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Digital switchover across the globe: the emergence of complex regional patterns

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The switch from analogue to digital television is now an established global trend. Switchover motives vary in emphasis from country to country but the common objective is to achieve greater spectrum efficiency by closing down analogue terrestrial transmission. The spectrum saved at this point can be reallocated or auctioned, for a wide range of broadcasting and telecommunications purposes.

Switch-off started at regional level with Berlin in 2003 and at national level with the Netherlands in 2006. Finland and Sweden followed in 2007. Firm target dates have been set for the United States (2009), Japan (2011), the United Kingdom (2008–12) and several other western European countries. In the wake of these pioneers, other governments around the world are following, and the 2006 Regional Radiocommunication Conference for Europe, Africa and the Middle East set a date of June 2015 for completing the transition to digital broadcasting.

Comparative study of switchover policy and its implementation has tended to stress the differences between countries (Brown and Picard, 2005; Cave and Nakamura, 2006; Frezza and Sorice, 2004; Galperin, 2003; 2004), as indeed has our own previous work (García Leiva, 2008; García Leiva et al., 2006; Starks, 2007). Differences can be explained by variations of emphasis in motivation, by national market characteristics and the extent of multi-channel development, by political and cultural factors, and by timing. Several of the pioneering countries faced crises at some point, characterized by a stalled market, bankrupt broadcasters or postponed switch-off timetables. Switchover has proved neither commercially nor politically simple.

However, as more and more countries now embark on the process, it becomes possible to see an emerging pattern of global regional blocs, albeit with subdivisions and exceptions, and to analyse with greater confidence the common principles which might assist the next wave of countries to avoid some of the early pitfalls. This article aims to look behind the many and varied national differences to draw out these points. The major blocs discussed are the United States, Europe, Japan and China, each of which has developed its own set of technical standards and each constituting a large TV receiver market. We look at their moves towards digital switchover and at how other countries, especially in Australasia and Latin America, relate to these blocs.

The United States and ATSC

Digital terrestrial television, as a potential substitute for analogue terrestrial, was first developed in the United States as an industrial response to Japan's bid in the 1980s to set global standards for high-definition television (HDTV) using analogue technology. When in 1990 General Instrument announced that it had designed an all-digital HDTV system, the United States industry knew it had a card which would trump Japan's analogue system and the early digital development work done under the aegis of a Federal Communications Commission (FCC) advisory group laid the basis for the ATSC (Advanced Television Systems Committee) set of technical standards for both standard and high-definition digital terrestrial television.

The FCC's initial idea was to loan all the existing terrestrial broadcasters an additional frequency (sufficient for an HD channel), require them to invest in HDTV production and transmission, oblige them to simulcast (duplicate) their analogue service in digital HDTV for perhaps 15 years, then shut down all analogue transmission and take back the extra frequency. Allocating existing broadcasters sufficient spectrum for simulcasting and HDTV limited the scope for new entrants – though, under the regulations finally agreed, the use of HD and the requirement to simulcast became optional. A tight timetable was set for switchover: the FCC target was to terminate the USA's NTSC (National Television System Committee) analogue transmissions by 31 December 2006.

The broadcasters lobbied for a softer switchover date and found ready allies in Congress who provided an escape clause whereby analogue broadcasts could continue after 2006 if fewer than 85 percent of households in any given area were at that point equipped to receive digital television, whether terrestrially, by satellite or by cable. In the market digital TV receiver sales were slow, as consumers waited for more digital content and lower receiver prices, and the shops continued to sell around 25 million analogue TVs a year. The 2006 date ceased to be credible. No date for 85 percent take-up could be confidently forecast.

In 2001, in the aftermath of the 9/11 terrorist strikes, pressure to clear some broadcasting spectrum for allocation to the emergency services received a major boost. Moreover, the government wanted the proceeds from auctioning saved spectrum to help deal with its budget deficit. The FCC became much more willing to use compulsion and in 2002 decided to make the inclusion of digital tuners in new TV sets mandatory. It proposed to use powers it had been granted in a very different context under the All-Channel Receiver Act of 1962. The manufacturers took the FCC to court and lost.

So in 2003 the mandatory policy went ahead, setting a 2005 deadline for large screen sizes, a 2006 deadline for medium-sized screens, and a 2007 deadline for small screens, VCRs and DVD recorders with tuners. The TV set replacement market was now yoked to digital switchover.

Around 60 percent of America's 100 million TV homes have cable and around 20 percent (and growing) subscribe to direct broadcast satellite – leaving terrestrial television accounting for less than 20 percent of main TV reception. Switching off analogue terrestrial television would not therefore alienate the majority of households. The Government Accountability Office (GAO) estimated in 2005 that about 21 million households (or 19 percent) relied wholly on terrestrial television, noting that these households were disproportionately non-white and Hispanic and disproportionately poor. With such needs in mind, the terrestrial broadcasters invited the receiver manufacturing industry to design cheap converter boxes which could keep analogue TV sets functioning once they only received a digital signal.

