to digital. According to Philips, as there is a wish to make Great Britain a leading digital television country with the consequences in terms of image (e-UK) and exports, the opportuneness of valuing the radio spectrum is merely a follow-up consideration. Finally, Philips thinks that the main obstacle to the sale of IDTVs lies in the fact that as sales staff receive commission on sales, they prefer to highlight products where the customer benefit is more immediately visible and understandable (16/9 screen type) rather than products whose advantages take a longer time to explain.

Samsung is basing its long-term strategy on the convergence of TV and computer monitors in the form of flat-screen displays which are considered separately from other peripheral devices.

Sony manufactures IDTVs in Europe (production centres in Spain, Wales and Hungary). Digital televisions have the same basic format as analogue televisions; a tuner and demultiplexer is simply added. In France, Sony markets simple IDTVs for non-encrypted satellite reception, as well as digital televisions suitable for receiving the Canal Satellite package. In the United Kingdom, Sony Visual Entertainment controls 60% of the volume of a market which the company estimates at 80,000 appliances sold in 2001. The digital terrestrial version of Sony IDTVs is based on an MHEG platform which also offers the opportunity to decode ITVdigital signals by using a conditional access module connected via Common Interface.

On the distribution side, distributors have stated officially that they are in favour of digital television, regardless of whether it is implemented via external converters or integrated digital televisions.

[24] Source: BIPE discussions with manufacturers (ANIEL, BREMA, SIMAVELEC, Sony France, Thomson Multimedia, Philips UK, Pace, Samsung) and distributors (Auchan, Darty, Dixons).

Darty notes that integrated digital televisions could create disadvantages in terms of technological obsolescence, although one of the attractive aspects of digital products for a retailer is actually accelerated product life cycles. Moreover, there is an noticeable trend towards shortening average television set life-spans in the European Union.

While the majority of electronics manufacturers favour the development of integrated digital televisions, why should digital tuners become compulsory and purely analogue televisions be forbidden? In other words, if there is a consensus among industrial players, these could decide to equip all of their models with digital spontaneously and collectively without a need for a regulatory obligation measure.

In fact, **a consensus of this type does not exist**. While the main manufacturers (including the trio of Philips, Sony and Thomson) tend to favour a measure of this type, their competitors tend to be against it, notably those operating in the low-end segment of the market. Even if players intend to migrate, in the absence of a regulatory obligation there will always be manufacturers and distributors prepared to place analogue products on the market which would automatically be less expensive than their competitors (economic “free rider” syndrome). Manufacturers are gambling on the fact that if an obligation measure is imposed, distributors will agree to lower their margin rate slightly to help towards absorbing the added manufacturing cost.

The following table sums up each player’s position regarding integrated digital television and a possible measure which makes digital tuners compulsory. 5 categories of players appear to have reasons for being favourable, while 5 appear to have reasons for disapproving of a measure of this type. We count the Government here as a player rather than a neutral umpire due to collective interests which cannot be taken over by other players in the game (such as macro-economic and social effects resulting from accelerated migration).

In the current state of affairs, an alliance of Government/PSB/manufacturer interests could lead to the advent of an obligation measure.

Table 8: Positions of the main players as regards a compulsory digital tuner measure

	For or against a compulsory digital tuner ?	Motivations
Leading pay TV operators	- -	Pay TV leaders supply added-value decoders, which act as a support towards creating loyalty and increasing ARPU. Sky and C+ have reached agreements with manufacturers for customised IDTVs, but they do not want a totally horizontal model which allows for less differentiation and greater competition (for the moment).
Challenger TV manufacturers	-	Challengers count on very low prices (no names) or alternative strategies (Samsung and modularity).
STB manufacturers	-	A measure of this type would reduce the market for external STBs, but would create economies of scale which would facilitate a more rapid drop in component prices.
Electronic retailers	-	Officially in favour of IDTV. In practice, slow to promote them as long as they can adopt alternatives.
Leading FTA broadcasters	-	Would favour FTA and pay TV challengers.
Challenger pay TV operators	+	Operators such as ITVdigital or Noos would not only like an IDTV world: they would like to have IDTV pre-equipped for pay TV (and therefore more expensive).
Leading TV manufacturers	+	Players such as Sony, Philips and TMM hope to overcome reluctance by distributors and to avoid the free-rider effect as a result. And to achieve scale-related savings plus to hold their share of the value to the detriment of challenger manufacturers and pay TV operators. Nonetheless, they are afraid of a negative price effect on entry-level products.
Public FTA broadcasters (PSB)	+ +	Concerned about penetration by digital public channels.
Challenger FTA broadcasters	+ +	In terrestrial countries, the development of free-to-air digital reception (terrestrial or satellite) is a matter of life or death for new entrants.
Government	+ + +	Would help to accelerate digital migration (switchover) mechanically and to release analogue frequencies (turn-off).

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7.4 Costs and advantages of the obligation measure

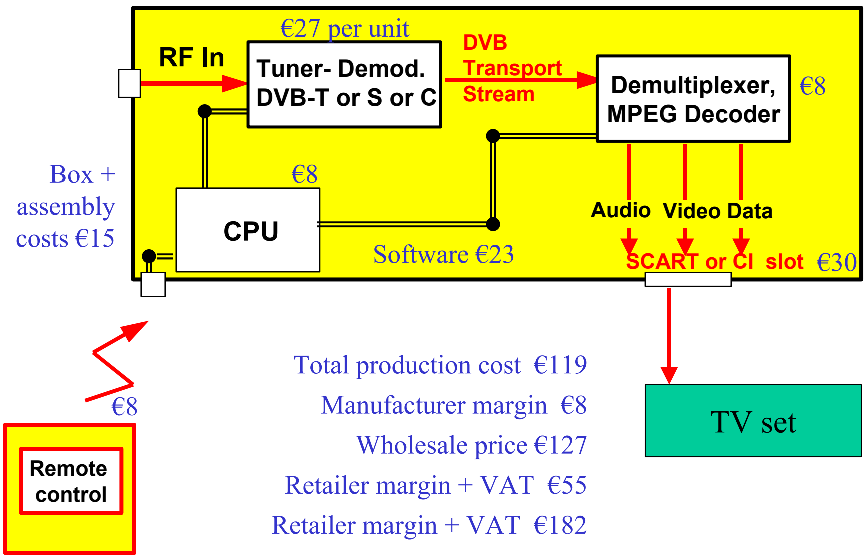
7.4.1 Intrinsic benefit of IDTV versus TV + converter: a less expensive digital reception solution

Incorporating demodulation functionality in the receiver is probably less expensive than adding an external converter to an analogue television. The latter solution actually leads to a **duplication of several functions**, components and costs (remote controller, casing, separate power supply, interface and the distribution costs) (see enclosed figure and table).

However, this cost saving could be reduced by two contrasting effects: mass production of converters could reduce costs in the near future, while introducing digital demodulators into existing TV set models would create **adaptation costs for models and assembly lines**. This would apply even more if each model had to be produced in three versions (cable, satellite or terrestrial digital tuner). The alternative (i.e. an IDTV equipped with *three* tuners) represents an added cost of approximately €54 (2 x 27) compared with IDTV with a single digital tuner.

Nonetheless, it is possible to assume a cost gap in favour of IDTV, whereby an IDTV (*integrated* solution) would actually be *less expensive* for the consumer than a package comprising an equivalent TV + an external converter (*modular solution*).

Figure 34: Main components of a "bare" converter and costs



Source : BIPE estimates based on interviews with Pace, Sagem, Mason, Canal +, OpenTV.

Table 9: Price differences between modular conversion and integrated conversion

Basic converter, basic 55cm analogue set, basic 55cm IDTV (no modem, no hard disk, no smart card reader for pay TV module extension)

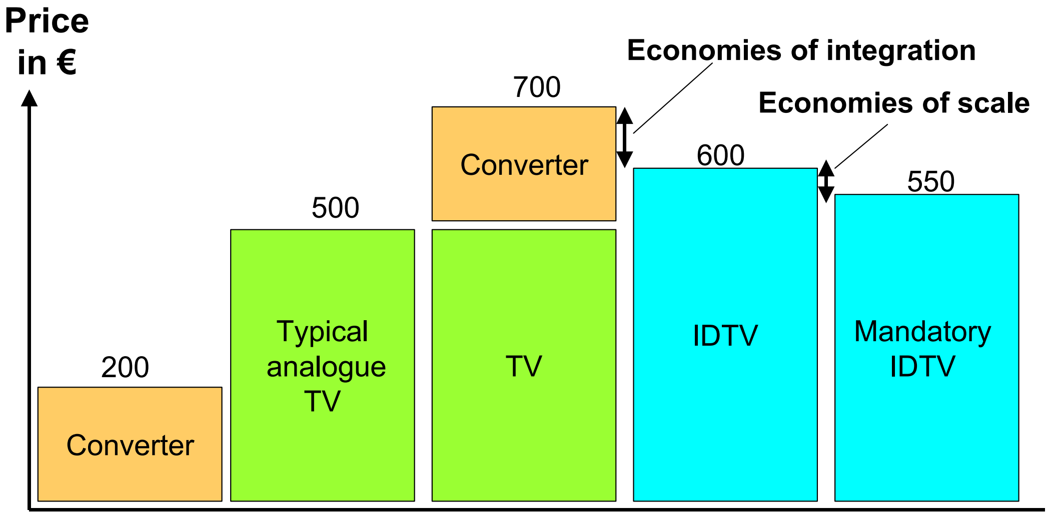
Quantities : 10 K, Year 2001

	Converter	Analogue set	Total	IDTV mono-tuner	Difference
Interface (Scart, CI, …)	30	30	60	30	-30
Remote controller	8	8	16	8	-8
RF frontend (tuner/demod)	27		27	27	
Analogue tuner		10	10	10	
Base band (Mpeg Codec)	8		8	8	
Processor and memory (CPU)	8		8	15	7
Modem					
Hard disk					
Smart card reader (pay TV)					
Screen 55cm		229	229	229	
Assembly	15	30	45	30	-15
Software amortisation	23	15	38	38	
Production cost	**119**	**322**	**441**	**395**	**-46**
Manufacturer margin	6	16	22	15	
	5%	5%	5%	4%	
Wholesale price	125	338	463	411	-53
Retailer gross margin	31	85	116	103	
	25%	25%	25%	25%	
Public price without tax	156	423	579	513	-66
Public price (with 20% VAT)	**188**	**507**	**695**	**616**	**-79**

Source: BIPE estimates based on interviews with Pace, Sagem, Mason, Canal +, OpenTV.

Semiconductor manufacturers have announced the arrival of integrated components which act as a digital + analogue tuner in 2002. This would make it possible to replace the analogue tuner (€10) and the digital tuner (€27) by a single component, for which effects of scale may also be much more substantial.

Figure 35 : relative TV, IDTV and mandatory IDTV prices



According to certain manufacturers interviewed, the development of the costs of digital equipment depends mainly on three elements:

- The quantities produced (effects of scale)
- The level of integration between components and among digital and analogue components
- The royalties paid to MPEG-LA

While the first two factors are under the control of the manufacturers, on the other hand there is no transparency concerning a drop in costs in the third category, which should develop in contrast at the same rate as the market in value. In its response to our questionnaire, Sony Visual Entertainment UK stated that it was in favour of government action aimed at reducing these licensing costs in order to move final costs downwards.

7.4.2 Benefits

a) Acceleration of reception migration.

With all other things equal, we believe that acceleration would be a certainty, as this measure would make it possible to withdraw analogue receivers from the stock automatically and to replace them by digital receivers at the pace of the natural replacement of the stock (see section 1).

In turn, the acceleration of conversion and turn-off would make it possible to achieve the general-interest benefits B1 to B5 identified by BIPE (re-allocation of frequencies, termination of analogue broadcasting, etc.) more rapidly.

b) Greater effects of scale and reductions in cost.

As regards a situation where televisions with integrated digital converters would be competing with analogue televisions alone in the market, the obligation would create **larger effects of scale** at component and finished product level which would probably **minimise the added cost between analogue and digital televisions**.

The effects of scale resulting from the "compulsory digital tuner" obligation would make it possible to **reduce** the price of components and therefore also **the cost of manufacturing external converters**. This effect could be reduced or even neutralised by a *negative* effect of scale on converters themselves, as the presence of purely digital televisions in the market would eliminate the market segment covered by the purchase of external converters *at the same time* as analogue televisions (for consumers who prefer a modular approach).

However, it should be noted that whether an obligation is imposed or not, some semiconductor manufacturers are preparing to produce integrated components which provide all of the functionality of a digital tuner, at a price of $ 7 to $ 9 for 10,000, which will significantly reduce the added cost of integrating this functionality into televisions. At present, television manufacturers have to buy several non-specific components before assembling them themselves. This advantage could be passed on either through lower prices or by adding new functionality at an equivalent price: 3 digital tuners instead of one could make it possible to watch a programme while recording another and to display a third in a quarter-screen frame. All of these things are impossible today and are therefore being announced here.

c) Creation of employment and re-deployment of assembly factories.

This measure could create or maintain employment in the electronics assembly industry. This benefit only exists in countries with an assembly industry. This is the case of the United Kingdom. However, it is difficult to see how IDTV production could generate *more* activity and employment than the production of external converters. We do not take account of this type of industrial policy benefit here.

d) A step towards a more flexible model of pay TV

Here, we have assumed that the measure would lead the manufacturers to incorporate minimum conversion functions (demodulator, CPU, baseband MPEG) in order to minimise the added cost for their different models. However, we should not exclude the possibility that the measure may encourage manufacturers to go further, because they will have to modify their range in any case. Thus, we may see the appearance in the market of **more sophisticated IDTVs, incorporating a smartcard reader, for example**, which enable the television owner to introduce a pay TV module *without having* to receive a proprietary decoder and to pay for it. In this hypothesis, the pay TV subscriber's balance resulting from the measure, as measured below, becomes significantly less negative. As the operator would have lower decoder costs to amortise, it could offer less expensive entry-level subscriptions and even subscription-free pay TV. This would reduce the transaction costs and customer and supplier changeover costs. Paradoxically, **bundling equipment functions would facilitate an unbundling of services**.

A development of this kind could benefit consumers and manufacturers (greater value in the equipment). Providers of services or pay TV access tend to be against it, as they view the STB made available to the customer as an integral part of the value provided and an essential component in their strategy of maximising ARPU through extra income (t-commerce, interactivity, PVR). However, two operators interviewed by BIPE expressed a desire to see the advent of a different lighter and more flexible pay TV model where acquisition costs and therefore the subscription would be significantly reduced. This would be made possible by the absence of a stock of proprietary decoders being managed, as the majority of current or potential subscribers would have their own equipment, thus making it possible to move to pay TV at a slight added cost (smartcard/conditional access modules at less than €100).

7.4.3 Costs and drawbacks

a) Risk of non-neutrality and competitive distortion

The measure can be rendered technologically neutral: television sets would all have to have a digital tuner, which could be a cable, satellite or terrestrial device.

However, even if the functionality is technically neutral a priori, it is equally true that a measure of this type will benefit the dominant platform in particular in a given market (e.g. the terrestrial reception platform in Great Britain) and most of all, it will **essentially benefit the free-to-air television economic model.**

As such, if the obligation covers the presence of a digital tuner and leaves the market players free to integrate a satellite, terrestrial or cable tuner, the dominant FTA platform risks dominating distributors' shelves. However, the price of components will drop to the extent that the added cost of a triple tuner (currently €50) will drop significantly in the coming years.

