Throwing the Switch:
Challenges in the Conversion to Digital Broadcasting

A Report to the Center for International Media Assistance

By John Burgess

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CIMA Center for International Media Assistance

NED National Endowment for Democracy
Supporting freedom around the world

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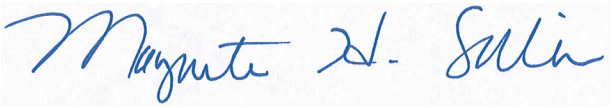
Preface

The Center for International Media Assistance at the National Endowment for Democracy is pleased to publish *Throwing the Switch: Challenges in the Conversion to Digital Broadcasting*.

The digital transmission technology that analog TV stations all over the world are adopting has the potential to bring new openness and diversity to the airwaves, because it allows the creation of multiple new channels. But the costly and highly politicized process of moving from analog to digital broadcasting poses dangers to the free flow of information and thus to democracy. Broadcasters that are financially weak or at odds with their governments could be pushed off the air in the relicensing process or otherwise disadvantaged, while large numbers of viewers might lose TV service due to the cost of digital receiver equipment. With the transition just beginning in many countries, media development organizations have time to work with regulators and broadcasters to head off such negative effects and ensure that digital technology makes good on its potential to create new and varied forms of on-air expression.

CIMA is grateful to John Burgess, a veteran journalist who has covered the transition to digital broadcasting for *The Washington Post*, for his research and insights on this topic.

We hope that this report will become an important reference for international media assistance efforts.



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Executive Summary

Broadcast television has begun the most important technological shift since its birth in the 1920s. The analog designs that from the start underlay "terrestrial" TV—over-the-air broadcasts from transmitter towers, the medium's traditional form—are giving way to the digital technology of computers. The shift has the potential to greatly expand the diversity of voices on the airwaves because digital stations, by making efficient use of the increasingly crowded airwaves, can broadcast multiple new channels. With broadcasting highly centralized in many countries today, notes Patricio Navia, a professor of global studies at New York University, "digital television might provide the opportunity to open the market to competition."[1] Digital technology can also send programming to the tiny screens of cellphones and bring interactive services to areas that have no Internet connections.

Yet in some countries, the new TV's advent poses danger to goals of media freedom, all the way down to a family's ability to get a picture on their set. The problem is not so much the technology itself as the costly and politicized process of switching to it. Before digital broadcasts can begin, governments must make complex decisions about reallocations of the airwaves and must relicense broadcasters. In these lengthy and sometimes hidden proceedings, small local stations could lose out in channel assignments to national networks that have more money and better political connections. Regulators unschooled in digital TV might craft frequency allocations that leave the technology's potential largely unmet. Authoritarian governments could use the relicensing process as a cover to put opposition broadcasters out of business. The high cost of digital transmitters and related equipment, meanwhile, could force some smaller stations to close down. And large numbers of people could lose TV service altogether if they cannot afford digital televisions or converter boxes for old sets, or if they live outside the sometimes smaller broadcast zones of digital stations.

The shift has the potential to greatly expand the diversity of voices on the airwaves ... Yet in some countries, the new TV's advent poses danger to goals of media freedom, all the way down to a family's ability to get a picture on their set.

In view of the rapid gains of the Internet, cable and satellite TV, and mobile communications in recent years, it is tempting to dismiss over-the-air TV as a dying medium unworthy of serious attention. Yet hundreds of millions of people worldwide, possibly billions, continue to rely on it as their window to the world. What they can see on TV varies vastly country to country. In some, it is officially approved programming aired by the monopoly state broadcasting system. In others, it is news that the government would prefer did not get out but is reported nonetheless by

independent stations. Some people turn to TV for guidance on such questions as which crops to plant and how to protect their children from disease. And almost everywhere, music, sports and entertainment shows are a big attraction. Broadcast TV viewing tends to be high in developing countries, where many people cannot afford satellite or cable or are not being offered them. But in some industrialized nations as well, France and Spain among them, over-the-air remains the dominant form of TV.[2] Terrestrial TV will remain a crucial form of mass media for many years to come.

Many viewers and broadcasters who have experienced the shift to digital resent it, feeling that big expense and botheration are being forced on them by far-away countries and companies that direct the world's TV technology. But there is little possibility of stopping it—broadcast television is undergoing the same digital makeover that has transformed virtually every other kind of consumer electronics. This particular shift is given added momentum by pressure to free up airwave space for cellphones and other mobile communications devices and to bring billions of dollars into government accounts by charging for that space. As analog TV inevitably passes into history, the challenge will be to preserve existing diversity in over-the-air service and to assure that the successor technology makes good on its potential to create new and varied forms of on-air expression. Managing the transition will be an important task for building democracy and pluralism.

Already there are early warning signs in some countries that things will not go smoothly. In South Africa, a private broadcaster's lawsuit has forced the government to rethink its ambitious plan to complete the transition in 2011. In Russia, complex decisions about digital channel assignments have been made without the hearing of public comment. Still, most countries of the world are just getting started and stand to learn from the experience of those that went first. "We're hoping that we can share the lessons of a developing country taking on this colossal process," said Karen Willenberg, a member of the Digital Dzonga Advisory Council, a private-public partnership that is helping in South Africa's transition program.[3] (Dzonga means "south" in South Africa's Xitsonga language.) By moving quickly and cooperatively, media aid organizations, broadcasters, regulators, and civil society groups still have time to head off potential negative impacts of digital conversion. The goal should be to assure that decisions on airwave space are made in a fair and open manner, free of political pressure, and that financially strained stations and households get help in making the switch.