A strategy for completing digital switchover by a fixed date emerged. The favoured timing was early 2009, after the 2008 Presidential and Congressional elections and while the newly elected politicians could still pin the responsibility on their predecessors. The political decision was made early in 2006: switchover should be complete by the end of 17 February 2009. A \$1.5 billion subsidy fund was created to provide eligible households with up to two \$40 coupons with which to buy converter boxes. Management of the subsidy scheme was entrusted to the National Telecommunications and Information Administration. The priority was to bring in the spectrum auction revenue and the spectrum auction therefore started in 2008.

The FCC ruled out doing a phased switch-off, region by region, because of the complexity of frequency boundary issues. In the event, however, a last-minute postponement from February to June 2009 proved necessary.

Europe and DVB

In response to Japan's analogue HDTV initiative, Europe had developed its own rival analogue high-definition satellite system, known as MAC (Multiplex Analogue Component) in the 1980s. Embodied in a European Directive, it was the European Commission's bid to end the analogue TV

divide between the PAL and SECAM systems within the European Community and to strengthen the European receiver industry's global position. MAC's over-ambitious technical profile contributed to its disastrous commercial failure. The European receiver manufacturers, Philips and Thomson, suffered seriously and the UK's national direct-to-home satellite venture, British Satellite Broadcasting, BSB, was humiliated by Sky, using simpler technology (and leading to the formation of BSkyB).

Consequently, as digital television dawned, the European audiovisual industry reacted against politically driven technological strategies and favoured a market-led approach. The European Commission took a back seat, concerning itself primarily with issues of platform neutrality and a light-touch regulation of conditional access. Europe's digital TV technical standards were forged in an industry-centred collaborative project termed the DVB (Digital Video Broadcasting) where technical experts were required to work to a remit set by their commercial colleagues.

Many European countries, with analogue TV structures historically dominated by state or public services, offered viewers a relatively narrow range of analogue terrestrial channels. Satellite and cable companies had started to provide multi-channel TV and found that digital technology helped them to enhance and automate their services. Meanwhile, digital terrestrial offered analogue terrestrial broadcasters the prospect of over-the-air multi-channel. The result was that Europe initially focused on standard definition digital services, giving multi-channel TV priority in spectrum allocation and delaying the introduction of digital HDTV. The DVB developed linked technical standards for satellite, cable and terrestrial television, and later for mobile TV, whereas the American ATSC standards were for digital terrestrial.

The UK, Sweden and Spain were the pioneers who embarked in the late 1990s on unpredictable journeys towards switchover using DVB technology. While analogue terrestrial incumbents were given digital spectrum on which to simulcast their services during the transition to switchover, the leading role in driving digital terrestrial take-up was awarded to new pay-TV operators. In the face of established satellite and cable pay-TV competition, ITV Digital in the UK and Quiero TV in Spain both collapsed, and Boxer in Sweden ran into difficulties. Finland was also an early starter and its digital terrestrial TV languished initially, as a result of relying excessively on interactivity as a service proposition. Sweden and Finland overcame their early problems, while the UK re-launched digital terrestrial in 2002 with a strategy based on free-to-view services (Freeview), in which the BBC played a leading role – prompting a similar rethink in Spain.

Digital switchover initiatives in Germany, Switzerland and the Netherlands followed, Italy then began in 2003, and France launched in 2005. Looking at the European picture now, with other countries also starting, two distinct patterns of development can be identified.

One model is represented by countries with extensive cable and/or satellite reception, where analogue terrestrial switch-off is relatively easy to achieve, and the political risk much reduced, since only a small proportion of main TV

sets are dependent on terrestrial reception. The Netherlands is the prime example of this, but Germany, Switzerland, Luxembourg, and a number of other northern and central European countries also belong to this group.

The second model includes those countries where terrestrial television plays a much greater part, often accounting for the majority of households at the outset, and this group includes the large markets of the UK, France, Spain and Italy, as well as several other southern European nations. Here a much longer, and less predictable, period of analogue-digital terrestrial simulcasting is required, allowing time for the majority of analogue households to switch either to another platform or to digital terrestrial, before it becomes politically possible to switch off analogue terrestrial.

Monitoring progress in different countries, the European Commission is now endeavouring to shepherd European Union members towards the completion of switchover by 2012 but each of the major European markets has its own distinctive features.

Germany

Switchover in Germany has been characterized by a process based on regional 'islands' – the model used in Berlin in 2003. This approach reflects the country's political organization by regional *länder*, its spectrum scarcity, and its low dependence on terrestrial reception. Switchover is already well-advanced, since digital terrestrial services have now been launched in all the main conurbations and analogue terrestrial switch-off has been completed in Berlin-Brandenburg, Bavaria and North Rhine-Westphalia, and is targeted to be complete throughout the country by 2010. Germany's example has been influential elsewhere, popularizing within Europe the concept of implementing analogue terrestrial switch-off region-by-region, rather than naming one 'big bang' national date.