7.4.4 Impacts on the different consumer segments

- **Slight extra cost for people who would have preferred a modular reception solution either because they want pay TV** and therefore will be supplied with a proprietary decoder by their provider in the medium term in any case (which they pay for in one way or another in the subscription) or because they wish to separate the components. Without the obligation measure, these would opt for an equivalent-price analogue television which is slightly bigger, for example, or would have bought the same analogue television at a slightly lower price.
- **Drop in cost due to effects of scale for people who do not wish to have Pay TV** but who simply wish to (i) receive the digital free-to-air channels available terrestrially or by satellite, and/or (ii) enjoy the use of reception equipment which survives analogue turn-off.

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We have tried to model these different effects schematically.

We assume that in the absence of an obligation measure, the average television set costs EUR 500, a converter 150, a top-end decoder 200, and an integrated digital television 600. Finally, it is assumed that the Pay TV subscriber pays EUR 50 for a decoder (whether it is explicitly rented or whether its cost is passed on in the subscription, the subscriber pays for the decoder made available to him).

Thus the price paid by each category of consumer for the digitisation of his equipment in a renewal context is made up as follows :

- The pay TV subscriber only needs an analogue television (500) plus the digital decoder supplied by his pay TV provider (50), representing a total of 550.
- The FTA consumer (who does not want pay TV) and who is interested in more sophisticated STBs than a simple converter or a television which does not exist in a digital version will select a modular digital solution, which amounts to having an analogue television (500) and a supplementary module at 200, representing a total of 700.
- For his part, the FTA consumer who simply wishes to receive free-to-air digital channels or to avoid being turned off will opt for an integrated receiver which will be slightly less expensive than the total for an external converter and an analogue television and will offer the advantage of simplicity in his eyes. Total investment: 600.

If we now assume a measure which imposes compulsory digital tuners at the same stage of technological maturity, these different categories no longer have an opportunity to acquire an analogue television. Whether they wish to or not, they are obliged to acquire a television equipped with decoding functionality. It is assumed that the obligation measure leads to a drop in component costs of approximately 20% which is passed on in the form of lower prices for various appliances. Once again, we see what each category will have to pay. For example, IDTV moves down from 600 to 582.

- The pay TV subscriber will pay slightly more for his television set, due to the addition of a functionality which he will not use as, once again, digital conversion has been implemented by his proprietary decoder. He will pay 582 plus another 49 for the decoder cost, amounting to 631 compared with the previous 600. He has therefore lost 31 relative to the previous situation.
- The “modular” consumer will also buy an IDTV at 582, plus the peripheral device which he will want in any case (as IDTV only replaces the elementary conversion function) which has dropped slightly to 180. He will therefore pay 762 compared with the previous 700, representing a loss of 62.
- Finally, the “integrator” FTA consumer will pay 582 for the television set, compared to 600 for IDTV prior to the effect of scale (or even 650 for the modular solution), amounting to a gain of 18.

If we then try to weight each category by its weight in the total population, we can obtain an estimate of the global impact on consumers. If it is assumed that pay TV subscribers represent 40%, the modular FTA viewers 10% and integrator FTA consumers 50% we end up with a negative balance: an average loss of –10 for consumers. On the other hand, if the composition of the public is 20/10/70, we end up with a perfect balance: the gains made by integrator FTA consumers offset the losses borne by the other two categories exactly. With fewer than 20% of pay TV consumers, the balance becomes positive.

The enclosed table illustrates the *reasoning* behind this, much more than claiming to be conclusive in terms of scale and calculations.

Table 10 : Gains and losses experienced by the different consumer segments with or without a compulsory tuner

	TV analogique	Convertisseur	Autre STB	IDTV	STB pay TV	Total
Sans obligation						
Prix publics	500	150	200	600	50	
Foyers pay TV	500				100	600
Foyers FTA modulaire	500		200			700
Foyers FTA intégrateurs				600		600
Avec obligation						
Effet d'échelle sur composants		-20%	-20%	-20%	-20%	
Effet sur prix produit fini		-10%	-10%	-3%	-2%	
Prix public		135	180	582	49	
Foyers pay TV				582	49	631
Foyers FTA modulaire			180	582		762
Foyers FTA intégrateurs				582		582
Différence (écart)						
Foyers pay TV	**-31**					
Foyers FTA modulaire	**-62**					
Foyers FTA intégrateurs	**18**					
Synthèse en fonction des pondérations						
Foyers pay TV	40%	-12		20%	-6,2	
Foyers FTA modulaire	10%	-6		10%	-6,2	
Foyers FTA intégrateurs	50%	9		70%	12,6	
	Moyenne	**-10**		Moyenne	**0**	

However, several qualitative considerations tend to offset the negative or zero result calculated for “pay TV” and “modular FTA” households. We may wonder about the reality of a drop in well-being suffered by these categories of consumers because they would not have an opportunity to *choose* modular digital conversion or because they would have to pay for this functionality *“twice”*.

- It might be observed that pay TV households already pay for a tuner twice, as marketed televisions all have analogue tuners which are no longer of value when a digital decoder is used. This does not shock anyone.
- Pay TV households could benefit from a drop in potential costs resulting from the appearance of an IDTV stock for operators in the medium-long term.
- Modular FTA households are an abstract concept, as what is the use of wishing to “modularise” a functionality as basic and as relatively undifferentiating as a tuner?
- Whereas it is actually possible to imagine a consumer preferring to buy a rare model analogue television (with no integrated digital version) and adding an external tuner to it in a *unregulated context*, the choice available is maintained and complete in a compulsory digital tuner scenario as all models are available by necessity in *digital.* The interest of a modular approach to the tuner function thus declines substantially.

7.5 Synthesis – Conclusions

Taken separately, making a “digital tuner” compulsory in televisions provides a strong impetus for digitisation because, as TV sets have an average life-span of 8 years (a replacement rate of 12% per year), 7 to 8 years would be enough to “digitise” all households (at least one digital receiver). However, slightly longer would be required to “digitise” all receivers (given a slightly slower replacement rate for secondary receivers and considering that the fixed added cost is more difficult to absorb on these low-end television sets).

Furthermore, we do not believe that a measure of this type could lead to a price increase which would end up leading to a fall in sales of televisions (at least the main TV sets). The impact on the converter market could also be low because a negative value effect (lower attractiveness of converters) could be offset by a positive price effect (thanks to the effect of scale induced by the obligation measure).

With all else equal, a measure which makes “digital tuners” compulsory could therefore only increase the pace of migration of household equipment.

The measure would therefore be **efficient**. However, we do **not** believe it is **essential**. As such, in the absence of a measure of this type and assuming on a conservative basis that in this instance the spontaneous rate of purchases of IDTVs is low or zero, a rate of 15 to 20% of analogue receivers “digitised” each year through the purchase of external converters would be enough to obtain almost similar results in terms of speed of penetration. “Household conversion” (all households “digitised”) would be achieved at the same speed; for its part, total “receiver conversion” (including secondary receivers) would probably be slower.

Once again, it is necessary to differentiate among the conclusions depending on the market contexts.

In terrestrial tradition countries, if the objective is simply to accelerate penetration of digital television, almost equivalent acceleration effects may be caused *in any case* through the impact of market forces. In contrast, if the sought-after public objective involves the fastest possible turn-off of analogue digital broadcasting (which implies the conversion of *all* household receivers), a measure of this type probably represents a major difference to what the market could produce spontaneously.

However and in any case, public decision-makers wondering about the advisability of a measure of this type should not base their decisions on the results of sales of IDTVs and converters recorded between 1998 and 2001. Profound changes in market conditions and consumer information should be able to place these products on a much higher trajectory without an obligation measure.

In countries with a multichannel cabsat tradition with a low potential for pay TV, regardless of whether one or other of these objectives is pursued, a compulsory tuner will represent an alternative to other forms of intervention (such as partial or total financing of converters by analogue broadcasters or by the public authority interested in recovering frequencies). In any case, one type of incentive or another will be essential in these countries if migration is to take place in a reasonable time frame as the added value offered by digital is lower.

If we now consider the positive and negative effects which could result from a public decision of this type, benefits and costs are available to evaluate its **relevance**. On the benefits side, we find the collective economic benefits which can be expected from more rapid penetration of digital television and the possibility of being able to halt analogue broadcasting earlier. Some of these benefits have been quantified in a different section. We may also consider the fact that a measure of this kind would contribute to creating an environment which may be more favourable to the advent of a lighter more flexible pay TV model in the long term as among the benefits, as IDTVs are favoured over modular reception solutions in the obligation scenario.

On the costs side, we took an interest in the impact on consumers. It emerges that while supporters of a "compulsory digital tuner" are right to say that migration would be "quicker", it is much less certain that it would be "less expensive" for consumers. While consumers who are only interested in free-to-air television would benefit from larger economies of scale plus integration savings associated with IDTV itself, we could adopt the view that consumers who are ready to subscribe to pay TV would pay for the digital tuner "twice". However, this latter point may be offset by the development described in the previous paragraph, thus leading to an improved long-term negotiating position for the pay TV customer.

A final cost, which we will not measure here, would be the risk that a "compulsory digital tuner" measure could reinforce the historically dominant access platforms in a given market even when technologically neutral and may favour the free-to-air television economic model to the detriment of competing access platforms and pay TV operators respectively.

To sum up, we think that a measure of this nature would produce the sought-for effects and that the cost/benefits result of these effects depends on (i) the national context (notably the current and future penetration levels of pay TV) and (ii) the political assessment of some effects which are difficult to quantify, such as the risk that a measure of this type may favour dominant platforms and free-to-air television to the detriment of competing platforms and pay TV respectively. However, we think that the certain economic prospects in savings on broadcasting costs and potential spectral management gains exceed the slight added cost and the potential disadvantages of a measure aimed at integrating an added tuner in televisions in most cases.

Figure 36 : Synthesis of the evaluation of the measure

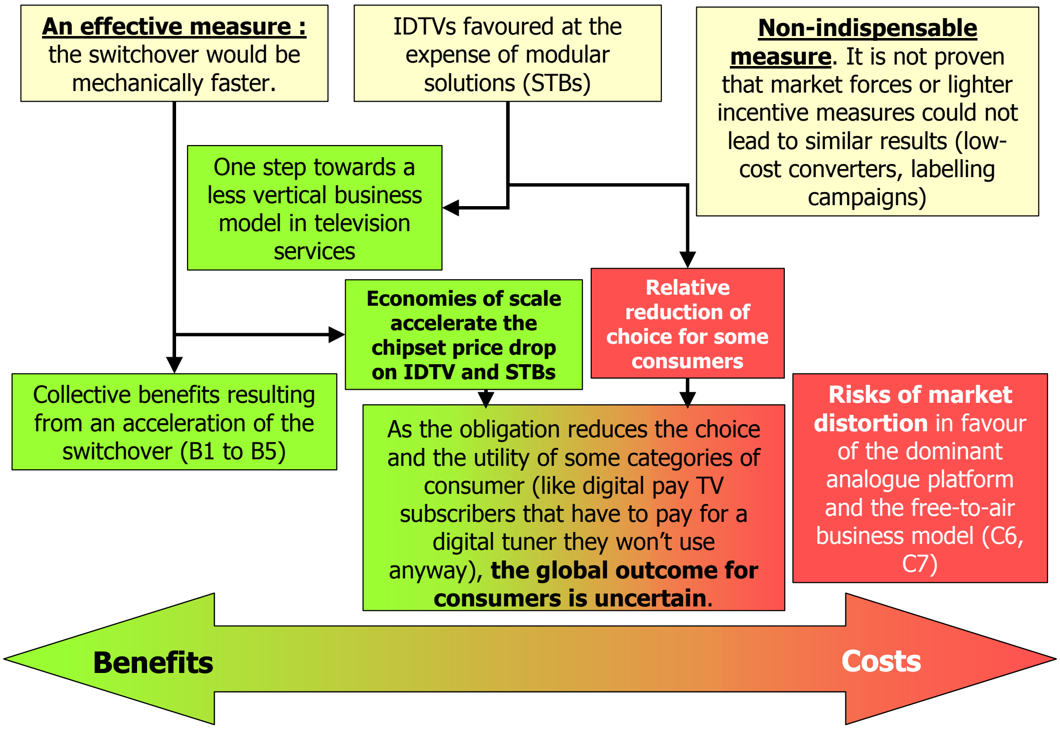
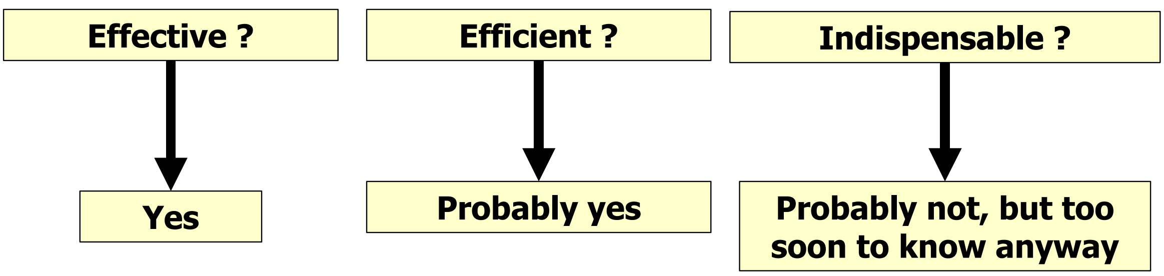


Table 11 : Benefits and disadvantages of the measure

Benefits	Disadvantages
Urging the migration and the analogue turn-off.	Risk of favouring the current dominant platform and FTA TV vs. Pay TV
LARGER SCALE EFFECTS AND DECREASE IN THE COST OF COMPONENTS.	
In the long term, encourage new, lighter, non-subscription pay TV schemes.	In the long term, risk of discouraging digital convergence through modular digital television
Migration less expensive for some consumers.	Migration more expensive for some consumers.

Would the « mandatory digital tuner » measure be ...



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a) *Complementary observations – Generalisation*

In this examination of the relevance of a measure making a digital tuner obligatory, we have strictly considered the incorporation of a digital tuner and a demodulator.

However, we are conscious that the debate concerning the "digital tuner" aims in certain cases at making a much more extensive integrated digital television obligatory in reality over time.

- Software and interactivity players would like a minimum television to include a hard disk, pre-installed software and even a modem.
- Pay TV players and notably new entrants would like the minimum television or at least the minimum living room television to include a conditional access module, which makes it possible to reduce consumer switching costs and operators' acquisition costs and thus lowers barriers to entry.
- Some consumer electronics players would like the minimum television to comply with the MHP standard.

Different categories of players would like the minimum specifications for television sets to be increased. We may therefore consider that the debate on the compulsory digital tuner could comprise **a precedent leading to an inflation in compulsory specifications**, thus supporting moves by given lobby groups.

In this section, we have restricted ourselves to the strict, simple compulsory tuner, a component which *only* allows the reception of signals in digital mode. In our view, the small added cost of integrating this component (which would be even lower if generalised), the relatively undifferentiating nature of the functionality which it provides and the potentially universal and non-discriminating character of its interest are so many more arguments in favour of its integration as a "standard" in all television sets. We believe that even though the regulatory obligation does not appear essential for the generalisation of this component in the medium term and even though there are many other means of promoting more rapid migration, the drawbacks and risks associated with a measure of this type are not very substantial.