Why Digital TV?

For more than a century, analog ruled. A product of the machine-age imagination, analog technology expresses information as variations ("analogous" variations) in physical media or radio waves. It was this approach that Thomas Edison used in building the world's first sound recorder, an 1877 device that captured his voice as minute changes in the grooves on a wax cylinder. Experimental TV sets of the 1920s received small ghostly images as fluttering in the strength of radio waves traveling through the air. Over the decades of analog's reign, engineers squeezed out higher and higher performance. Edison's cylinders evolved into vinyl long-playing albums (LPs) capable of breathtaking fidelity. Those pioneering TVs led to big-screen color sets with stereo sound. But ultimately, improving analog became a quest for better ways to do the wrong thing. The technology was saddled with performance ceilings enforced by the laws of physics and math. A turntable's stylus, for instance, had to rub up against the LP's grooves to generate sound, eventually wearing out stylus and record alike. A newscaster's image beaming in analog form from a TV station's tower took up a big portion of an increasingly limited resource, the airwaves.

Broadcast television was a latecomer to the digital revolution, in part due to unique technical challenges of sending video over the air by this means.

Digital technology expresses information as sequences of ones and zeroes, the two digits (hence "digital") of binary code, the lingua franca of computers and integrated circuits. Sounds are recorded by taking many samplings per second and expressing the resulting readings of pitch, timbre, volume and the like as strings of ones and zeroes. Pictures are broken down into grids of tiny pixels (picture elements), with a numeric reading for the brightness and hue of each. Why go to such trouble? The answer is that binary code, has virtually limitless potential. The microscopic transistors that form those devices' building blocks have just two physical states: open to the passage of electrical current or closed, which correspond to the ones and zeroes of the code. Once a piece of information has been converted into digital form, it can be stored, displayed and manipulated at virtually the speed of light, with no moving parts to slow things down or wear out. A digitized photo from a wedding reception can reside on a flash drive. It can be sorted, cropped, and purged of red-eye effect. It can be copied over and over with no loss of quality. A digitized rap song can be stored with hundreds of others in a tiny MP3 player, ready to play immediately to break the boredom of an evening commute. Digital technology also enables the near costless transmission of information. Fiber optic strands the diameter of human hairs simultaneously carry conversations, e-mail, and video across oceans as blips of light corresponding to digital ones and zeroes, maintaining

flawless sound and visual quality for many thousands of miles. When the medium is the airwaves, as with cellphones, a digital signal ties up only a fraction of the frequencies that a comparable analog one does.[4]

Broadcast television was a latecomer to the digital revolution, in part due to unique technical challenges of sending video over the air by this means. For a long time, in fact, many engineers doubted it would ever be practical. One issue was the need for good compression software. The ocean of ones and zeroes that make up just a few seconds of high-definition video stood to overwhelm even the big pipe of a digital broadcast. First the digits would have to be culled down to a manageable number, through such software tricks as signaling the receiving TV that the blue patch of sky over a pair of on-screen lovers is not changing frame to frame for the next few seconds and therefore will not be retransmitted with each frame—the TV can just continue displaying sky that it has already received. Another hold-up was signal echo. Any TV set has to sort out a confusing collection of signals. Some of the waves emitted by a broadcast tower travel directly to the set's antenna, while others carrying the same information take a detour zigzag route, bouncing off hillsides or office towers before arriving at the set a millisecond after the direct signal. In analog, the echo creates a ghosting effect on the screen, hardly a fatal flaw. But with digital, the echo delivers a redundant set of data right after the direct signal, and the TV set must conduct some very complex processing to sort out which data to use and which to ignore.

Eventually these and many other obstacles were overcome, hurried along by trade tensions between the United States and Japan.

In the early 1980s, Japanese companies developed an analog high-definition television (HDTV) system known as Hi-Vision and offered it up as the world standard for next-generation home entertainment. Broadcast from satellites, it would bring theater-quality video to big screens in living rooms around the globe, its developers promised. In official Washington, the letters HDTV were soon on everyone's lips. Already facing multi-billion-dollar trade deficits, legislators fumed that Japan was about to take over yet another field of consumer electronics. Word went out forcefully to U.S. electronics companies: Create an American HDTV. Take back the electronics market. Research accelerated. But before long, engineers concluded that the old analog ways were not up to the job for HDTV and that whatever came next should be digital.

In 1992, General Instrument Corporation staged the world's first demonstration of terrestrial digital TV, beaming a collection of patriotic HD clips from a suburb of Washington to a five-foot-wide video screen in the U.S. Capitol building. A coalition of U.S. companies came together as a "Grand Alliance" to develop the American standard. As work progressed, engineers took advantage of digital's inherent flexibility and efficiency to give broadcasters the option of using the spectrum of an old analog TV channel to offer a single HD program or up to six multiple standard-definition ones. Thus was the "multiplex" invented—a potpourri of channels and over-the-air services all carried by a slice of radio spectrum that in former days could accommodate just a single analog signal. Digital TV managed all of this even while needing less transmission power and creating less interference for other signals.

Case Study: Ukraine

In Ukraine, where does regulatory authority over digital TV lie? Some can be found at the government council that licenses broadcasters. Some is in the Ministry of Transport and Communications, while other shares are in the president's office, the prime minister's office, the Ministry of Defense and the parliament.