Germany's experience is noteworthy in two other respects. First, despite the low level of dependence on terrestrial reception, Germany valued digital terrestrial technology as a non-disruptive and low-cost option for consumers and for its portable indoor reception and mobile service capabilities. Digital terrestrial coverage reached 80 percent of the population by the end of 2007 and is due to expand further, though not to be universal. Second, German regional governments initially sought to lubricate switchover with the selective use of subsidy, but in 2005 and 2007 the European Commission declared aids provided in Berlin and North Rhine Westphalia illegal.¹

The United Kingdom

In September 2005, on the strength of the digital take-up driven by BSkyB, Freeview and cable providers, the British government committed to switch over fully from analogue to digital television on a region-by-region basis

between 2008 and 2012. The aim is to preserve the role of terrestrial television as a universal and affordable service – and, the cost of the transmitter investment notwithstanding, free public service digital terrestrial television will be made available to between 98 and 99 percent of all households. Released spectrum is due to be auctioned.

After ITV Digital's failure, the emphasis has been on digital terrestrial as a free-to-view alternative to the predominantly pay-TV services of other platforms, though in 2004 some pay options returned to the terrestrial platform in a supplementary role. With digital take-up nationally the highest in the world – by the end of 2007 85.1 percent of households received digital television services on their primary set – the UK cautiously began analogue switch-off in the small town of Whitehaven in north-west England in the autumn of 2007. Operationally, the process is being led by an industry-based company, Digital UK, with a prominent role for the BBC and with licence fee funding for a Digital Switchover Help Scheme for those aged over 75 or with a significant disability.

Spain

In Spain, after the period of inaction following the failure of Quiero TV, the government elected in 2004 decided to re-launch digital terrestrial with a new regulatory framework and technical plan, favouring free-to-view services and giving a more important role to the public service broadcaster, RTVE. The former Quiero multiplexes were reassigned to the existing national broadcasters, analogue and digital, and to a analogue channels with simulcasting obligations. The 17 Spanish regions were granted an additional regional multiplex, and local services completed a distinctively Spanish three-layer structure.

Digital terrestrial TV has been given a universal service role, but take-up in the market has not yet proved strong. Broadcasters have been accused of not complying with their legal obligation to provide innovative programming, different from that on analogue television, but defend themselves by arguing that the free-to-view business model only supports limited commercial investment. They have been pressing for permission to offer pay services.

In September 2007 the government approved a proposed digital switchover plan, based on a division of the country into 73 technical areas, and scheduling analogue switch-off in four phases, starting in 2008 and completing in 2010. With aid approved by the European Commission to help finance digital receivers, the area of Soria in Castile-Leon, was the first to switch-off in 2008.

Italy

Italy, where terrestrial television has a dominant role, launched digital terrestrial with a universal service role in 2003, assisted by a legally controversial

receiver industry subsidy linked to receivers with the potential for advanced interactive services. After questioning aid granted in 2004 and 2005, the European Commission decided that subsidies for equipment offered in 2006 and 2007 were in compliance with EC Treaty state aid rules.² While Italy's digital terrestrial business model was initially based on free-to-view services, event-based pay-TV premium content proved popular, especially for individual football matches. By the beginning of 2008, depending on the region, approximately 45 national channels (20 pay-per-view options) and up to 15 local ones were available (simulcast services included).

Analogue switch-off was originally set for 2006 but then postponed twice: in 2006 until 2008, and in October 2007 until 2012. Regionally based switch-offs began in Sardinia and Valle d'Aosta in 2007, with Trento and Bolzano, and Veneto, Tuscany and Sicily scheduled to follow.

France

France waited until 2005 to launch digital terrestrial TV. By the end of 2007 coverage had been extended to 85 percent of metropolitan areas, with encouraging take-up figures. The business model is a hybrid of free-to-view and pay-TV, with the former based on the well-established MPEG-2 compression technology and the latter using the newer, and much more efficient, MPEG-4 system which facilitated the introduction of high definition and pay-services. *Télévision Numérique Terrestre* (TNT) offers 18 free-to-view national channels and TNT Sat, a satellite-based equivalent, has been launched to 'fill in' areas where digital terrestrial coverage is not available. Free-to-view local channels and 11 national pay-TV channels are also available.

In 2007 a new organization, France Télé Numérique – a public body constituted by the government and public and private broadcasters – was set up to take responsibility for managing the digital switchover process. The aim is to switch off analogue terrestrial TV region-by-region between 2008 and 2011. Digital terrestrial coverage will be extended to 95 percent of the population; funding will be made available to low-income households; manufacturers will need to label their products; HDTV sets will need to have an HD MPEG-4 decoder; and, more controversially, all television sets sold from 2008 must have a digital tuner.