Our reasoning and conclusions concerning the digital tuner cannot be extrapolated to the question of the compulsory integration of components/functions which are both more expensive, discriminating and differentiating, such as built-in memory, configured interactivity or Pay TV modules.

Finally, it is necessary to mention a Community-related obstacle to a national specification measure. A measure which is specific to one EU country could be considered as creating an **obstacle to the free movement of goods** in the internal market. To avoid this disadvantage, to achieve genuinely interesting economies of scale for manufacturers and to avoid any **market fragmentation**, it would therefore be necessary for a measure of this type to be taken **at European level**. However, two problems seem to make this impossible at this stage:

- As we have seen, a measure of this type is only likely to make sense in *certain* national contexts only and would be useless and even counter-productive in other contexts

The European Union approach in the area is **a "market-led" standards approach,** which excludes imposing such minimum specifications, notably when they would lead even provisionally to an increase in the prices of the goods concerned

Part 2 :
Spectrum

Table of contents

1 The current spectral situation in Europe

The next page provides a global view of the spectrum in Europe, based on ITU data and simplified to the extent that bands have no exclusive use and their utilisation may sometimes differ according to the European countries concerned.

The major users of the terrestrial spectrum are: governments for their civil and military uses, aviation communications and radar, analogue television and mobile telephones.

Figure 37: Main users of the terrestrial band in Europe (50-2200 MHz)

	TV, radio	509 MHz	21.7%
	GSM 900 &1800, DECT	255 MHz	10.9%
	UMTS	215 MHz	9.2%
	Others (defence, aviation, security)	1369 MHz	58.3%

This breakdown is also reflected in the report by Professor Martin Cave[25] on the British situation: in the 300-3000 MHz band, 28% of the spectrum is allocated to defence and rescue services, 25% to aviation, 16% to television, 8% to GSM, etc. This exercise was also carried out by the OECD[26] for its different affiliated countries and revealed a certain disparity revealing different national choices in spite of theoretical ITU harmonisation.

Furthermore, the State's position is ambiguous, as it is simultaneously a user of the spectrum for its sovereign needs as well as the allocator and sometimes even direct regulator of the spectrum for other uses.

Figure 2: Radio and TV bands in the ITU 1 zone

Band name	Wave category	Fmin – Fmax (*)	Bandwidth
Band I	VHF	41-68 MHz	27 MHz
Band II	VHF	87.5-108 MHz	20.5 MHz
Band III	VHF	162-230 MHz	68 MHz
Band IV	UHF	470-582 MHz	112 MHz
Band V	UHF	582-960 MHz(**)	378 MHz

(*) Frequencies not mentioned have other uses

(**) The upper band 830-960 MHz, is usually shared by different services (defence/broadcast)

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[25] Radio spectrum management review: a consultation paper

[26] The Economics of Radio Frequency Allocation, OECD

Figure 3: Allocation of the terrestrial spectrum in Europe

MHz	Services	Band names
47		
68	VHF TV	Band I
174	PMR/FM radio/ Aero/Meteo	Band II
230	VHF TV / T DAB	Band III
470	Digital PMR/Meteo/Defence/Aero	
806	UHF TV	Bands
862	UHF TV	IV & V
880	Defence/PMR	
915	GSM	
925	Defence/PMR	
960	GSM	
1452	Aero/Nav/Space	
1492	T DAB / S DAB	Band L
1710	defence/aero/sat	
1880	DCS (GSM 1800)	
1900	DECT	
1980	UMTS terrestrial core band	
2010	UMTS satellite core band	
2025	UMTS terrestrial core band	
2110	space research	
2170	UMTS terrestrial core band	
2200	UMTS satellite core band	

1.1 Satellite transmission

In terms of resource distribution, the operators (SES Astra, Eutelsat, PanAmSat, Intelsat, etc.) presently use geostationary satellites, located at an average interval of a 2° angle, which creates a resource of 180 orbital positions ('slots'). It is, however, possible to group a cluster of satellites on one 'slot'.

The utilisation rates for the capacities of European operators were 92% for SES-Astra and 97% for Eutelsat in 2000, with more than 15% of this used for IP traffic for Eutelsat.

These two elements (saturation of the GEO Belt and utilisation of capacities) highlight the limited capacity of the current system if it were confronted with substantial new demands (in addition to the hundreds of TV and radio channels already transmitted). Opening new frequency bands (Ka 17.7-21.2 GHz band in reception), using other orbits (example of the 'Virtual Geo Proposal', which would use elliptic[27] orbits), changing the allocation method, abandoning analogue transmission or dividing the band differently between IP traffic and TV broadcasting would enable new resources to be obtained and demand to be regulated. The scarcity of the spectral resource is thus relative for satellite broadcasting.

Figure 4: Transmission capacities of Astra and Eutelsat

(year 2000)	SES Astra (Europe)	Eutelsat
Revenue (Meuros)	836	685
Revenue mix	94% TV 4% IP data	83% TV
Number of satellites	12	19
Upcoming Launches	2	7
Ku Transponders	206	442

Source: Satellite Communications Sept. 01, Bear Stearns & Co.

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[27] Satellite 2001 Europe Conference, Sept. 4-6 2001

1.2 Cable transmission

Most of the cable networks use the VHF-UHF frequency band, the same as for terrestrial broadasting, through a network infrastructure known as Hybrid Fiber Coax (HFC), which, in particular, enables simulcasting of analogue and digital broadcasting due to the widening of the transmission band (up to 860 MHz). This facilitates transmission of the same analogue TV programmes (generally about thirty), the broadcasting of digital TV programmes (generally 100 to 150 channels) and, possibly, the introduction of new services (interactive services, Internet access, telephone)[28]. This expansion of bands and services is commonly known as '*broadband'*.

This transition to 'broadband' is thus more extensive – especially by virtue of the investments announced - than migration of the same television programmes with identical coverage for the same subscribers from analogue to digital in the strict sense.

In order to avoid this confusion, the costs of 'analogue to digital' migration for cable should therefore take the following into account:

- the updating of transmission and distribution networks (transition from coaxial to fibre) calculated in proportion to the use of the band for television given identical service and coverage (excluding network extensions, in particular).
- a change of STB (Set Top Box) for existing analogue subscribers.

We estimate in this case that these two investments are on the same scale per subscriber but with substantially different amortization periods (20 to 30 years for the network, but normally 5 years for an STB), which reduces the significance of the cost of updating networks in terms of the annual burden for the cable operators.

On the other hand, the transition to broadband is carried out by entire zones and is already underway to such an extent that the speed of migration will depend on capacity to finalise this coverage and on digitalising the stock of receivers capable of using the DVB-C norm which remains subject to the analogue subscriber's decision to take out a digital subscription. Thus, true digitisation of cable depends on operators' capacity and readiness to provide financing in relation to the cost of **digitising terminals** via an adapter or decoder and, to a lesser extent, on finalising digitisation of the networks.

The **must-carry** of 'terrestrial' programmes on cable could adopt 3 forms: (i) inclusion of terrestrial programmes broadcast in terrestrial mode (COFDM modulation of the DVB-T on the cable), which would enable digital terrestrial receivers to access them without an external decoder, (ii) inclusion of the terrestrial programmes but in a transmission mode specific to cable (QAM modulation of the DVB-C), (iii) inclusion of the digital terrestrial programmes but transmitted in analogue mode.

- The first solution, which is not ideal in technical terms and has not yet been put to the test on an industrial scale, would use part of the cable band to broadcast free-access programmes not constituting part of a package marketed by the operator, resulting in a loss of earnings for the latter. Such a solution also assumes that the digital receivers already acquired and on the market are predominantly terrestrial and call for the development of such a market to the detriment of other types of access.

[28] HFC architecture evolution for high bit rates, J.C. Point at DVB World 2001, Dublin

- The second solution, already tried and tested technically and commercially in the cable transmission of programmes broadcast via satellite (through DVB-S transcoding to DVB-C at the cable network head), would be better for the cable operator as the must-carry programmes could easily be clustered in its packages, especially with good use of multiplex compression and optimisation.
- The 3rd solution remains a temporary one in terms of the digitisation of all networks.

2 Spectral resource management in terrestrial broadcasting

Figure 5: Spectrum Supply and Demand and Regulation

	New Supply	New Demand	Regulation mode
20-40's	HF	National AM radio	State-owned radio
40-70's	VHF	FM radio PSB	Public administration
70-85's	UHF	Commercial TV	Split of public activities between content and networks
85-90's	Extension of GHz bands Refarming of UHF	Professional mobile Satellite broadcasting Pay TV	Regulation agencies for TV, radio, telecom
90-00's	Digitisation of the transmission Defence bands refarming	Consumer mobile but still narrowband	Development of telecom agencies, first auctions
00's-10's	Refarming frequency stocks Full digitisation	Broadband communication Digital broadcasting	*Open to question*

Source: BIPE

2.1 Spectral efficiency or efficiency of spectral management

Spectral efficiency is defined in technical terms[29] as the ratio of the quantity of information transmitted (the bitrate in digital transmission) relative to the quantity of spectrum used for a given geographical coverage. The unit of measurement in this regard is Mbit/s / MHz /m².

At a given point of the network, the average quantity of the spectrum used is the product of the width of the transmission channel (8 MHz for television), a frequency re-usage planning factor and usage time.

[29] NTIA report 94-311, A Survey of Relative Spectrum Efficiency of Mobile Voice Communication Systems, R.J Matheson

Examples:

- The spectral efficiency of UMTS varies between 80 kbit/s /cell/MHz for the large cells and 500 kbit/s / cell / MHz for the small cells (indoor, a situation of reduced mobility) ;
- The spectral efficiency of DVB-T according to MFN planning for fixed reception is approximately 3 Mbit/s /cell / MHz;
- The spectral efficiency of T-DAB according to MFN planning for fixed reception is approximately 0.8 Mbit/s /site / MHz;

The differences between UMTS and DVB/DAB are accounted for by mobility and the fact that UMTS involves calls whereas DVB/DAB involves broadcasting.

These elements provide a technical definition for spectral efficiency but **the more global question is the efficiency of spectral management,** which not only takes account of the technical parameters but also the frequency management and allocation parameters.

2.2 Assessment of spectral efficiency factors

Spectral efficiency depends on a number of factors, the product of which indicates global efficiency. This means that the least efficient factor determines global efficiency and must be improved as a priority through good frequency-allocation management.

The following *main* factors can be listed when referring to the information chain as a whole (for calls or broadcasting):

- **Data compression** efficiency. In Europe, digital television uses MPEG2[30] compression algorithms. Improvements are expected with the MPEG4 version. A more drastic development (changing the compression algorithm) would require changing receiver components or replacing the installed base of receivers;

- **Modulation efficiency**. For a digital transmission system, this factor is the ratio of the number of bits transmitted per Hz. COFDM access to DVB and its main modulations (64 QAM, 16 QAM or QPSK, Cf. Glossary for these acronyms). In 64 QAM, for example, modulation efficiency in fixed reception is approximately 24 Mbit/s / 8 MHz, i.e. 3 bits/Hz;

- **Multiplex efficiency** per channel. This can be characterised by the number of programmes per channel and the bitrate per programme (in digital, a programme is a combination of audio, video and data flows). There are 2 types of multiplex in digital television: CBR (Constant Bit Rate) and VBR (Variable Bit Rate). For instance, ITV Digital uses VBR and has 7 to 8 programmes per multiplex while the BBC uses CBR (March 2001) and has 4 to 5 programmes (of which one is purely audio) per multiplex.

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[30] ISO 13 818 standard

- **Frequency reuse rate**. In an MFN (or cellular) configuration, this rate depends on the distances required between transmitters to avoid interference a single channel. It makes it possible to estimate how many channels should be used to transmit a programme for a given geographical coverage;

- The frequency **assignment efficiency** per transmission site. This assignment function is performed by the national spectrum regulators. This efficiency can be indicated by: the possible coexistence of several types of services (mobile/broadcasting) or of several operators within the same bands by means of fine segmentation of the channels, the number of unused or frozen channels, the time needed for an operator to get a channel, the number of licences requested, granted, rejected or withdrawn, the management and availability of the current assignment database planned for the operators, the re-planning capacity, the setting up of mechanisms for freeing channels between 2 operators, and the number of regulators or parties intervening in the process.

Figure 6: FCC licensing process duration

Licensing process	Duration in months
Auctions	4.1
Lotteries	14.6
Hearings	48

Source: FCC

- **Allocation efficiency** of services per frequency band. This allocation function is performed by the ITU, particularly through WRC meetings.

- **Economic efficiency of the resource**. This factor goes beyond the direct competence of the regulator and concerns management of the public asset, as defined by the governments and parliaments.

The first four factors, of a *technical* nature, have benefited from very significant advances, which will enable big improvements in productivity (or lower the costs for producers and consumers). They represent the global benefits of digital technologies applied to television. In the present context, these factors are subject to the DVB[31] standard and national planning preferences (e.g. MFN vs. SFN).

In contrast, the last three factors are of an *organisational and economic* nature. The limited improvement in their productivity levels compared with the technological leap experienced by the first four factors could restrict the global efficiency of spectrum management. **The dynamics of technological innovation therefore make it necessary to establish dynamics for improving resource management**, a question that each member country is entitled to ask itself in light of the factors referred to above. The band re-allocation examples give an illustration of efficiency in practice.

[31] IN 300 744 for the DVB-T, Cf. http://www.etsi.org/broadcast/dvb.htm for the DVB norms' portal.

3 Economic optimisation of spectrum management

3.1 Oligopolies and spectral valuation

Within the context of spectral valuation, economists identify several assessment methods:

- **Spectral valuation in terms of its administrative management cost**. The type of management is suited to non-commercial uses.
- **Valuation with the help of formulas which take account of different parameters** (population, bandwidth, coverage, etc.). This valuation adopts an economic approach whereas the first option is purely administrative; however, this method requires the fixing of arbitrary coefficients.

The formulas take the following form: $F = a * B * N$

F: the fee of the spectrum used

a : a constant determined by the owner (the regulator in practice), *a* is expressed as a monetary amount per MHz (€/MHz)

B: bandwidth occupation (MHz)

N: population coverage (or surface or power of transmitters, etc.)

A more complex formula is possible: $F = b\ 1/R\ \ N_{cov}/N_{tot}\ \ \log(f_{max}/f_{min})\ \ +\ \ c\ T$

In this expression[32], F is the sum of a fixed value and a variable value (in proportion to the turnover earned by the services).

R: coefficient of re-usability of the channel in the area covered

N_{couv}: population covered

N_{tot}: total population

f_{max} : maximum frequency limit of the channel

f_{min} : minimum frequency limit of the channel

a and *b* : 2 arbitrary constants

T : turnover

- **Valuation based on the earnings of spectrum users**. This formula is suited to operators who use the spectrum directly for commercial purposes, although indirect use (terrestrial contribution links, taxis, etc.) is difficult to evaluate;

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[32] The Right Value of Spectrum, Sylvain Moll, Euroforum Congress on Radio Spectrum, June 2001

- **Valuation by market simulation**, which makes it possible to determine how much users are prepared to pay (mechanism revealing the willingness to pay). This method is theoretically the most ‘accurate’ but also the most difficult to implement (the market model must be accepted by everyone and it is difficult to collect data to feed the model).