So it is no surprise that broadcasters and civil society groups are uncertain where to turn to make their voices heard as the country of roughly 46 million people moves slowly toward the new technology. That pace is slow in part because government agencies, as unsure as everyone else about who is in charge, are feuding for control of the vital new national project.

Experimental digital broadcasts have begun in Ukraine, where roughly half the citizenry depends on over-the-air TV. But the tests have failed to evolve into regular scheduled programming. Broadcast legislation that many industry people here feel is urgently needed remains unpassed. And there are few of the mass of implementing details in place that a country needs to proceed—on what terms would broadcasters switch, for example, and how would low income citizens be helped with buying set-top boxes necessary for TVs to receive and decode digital broadcasts.

Analysts here attribute much of the impasse to conflict between the communications ministry and the frequency licensor, the National Television and Radio Broadcasting Council. Each is said to want to control the government's budget for the transition. That assumes there will be a big government budget—but with the global recession taking its toll in Ukraine, no one can say where the money would come from.

Ukraine's government began contemplating the switch as long ago as 1997. Some NGO officials here complain that it consulted with neighboring capitals on frequency use long before it consulted with them. But now this former Soviet republic's vibrant collection of independent broadcasters are firmly engaged, though not entirely convinced that their views get real consideration in government offices. "We're afraid the coordination will be like a Soviet one," said Kateryna Myasnykova, head of the Independent Association of Broadcasters.[5]

In September came a new attempt to break the jam: the politically powerful National Security and Defense Council, which is chaired by the country's president, Victor Yuschenko, jumped in with a pledge to focus on this issue. Among other steps, it would create another digital TV body, a working group that would bring together members of disparate government agencies and try to blunt the internal fights.

At a conference on digital television later in September, senior security council official Stepan Gavish described the digital TV planning process in terms more commonly heard from NGOs: "It's not clear, it's not transparent." He also cited threats to "information security."[6] Some broadcasters say that his comments reflect] concern that if Ukraine lags, its airwaves might somehow be used against it by a newly digital Russia.

So, there is a new head of steam. But in January, Ukraine will conduct national elections that could bring in a new government—and yet another new way of looking at the digital transition.

In 1996, the U.S. Federal Communications Commission (FCC) adopted the American digital standard, based on the Grand Alliance system and standardization work of the Advanced Television Systems Committee. The standard is known as ATSC, the committee's initials. The commission set timetables for U.S. stations to convert.

After digital broadcasting passed the theoretical stage in the United States, electronics companies elsewhere in the industrial world got to work on competing, incompatible versions of the technology. They were following a long-established practice in the electronics industry, the fielding of rival technical standards for battle in world markets—Beta versus

VHS videocassettes, for example, and Blu Ray versus HD-DVD for high-definition video discs. Large financial rewards would go to patent holders and national economies if one of the systems eventually vanquished the others. A consortium of European companies came up with a digital TV standard called Digital Video Broadcasting (DVB). In Japan, the analog Hi-Vision system died a quick death and companies replaced it with a digital system that became known as Integrated Services Digital Broadcasting (ISDB). China, an ever-larger presence in the world electronics trade, was the last to the field with a homegrown version, Digital Terrestrial Multimedia Broadcast (DTMB).

Actual conversion began in 1998, when an elite group of stations in the United States and Europe switched on the new-style signals, while keeping their old analog ones on as well. The audience at first was just the local handful of early adapters who owned the very costly early digital receivers. But the switchover steadily gained momentum. In 2003, Berlin became the world's first major city to complete the job, with an early-morning shutoff of its analog signals. In 2006, Luxembourg became the first country.

China got its first digital signals on the air in time for the Beijing Olympics of 2008, and its state-owned broadcasting sector is moving forward with the biggest national conversion program in the world. Plans call for digital TV to operate initially in 37 cities and expand to 333 cities and 2,861 counties by 2012. Approximately 250 million of China's 400 million TV households depend on over-the-air signals.[7]

The United States, the country that set the great shift in motion, turned off its last full-power analog signals on June 12, 2009.

Adding momentum almost everywhere is a trend that those unhappy American lawmakers hardly foresaw in the 1980s—the explosion of wireless communications. Cellphones, wi-fi laptops, and other gadgets for staying in touch on the go were once expensive devices for the wealthy. Today they are mass-market items available worldwide, used by rich and poor in cities and in villages alike. But each of the devices requires a slice of the airwaves. Governments and electronics companies began hungrily eying the local analog TV signals—the sooner those spectrum hoggers were put out to pasture, the better. Their frequencies would be reassigned to new uses, notably in mobile communication. And they would not be given away but rather auctioned, creating a "digital dividend" for national treasuries. In March 2008, the U.S. FCC announced that winning bids in an auction to refashion TV channels for mobile communications use had rung up at more than $19 billion.[8]

TV transmitters, navigation beacons, baby monitors, wireless doorbells—in short, every kind of wireless communications device—make use of frequencies on the radio spectrum. This is the communications-

friendly portion of the electromagnetic spectrum, the array of energy that radiates throughout the universe at frequencies infinitely high and low (visible light, x-rays and gamma rays are other forms of this energy). Radio spectrum is materially valuable because nature provides each country of the world with a rigidly finite supply—precisely the same amount, in fact, a rare equality in the distribution of a natural resource.[9] Different ranges of frequencies, or bands, of the radio spectrum work better for different kinds of services. The U.S. Navy keeps in touch with distant submarines using low-frequency radio waves, because although they convey data at relatively slow rates, they can penetrate deep into sea water. Communications satellites, in contrast, employ high-frequency waves. Although these waves need an unobstructed, line-of-sight transmission path, they can easily carry data-intensive signals such as video and have no trouble passing through the upper atmosphere region known as the ionosphere, which tends to reflect back to earth lower frequency waves. TV employs frequencies that lie between these two ranges.