With the rapid spread of large-size flat-screen receivers, replacing cathode ray tube technology, all the major European countries are now beginning to take an interest in HDTV on all platforms.

Japan and ISDB

When the United States' development of digital television turned analogue high definition into a cul-de-sac, the Japanese government and industry changed

course and designed a set of Japanese digital television technical standards, with HDTV as a central feature. Although Japan's analogue TV used the American NTSC system, the Japanese had no intention of adopting ATSC. Their own digital technical standards, termed Integrated Services Digital Broadcasting (ISDB), were designed to encompass digital satellite, digital cable, digital terrestrial, data-casting, multi-media and mobile services.

Learning from the lack of platform interoperability in the USA and Europe, Japan prescribed sufficient technical compatibility to facilitate the manufacture of digital TV sets which could handle both satellite and terrestrial reception. A mobile component to the digital terrestrial system was also built in at the outset. Domestic digital satellite television began on a government-regulated basis in 2000. An open market in digital receivers then developed, with tuners either built into, or sold to accompany, large flat-screen TVs. Analogue satellite services are due to end fully in 2011.

This is also the year in which analogue terrestrial television is due to cease, on 24 July – a date which was nominated before digital terrestrial television in Japan was even launched. The prime mover behind full digital switchover was the Japanese government. The motives, as in other countries, were to remain abreast of changing television and telecommunications technology, and to seize the opportunity to release, and re-use, scarce spectrum. Some of the surrendered frequencies are due to be used for digital radio and, while plans have yet to be finalized, the needs of telecommunications, including mobile communications, are also one of the drivers.

Japan is a populous country, with some 48 million TV households possessing over 100 million TV sets. Moreover, the population is densely crowded, with a high level of communal reception.

Cable systems and master-antenna relay systems account for around 50 percent of households. Historically, most of the cable companies have been small and local and many lack the capital to fund a major investment in digital infrastructure and digital cable receivers. The government is encouraging them to switch on the same 2011 timetable but has not required them to do so by law. Cable broadband services have grown rapidly in recent years and broadband TV has now become an important platform.

Perhaps the greatest challenge comes from Japan's mountainous topography. This requires Japanese terrestrial television to rely on huge numbers of small relay transmitters: in total Japan has around 15,000 transmitting devices mounted on around 8000 transmission masts. Spectrum is intensively used and vacant frequencies correspondingly scarce. The Japanese government decided to spend 180 billion yen (about £900 million) reorganizing the analogue terrestrial frequencies in order to make space for digital terrestrial television. While this entailed initial disruption for viewers – over 4 million homes had to be visited for TV retuning – it meant that, for the most part, the digital terrestrial transmissions could begin on their correct long-term frequencies, thus avoiding a complex set of digital frequency changes at analogue switch-off.

The Japanese government awarded digital terrestrial licences to the public service broadcaster, NHK, and to the current terrestrial commercial broadcasters who, while spared the costs of the analogue adjustment programme, were both expected to make large investments in digital production and transmission infrastructure. Eighty-five percent of their output has to be a simulcast of their analogue terrestrial services and 50 percent has to be in high definition, a key attraction for receiver manufacturers. As in the United States, the spectrum requirements for high definition had the incidental effect of ensuring that, when digital terrestrial was launched, no new broadcasters could enter the market.

By 2007 digital terrestrial coverage had reached 90 percent. A government-coordinated group of broadcasters, receiver manufacturers, cable companies, local government bodies and other stakeholders, issues annual Action Plans focused on the end goal of converting all households to digital terrestrial (or to wired relays of digital terrestrial) by 2011. By the end of 2007 over 20 million digital receivers had been sold, plus 5 million digital recorders.

China and DMB-T

Digital TV take-up in China is still small in percentage terms, but the Chinese government has made a commitment to complete analogue cable switch-off by 2015. China too has adopted its own set of technical standards, though with some similarities to DVB. Digital transmission by satellite and cable is now well-established, with reception mainly via digital set-top boxes. Digital terrestrial TV was piloted in 2008 in the major cities hosting the Olympic Games, using China's own DMB-T (Digital Multimedia Broadcasting – Terrestrial) technology.

The motivation behind switchover perhaps has less to do with maximizing spectrum efficiency and more to do with keeping abreast of the global technology change in the TV receiver market. Chinese manufacturers' exports play a major role in other countries, and China's huge domestic market for TV receivers – with some 380 million TV households – makes digital switchover with distinctive Chinese technical standards an attractive proposition for its industry.

While Chinese television remains state-owned and under tight editorial supervision, the current structure of the industry is pluralist and semi-commercialized. Central China Television (CCTV) is dominant at national level – but, below national level, a multitude of different broadcasting organizations now operate. Each province and autonomous region mounts its own TV broadcasts, including a channel carried by satellite for distribution across the whole country. In addition cities and counties have their own local TV channels. While there is some state subsidy, over 90 percent of finance comes from advertising, with private capital and commercial loans also playing a part.