The problem of spectral valuation arises for the regulator/government should it wish to maximise the advantages of the spectral resource for the community and recover the oligopoly rent. The evaluation of the spectrum price must therefore be compared with the market value that each operator attributes to the terrestrial resource (a value which will not be revealed by these potential users, who want to pay as little as possible).

- If the evaluation price < market value: incentive for using the spectrum. This is the case with terrestrial television today by virtue of the price being next to nothing.
- If the evaluation price > market value: the applicants try to find alternatives to using the spectrum, hence the development of fibre, cable networks, etc.
- If the evaluation price = market value: the situation is balanced.

Economists explain that a price regulation system is the most efficient means of reaching this balanced position. The allocation procedure associated with achieving this objective is the auction procedure.

Figure 7: Examples of spectral valuations

	Type of service	Number of licensees	Note on licence	Licence duration (year)	Total payment asked of licensees (Meuro)	Average annual payment due by all licensee(s) (Meuro)	Total bandwidth used by licensees (MHz)	Euro/MHz/ inhabitant/year
D	UMTS (2000)	6		20	50,800	2,540	85	0.36
UK	UMTS (2000)	5	until 2021	21	38,475	1,832	140	0.22
E	*UMTS (2000)*	*4*		*20*	*14,100*	*705*	*140*	*0.13*
E	UMTS (2001)	4	75% fee decrease			176	44	0.04
I	UMTS (2000)	5		15	14,640	976	145	0.12
USA	PCS (1993)	1	A band : one national operator	10	7,700	770	30	0.10
UK	TV broadcast (2000)	2	ITV has 2 nat. channels			661	144	0.08
NL	UMTS (2000)	5		16	2,680	168	145	0.07
F	*UMTS (2001)*	*2*		*15*	*9,800*	*653*	*160*	0.07
F	GSM (1998)	3				81	35	0.04
F	UMTS (2002)	4	auction refarmed	20	6,059	303	400	0.013
E	DVB (2000)	1		10	240	24	84	0.007

Source: BIPE from ANFr, French Ministry of Industry, ITC, CMT, COM(2001) 141 of March 2001

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3.2 Valuations of the TV spectrum in Europe

Five European countries use or are introducing direct payment for use of the spectrum (or licence) in terrestrial TV broadcasting: the United Kingdom, Greece, Ireland, Finland and Spain.

a) United Kingdom

ITV acquired licenses to broadcast Channel 3 and Channel 5 by way of calls for tender under the 1990 Broadcasting Act (Sections 19, 52 and 77). These licenses stipulate a payment based on annual revenues and a fixed sum determined by the consumer price index. These payments are made to the *ITC* and then to the British Exchequer to contribute towards the national budget; they are not allocated specifically to the audiovisual budget. These payments amounted to £421m in 1999 and £419.1m in 2000 (i.e. €661m).

In digital, *Ondigital* and now *ITVdigital* have obtained a 10-year derogation before having to make the first payment.

b) Greece

The private pay-TV channel *Multichoice Hellas* is paying a fixed annual amount of €14m plus 0.5% of its gross annual profits for a 15-year national license.

c) Ireland

In digital, licensees will have to make an annual payment amounting to 3.5% of their turnover.

d) Finland

An analogue or digital television license is valued on the basis of a fixed amount plus a percentage of advertising and subscription revenues.

Figure 8: Prices of television licenses in Finland

Annual turnover (euros x million)	License fee payable at the lower limit (euros x million)	Amount payable for the part of turnover exceeding the lower limit (in %)
3-5	0	10%
5-7	0.17	15%
7-10	0.42	20%
10+	1.09	24.5%

Source: BIPE

e) Spain

The consortium *Onda Digital* (commercially represented by *Quiero*), the only party to respond effectively to the invitation to tender for a digital PayTV license, has paid a total of Pts 40 billion (€240 m) to operate 14 channels on 3.5 multiplexes for a period of 10 years.

3.3 Oligopolies and consumer well-being

They are not many significant examples of re-allocation of frequency bands between commercial operators globally. The general case is the re-allocation of public-usage frequencies to commercial use (e.g. re-utilisation of military channels for GSM in Europe).

Most of the examples of purely commercial re-allocations can be found in the United States due to the existence of an auction procedure since 1993 and a secondary market since the creation of the FCC (1927).

3.3.1 The FM situation in the United States: rival service on a new band

FM broadcasting was patented and commercially tested by Edwin Armstrong in the United States in 1933. In spite of the availability of the VHF frequency from the outset, the FCC did not officially approve FM stereo broadcasting until 1960.

The explanation of this ‘delay’ given by Hazlett, the former *FCC* chief economist, is revealing: “a virtually unlimited number of FM stations was made possible on short wave, which would have put to an end the restrictions imposed on long wave. Had FM been able to develop unchecked, the number of stations would have been limited solely by competition and economics rather than by technological restrictions”.

In fact, the existing radio channels, *RCA, CBS, NBC, AT&T,* were broadcasting in AM on long wave and taking up the entire band, which made it impossible for new entrants to access the market and restricted competition. Opening up the FM band therefore represented a major risk by reducing the cost of entry while greatly improving audio quality. The influence of these players was sufficiently great to delay the penetration of FM for 30 years. In Europe, FM only gained a firm foothold about 20 years ago.

Hazlett describes other examples of new technologies[33]: CATV, MMDS, DARS (digital audio radio satellite services), which were competing with the existing operators, who then made use of all possible means to check their introduction, particularly by impeding access to the spectrum and exerting pressure to make the regulator create artificial spectrum scarcity. The scarcity level (and the number of channels) actually varies according to the broadcasting power restrictions established in the broadcasting agreements, restrictions justified by the limitation of interference: e.g., lowering thresholds by a few dB can free up others channels. An apparently technical decision linked to interference thus has major consequences for the development of economic activity and benefits for the consumer (in this case, the range of channels or improvement in image quality).

Hazlett also demonstrates that the development of cable television is a consequence of such blocking because the new players were not able to access the VHF-UHF spectrum. In the same way, the Internet was able to develop in the United States because it did not use the spectrum.

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[33] Thomas W. Hazlett, An Essay on Airwave Allocation Policy, Harvard Journal of Law and Technology, Spring 2001.

3.3.2 The VHF band situation in France: re-allocating VHF-UHF

France currently has 6 terrestrial channels, as one of them (Canal+, set up in Nov. 84) is broadcast in VHF while the other 5 channels use the UHF spectrum. This national VHF frequency was, in fact, recovered from a former network that fell into disuse in 1976, i.e. the frequency used to transmit the former first channel in 819-line black and white.

The VHF band was allocated to the public broadcaster, which did not have any use for it but did not want to lose control of it, particularly to the analogue mobile telephony operator (NMT-type analogue mobiles worked on the 450 MHz band). Because of rivalry with analogue mobile telephony, the broadcaster exploited the VHF band at a time when the UHF band had not yet been saturated. In this example, refarming of the spectrum was in fact market-driven.

The incentive for spectral efficiency arose again when 2 new terrestrial channels (La5 and M6) were introduced in 1985 at the government's initiative. The owner of the UHF spectrum had organised it for the 3 historical channels without optimising it to receive the 5 channels theoretically made possible by the UHF band in analogue format. This meant that the installed base of antennas was in the narrow UHF band and its adaptation was paid for by the new channels and households. These also paid for spectral re-adjustment of transmitters and retuning the receivers.

This example illustrates low spectrum management efficiency, which, in particular, prevented consumers from accessing two additional channels.

3.3.3 The digital terrestrial situation in the United States: re-allocating TV bandwidth to mobile telephony

The FCC would like to reutilise 80 MHz of the UHF band and to auction them for 3G mobile services because the USA only has 100 MHz available for this service at present (the situation is different in Europe).

In the migration planned by the FCC, the terrestrial TV stations can keep their analogue frequency up to 2006 or until digital television has penetrated 85% of households. The FCC has simultaneously allocated one digital channel (6 MHz) free-of-charge to each of the TV stations. In 1997, all of these broadcasters (grouped within the NAB) promised to quickly vacate their analogue frequencies to comply with this timing.

Of the 1413 digital television licenses granted, 212 were effectively broadcasting in digital simulcast in November 2001, which is in line with deployment assignments for digital broadcasting. On the other hand, the broadcasters made it known that they did not intend to give back their analogue frequencies without compensation from the subsequent occupiers, i.e. the mobile telephony operators, although they themselves had had free access to the analogue spectrum (except for purchases on the secondary market).

Although the FCC makes this payment possible by defining rules for such transactions, the transferring parties and purchasers are free to set the transfer price among themselves. Consequently, the schedule of auctions has been postponed to 2004.

4 Spectral management during the terrestrial simulcast

4.1 Cable and terrestrial transmission interferences

It has been shown that terrestrial digital broadcasting may cause interference with analogue terrestrial broadcasting and cable transmission. In the latter case, insofar as this technical argument may become a disruptive factor in the competition between terrestrial and cable players in the future, we consider it important to look at the factual elements available. We base this examination on the results of a study commissioned by *AFORM* [34], interviews with cable operators (*UPC, Noos, NTL, Casema*, etc.), a report by *ECCA* dated June 2001[35] and the public discussions conducted by *CSA* study groups parties in France, in which the cable and terrestrial television players are represented.

These cases of interference occur if the cable operator's distribution plan is in the same band as terrestrial digital broadcasting, i.e. UHF for DVB-T and VHF for DAB. The question does not arise over the entire cable network, which is shielded (EN 500083-2 standard) or fibre-optic, but essentially at the level of the terminal and its connection (plug and tuner), particularly on 'old' terminals (i.e. which are not digital STBs).

A distinction made between 2 types of interference. In this case:

- disturbances of the analogue cable by DVB-T
- disturbances of the digital cable (DVB-C)[36] by DVB-T

AFORM comes to the following conclusions concerning these 2 cases:

- With regard to the first case, it states that the channels used in DVB-T will not be usable for analogue distribution via cable. The frequency plan for analogue cable distribution will, in this instance, have to be reviewed in the disturbed zones.
- As regards the second case, coexistence on the same channels is possible except in the proximity of DVB-T transmitters (the sites that pose problems are those with a power output in excess of 5 kW (Effective Isotropic Radiated Power) within a 20 km radius).

On the other hand, *AFORM* indicates that portability, which strengthens the intensity of the electromagnetic field, does away with any possibility of having analogue and digital cable distribution on the same channels. In practice, cable operators would not be able to use 5 or 6 channels in this case (according to the number of DVB-T multiplexes).

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[34] Study of the possible effects of interference on the cable networks caused by the development of terrestrial digital broadcasting, dated 4/1/2001

[35] Report on the interference problem in cable communication networks in Europe, ECCA, 14/06/2001

[36] It should also be noted that the cables emit radiation that disturbs terrestrial transmission (in particular air-to-ground communication).

ECCA contradicts the *AFORM* studies by indicating that the digital property of the DVB-T signal produces less interference than transmission in PAL or SECAM, provided the existing terrestrial broadcasting sites are reused.

The Netherlands (93% access to TV via analogue cable) plans, for example, to deploy new sites for portable DVB-T transmission: although 30% of households with cable television would be affected, the change of connector with shielded cables would reduce the number of affected households to 1%. According to the *ECCA*, the difficulties would then arise from the cables and connectors sold on the market (i.e. not controlled by the cable operators if they do not market the STB), whose standards vary greatly. It should also be noted that in the United Kingdom, where the terrestrial digital (69% coverage in March 2001) and cable networks (15% penetration of households) coexist side by side, there have not been any major interference problems.

4.2 Trade-offs between image quality and the number of programmes

Thanks to multiplexing digital broadcasting makes it possible to combine a number of programmes on a 8 MHz transmission channel with a throughput of 20 to 24 Mbit/s.

A digital programme requires between 2 and 6 Mbit/s at the consumer level, according to the current state of the art (MPEG 2 compression) and the type of programme (movies, cartoons, image definition etc.). According to equipment suppliers and software editors, MPEG 4 compression should further reduce these bitrates significantly (by a ratio of 1 to 2). Such techniques are particularly interesting if the installed base of receivers (MPEG2 in digital) does not need to be physically replaced at the time of transition from one algorithm to another.

The real-time allocation of the different flows (audio, video and data) can be optimised by the use of statistical multiplexing (VBR: variable bit rate). The private Pay TV operators tend to use VBR to increase the number of programmes available because they consider that the more programmes there are, the more attractive their package will be, while public operators, which are subject to greater budgetary constraints, have fewer programmes to broadcast and do not use this technique. Instead, they use CBR (constant bit rate), which under-utilises the multiplex and indirectly takes up more frequencies in an MFN plan. In March 2001, for example, a BBC multiplex programme consumed 4.9 Mbit/s in CBR while consumption in VBR would have amounted to 3.6 Mbit/s (according to BBC R&D) without the viewer perceiving the reduction in image quality.

5 The stakes involved in releasing spectral bands

5.1 Theoretically releasable bandwidth

CEPT-EBU has conducted a theoretical study on this quantification[37]. It quantifies the number of 8MHz channels necessary for digital transmission of a multiplex in MFN or in SFN for a defined territory. For the record, broadcasting an analogue TV programme consumes nine 8-MHz channels at national level.

We have selected 3 results from which reflect the main situations encountered from this technical study.

Case no. 1: MFN broadcast with fixed reception (roof reception antenna)

- Hypotheses: 64QAM modulation, 95% reception in the zone covered[38]
- Height of transmitting antennas: 300 m, distances between transmitters: 50 to 100 km
- Number of channels necessary for transmitting a multiplex: 6 (9 with 150 m high antennas)
- 85% reception requires one less channel.

Case no. 2: MFN portable broadcasting (indoor reception antenna)

- Hypotheses: 64QAM modulation, 95% reception in the zone covered
- Height of transmitting antennas: 150 m, distances between transmitters: 10 to 60 km
- Number of channels necessary to transmit a multiplex: 15 to 18 (more than 26 with 37.5 m transmitters).

Case no. 3: SFN transmission with fixed roof antenna or indoor antenna (the strictly mobile case is not dealt with)

- Hypotheses: 64QAM modulation, 95% reception in the zone covered
- Height of transmitting antennas: 300 m, diameter of service zone: 150 km
- Number of channels necessary to transmit a multiplex: 3 for fixed SFN, 4 for indoor SFN

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In these cases, SFN transmission is therefore the best solution theoretically in terms of spectral consumption at a ratio of 2 to fixed MFN transmission and 4 in the case of portable MFN transmission.

[37] Report from ad-hoc group B/CAI-FM24, Feb. 2001

38 See Chester agreement

In the analogue scenario, there are 49 x 8 MHz channels available in the UHF band (392 MHz). 9 channels are required to broadcast a programme at national level, which permits theoretical transmission of 5.4 programmes on average (5 in practice). Thus, each programme consumes 392/5.4 = 72 MHz.

Digital:

Case no. 1: 6 channels are necessary for the national transmission of one multiplex, which means that each multiplex thus requires 6*8 = 48 MHz., and 49/6= 8.1 multiplexes are possible. If 6 multiplexes are inserted during the simulcast period (example of France and the United Kingdom), it will be possible to open 2 other multiplexes after analogue turn-off, i.e. the equivalent of 2*48 MHz = 96MHz. This figure has been confirmed by BBC and ANFr for the 2 cases mentioned.