How the World Regulates TV Signals

Because radio waves do not respect national borders, consultation over frequency assignments emerged more than a century ago as an early form of global cooperation. In 1906, delegates from multiple countries met in Berlin to craft the first International Radiotelegraph Convention. Its purpose was to coordinate use of frequencies that were carrying coded messages through the air in new modes of ship-to-shore links and other types of signaling. (Radiotelegraphy was the first form of radio communication.) In subsequent decades, use of the radio waves mushroomed and so did the need for coordination. Today the job is overseen by the International Telecommunication Union (ITU), a United Nations agency based in Geneva, Switzerland. One hundred ninety-one countries and more than 700 companies and other bodies are members. The ITU has a full-time staff of roughly 735 engineers, lawyers, administrators, and other employees working not only on frequency questions but also on related issues such as technology standards for better interconnection, orbital slots for satellites, and improvement of communications infrastructure in the developing world. The really big decisions on frequency policy are made every few years (there is no fixed interval) when delegates from member countries sit down for a mammoth weeks-long gathering, a World Radiocommunication Conference. The next is scheduled to take place in Geneva in 2012. Typically these meetings focus on issues regarding existing communication services and ways to introduce new services; the reassigning of vacated analog TV channels to mobile communications was a big subject of discussion at the last conference, held in 2007. Decisions reached at the meetings become amendments to the Radio Regulations, the international treaty that governs use of the radio spectrum and the orbits of satellites.

ITU member countries (they make up the entire world, with the current exception of East Timor and Taiwan, according to the ITU) agree to abide by one of the organization's master documents, the frequency allocation table, which assigns specific services to specific bands, or sections, of the radio spectrum. Countries agree to work with neighboring countries to avoid interference with each other's signals.

It is a question of self-interest—if two TV stations facing each other across a border broadcast on the same frequency, neither station's signal will be watchable. Unlike the World Trade Organization, which tries trade disputes in court-like proceedings and issues rulings, the ITU has no formal enforcement powers. Rather, it relies on consensus-building and consultations.

Digital TV is now front and center for the ITU. In 2006, close to a thousand delegates from 104 countries in Europe, Africa, and the Middle East met in Geneva to craft a grand plan for the transition in their parts of the world. Sixteen countries were not present, but were represented by the ITU. During the course of five weeks, delegates proposed and counter-proposed complex plans by which thousands of digital stations in the 120 countries could go digital without creating havoc on the airwaves. Political horse-trading figured in the deliberations, but so did charts and numbers generated in countless engineering studies. On Friday, new versions of the plan

Case Study: Armenina

The government of the former Soviet republic Armenia has a long history of conflict with private broadcasters, notably the channel known as A1+, owned by a local company, Meltex Ltd. A1+ first went on the air in 1991 in the tumultuous times of the Soviet Union's dissolution and the independence of the constituent republics. Four years later, during an election campaign in which the station refused to broadcast certain government programming, its license was suspended. But in 1997, after a corporate reorganization, it won a new five-year license. With that permission expiring, an application for renewal was denied in 2002 when a council appointed by the president awarded the station's frequencies to another company. The winning bidder scored higher in a points-based evaluation, Armenian officials said. The following day, A1+ went off the air; six subsequent efforts to get a license were unsuccessful.

In 2004, A1+ took its case to the European Court of Human Rights, which enforces the European Convention on Human Rights, to which Armenia is a party. The suit alleged political motives in the denial of a license. In a June 2008 ruling, the court set aside some of the station's claims but ruled that the government had violated the convention's protections for freedom of expression under Article 10. The court levied a fine of 20,000 euros against the Armenian government and urged it to accept a relicensing application from A1+ .[10]

In September 2008, shortly before applications were due to be taken for a new round of licensing, the Armenian parliament passed a bill declaring that no more analog TV licenses would be issued pending digitalization of Armenian television in 2011. This has so far prevented A1+ from applying for that new license. Various other countries have suspended analog licensing as means of pushing broadcasters toward digital, but given the political environment, this move in Armenia seemed to media activists to add up to something different. In the view of Nouneh Sarkissian, managing director of the media development NGO Internews Armenia, the government is using the digital changeover as an excuse to prolong the station's absence from the airwaves.[11]

A1+ agrees. It has expressed support for the government's decision to move to digital and says it hopes to offer its own digital service. But a year after the licensing freeze, according to A1+ President Mesrop Movsesyan, the government has not put into place a viable transition plan. "Full digitalization is impossible in two years," he said. He predicted it will take 10 to 15 years. The licensing freeze, he said, is intended to put pressure on freedom of speech in Armenia and ignore the rights of his company.[12]

The Armenian government did not respond to a written request, submitted to its embassy in Washington, seeking comment and information for this study.

were submitted with their many studies for number crunching over the weekend. "It's a complex process with a lot of calculation time. We were using thousands of computers all over the world," said Pham Nhu Hai, head of the ITU's Broadcasting Services Division.[13] The results were presented to delegates for debate the following Monday.