The principal means of transmission historically was terrestrial television and this remains the case for rural areas. In the 1990s pan-national satellite

services, based in Hong Kong and in other countries, arrived and the difficulty of regulating their content gave China a political dilemma. It was resolved by restricting satellite dish reception by special licence to hotels, embassies, foreign compounds, etc., and thus funnelling satellite services through cable systems which could be regulated. Since then, television development in the cities has been predominantly cable-based, to the point where, by 2007, China had over 126 million cable TV subscribers, accounting for about one-third of all TV households.

To date much of China's digital switchover thinking has focused on cable TV households, where, given that analogue cable can deliver 40 channels, the quest for distinctive new digital content to motivate consumers has been an issue. Different models – with variations in the free provision of set-top boxes, changes to cable subscription levels and the range of new digital services on offer – have been explored in different cities and provinces.

Rural areas have far fewer channels, delivered by terrestrial relays or by local cable systems fed by communications satellites. Rural households have access to far fewer channels than the cities, so the appeal of extra digital channels may be greater here, but their financial means are limited. Moreover, not all yet have analogue TV reception and a government project is under way to improve coverage in remote areas. DBS (direct broadcast satellite) services may also feature in the provision for rural areas in future.

A generation ago, China might have adopted top-down directives backed by full-scale state funding to achieve its digital switchover objective – and, for some parts of the country, this may well be the course ultimately adopted. However, the predominance of commercial funding in Chinese television gives China's policy-makers an interest in investigating the varied experiences of other countries which have utilized the market to achieve public policy goals.

Selecting technical standards around the globe

Clearly not every country can sensibly, or practically, design its own digital technical standards. So around the globe other countries embarking on digital switchover have been faced with a choice between the main standards developed in the United States, Europe and Japan – and indeed the American, European and Japanese proponents of these systems have been competing for their business, since royalty payments for intellectual property are involved. For any country considering which system to adopt, the technology of its analogue television systems (e.g. NTSC or PAL) is a significant factor, as are import patterns for TV receivers and programmes. Canada and South Korea, for example, have adopted the ATSC system. Russia, South Africa and Kenya, among many others, have selected DVB technology. Below we look at two other areas of the globe, Australasia where choosing DVB was straightforward, and Latin America which shows signs of fragmenting.

Australia: DVB and HDTV

Australia started early, launching digital terrestrial television on 1 January 2001, with the intention of switching off analogue terrestrial transmissions in its major cities by the end of 2008 and elsewhere by 2011.

At the start, the strategy was not dissimilar to the early approach of the FCC in the United States. The main incumbent analogue terrestrial broadcasters were allocated sufficient spectrum to simulcast their analogue services in full, with a quota of 20 hours in digital high definition. On this basis the broadcasters were expected to create a new market for digital HD receivers. The emphasis was on technically better TV services, and indeed the commercial broadcasters were initially prevented from using their new spectrum for the provision of new services. While the public broadcasters, ABC and SBS, were each able to provide an additional channel, their new content was restricted to minority-appeal public service genres.

This market strategy – in many respects the antithesis of the standard definition multi-channel approach adopted in the UK and elsewhere in Europe – reflected early faith in the future of terrestrial HDTV. Other influences, however, included the political and commercial strength of the three major commercial analogue terrestrial incumbents, who had no wish to create a more pluralistic and competitive broadcasting environment, and successful lobbying on the part of satellite and cable subscription television providers, who wanted to build up their own pay-TV customer base before viewers were given the option of digital terrestrial multi-channel television.

The result, as initially in the United States, was a disappointingly slow take-up by consumers of expensive HD digital receivers: by mid 2006 digital terrestrial TV had been adopted by only about 20 percent of Australian households. Moreover, complex Australian television regulations, reflecting the regional structure of the terrestrial television industry and protective of the commercial terrestrial broadcasters' access to sporting rights, prevented national satellite carriage of the commercial terrestrial channels. Whereas most other countries, in assessing their readiness for switchover, added the take-up of digital satellite and cable TV to their digital terrestrial figures, on the grounds that these platforms carried digital versions of the main analogue terrestrial services due to close, Australia could not do this.

The 2008 target had to be abandoned but the switchover goal remained. Australia did not wish to be left behind as other countries switched; moreover, financing the simulcast transmissions of the public services was expensive for the government. A new Digital Action Plan announced that from 2007 the broadcasters could use their HDTV channel for broadcasting new content and that from 2009 the commercial broadcasters would each be permitted to launch an additional standard definition channel. Content restrictions on the public service digital channels would be eased and new data-casting and mobile developments licensed. The aim was for new content to drive the set-top box market

and, coincidentally, HDTV was coming of age with the growing popularity of new large-size flat-screen TVs.