Case no. 2: 15 channels are necessary for the national transmission of one multiplex with the portability option. 3.2 multiplexes are possible with a 392 MHz band (knowing that each multiplex requires 15*8 = 120 MHz). Portable MFN transmission consumes a large number of channels and is not very efficient in spectral terms.

Case no 3: 3 channels are necessary for one national SFN multiplex (4 for indoor portable); 16 multiplexes are possible on the UHF band, with each multiplex consuming 3*8 = 24 MHz. With 6 multiplexes transmitted during the simulcast, 248 MHz would become available on turn-off. Here, we again find the spectral advantage of SFN, particularly in portable transmission.

5.2 Uses for released bands

5.2.1 Demand from mobile telephony operators

The UMTS Forum is seeking the 2520-2670 MHz band rather than the UHF band because the former is not used much in Europe, the increased frequency is favourable for heavy traffic communications, the band is wide (150 MHz) and there is less uncertainty associated with the possibility of using this band than in the case of the UHF band.

This point of view has been confirmed by operator interviews and conferences and by the frequency agencies. This interest can be explained by the existence of economic motivation.

The least expensive coverage and the best traffic management are achieved with the same investment when the cellular network planner can access a range of frequencies to meet the following needs:

- high frequencies (2.7 GHz) for high-traffic cells in indoor coverage (reduced mobility), where the cell has a diameter of 5 to 50 m;
- intermediary frequencies (1.8-2 GHz) for outdoor coverage (high mobility) in high traffic density zones where the cell has a diameter ranging from 50 to 500 m;

- low frequencies (450-900 MHz) for low-traffic zones with large distances covered or high-speed mobiles where the cell has a diameter ranging from 0.5 to 10 km.[39]

Deploying a 2.5 GHz mobile network, for example, costs 6 to 10 times more than a system using the 900 MHz frequency with identical coverage because the number of cells grows exponentially with the rise in frequency. This type of investment is justified in high density and heavy traffic zones but cannot pay for itself in light traffic zones. GSM is another example: initially set at 900 MHz, it evolved in the 1.8 GHz band in heavy traffic zones, but in rural areas some constructors and operators had planned to implement it at 450 MHz, a plan that failed because the band was not available. This 450-600 MHz band is particularly interesting for low population density countries (Russia, African countries, etc.).

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[39] 3rd Generation Mobile Systems, Alain Charbonnier, head of 3G at France Telecom R&D – contribution to the France Telecom scientific committee.

6 The radio spectrum[40]

6.1 Frequency bands

- Radio is historically the oldest service, which has led to it being allocated frequencies distributed right across the HF-VHF-UHF band depending on the economic conditions offered by new technologies. FM, whose transition linked to AM has been mentioned as an example, is the technology best known by consumers in the 87.5-108 MHz band, though numerous other bands are used or reserved: AM, 47-68 MHz, 87.5-108 MHz, 174-230 MHz, 230-240 MHz and 1452-1492 MHz (L band) bands. Such a frequency range makes it possible to provide long and short-distance services depending on wave propagation characteristics.
- The L band, which would serve as a new radio band in Europe, is currently the subject of rivalry between terrestrial radio broadcasting (T-DAB) and satellite radio broadcasting (S-DAB). In 1995, the CEPT conference in Wiesbaden effectively allocated frequency blocks for terrestrial digital and satellite radio in the L band (1452-1492 Mhz). Some radio broadcasters consider this capacity very insufficient for their needs. Seven blocks that are presently allocated to the satellite could be reassigned to terrestrial broadcasting at a CEPT conference to be held in June 2002. The obsolescence of MUSICAM compression, established a few years ago, is used as a technical argument for this opposition. The organisations in favour of maintaining the present norm fear that the reappraisal of DAB caused by this technical difficulty could reduce the confidence of industry and consumers in this standard.
- Some operators are equally interested in using certain T-DAB bands for mobile television services (in Sweden, Teracom operates a mobile television service on urban trains).

  This once again illustrates the need to establish a mechanism to reveal the benefits for operators as part of the band-allocation principle in order to optimise economic efficiency and the social good.

  The use of these different bands primarily depends on the initiatives of equipment manufacturers and radio broadcasters for establishing new digital radio transmission systems and new services. Initiatives that can be mentioned in this regard include DAB, initiated by Eureka project no.147 and officially concluded on 1/1/2000[41]; DRM, launched in 1998 (Digital Radio Mondiale, DRM), which would enable digitisation of the AM band; and DARS for satellite transmission of radio services.

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[40] Cf. the section titled 'Digital Radio' in the main report

[41] Eureka Project 147. Launched on 1/1/1987, concluded 13 years later on the 1/1/2000. Total Cost 89.2 Meuro shared between Germany (36%), France (36%), the United Kingdom (6%) and the Netherlands (6%) according to the Eureka project base (www.eureka.be).

In contrast to television, the digitalisation of **radio offers little prospect for significant recovery of the radio spectrum**. On the other hand, simulcasting on the same frequency bands is not possible for DAB – in contrast to television - which means that it is necessary to seek new frequency bands to transmit digital radio. This could result in a longer period of simulcasting.

- The small bandwidth necessary for a radio programme (or audio file) will allow **radio services to develop on most low-cost terminals** if the compression and transmission techniques available on such terminals are reutilised.
- In the case of competition in broadcasting, digital terrestrial transmission may eventually be subject, under the present conditions, to partial or even complete **substitution** depending on cost. The alternative carriers also permit an increase in the number of programmes inasmuch as the spectral limitation is less pronounced. "The real challenge", according to the Coutard report[42], "is not of a technical but of an editorial nature". It could be added that, apart from the spectral issue, the question asked of DAB digital radio is also that of the cost of receivers in proportion to the services provided.

6.2 Frequency savings with digital broadcasting

With DRM, digitisation of radio broadcasting is of interest spectrally as the bandwidth needed to broadcast the same analogue radio programme can be divided in two (4.5 kHz instead of 9 kHz[43]), while providing superior audio quality.

This advantage is not available on a DAB (1.536 MHz width) multiplex that can transmit 7 to 32 programmes (per multiple of 64 kbit/s per programme). If we consider the average case of 10 programmes, each of them uses 153 kHz compared with the 25 kHz (or 12.5 kHz) distance between channels in FM, though it is true that the audio quality of DAB is superior. However, this still has to be recognised by consumers in economic terms.

Transmitting around hundred radio programmes via satellite would use 12.5 MHz in a project such as Alcatel's (64 kbit/s per programme, Advanced Audio Coding compression).

Figure 9: Comparative spectral efficiency of radio transmission technologies

	Audio quality	Band used per programme (kHz)	Re-utilisation factor in radio planning	Total band needed for one transmission at a European country level (kHz)
T DAB (MFN)	CD	153	6	918
S DAB	CD	125	1	125
FM (MFN)	FM	25	6	150
DRS	FM	4.5	1	4.5

Source: BIPE

[42] Future of the radio in the digital era, September 2001

[43] DRM General Presentation 2001, Thomcast, Pierre Vasseur, Euroforum Conference, June 2001.

The spectral efficiency of T-DAB is poor compared with other solutions because it requires a wide band for each programme (poor compression coding efficiency) and radio planning in MFN increases this need in contrast to S-DAB, which benefits from the effects of scale associated with satellite broadcasting as well as from its disadvantage in terms of uncertain reception in mobile situations, particularly in urban areas.

DRS is particularly efficient because it uses a long-distance wave range that can cover countries or even continents and its compression principle is very efficient (3 to 4 bit/Hz) even though its audio quality remains inferior to that of a CD.

6.3 Specific features compared with other services

Although the principles governing spectrum allocation to radio services are the same as for television, the relative economic importance of the radio places it in an unfavourable competitive position in the case of spectral allocation in open competition or auction. Furthermore, this lower degree of economic significance is correlated to its low-level occupation of the spectrum compared with television.

This difficulty increases with technological migrations such as the digitisation of broadcasting and receiver stock if no new services emerge just when analogue solutions are competitive, particularly in terms of FM quality, and when there is an abundant supply of programmes.

In particular, if the ratio of “increased benefit to cost of migration” is applied for consumers, it becomes obvious that the benefit increases only slightly while the cost rises substantially (price of terminals) in the case of DAB.

In view of these economical complications at the consumer level, it would be rather difficult to expect direct payment for use of the spectrum if such problems are to be taken into account or partially financed by the providers in the course of migration.

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Part 3: Technological migration case studies

Table of contents

1 Case studies: "market-driven" migrations

1.1 Different types of technological innovation: examples from the history of the cinema[44]

Certain technological innovations have proved to be turning points in the life of products/services. The improvement has been such that the product/service has been regarded as new and the increased saleable value considered sufficiently great to justify total substitution, possibly giving rise to substantial migration costs (partial re-equipment anticipated by users, purchase of back-up ranges). Other technical improvements have not resulted in rapid migration and total substitution because the potential increase in saleable value was not perceived to be as strong.

The history of the cinema enables us to illustrate these different types of revolution.

a) One of the ***turning points*** was **the introduction of the talkies in 1927-1930**. Despite the initial technical shortcomings of the talkies and to the amazement of most of those connected with the industry, silent films disappeared within the space of less than three years. The production of silent films was stopped, while film studios and projection equipment were readapted all over the world with vast investment although much of the silent movie equipment had not yet paid for itself. Furthermore, a 30-year stock of silent films lost its entire market value more or less overnight. The professionals in the movie industry thus had a lot to lose through quick and total migration and although some of them tried to resist for economic or artistic reasons, the demand for talkies was such that the migration became a tidal wave. **Without any centralised planning and through the mere effect of demand and market forces, a total extinction of silent movies was achieved in less than three years.**

b) **The introduction of colour** in the years 1940-50 can be regarded more as a ***development/improvement*** rather than a turning point. For many years, European audiences had accepted watching American movies in colour and a proportion of European films in black and white. The general use of colour occurred so gradually that it did not necessitate any significant modification of projection equipment. The different sound-reproduction technologies that followed each other over a period of 30 years are regarded even less as major revolutions. Instead, they are seen more as an ongoing improvement from the technical viewpoint and in customers' perception.

[44] The history of the cinema provides us with examples of market-driven and industry-driven innovations. To clarify the analysis, we present them here in the same section.

c) Finally, the development of **digital video projection**, which eventually replaced the photochemical model entirely (analogue projection through a 35 mm positive film), represents a *technological innovation* that is virtually imperceptible for the end-consumer and concerns only the upstream players in the filmmaking chain. It comes close to being a mere technical improvement.

Digital projection will eventually make it possible to obtain quality which is equivalent or slightly superior to traditional projection. Moreover, the dematerialisation of films could allow cinema operators access to a greater variety of movies, events and content. Ultimately, the cinema service segment could be transformed by the change in the projection method.

However, the current debate is entirely oriented towards the technical and financial aspects related to the change in projection technique. There is, indeed, a widespread view - even hypothesising that digital projection will not result in *any* value added for the final consumer – that it would still be desirable insofar as the investments required to readapt cinemas would quickly pay for themselves through the savings made by distributors on the production and logistics of film reels. **Even if digital projection does not increase the takings of cinema operators, it would sufficiently reduce the costs of the film-making chain as a whole in the longer term to justify accelerated renewal of the stock of projectors.**

<u>Lessons for digital television</u>

- Digital television is, to an extent, in a similar situation to digital movie projection, with migration (and turn-off) giving rise to some advantages that remain invisible to end-customers but which are perceptible to the players in the industry and/or communities. Although migration thus seems to be "macro-economically" desirable as quickly as possible, the problem is that the parties who have to invest (see table below) are not those who reap all the benefits.
- In the case of digital projection, the industry envisages that the main direct beneficiaries of the change in technology (films distributors and projector manufacturers) should finance or even subsidise part of the investment by cinema operators. In the case of digital television, the State and the players in the electronics sector, who will be the main beneficiaries of the transition to complete digitalisation and the turn-off of the analogue system, could do the same.

Figure 38: Investors and beneficiaries, digital television and digital cinema

	Who invests?	**Who benefits?**
Digital television	The viewer and the Pay TV company (digital decoder).	The community (owner of radio frequencies).
Digital movie projection	The cinema operator (replacement of projection equipment).	The distributor (no more copies of films to be published); digital projector producers.

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Figure 39: Types of migrations depending on the technical turning point

Migrations - turning points	Migrations - improvements	Essentially technical migrations
Strong increase in perceived value	**Medium increase in the well-being of the final consumer**	**Low increase in the well-being experienced by the final consumer**
Colour television, multi-channel TV	HD TV, widescreen television (16:9)	
Talkies	Colour movies, Cinemascope, digital sound	Digital projection movies
Transition from vinyl to audio CD		
Transition to video DVD		
		Transition to unleaded petrol
		Transition to the euro
		Transition from 110 to 220 V
		Transition to right-hand driving in Sweden
-> **Market forces sufficient to ensure rapid migration** to the new technology	-> The new technology needs to be **supported by manufacturers and/or a public planning** (scheduled turn-off)	

Source: BIPE

1.2 Replacement of vinyl records by compact discs[45]

The Compact Disc signalled a technological turning point in the recording industry similar to the introduction of talkies in the cinema and colour in television. The advantages of the new format over the old one were so well received that nearly all households in the western world were prepared to purchase non-retrocompatible disc players and replace their vinyl record collections. The migration and substitution took less than ten years. The transition to the CD has made it possible to renew the audio equipment market as well as develop the phonogram market well *beyond* the mere renewal of the vinyl collections. Invented by Philips, promoted via a strategic alliance between Philips and Sony and accepted as the standard by the other manufacturers (JVC, Telefunken), the CD format has been successful thanks to its intrinsic advantages as well s by virtue of the relevance of the economic model and the strategic decisions made by its promoters. Three factors account for the rapid success of this migration.

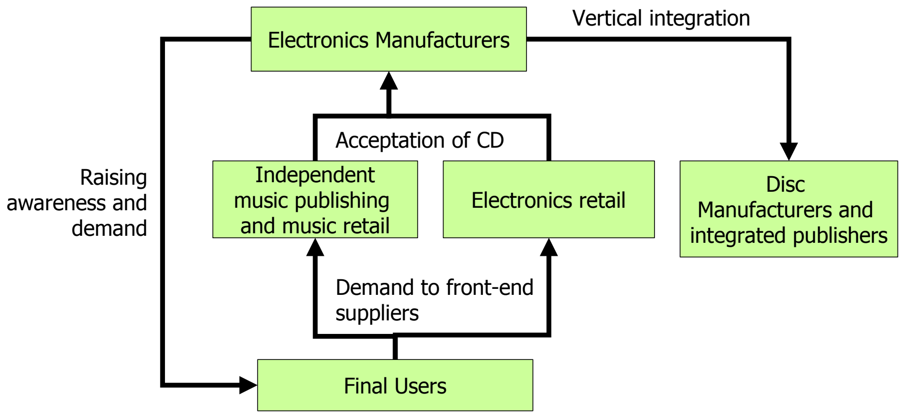
a) **Open standard**. First of all, Philips & Sony rapidly made the technology accessible to the *other* manufacturers in order to avoid fragmenting the market between rival standards and repeating the error made by Sony in trying to preserve the Betamax video format as proprietary technology.