What emerged at the end was a plan running many thousands of pages long and focusing on a precise deadline for shutting down the last analog transmissions, one minute after midnight Coordinated Universal Time (a time measurement system that is virtually the same as Greenwich Mean Time) on June 17, 2015. After that, analog broadcasts will have no right to protection from cross-border interference in most of the 120 countries—it will be the old technology's sunset moment.[14] Some African and Arab countries will get extensions to 2020, however.

That deal had no legal force outside Europe, Africa, and the Middle East, but it built momentum in countries elsewhere for a switch in 2015 as well. The 10 member states of the Association of Southeast Asian Nations (ASEAN), for instance, plan to finish the job by that year.[15] In the Americas and in East Asia, 2015 is also a year to watch as governments negotiate the same issues of the conversion's frequency coordination, not through a formal ITU convocation but through regional groupings and one-on-one talks. But no country is compelled under international law to make the shift. In the same way that an audiophile might remain loyal to a collection of old LPs, a country could choose to stick with analog TV. However, as with the LPs, inconvenience would mount. Analog transmission equipment and sets are going to become increasingly hard to find on world markets. The country's citizens would miss out on digital's potential boon of extra channels and new services, while its treasury would be denied the windfall income from auctions of vacated frequencies. Interference protection for analog would end. National pride might suffer as well—governments all over the world are telling their citizens that conversion is part of a resolute march into the future.

Though in many places people are upset about the cost and confusion, so far the ITU knows of no country that plans to stick with analog.

It all adds up to irresistible pressure to dump analog. Though in many places people are upset about the cost and confusion, so far the ITU knows of no country that plans to stick with analog. (In a world industry as complex as this one, there are always exceptions, however—the United States, for instance, is letting low-power TV stations, which have a very short range, continue to operate in analog.)

What it Takes to Go Digital

Going digital involves three complex sets of decisions, each typically taking years.

The first is to pick a digital technical standard. Each of the world's four candidate systems has different characteristics of cost and performance. The Japanese and Chinese systems, born after the American

and European ones, began life with some features of greater sophistication than the older ones had, notably the ability to broadcast to mobile telephones. In recent years, American engineers have been retrofitting mobile capabilities and other advanced features into the ATSC standard, which was developed at time when a high-definition picture was the overriding goal. The European technology has undergone a similar upgrading.

In the capitals of undecided countries around the world, sales pitches are underway. Station equipment makers dispatch executives to put on demonstrations of their systems, sometimes inviting the public in to see to ghosting-free pictures. Officials from those countries go abroad on fact-finding missions as well—the U.S. National Association of Broadcasters recently talked up the American system to a visiting delegation from the Dominican Republic, which is on the fence. "It's played out like gladiators in the coliseum," joked Lynn D. Claudy, the association's senior vice president of science and technology.[16]

Considerations that ultimately carry the day are often less about technical specifications than politics and socioeconomic ties, promises of domestic manufacturing of equipment, and the convenience of citizens living near national borders. Canada and Mexico have signed up for the United States' ATSC system, for instance. This will allow people in border communities to tune in to broadcasts from the neighboring country. The common standard also reflects the close economic ties between these three members of the North American Free Trade Agreement and the United States' industrial leadership of North America. American developers at one point had visions that their system would spread south to become more or less the uniform standard of the Western Hemisphere. But as of August 2009, it had been picked up south of Mexico only by Honduras and El Salvador. For a while, Argentina was officially in the U.S. camp, but then a new government reversed that decision. (South Korea is the only other country so far to decide to go with ATSC.)

South America has meanwhile shaped up to be a battleground between the Japanese and European systems. Brazil worked for a while to develop a fifth standard, believing this would benefit its high-tech sector, but then abandoned the goal as too ambitious and opted for Japan's ISDB, with some local customization. With the continent's largest economy having set its course, Argentina has gone for the Japanese system too, as has Peru. The Europeans have continued to press hard for their system, which in South America has won out so far in Colombia and Uruguay. In July, Benita Ferrero-Waldner, the European Union's commissioner for external relations, made a face-to-face appeal to Argentine President Cristina Fernández de Kirchner, adding a mention of potential European help with financing.[17] That plea was not successful, but worldwide, the European system is so far the most common, having been adopted not only in Western and Eastern Europe but also in a number of African countries, Iran, India, the ten members of ASEAN, Australia, and New Zealand.[18]

China, meanwhile, has made no serious effort to sell its system abroad, focusing instead on converting its own huge domestic broadcasting system.

In parallel with a country's system selection comes a job known as spectrum

design. Spectrum design involves a host of decisions: On which specific frequencies will the new digital broadcasts take place? How many licenses will be assigned to state-owned broadcasters, and how many to private? How many to free TV, how many to pay channels? How many will go to a single licensee to carry a uniform signal all over the country, and how many to broadcasters that serve just a single city or province? How many to mobile TV?[19] And what will happen to the frequencies that the analog stations surrender? Engineering studies and economic analysis enter the equation too—academics have for years engaged in near-theological debates over how to extract the best returns for society and government tax accounts from the airwaves. Whatever decisions ultimately emerge will have an impact felt for decades, directing the course of billions of dollars of investment and the habits of generations of TV viewers and wireless service users.