In 2007 the regulator was able to report digital terrestrial take-up of almost 30 percent, a sharp increase from the previous year. Switchover was rescheduled to begin in 2010–12.

Ownership changes in one of the major commercial broadcasters helped stimulate commercial business strategies based on an expectation of digital switchover. The new Labour government, elected at the end of 2007, has promised to establish a public–private partnership to build a fibre-to-the-home network reaching 98 percent of the population (Given, 2007). Once in office, it also committed to complete digital switchover by 2013, with a newly configured Department of Broadband, Communications and the Digital Economy leading the transition.

New Zealand: DVB and MPEG-4 HDTV

New Zealand belongs to the second generation of entrants to the field of digital terrestrial television. Initially digital technology was left to the market. New Zealand's Sky satellite service adopted it and, armed with key sports rights contracts, built up a very successful pay-TV business, penetrating over 40 percent of households. The Sky satellite service carried the main public service and commercial terrestrial channels as well, so subscriber households were no longer dependent on analogue terrestrial transmissions.

The government and the terrestrial broadcasters grew concerned that digital TV in New Zealand was becoming synonymous with Sky subscription TV and they investigated the possibility of launching a free-to-view digital television option. A cost-benefit analysis showed that, as in other countries, analogue terrestrial switch-off would bring spectrum efficiency benefits of sufficient value to warrant a public policy intervention, but that it did not make economic sense to launch free-to-view digital TV without an analogue switch-off strategy.

The government offered digital terrestrial spectrum, without charge until analogue switch-off, to the public service broadcaster TVNZ, to the commercial analogue terrestrial broadcaster Media Works, and to the transmission provider Kordia (which would offer carriage to other terrestrial broadcasters including Maori Television). The government also provided some public funding towards the digital terrestrial simulcast costs of national free-to-view channels and towards new public service digital programming by TVNZ. A Freeview consortium was formed, similar in many respects to the UK model, to bring together into a single marketing package a range of potential free-to-view digital services, including radio, and to liaise with the receiver industry.

Given the costs of full terrestrial coverage in thinly populated mountainous terrain, New Zealand decided on an initial target coverage figure for digital

terrestrial of 75 percent of the population, with the remainder of the population to be served by satellite. Freeview launched on digital satellite 2007 and its digital terrestrial launch launched in April 2008.

Because its entry into digital terrestrial is taking place so much later than in the early pioneering countries, New Zealand aims to use second-generation digital compression technology (MPEG-4) and therefore to broadcast in HDTV without too high a cost in spectrum. Freeview's digital terrestrial appeal is based on a mix of new services and HDTV. Its satellite proposition is restricted to standard definition. Different receivers are required for the two different platforms.

Analogue switch-off is a firm political goal but the timetable will only be set once digital take-up (free-to-view and pay TV figures combined) reaches 75 percent of households or in 2012, whichever occurs first.

Latin America: divergent approaches

In Latin America the existing pattern of analogue television is complex, with NTSC and different versions of PAL in different countries. The transition to digital television offers an opportunity to forge a more consistent regional approach, especially as terrestrial television is the most important means of delivery, and satellite and cable penetration are not as significant in this process as concentration and foreign ownership (Mastrini and Becerra, 2001; 2006). The major markets, in terms of size and influence, are Mexico, Argentina and Brazil – with TV receiver manufacturing an important industry in both Mexico and Brazil. Developments here are at a much earlier stage than in Australia or New Zealand. Latin America has not yet established, generally speaking, coherent strategies for analogue switch-off. The major regional issue is the selection of technical standards (CITEL, 2005; Cruz, 2006).

The Mexican broadcasters Televisa and Televisión Azteca began digital terrestrial trials in 1999 using the ATSC system, but only in 2004 did the Mexican government decide to adopt ATSC formally. Its decision was no surprise and should be seen in the context of NAFTA (North American Free Trade Agreement). The North American TV market, encompassing Canada, the United States and Mexico, with around 140 million TV households, represents an industrial opportunity. Mexico has now allocated digital terrestrial spectrum to the incumbent terrestrial broadcasters to simulcast their analogue channels; the government has approved a plan to extend coverage in six phases leading up to 2021, but no precise date for the switch-off of analogue transmissions or the return of the analogue frequencies has been established. Honduras and El Salvador have also chosen to adopt ATSC technology, so Mexico's strategy may set the pattern for much of central America.

While South America has its own regional trade agreement (Mercosur), decision-making has to date been by individual nations. Argentina started early

and decided initially to test and compare the different technical systems. In 1998, however, before any progress took place, President Menem decided that Argentina should align itself with the United States and adopt ATSC. Trial broadcasts began and Argentina hoped to keep ahead of Brazil. A change of government created doubts over the strategy and the socio-economic crisis of 2001 pushed the whole question of digital TV policy off the political agenda. By 2005, when political and business interest in the subject revived, a significant industry initiative had occurred: the telecommunications company Telefónica had decided to enter the television market and it threw its weight behind DVB (Hernández and Postolski, 2003). The consensus around ATSC evaporated and in 2006 the Kirchner government established a working group to evaluate DVB and ATSC. Nonetheless, by mid 2009 no official announcement had been made.