[45] Sources: André Lange : *Stratégies de la Musique* (Pierre Mardaga Publisher, 1984) ; Corain McGinn and Kristina Nordsten: "Philips and the Compact Disc" in *New Product Success Stories* (Robert J. Thomas, Wiley & Sons, 1995).

b) **Large-scale communication.** Then, in order to overcome the resistance of the record industry confronted with the new format (particularly because of the 3% royalties that the CD consortium would pocket on each CD), the CD promoters established a **"pull" strategy**. Initially unable to count on distributors to push the new players instead of the old ones, nor on editors or record dealers to promote the new devices, the CD consortium directed its attention directly at the public in order to create demand. It did this through promotions focusing on audio enthusiasts and professional journals. Lured by the CD's intrinsic advantages, end-users then put pressure on the distributors and record publishers to favour the CD format. Instead of being imposed in a top-down manner through supply (the "push" strategy), the new format was advanced by a bottom-up approach pursued through an objective alliance between producers and users.

c) **Vertical Integration**. Finally, the manufacturers cum promoters of the new format were in a position, by virtue of controlling a number of the record publishers (Philips/Polygram, Sony/CBS) and owning the world's two largest production facilities, to exert influence from inside for the format to be adopted by the other players in the value chain.

Figure 40: Introduction strategy of audio CD promoters



Source: BIPE

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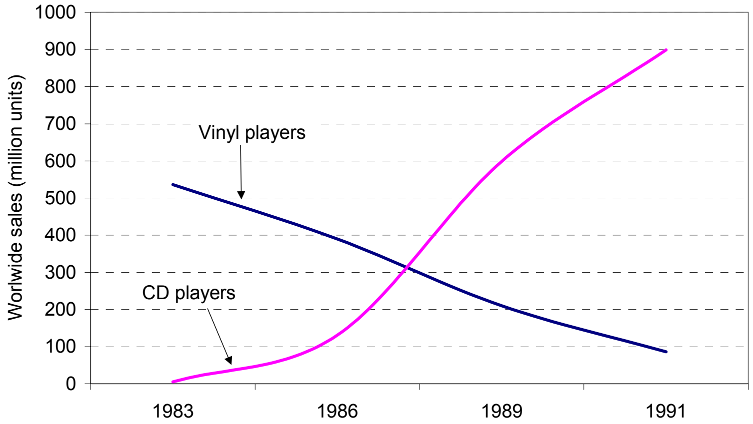
Figure 41: The replacement of vinyl-record players by CD players



Source: BIPE according to EACEM

Like most new electronic products, the CD player was launched at a high price, simultaneously aligned to: (i) the willingness of "early adopters" (i.e. music and technology enthusiasts) to pay, (ii) the desire to position the product as an up-market model and (iii) avoiding any risk of shortage that may have resulted from strong initial success. The price subsequently fell following economies of scale and the winning over of consumers less concerned with audio sound.

Lessons for digital television

The rapid success of the CD resulted from correct economic and technological choices, an industrial consensus and perfectly orchestrated mass marketing. Several lessons can be drawn from this for digital television

- **The need to bring about a real turning point** compared to previous products and a turning point clearly *noticed* by the user. Digital television, as a technology, has to find different "killer applications" from multichannel pay TV if it wants to become universal: interactive programmes, high definition, an increase in the number of free channels accessible, etc.
- **The ability** of **consumers to invest** when they perceive strong value added in new technology. Purchases of CD players were greater than expected, exceeding the normal renewal rate; the renewal of collections in CD format also surpassed expectations and the global spending on music (soft and hardware) increased constantly.

  So far, not many Europeans are ready to *invest* in digital TV reception because they cannot yet perceive any definite value added. However, an additional cost not exceeding €150[46] for the acquisition of a converter or a digital television is likely to be absorbed more easily *when* free digital "killer applications" appear.

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[46] €150 or £99 represent the price envisaged by the big producers of consumer decoders, like Pace and Netgem, and considered to be the psychological upper limit for this type of equipment.

- **The need to aim directly at users in order to raise awareness** and generate a demand. Today, digital television is essentially a technical and vague concept and, beyond the fact that Pay TV is by and large broadcast digitally, the consumer does not have much knowledge of the advantages of digital transmission *per se*.
- In the case of the audio CD, it was **not necessary to schedule a withdrawal** of the former analogue (planned extinction or analogue turn-off). It was **not necessary to subsidise** the first CD players because the early adopters in any case had sufficient willingness to pay.
- The analogy between offline and online migrations carries a certain number of limitations (see above).

1.3 Transition from black and white TV to colour TV in the USA[47]

The early stages of colour TV in the USA gave rise to a war of standards between RCA and CBS. RCA had given birth to the black and white broadcasting standard. The CBS system had been the first to be approved by the FCC in 1948 (in opposition to an RCA technology) but failed to impose itself on the market for two reasons:

(i) Colour transmissions in the CBS format could not be picked up by the black and white receivers already installed, equivalent to 23 millions units around 1950 (**non-retrocompatibility**); and

(ii) CBS' production capacity did not facilitate the distribution of a sufficient number of receivers which would enable it to "capture" the market quickly.

On the contrary, the RCA system devised a few years later was better suited to mass production, and, above all, ensured proper reception of the colour signals on black and white receivers (retrocompatibility). This was the one ultimately adopted by the FCC in 1950 and which became the colour television standard in the USA (NTSC - National Television System Committee).

However, in spite of the rapid success of one standard over the other, sales of colour TVs were extremely slow to take off in the USA. The reason was very simple: the main promoter of the colour standard, RCA, was also the principal black and white TV operator, both on the broadcasting side (NBC) and on the receiver side. **For many years, RCA therefore opted to secure a return on its investments and accumulate black and white technology profits *before* launching a new technology.**

The number of colour broadcasts appeared quite insufficient to justify the extra cost of buying a colour television[48]. Upgrading to colour televisions was much slower compared with the initial monochrome receivers, proving that buying a colour TV (or change to a colour receiver) appeared substantially less necessary than acquiring television initially. However, from 1957 onwards, 106 of the 158 stations operating in the 40 largest markets had the equipment enabling them to broadcast in NTSC.

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[47] Sources: Carl SHAPIRO, Hal VARIAN: Economie de l'information *Information rules* (De Boeck for the French translation, 1997); Tino BALIO: *Hollywood in the Age of Television* (see in particular "Red, Blue and Lots of Green: the impact of Colour Television on Feature Film Production" by Brad CHISOLM).

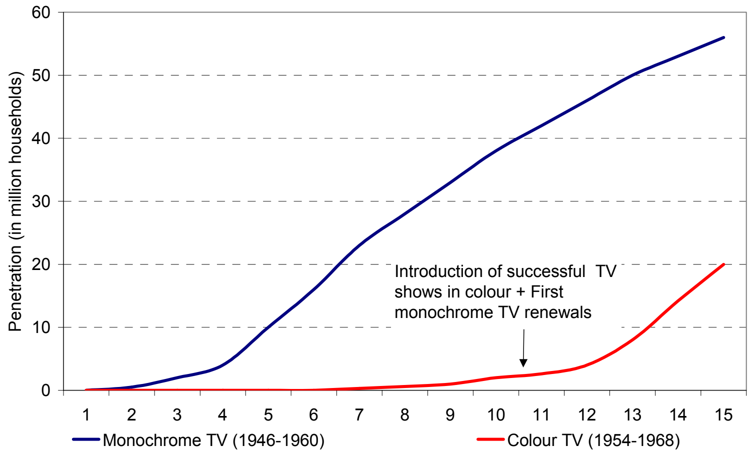
[48] A 12-inch RCA colour TV cost 1000 euros, as against 300 euros for a 21-inch B&W set.

The veritable take-off in sales in the early 60s coincided with the huge success of a transmission produced by the Walt Disney studios, “The wonderful world of colour”, a documentary series specifically designed to highlight the beauty of colours and thus frustrate viewers who could only receive black and white images. **This broadcast in a way constituted the “killer application” for colour television in the USA** and undoubtedly helped to speed up sales by making the colour television a “must-have”.

When the rate of black and white TV penetration came close to reaching saturation point, RCA successfully re-launched colour by introducing it on NBC (5 hours a week in 1959, 100% of prime time in 1965).

It is also evident that colour cinema technology, which had been ready since the 40s, did not become really widespread until the 60s, *after* colour TV migration. In fact, the heads of the Hollywood studios were at that time beginning to consider television as a real rival to the cinema. As long as television remained black and white, colour (expensive and poorly mastered) was only used in a few blockbusters, but when TV changed to colour it became necessary for films to align themselves with it.

Figure 42: The first 15 years of monochrome and colour TV in the USA



Source: BIPE

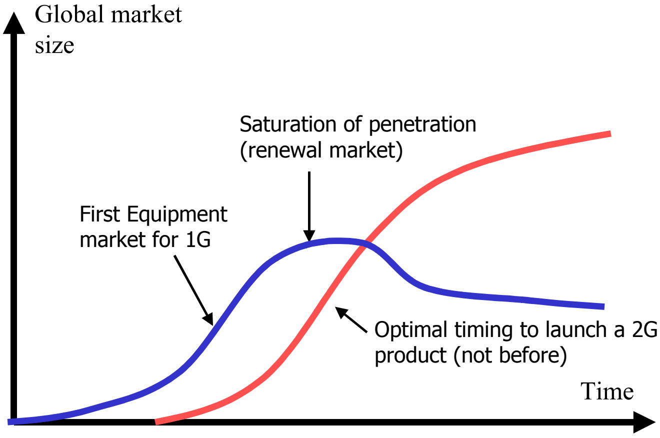
<u>Lessons for digital television</u>

The lessons to be drawn from the transition to colour for the migration to digital television are as follows:

- Colour TV was not regarded as a new product but, rather, as a **mere improvement** in television - albeit an insufficient one because of the additional cost, which for a long time prevented colour television sales from gaining a significant share of receiver replacements. It was only when transmissions attracting large audiences appeared and the value added of the colour system was highlighted that a significant part of first purchases and replacements was accounted for by colour receivers.

- In the same way, only a small number Europeans presently perceive the value added of digital broadcasting. Households will only be inclined to buy digital receivers or converters when **successful** “**killer applications”** come along and displaying the value added of digital TV (interactive transmissions, high definition, new free channels available exclusively in digital, portability-mobility of reception, etc.).
- As the promoters of colour TV were *the same* as the black and white operators, they preferred to **accumulate the profits from a black and white market in full growth *before* launching colour**. They **deliberately delayed the advent** of colour. In the same way, leading free-to-air television operators, who benefit from a kind of guaranteed income in terrestrial countries, do not have any interest in encouraging rapid migration.
- The vertical Integration that made it possible to curb the development of colour in the 50s also enabled rapid development ten years later. Since the same players controlled the production of hardware (TV sets) and software (main networks), it was easy for them, once they felt the time was ripe, to launch a fairly rapid migration by **synchronising** the supply of colour broadcasts with the advent of low-priced receivers.
- **The FCC decision to opt for a colour television standard around 1948-1950 was premature** insofar as neither the technologies nor, in particular, the market were ready for this (as was subsequently shown). The confused range of objectives governing the choice (i.e. initially attempts to counterbalance RCA’s technological dominance and then to avoid fragmenting the market) can be seen again in the political management of digital television, where different categories of objectives interfere in technical decisions.
- Finally, the widespread use of colour in the cinema after television shows **the importance of competition for disseminating a technology**: as they believed TV was a rival, film producers felt the need to follow the innovation introduced by television.

Figure 43: Product cycle and innovation cycle



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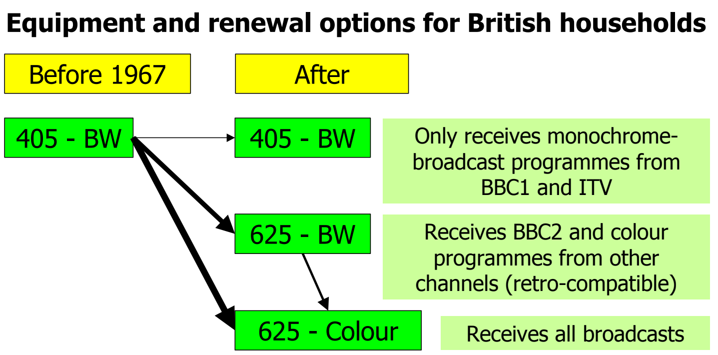
1.4 The transition to colour and the turn-off of 405-line broadcasting in the United Kingdom

Migration to colour TV was more rapid in the United Kingdom than in the USA for different reasons, i.e. the timing of the introduction and the presence of broadcasts available exclusively using the 625-line system.

Timing of the introduction. Colour TVs were introduced later in Europe than in the USA at a time when black and white television was already well established, while in the USA colour receivers arrived on the market only eight years after the first black and white sets. Consequently, the price difference was smaller in Britain and, above all, the stock of black and white receivers was already sufficiently developed for the annual volume of replacements to generate substantial opportunities for the purchase of colour TVs.

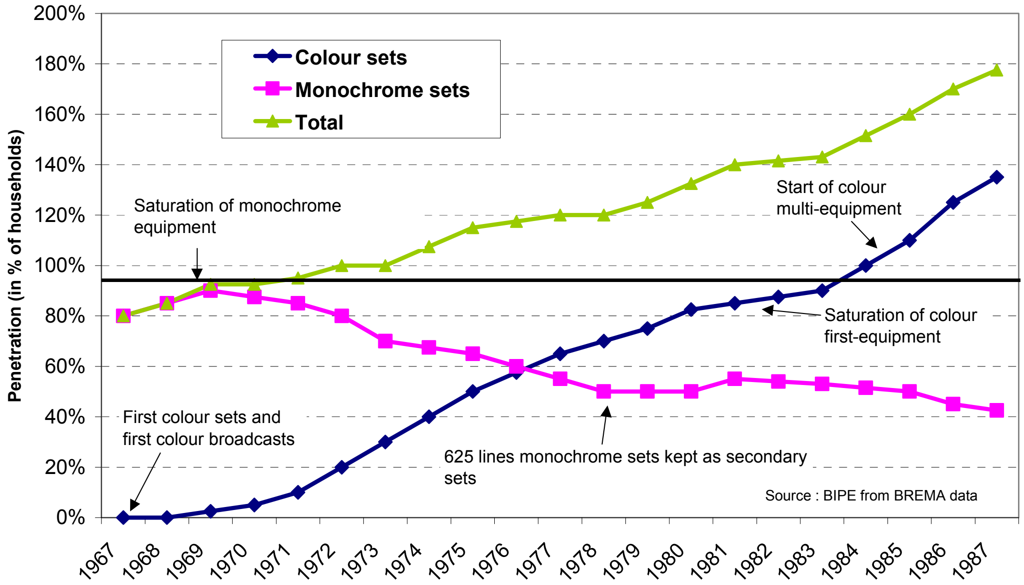
Programmes exclusively on 625-line receivers. The BBC2 channel was launched in 1964 with the PAL 625-line format in the UHF waveband. While the two traditional channels (BBC1 and ITV) were still broadcasting in the old VHF 405-line format in addition to the 625-line system (simulcasting), BBC2 was transmitted on 625 lines *only* (non-simulcasting). Thus, only 625-line receivers could receive BBC2. The colour system introduced in 1967 operated in the 625-line format only, which meant that the black and white 405-line sets could not receive colour transmissions. So the possibility of receiving BBC2 was clearly associated with the attraction of colour, thus generating rapid growth in the sales of 625-lines colour televisions and, to a lesser extent, of 625-line black and white sets.