In any country, the spectrum allocation process becomes politically contentious, given the big stakes. Lobbyists are mobilized, editorials written, favors called in ... In an ideal environment, airwave regulators resist the pressure.

In any country, the spectrum allocation process becomes politically contentious, given the big stakes. Lobbyists are mobilized, editorials written, favors called in. The U.S. FCC was the focus of more than a decade of this pushing and pulling before it arrived at the U.S. spectrum allocation plan for digital TV.

In an ideal environment, airwave regulators resist the pressure. First they school themselves in the myriad potential benefits of digital TV. Then, after lengthy prior notice to all involved parties, they conduct a thoughtful, open evaluation of pros and cons of the many ways in which it might be introduced. Engineers carry out test broadcasts and other fieldwork to generate data that will help identify the best mix of services. The regulators fairly and objectively consider all options and refuse to favor one party over another. With skillful, thoughtful changes to their country's frequency allocation table, they bring a flowering of new broadcasting and information services to the country's airwaves.[20]

It rarely goes so smoothly, of course. In any society, large and well-financed enterprises tend to come out ahead of those of modest means. Officials from big national TV services may be a constant presence in the halls of the country's Ministry of Communications, pushing their masters' interests, while executives from small rural stations rarely make it to the capital. State-owned TV may successfully press that it should get more space on the airwaves than large profit-oriented private services.

Moreover, regulators may be hampered by lack of information and experience in this confusing new world. Digital TV technology does not hold still. It is constantly being fine-tuned, reworked, upgraded, re-priced, and rethought in labs in the industrial countries. Its evolving

Case Study: Venezuela

The digital TV transition has reached only its very early stages in Venezuela, but it has been politicized and secretive from the start.

In considering which technical standard to adopt, the strongly anti-American government of President Hugo Chávez appears to have given no consideration to the U.S. ATSC standard, though Venezuela's current analog stations employ U.S. technology systems. For some time, Venezuelan officials showed strong interest in the Chinese standard, though it had been adopted nowhere outside of China, but as of September 2009 appeared to be moving toward the Japanese system, which neighboring Brazil had previously picked.[21]

At present Venezuela has only one privately owned terrestrial broadcaster, the 24-hour news channel Globovisión, which is often vociferously critical of Chávez and in 2002 gave positive coverage to rebels who briefly overthrew him.[22]

Globovisión executives were invited to attend technical presentations about the Chinese and Japanese systems, according to station Executive Vice President Carlos Alberto Zuloaga, but the government made no effort afterward to seek their views on which standard to choose. News of government deliberations about digital TV comes mainly through occasional public statements by officials, he said.[23]

For now the digital switch is a minor concern for Globovisión, because it is struggling day by day to stay on the air in the face of a virtual siege by Chávez's government. Citing "media terrorism," government officials have publically threatened to revoke the station's license. Its reporters are frequently barred from government-sponsored events and jostled in public places by Chávez supporters.

In August 2009, the government closed more than 30 Venezuelan radio stations, alleging licensing irregularities.[24] Officials have contended that wealthy families have illegally operated stations for years to advance their own interests. Surrendered frequencies, Chávez has said, should be used to create "popular radio in the hands of the people."[25] The government's opponents call the closures an abuse of licensing to silence critics.

Globovisión executives say that the government has for years used licensing powers to restrict their own TV service's signal to about 40 percent of the Venezuelan population. When digital TV licensing eventually occurs, they predict, it will be misused in a similar way if Chávez is still in power. Globovisión might submit its digital application and find that officials simply sit on the paper. "The government is going to use that as an excuse to redesign the spectrum and discriminate—that's going to be a threat to us," said Zuloaga.[26]

Written questions about digitalization were submitted to the Venezuelan government through its embassy in Washington, but no answers were forthcoming.

impact on society, business, and human communication is equally hard to quantify. The ITU runs programs in developing countries designed to help build the expertise needed for such decisions.[27] The task may be especially challenging for regulators in developing countries. Whatever training they have received, they may find themselves captive to whatever the local broadcasters and equipment salespeople choose to tell them. They may make the wrong calls, out of lack of experience.

Concern about wrong-headed decisions exists in wealthy countries as well. In Australia earlier this year, news media

Case Study: Russia

Russia's digital switchover is scheduled to run until 2015, but already the government in Moscow has used it to reaffirm and expand the existing advantages of politically favored broadcasters.

In the 1990s, following the collapse of Soviet power, Russia had a lively and politically diverse lineup of national broadcasters. After Vladimir Putin took office as president in 2000, the government systematically reined in the national industry through state acquisitions and the striking of alliances with cooperative media owners. (Some diversity does endure in local broadcasting, however.) In recent years, a new national network has come into existence with speed and breadth that many media analysts believe can only reflect Kremlin connections. It is Petersburg Channel 5, based in Putin's home town. In November 2006, it won a tender for 29 frequencies, giving it reach into 75 cities.[28]

President Dmitry Medvedev has long played an important role in Russia's digital transition. In his former job as first deputy prime minister, he chaired a media oversight committee that brought together senior Russian broadcast officials to map the route to the new TV.