The Brazilian approach has been very different. Brazil's domestic receiver market is very large, with over 60 million TV households, and it was far from self-evident, either to the government or to the wider range of interested parties, that the country should simply adopt one of the established set of standards and pay the royalty costs entailed in using foreign intellectual property.

Initial investigations began in the 1990s and, from 1998 onwards, were overseen by the newly created regulator ANATEL. To the surprise of many, the outcome of 1999/2000 tests on ATSC, DVB and ISDB favoured the Japanese system, ISDB. This opened a broad debate about both technical and commercial factors, and about Brazil's role within the region, and it was clear that the complexity of the issues at stake meant that the decision would be beyond ANATEL's jurisdiction. The Cardoso government postponed any decision, but meanwhile dismissed a Chinese offer jointly to develop a fourth international standard.

President Lula's victory in the 2002 general election brought a major shift in strategy. After reconsidering the idea of international collaboration, and then ruling out China's offer for fear of being swallowed by its much larger market, Brazil formed an ambition to create a national Brazilian standard from scratch. The aim was to revitalize the Brazilian consumer electronics industry and to use a national digital communications strategy to address the significant inequalities in access to advanced information and communication services among Brazil's population (Galperin, 2007). So, in November 2003, the Sistema Brasileiro de Televisão Digital Terrestre (SBTVD) was conceived.

In the end, for a combination of technical, financial and political reasons, the Communications Minister Helio Costa, halted the development of a completely independent system and steered Brazil towards a hybrid system, based on Japan's ISDB but specially adapted for Brazilian requirements. In 2006 President Lula decreed that the Japanese ISDB-T system would be the basis for a 'new' Brazilian standard called SBT-D-T (*Sistema Brasileiro de Televisão Digital Terrestre*). It will use MPEG-4 compression and Brazilian middleware and will be adapted for Brazilian infrastructure. It has the capacity for low bit

rate video transmission to mobile devices, an important consideration for the broadcasters who wanted to be able to deliver mobile TV without relying on telecommunications companies.

In all this Japanese promises proved a decisive factor: exemption from some of the royalty payments, the possibility of building a new semiconductor factory in Brazil, and joint funding for the transition from the existing PAL-M TV standard to SBT-D made an attractive package.

The decree has been legally challenged, so there may be further instalments in the saga, but the current plan is to give incumbent terrestrial broadcasters the frequencies required for simulcasting their analogue services using this new hybrid standard and to allow a 10-year transition period before switching off analogue TV.

Conclusions

After this global survey, the conclusions are presented under four headings that aim to shed light on the emerging patterns of switchover across the globe and some common principles.

The selection of technical standards

While the switch to digital television has become a global phenomenon, there is no global set of standards. Instead a complex pattern based on regional blocs is emerging and national choices are influenced, among other factors, by:

- technical performance
- interoperability across platforms
- characteristics of the analogue TV system
- size of the domestic TV market and market advantage for domestic manufacturers
- source(s) of imported TV receivers
- source(s) of imported programmes
- intellectual property royalty costs
- mobile TV considerations.

While countries pondering their options might instinctively start by setting up some technical working group to compare technical performance, the decision is also political and commercial. The introduction of digital television must take into consideration the advantages and disadvantages in terms of the potential impact on existing broadcasters, transmission networks, receiver manufacturers and retailers; the new opportunities offered for R&D and for the consumer electronics sectors; the prospect of new investment and job generation; the

risks of undue technological dependence on external suppliers; and, in the case of developing countries, the danger of becoming a 'dumping ground' for legacy equipment which has become obsolescent in a more advanced economy.

The influence of international and regional forces

In appraising their choices, countries are also influenced not only by domestic dilemmas and disputes but also by international forces. Most newcomers have to take a decision for one of the three main digital TV standards and they become drawn into a global battle in the field of communications, with pressure from governments and transnational corporations with a stake in these systems. While the majority may be adopting DVB at present, the competition continues.

As Brazil's case illustrates, the larger, more developed and proactive countries have some capacity to support some self-development in digital television. Smaller and less developed countries have scarcely any room for manoeuvre in developing new local standards and, in any event, such a course is unlikely to be cost-effective as a long-term strategy. Cooperation is the only real path to fight dependence, but decision-making can be hampered by scarce public resources, lack of transparent decision-making processes and competing domestic interests.

In the case of those countries that are part of regional integration agreements, additional coordination issues emerge, against the backdrop of emerging international regional timetables for resolving cross-border issues among countries switching off analogue transmissions.