Figure 44: Transition to 625-line and colour television in the United Kingdom



Source: BIPE

Figure 45: Migration to colour television in the United Kingdom



The final turn-off of VHF 405-line broadcasting did not happen until 1987, after 20 years of simulcasting. No date had been announced in advance. Quite simply, the VHF 405-line transmitters that had reached the end of their service life were not replaced from the 1980s on. As a matter of fact, the British authorities did not see any urgency in freeing the VHF band from BBC1 and ITV transmissions because of the low demand for frequencies in that band.

When the VHF 405-line system finally became extinct in 1987, there were still around 8.5 million black and white televisions in British households (second TVs, country homes) but only a few thousand of these were 405-line sets.

<u>Lessons for digital television</u>

- The transition to 625 lines and UHF waveband was essentially **a technical choice**. However, in spite of a slightly better image definition, **the benefit to the consumer would not have been sufficient to produce a huge migration to the new standard**. What made the difference was that the programmes transmitted in colour and, in particular, the new BBC2 channel were only available on 625 lines and *not* in the old 405-line format. This led to a high rate of colour renewal, and even of anticipated renewal in order to change to the colour 625-line system.

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- **The 625-line system alone could only have established itself in a planned framework with incentives or compensation for the extra financial cost.** The consumer advantages associated with the 625-line format (new channel, black and white and even colour retrocompatibility) enabled this technology to make a name for itself quickly despite the additional costs for equipment and the licence fee (the latter rising from £5 to £10 for a colour set at the time). This suggests that digital technology will have to find clear, attractive and, where possible **exclusive** consumer advantages in order to become established. In this respect, the launching (in digital only) of a channel such as ITV2 in the United Kingdom is reminiscent of the launching of BBC2 and then of BBC2 colour, which was also available in the new format only at the time.
- **The superiority of colour television, evident in the eyes of consumers, enabled migration to take place without a subsidisation of new equipment, without government planning[49] and simply through market forces**. The lack of demand for the use of the range of radio frequencies and the administrative management responsible for broadcasting in the old format did not encourage governments to accelerate the turn-off of broadcasting in the former technology: this then occurred gradually with the obsolescence of broadcasting equipment (natural death). Digital is a different situation because a long period of simulcasting could be regarded as wasting public and private resources.
- Although quicker than its American precedent, **equipping British and European households with colour receivers nonetheless took more than 15 years**. This implies that, without specific regulatory or industrial measures, the use of analogue reception could last at least just as long.
- When an innovation is perceived as having a very strong value-added component, **non-retrocompatibility may be accepted** by the market **in certain cases** and even act as a catalyst towards more rapid migration (vinyl to CD, B&W to colour in the United Kingdom).
- **The advantage for the consumer does not need to be intrinsically linked to the new technology: it just has to be "bundled" with it.** In the United Kingdom during the sixties, transmitting colour television in the 405-line format could also have been imagined, but it was decided to develop and launch colour with the technological carrier of the future *only, i*.e. 625 lines. In the same way, multi-channel television, high definition, widescreen images and even certain forms of interactivity are technologically possible in the analogue format; what is important is that some of these characteristics should be definitively associated with digital in the consumer's mind someday.

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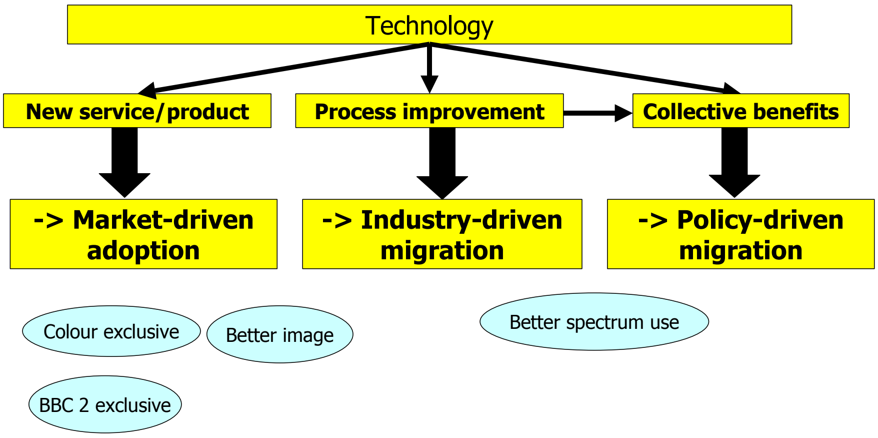
[49] Government intervention was limited to the fixing of a colour standard (PAL) and an increase in the licence fee in order to finance the conversion of the public broadcasters to colour.

Figure 46: Migration to 625 lines backed up by "bundled" benefits (colour, BBC 2)



Source: BIPE

2 Case studies: supervised technological migrations

2.1 Transition to 220v[50] electrical current

Almost all countries in mainland Europe switched to a common electrical voltage of 220V between 1940 and 1970. The 220V current did not in itself produce any decisive improvements for consumers compared with other possible voltages such as 110V, but users, the industrial equipment manufacturers and the electricity operators were eager to have **a *homogenous* voltage network** throughout their territory rather than the previous situation with local 110v, 220v and other voltage networks coexisting side by side. Standardisation was intended to lower the costs resulting from fragmentation (transformation) and achieve **economies of scale** in terms of both equipment networks and electrical appliances.

In this case, we are therefore not talking about a new and superior product that can be promoted by market forces but, rather, about a change in the technical system, which enables the **provision of the same final service at lower cost for a number of the players involved**.

At a time when the generation and distribution of electricity was controlled by state monopolies, migration was steered throughout by governments and national power companies. In France, the decision to make 220v generally accessible and gradually to discontinue 110v distribution was taken in 1956. **This migration, led by Electricité de France (EDF), took a total of thirty years.**

There was no simulcasting at local level but, rather, a series of switchovers/extinctions - from 110V to 220V – from town to town and district to district. At national level, however, there was a very long “simulcast” period since both voltages continued to be used in the country for many years. The migration was **mandatory but subsidised**, thus greatly reducing the conversion costs borne by the consumer. EDF distributed 220v light bulbs and adapters free of charge to all households in the switchover area and even paid for the conversion of some electrical appliances.

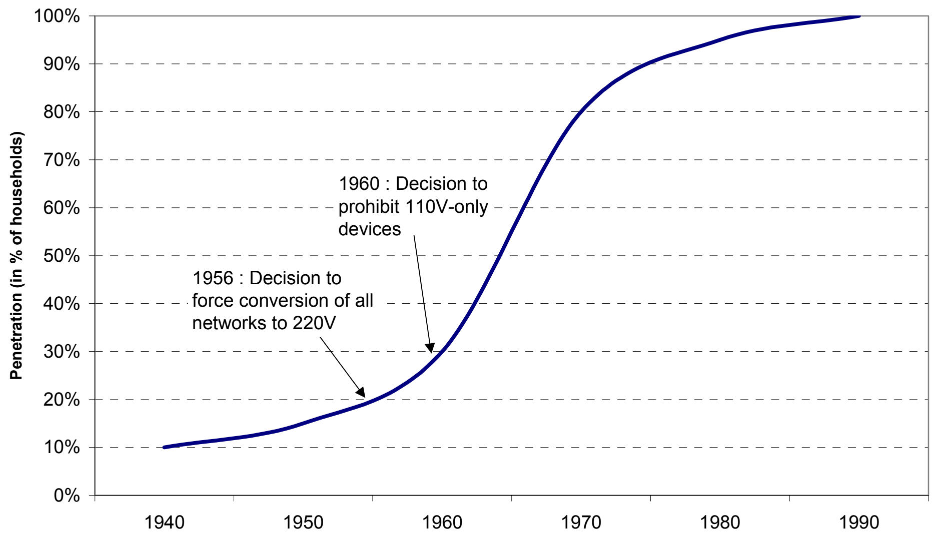
At this stage, two harmful effects surfaced: the 110v bulbs left in households were resold to those still located in 110v zones, which increased the stock of 110v bulbs to be replaced; and more seriously, a large number of 110v electrical appliances were still being sold. Households located in the 110v zone, not knowing exactly when they would be “migrated” (switched over) but knowing that the cost of adapting their electrical appliances would in any case be taken care of by EDF on the day of turn-off, **were not inclined to buy bi-standard appliances** that were more expensive and offered a more limited choice. To solve this problem and put a stop to the rising stock of 110v appliances, **a law enacted in December 1960 banned the marketing of appliances that could not work on 220v**, thus making 220v or bi-standard supply compulsory.

[50] Sources: Histoire de l’électricité en France *History of electricity in France* (Henri Morsel, Fayard, 1996), 25 ans de vie technique et économique d’EDF *EDF’s 25 years of technical and economic life* (P. Ailleret, 1971).

This measure was welcomed by industry, given that it favoured standardisation so it could simplify product ranges and thus reduce costs.

In this example, it was not technically feasible to fix a 110v **national extinction date** because conversion of the network could only be carried out slow and gradually. In the end, total conversion was not achieved until 1987. During those latter years, EDF opted to finance the replacement of 110v electrical appliances that had been purchased before 1960 and which could not be converted.

Figure 47: Migration to 220v in France



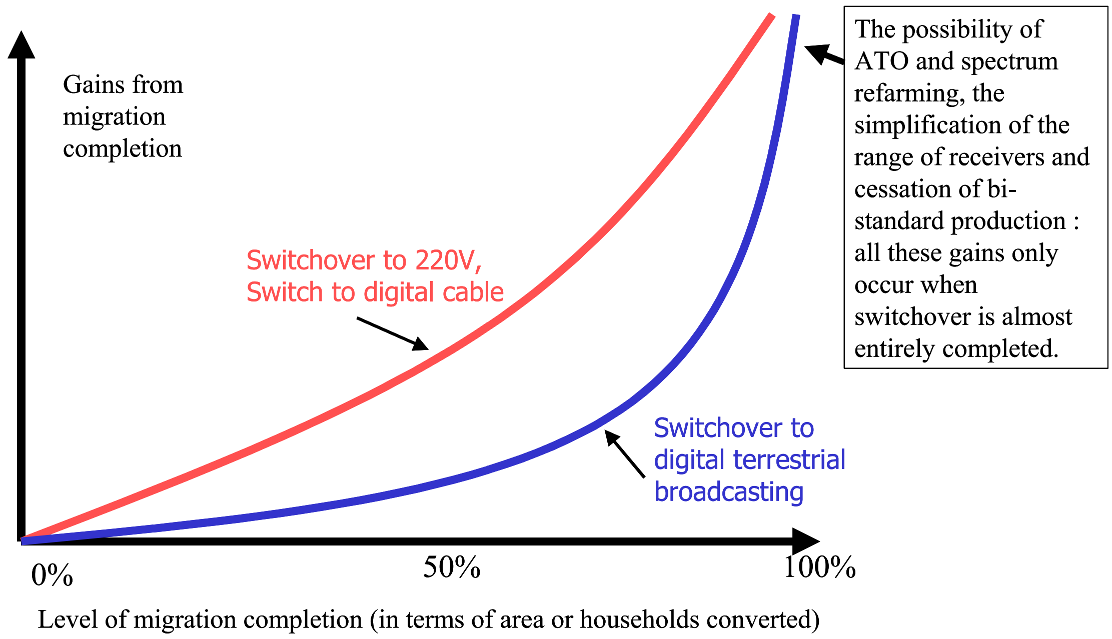
Source: BIPE

<u>Lessons for digital television</u>

- Network standardisation (in this case to 220v) shows certain similarities to the general transition to digital television and the end of analogue broadcasting. In both cases, **the benefit to the end-user constitutes only a (small) part of the global benefits**. It is a case of rendering a similar service under more efficient macro-economic conditions, more mindful of public resources (cost of the national electricity infrastructure, cost of public channel transmission, use of radio frequencies, etc.) or, in short, better attuned to the general long-term interest. Thus, as was the case for the switchover to 220v on mainland Europe and although the present case is concerned with extensively liberalised and competitive markets, it would still appear (all the more?) necessary for most of the present European governments to supervise the transition to all-digital television and the discontinuation of analogue broadcasting.
- Under normal market conditions, **non-compatible terminals continue to be sold, causing fragmentation of the market** in the transition phase. To avoid the costs resulting from such fragmentation and to accelerate migration, some European governments plan, for instance, to **ban the marketing of TV sets that only have an analogue tuner** in the same way that some governments prohibited 110v electrical appliances forty years ago.

- **Generally footing the bill for consumer migration costs can give rise to certain undesirable effects** (moral hazard, opportunism effect). This example shows, in particular, the need to provide consumers with complete information about the **timing** of the migration and the options presented to them to migrate at their own pace. This information must be complete and understood by all before being able to judge whether more interventionist measures (compatibility obligation) are really necessary.
  - In the case of electricity, it was possible for the transition to last a long time because the upkeep of some 110v areas did not create any substantial additional cost at national level. The same situation applies now for cable television: **some networks could be maintained in analogue format by their operators if it were not economical to convert them**. In the case of terrestrial digital television, on the other hand, it would be uneconomical to maintain large-sale digital/analogue simulcasting for too long as this would prevent transmission cost savings and the freeing up of frequencies. Finally, from the point of view of today's electronics producers - like yesterday's electrical manufacturers - there is a strong side and threshold effect associated with conquering the last few percentage points of penetration and the turn-off of the old format (110v or analogue). As long as there are still 110v zones, areas without digital reception or analogue households, it will be necessary to maintain the production and the distribution of *bi-standard* appliances.

Figure 48: Non-linearity of the gains of technological conversion (side effect)



Source: BIPE

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2.2 The failure of the high-definition analogue television in Europe

In 1980-84, the European Community sought to avoid any recurrence of the technical fragmentation that occurred in satellite transmission during the 60s when defining the standard for analogue colour terrestrial television (PAL vs. SECAM). At that time, the Commission was requested by the public broadcasters (EBU/UER) to make the MAC format (which, in itself, presented few improvements in quality perceptible to the end-user) mandatory by means of a Directive.

Japanese industrialists devised a high-definition analogue television system (1125 lines) at the same time. Fearing that global success of the Japanese standard could help the Japanese electronics industry to further strengthen its market domination over European manufacturers, the European Community launched a TVHD[51] standard project, i.e. the HD-MAC[52]. The transmission strategy was based on the hypothesis of prior development of standard definition MACs (D2-MAC).

In spite of the support of European manufacturers (Philips and Thomson) as well as component and decoder producers and despite an elegant technological solution offering a progressive path towards high widescreen definition (D2-MAC then HD-MAC), the norm failed to replace the existing European analogue television standards of PAL and SECAM.

a) The technological migration was intended to rely on **mandatory regulation at European level[53], using the D2-MAC norm within the context of high-power teletransmission satellite broadcasting** (Direct Broadcast Satellite or DBS). However, this requirement was **ignored** by BskyB when the group started to broadcast from medium power telecommunication satellites (Astra, in this case) in the traditional PAL format, thus setting the *de facto* technical norm for satellite television. When the MAC components and then the decoders arrived on the market, it was **too late**: the principal private broadcasters (free-to-air or pay TV) were already offering their analogue signals on Astra. No private television programme was broadcast in HDTV and no HDTV receiver was brought onto the market.

b) Apart from a desire to bolster the technology and a European industry faced with Japanese competition, **there were no economic advantages of the type that can be hoped for today in the transition to all-digital TV** (reduction of transmission costs, savings on use of frequencies). Thus, the European Commission and the Member States did not find sufficient reasons for going *all the way* in their project: the 1992 revision of the 1986 directive did not extend the obligation to use the D2-MAC norm to broadcasters using telecommunication satellites.