The Russian federal government estimates it will spend about $2.4 billion on the switchover. It justifies the expense by pointing out that today many of Russia's citizens receive only one or two free over-the-air channels. When the digital transition is complete, the government promises, virtually every Russian will have a minimum of eight free channels, a "social package" or "free package" that will be broadcast on a single digital multiplex. (Some remote parts of the country will continue to be covered only by satellite TV.) Government funds will cover the new infrastructure costs for those channels. The free package will bring about "the abolition of the inequity of our citizens in terms of information," Minister of Communications Igor Shchegolev told an interviewer in May.[29] Russian officials have talked of two more sets of eight free channels going on the air at some point to bring further programming variety to Russian homes. Those channels might specialize in such subjects as fishing, history, and "the art of living," Shchegolev said.

On June 24, 2009, President Medvedev signed a presidential decree formalizing places in the first package for a familiar group of state broadcasters and politically vetted private ones: Channel One, NTV, Rossiya, Vesti 24, Kultura, Sports, and Petersburg Channel 5. The eighth channel is to go to a new service under development for children and young people.[30] Later, the government announced that the same eight signals would also be available on new digital mobile broadcasts.[31]

There was no public tender or open discussion. "The channels (and their owners) were selected purely on principles of loyalty and kinship with the Kremlin and the head of government. This was clear to all the main operators and just a few people voiced some kind of mild complaint," wrote media researchers Anna Kachkaeva and Floriana Fossato.[32] Andrei Richter, a professor at Moscow State University of Journalism, called the government's selection method an "utmost violation" of Russian selection procedures and general democratic principles.[33]

But Yevgeniy Khorishko, spokesman for the Russian Embassy in Washington, said that because the government is paying for the transmission infrastructure, it has a right to decide whom to include. Already broadcasting nationally in analog, the selected broadcasters "have very important social functions," Khorishko said. "They inform the population about what's happening in the country, about the culture of the country, about the history of the country. These channels promote healthy attitudes, a healthy way of life." [34]

Broadcasters that do not get onto government-financed channels will have to pay the considerable capital costs themselves. Richter predicts that in some cities this will bring a decline in the number of free stations on the air. Currently, there are 18 in Moscow, he said. Those that must raise their own capital for digital equipment may opt to get the money by converting themselves into pay services.

reported that the government might give no digital airwave space to a class of stations specializing in locally produced content for particular social, ethnic, and interest groups. The Internet would carry the signals. That brought a quick and sharp public response from Laurie Patton, head of the stations' trade group, the Australian Community Television Alliance. He called it "ludicrous" and a "total misunderstanding" of community TV's role in the 21st century. Many of his stations' viewers did not even have computers, he pointed out. "The issue is about Community TV remaining a free-to-air medium accessible to everyone with a standard television," Patton later wrote.[35]

The third and final big decision that governments make in the transition is, who will be licensed to broadcast? Officials are supposed to evaluate applications fairly and without prejudice. Yet in many countries, licensing of all kinds is manifestly corrupt. Whether it is for permission to drive a taxi or beam TV to 10 million people, licenses generate income, and the people handing them out may expect to be paid for their trouble. And those who conduct the job with integrity may find themselves receiving phone calls at home suggesting that they really should look kindly upon an applicant company that everyone knows is controlled by the brother-in-law of some senior political figure. Whatever form the corruption takes, the result is licensing that misallocates a valuable resource and harms the public interest.

Even if money is not corrupting the licensing process, politics can. The world has many examples of licensing problems conveniently forcing opposition broadcasters off the air. Following a 2006 military coup in Thailand, for instance, the government that the generals installed took over the country's sole privately owned terrestrial TV service, ITV, citing disputes over how much news it should carry and unpaid concession fees and fines. This was widely seen as a move by the coup leaders to further break the power of the prime minister they had overthrown, Thaksin Shinawatra: ITV had been owned by a company controlled by Thaksin's family. ITV shut down, and its frequencies were transferred to the newly formed Thai Public Broadcasting Service, which continues to use them today.

With most every country of the world either conducting digital relicensing or planning it, the process could give governments cover for action against TV stations they do not like. Officials might say that Station A's application papers for a new license were incomplete or were filed an hour after the deadline. Or that Station B got a lower score than others in a points-based evaluation that under privacy rules must be kept confidential. Both applicants would vanish from the air when the country closed out the analog era. The government could deny that politics had anything to do with it.

The Cost

Elsewhere, the big challenge for broadcasters will be not politics but money, which is in particularly short supply during the global recession. Becoming a full-blown digital station able to broadcast on its own can mean acquiring a new transmitter (these can be added to existing towers if there is room), special cables that carry signals from studio to tower, associated equipment such as backup generators, and perhaps some new land. Stations also need complex computerized equipment that encodes programming into digital

format. And they must put their staffs through lengthy retraining to run it all. Britain's so far uncompleted conversion of more than 1,150 transmitters will cost an estimated 500 million pounds,[36] about $840 million at current exchange rates. The U.S. National Association of Broadcasters, meanwhile, estimates there was a $5 billion infrastructure price tag for the United States' roughly 1,750 full-power stations.[37] U.S. commercial stations paid their own way; public ones got grant help from the federally funded Corporation for Public Broadcasting and state governments.

Financial challenges of conversion can be particularly serious for special categories of stations that transmit deliberately weak signals. Many of these low-power stations exist to offer original programming just to very small areas of city or countryside on a nonprofit basis—they might be operated by a school or a local government. Others serve as "translators," enlarging the broadcast footprint of a full-power station some distance away. Not every country has low power broadcasting. Mexico and Canada have it, as do some countries of Africa, where it carries religious programming. The United States has a particularly large collection of low-power stations, approximately 2,800, and chose to let them continue in analog. This eased their financial strain. From a signal engineering point of view, the decision was eased because their signals do not carry far.