Switchover policy success factors

While the broad aim of switchover is common to all the countries surveyed above, different national circumstances, approaches and experiences are very significant. Key variables include:

- market size and maturity
- the balance between terrestrial, satellite and cable platforms
- the extent of multi-channel provision and the balance between advertising funding and subscription
- the availability of sufficient terrestrial spectrum to allow for an extended period of analogue/digital simulcasting
- the role of publicly funded television
- subsidy policy.

That said, common success factors can now be identified. It is striking that no country has yet decided to 'skip' digital terrestrial television completely, even

countries where terrestrial reception is of very minor importance, and that no country has embarked on digital terrestrial without also intending to cease analogue terrestrial transmission after a period. Learning points which can be drawn from the experience of the pioneers can be summarized as follows:

- To facilitate analogue switch-off, digital terrestrial spectrum needs to be allocated to existing terrestrial broadcasters (not necessarily exclusively).
- To facilitate analogue switch-off, consumers need to be offered a free-to-view option, with receivers available at affordable prices in the open market: in practice this tends to mean digital terrestrial and/or free-to-view satellite.
- Digital terrestrial pay TV is commercially risky where satellite and cable services are well established and strong – but hybrid systems, including both free-to-view and pay digital terrestrial services, can work (especially with pay-per-view premium content).
- Analogue switch-off dates which are set politically without regard to consumer take-up of digital TV or industry consensus tend to be postponed.
- Full switchover is generally much easier in countries where terrestrial reception is of limited importance and, at least in respect of their main TV set, only a minority of households is affected.
- In countries where terrestrial reception is dominant, high digital penetration achieved during the period of voluntary take-up is important as a pre-condition of switchover, since this reduces the number of households whose main TV set is likely to be analogue at the point where switching over becomes compulsory. Such take-up does not have to be exclusively digital terrestrial, but other platforms only contribute if they carry digital versions of the analogue terrestrial services to be withdrawn.
- Subsidy can play a role, especially in the closing stage of compulsory switchover, but any such policy needs to be carefully designed so as to avoid unfairly favouring terrestrial broadcasters and discriminating against other platforms.
- Close collaboration between the principal stakeholders – the government, regulators, broadcasters, transmission providers, receiver manufacturers and retailers, and consumer representatives – is essential.

The impact of timing

Generally speaking, countries which embark on switchover later can benefit from more mature technology and from the main learning points above. However, digital technology continues to develop. The HDTV market, initially weak at the turn of the century, is now growing in conjunction with the new flat-screen receiver technologies which are replacing the cathode ray tube, and the increasing popularity of large screen sizes. Improved compression technology – specifically, the use of MPEG-4 compression technology, is

reducing HD's requirement for large amounts of spectrum. Mobile television has been extensively piloted and launched into the market in the United States and several west European countries as well as Japan. On-demand services are developing rapidly, as the broadcasting and telecommunications technologies continue to converge.

The countries which start later will now increasingly include developing nations. Their motives for embarking on switchover are likely to be similar in some respects to those of the more advanced economies – spectrum efficiency, industrial policy and digital communication inclusion initiatives. While being in the vanguard of television technology may not be a political priority for many developing countries, they will find that, as the advanced economies of the world switch, analogue transmission and production equipment becomes less available for import. The implications of the United States' analogue switch-off in 2009 are already being digested in Caribbean countries.

In the most advanced economies, where domestic internet connectivity is now widespread, digital television transmission using broadband telecommunications technology has emerged as a fourth platform. Internet Protocol Television (IPTV) is able both to deliver the full range of broadcast channels and provide on-demand and interactive services. Wireless broadband may well be one of the main uses to which some countries put the spectrum which they save at analogue switch-off. Whether access to TV by broadband will ever become sufficiently universal as to render obsolete digital switchover strategies based on terrestrial transmitters is an open question. It seems unlikely at present, especially in less developed countries, but, as the spread of mobile telephony illustrates, step-changes in communications technology can sometimes alter the global picture surprisingly rapidly.

Notes

1. Commission Decision of 9 November 2005 on the State Aid which the Federal Republic of Germany has implemented for the introduction of digital terrestrial television (DVB-T) in Berlin-Brandenburg (2006/513/EC).

Commission Decision of 23 October 2007 on the State Aid C 34/2006 (ex N 29/2005, ex CP 13/2004), which the Federal Republic of Germany is planning to implement for the introduction of digital terrestrial television (DVB-T) in North Rhine-Westphalia.

2. Commission Decision of 24 January 2007 on State aid C 52/2005 (ex NN 88/2005, ex CP 101/2004) implemented by the Italian Republic for the subsidized purchase of digital decoders (2007/374/EC).

European Commission, State aid: Commission endorses subsidies for digital equipment in Italy, Brussels, 28 June 2007 (IP/07/960).

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