[51] Télévision Haute Définition, *High-Definition Television*

[52] MAC : Multiplexed Analogue Components.

[53] European Directives of 1986 (86/529/EEC) and 1992 (92/38/EEC).

Lessons for digital television

The lessons generally drawn from this episode are the following:

- **The MAC plan was the by-product of a political and industrial lobby influenced of public decision-makers, public broadcasters and the champions of European electronics**. It called for substantial public and private investments (Eureka 95 programme) to establish a transmission norm which, although technologically advanced, was also costly and, above all, was **not in line with the level of development in European television**: operators' and consumers' priorities focused on multichannel and premium TV, not high definition. Thus, most of today's consumer surveys tend to show that the general public is not ready for high levels of interaction with television beyond NVOD and the use of the electronic programme guides.
- Caution is therefore required when it comes to digital television. **The advantages of digital television should not be over-estimated and we should not jump to the conclusion that there is a need for public intervention**. Although it would appear that the direct players in the market (consumers and broadcasters) are interested in digital broadcasting if it facilitates a greater choice of channels (particularly in terrestrial broadcasting) and the introduction of a number of perceptible improvements like electronic programme guides, digital technology in itself will not constitute a turning point with regard to how most users perceive the television service – in the same way as the benefit provided by MAC technology was assessed as negligible by operators and consumers. Furthermore, the real economic interest associated with the release of frequencies potentially due to the turn-off of terrestrial analogue broadcasting has not yet been clearly established or measured.
- **Technological timing is a decisive factor**. While arriving too early in terms of market needs and priorities, high-definition analogue technology arrived too late to the extent that digital transmission started to appear in the USA in 1992 and in Europe from 1996 on. In the same way, there are voices today who maintain that digital technology has comes so late that it is not worth "upgrading" terrestrial transmission and that we should migrate directly to cable/satellite[54] transmission.
- Incentive or restrictive measures by governments aimed at accelerating migration can be **circumvented by the key market players**, who are always ready to exploit loopholes in the regulatory framework if things go too much against their interests.

The lessons drawn from the MAC episode should perhaps encourage the public authorities to display greater caution and modesty in the accompanying measures likely to be taken now or in the future with regard to migration towards all-digital television. However, it should be noted that there is at least one fundamental reason for the general interest in the turn-off of analogue broadcasting (particularly in the terrestrial mode) that was not present in the MAC episode: optimisation of the public radio resource.

[54] Is it better to improve a condemned technology or abandon it immediately? Historically, France fell several decades behind in the field of telecommunications when it was decided, under pressure from the Professional Association of Engineers, to electrify the semaphore network rather than get rid of it in order to develop the wireless telegraph.

Figure 49: For and against migration to MAC

For MAC	Against MAC
European electronics manufacturers (Philips, Thomson), public broadcasters (EBU)	Private broadcasters (German free TV, UK and Scandinavian Pay TV)
Public engineers and decision-makers	Television professionals

Source: BIPE

2.3 Breaking the "chicken-and-egg" cycle: introduction of widescreen television (16/9)

It is possible that although innovation may lead to a perceptible improvement in the service concerned, market forces will be powerless to achieve the migration because of classic chicken-and-egg difficulties.

For example, colour television started very slowly in the USA because colour programmes were extremely limited in number at the time the first receivers were brought onto the market.

To a lesser degree than colour, widescreen television provides additional viewing comfort and quality of experience. Nevertheless, European producers and broadcasters have for a long time hesitated in relation to bearing the additional cost of 16/9 production in view of the low number of viewers equipped with suitable receivers and, on the other hand, the interest in 16/9 television being very much confined by the small number of programmes designed and broadcast in this format.

The European Commission's aim in drawing up an **action plan** for the development of Advanced Television Services[55] was precisely to break this "chicken-and-egg" situation. The objective was to **break the vicious circle of receivers and programmes** by influencing supply and enabling the markets to reach a critical mass. Financial assistance to the tune of €228m spread over four years was designed to encourage the production and transmission of high-quality 16/9-format programmes by compensating for the additional cost associated with 16/9 production compared to traditional 4/3 television productions.

The action plan effectively enabled the acquisition of equipment by producers and broadcasters, the emergence of "know-how" and the building of a stock of 16/9 programmes. However, the showing of 16/9 programmes on analogue television remained marginal and in any case insufficient to encourage households to purchase 16/9 TV sets.

In reality, **it is the success of two products/services complementing 16/9 "monitors" that has perhaps made the greatest contribution to sales taking off** from 1998 on: digital pay TV (where the cost of 16/9 transmission is marginal and constitutes an interesting differentiation factor) and DVD players.

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Thus, it is not certain whether the programme subsidies were a *necessary* condition for the 16/9 format taking off. However, it is likely that the existence of an initial stock of 16/9 receivers *itself* contributed to DVD players taking off, which then helped the commercial take-off of 16/9.

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55 Action Plan for the Development of Advanced Television Services. Council Decision of 22 July 1993.

Figure 50: Sales of widescreen TV sets in the United Kingdom

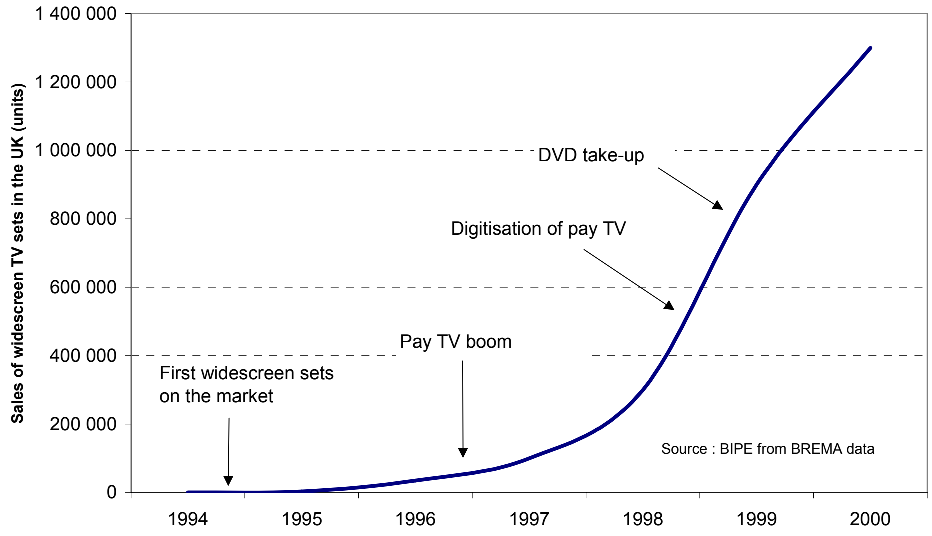
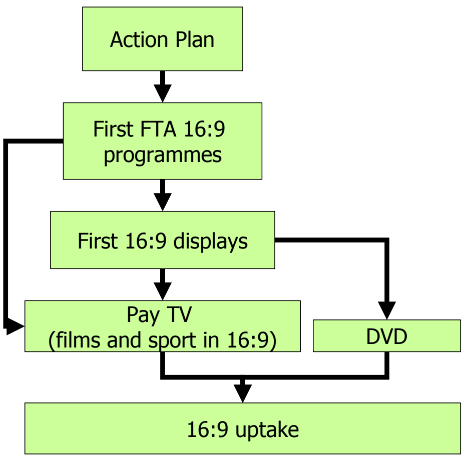


Figure 51: Main driving forces for 16/9 taking off



<u>Lessons for digital television</u>

- **The development of all-digital television is faced with a chicken-and-egg situation**. Free-to-air TV consumers have no strong incentive to purchase digital TV sets or digital adaptors as long as content and services produced exclusively for this format do not exist to provide a strongly perceived value-added component. And broadcasters will not be encouraged to develop new services that are "typically digital" or to devote new developments to digital television as long as the number of digital households has not reached a critical mass.
- Television and, all the more so, **digital radio** are in a chicken-and-egg situation.
- The success of premium pay TV, digital of course, may just be one way of **breaking the chicken-and-egg** cycle by giving the free-of-charge broadcasters and other service providers a basic stock of digital households to whom they can offer their services.

- However, some European governments do not want to be left at the mercy of current market forces. As in the case of the 16/9 precedent, several of them want to see **catalytic movement and an acceleration of migration through financial incentives**. These would once again be provided to the broadcasters (subsidies for public broadcasters to switchover to digital and even develop new FTA channels only available in digital format) and also to end-users (subsidies to cover the migration costs of Italian households).
- It should, however, be borne in mind that the "chicken-and-egg" situation also existed in cases like the audio CD and DVD, and that **there was no need for subsidies or regulatory intervention** to break the vicious circle, establish confidence and to lead the market to take off after a few years.
- As for public incentive policies, it should be remembered that the Action Plan provided for subsidies to the market players and not end-users, as presently envisaged by a number of governments for the purpose of boosting free-to-air digital TV.
- On the other hand, although the Action Plan was directed at the development of widescreen, it allowed the market to decide what type of technology was the most appropriate to deliver this service. In the same way, any public policy aimed at the development of a service today (digital television in this case) should take pains to regulate *as little as possible* and in a *technology-neutral* manner so as to **limit the risks of competitive distortion** between players or technologies.

Part 4:
Secondary sets and terrestrial reception

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1. Terrestrial reception is under-estimated if we consider it from a **per-home basis**, main set approach. All the available statistics are made this way. We know that many DTH or cable homes in Europe do use terrestrial reception for their secondary sets. As a result, though there are no field study on this, the ratio of active receivers using terrestrial reception is probably well above the ratio of main sets (ie 50%). The **per-TV** ratio might be up to 60% or 70%. In Benelux some households have several cable plugs installed, but this is not universal.
2. By the way ***digital*** **penetration** statistics are also always per-household oriented, which means that a household is considered « digital » as soon as one receiver is equipped for digital reception. The per-TV digital penetration is well below the per-household rate (ie about 20% on European average). ATO criteria, though sometimes apparently very protective, tend to omit to use a per-TV approach. But it is very unlikely politically that any ATO might be organised while there might remain active analogue sets.
3. The main question is : digitisation is driven by pay TV on main sets and non-payTV homes might be ready to invest in new equipments to upgrade their main sets… but what will be the **drivers of the switchover on secondary sets** ?
4. **Indeed pay TV operators** have not really put the stress on the issue of secondary sets up to now, as they were in a extension phase (conquête). But they are starting to do so now they face a maturing market and have to build loyalty and increase ARPU. For example there are subscription offerings coming with *two* decoders ; and when a new generation of STB comes, subscribers are allowed to buy/keep the old STB for a discounted price and/or second discounted subscription (this is not possible when the move is from analogue to digital, but within the generations of digital decoders).
5. Whatever the delivery mechanism, digital reception on a analogue set requires a converter. But beyond that cable and DTH reception require outdoor reception equipments (rooftop satellite dish and cabling or connection to the cable network). Analogue terrestrial reception also usually requires rooftop aerial most of the time, **but** *digital* terrestrial broadcasting can allow **indoor reception**, with only small, un-expensive set-top aerials. This capacity of terrestrial broadcasting is sometimes also referred to as “portability” as indoor reception makes it easier to move the TV set all over in the home as you don’t need to put it near an “antenna plug”. This means that it might be easier for analogue terrestrial homes (sets) to migrate towards *digital* terrestrial than to other digital delivery mechanisms.

6. The robustness of indoor reception depends on **technological/policy choices** (signal power, network infrastructure) and housing conditions (good in suburban individual houses and high floors, bad in city centers' first floors). Considering current choices in Europe, indoor reception is to be possible for only a portion of the population, except in the Netherlands, where DTT has been designed from the beginning to be universally "portable".
7. There are **technical solutions to address secondary sets** from a main set equipped for DTH or cable reception (cabling, infrared : see following points), but **DTT indoor reception appears to be the most convenient**, in most cases.
    - In some countries, people with basic cable connection connect their secondary sets themselves with wire.
    - There are on the market some **infrared or wired solutions allowing to transmit to secondary sets the signal produced from the main TV station** : pay TV, digital STB, VCR/DVD. This can prevent from duplicating peripherical equipments on secondary sets, but with limitation (doesn't allow two people in separate rooms to watch two different digital channels at the same time – since there is only one tuner). These solutions are not pushed by major consumer electronics manufacturers nor by pay TV players (although C+, for instance, mentions CGV products – www.cgv.fr). They seem to be poorly developed so far, partly because the technology is not robust enough to every house environments.
8. Indoor reception enables consumers to not **depend on local conditions/regulation** for the TV access : whether the neighbourhood is or is not cabled, whether the building is, or not, equipped with cable, collective rooftop aerial or SMATV, whether individual rooftop dishes or aerials are, or not, allowed by local planning authorities or landlords.
9. So, as indoor terrestrial is in many cases the most accessible, convenient and affordable (ie "democratic") way of getting television on secondary sets, some policymakers might require **a *per-TV* universal penetration of digital reception** (whatever the delivery mechanism) before turning-off analogue terrestrial broadcasting.
10. Considering the lack of information on this matter, one recommendation could be to organise a **per-TV monitoring** based on surveys at national levels.
11. Though indoor DTT might be in many situations the cheapest way to convert secondary sets to digital (and to multichannel) on a consumer point of view, we must bear in mind that there are collective **opportunity costs** at stake. As we underlined in the Spectrum chapter, indoor and *a fortiori* "mobile" broadcasting of a TV channel need much more bandwidth than for fixed reception. Besides there is a **technical trade-off** between indoor reception, number of channels, image quality and spectrum release. For instance, in "cable countries", would consumers like DTT to be less multichannel than the current basic analogue cable but (because) featuring indoor reception/portability. Rather than to decide which is the optimal trade-off, a more efficient and dynamic approach for policymaking could be to give market players the structure and signals enabling it to find its own equilibrium.

12. **The markets will be able to address digital reception for secondary sets**. Many small or medium consumer electronics manufacturers in several member states have made announcements indicating that they plan to develop and launch basic, cheap digital converters. These “zapping box” will be designed for those that are not interested in pay digital TV, but may be interested in receiving more free-to-view channels or interactive features, as soon the price is below a psychologic limit which is believed to be around €150 or £100. Then for a similar price, this solution would be more flexible and convenient then the current “relay” solutions. Some manufacturers are particularly focusing on DTT reception, especially in “terrestrial” countries with scarce free-to-air supply.

Figure 52 : Penetration % for multiset and VCR[56]

46% of European households have more than one TV set. 80% have (at least) a VCR. This makes 1+0,46+0,80=2,26 analogue receivers per home as a minimum (without taking tertiary equipment and holiday houses into account).

For instance in France there are about 40 million active sets and 20 million active VCRs for 22,5 TV households, which makes 2,6 analogue receivers per household.

	Multiset*	VCR**
Austria	52	80
Belgium	24	73
Denmark	45	85
Finland	43	77
France	40	83
Germany	30	83
Greece	55	64
Ireland	34	76
Italy	50	66
Luxemburg	51	70
Netherlands	42	71
Portugal	69	57
Spain	59	72
Sweden	57	83
UK	60	89
Total EU	46	80

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[56] Source : *IP European Key Facts 2000, ** EAO Statistical Yearbook 2001.