U.S. full-power stations, of course, got no such exemption. A handful responded by closing down. Most were already in trouble; the cost of digital was the last straw. One such casualty was station KBGH, operated by the College of Southern Idaho, a community college in Twin Falls, Idaho. The station's main mission had been broadcasting taped educational material, but in recent years, with educational services expanding quickly in the online world, airtime had been declining, down to just brief periods two or three days a week. The college had been exploring the cost of upgrading the station's equipment and hiring a staff to field a more comprehensive lineup of programming. The ultimate decision was to let the station go. "It certainly was not worth an investment to convert over to digital," said Doug Maughan, the college's public relations director.[38] KBGH broadcast its last material in December 2008, then went dark without ceremony. Its studios are now vacant, with the college thinking of remodeling the space.

Given the national count of roughly 1,750 full-power stations, the U.S. casualty rate is very low. But the impact in developing countries, where many stations have weak advertising bases and cannot tap government or investors for help with capital costs, might be much bigger. Any stations shutting down may disproportionately be ones that are small and privately owned, the very stations that tend to bring diversity and local coverage to broadcasting, whether it is in courageous reporting or ethnic music that the national networks do not carry.

Ways to Ease the Financial Pain

Some governments say they have found a way to ease broadcasters' financial pain: centralized distribution networks. In this model, a government-owned corporation or a private company operating on a government license builds and operates a national network of transmitters and rents capacity to broadcasters. A country might have several such networks. In some countries, this model has a long history in analog TV. From hilltop transmission centers, the Sentech company has for years blanketed South Africa with multiple stations' analog signals. With digital, this approach is spreading. The Slovenian company Telekom Slovenije recently signed to distribute digital signals in the Balkan country of Macedonia.[39]

Some governments say they have found a way to ease broadcasters' financial pain: centralized distribution networks.

Many experts argue that this structure makes sense for the unique characteristics of digital TV, and not only because it can save broadcasters from capital costs. With analog TV, one channel equaled one stream of programming. With digital, that one channel can support a multiplex of six or more subchannels. But a single broadcaster might not have that many content streams to offer up. So multiple broadcasters use a single multiplex for transmission. In another example of digital's inherent flexibility, an unused multiplex channel might be rented out à la carte for a few days at a time in order, say, to put the merrymaking at an annual temple festival onto local people's TV screens. In the multiplex model, a license grants a broadcaster rights to offer a particular programming lineup at a particular channel number, not to operate at a particular frequency. That license is given to the third-party company running the multiplex.

The multiplex, then, is essentially an over-the-air version of a cable TV system, which carries the content of other parties, whether they are terrestrial stations or companies offering cable-only shows. Cable TV has a long history of fights over who gets to occupy the finite number of channels that the cables can deliver and on what terms. Already, similar tussles are cropping up concerning multiplexes. In Romania, a government-appointed audiovisual council and broadcasters have been at odds over who should nominate the country's multiplex operator.[40] In Slovenia earlier this year, the country's sole multiplex dropped three commercial channels in a pricing dispute. The channels' owner, Central European Media Enterprises Ltd., says it likes digitalization and the multiplex system because they have allowed it to get its shows on the air in more of the region's countries. But the company felt that the prices that the Slovenian multiplex was demanding were too high. So it is sticking with still legal analog broadcasting in Slovenia and hoping that by the time those transmissions must be shut off, Slovenia will have a second multiplex that will bring competition and lower prices.[41]

The multiplex system also opens the door to another common fight in the communications industry, accusations of cross subsidies. Take the example of a telephone company that provides transmission capacity to a client that offers data services. If the phone company is also in that same data services business, friction can arise. The client may come to suspect that the phone company, which controls the wires, is finding secret ways to discriminate against the client—channeling hidden subsidies to its own data service division, perhaps. And, being a monopoly provider, the phone company may try to charge unfairly high prices.

Recognizing such possibilities in digital TV, many countries are establishing strict rules on rates and conditions concerning multiplexes to outlaw cross subsidies. In 2006, the Finnish Communications Regulatory Authority issued a 13-page single-spaced set of rules governing pricing and profits for the multiplex company Digita Oy. Pricing must be "cost-oriented and non-discriminatory," it said.[42] Rules for depreciation were laid out down to the level of how to treat the value of cooling units. Providing for competition by licensing more than one multiplex is another safeguard.

These may seem like the business disputes that arise in any industry. But broadcasting has a special place in the life of any society. If multiplex operators gain the upper hand in dealing with broadcasters, that could ultimately distort the selection of programming that makes its way across a country's airwaves. Media freedom and diversity are not just a matter of enabling hard-hitting political reporting and exposure of corruption. These goals also entail cultural programming that has special meaning for a country's minority ethnicity, or television coverage of a soccer match featuring the local team, not just the national one.

Centralization also figures in concerns of brute politics. In times of street unrest, beleaguered presidents have been known to order the immediate shutdown of broadcasters deemed to be putting out the wrong message. With analog stations, they have often employed a highly visible blunt instrument: police squads. In 2007, the government of Georgian President Mikheil Saakashvili created a public relations fiasco for itself by sending security personnel to seize the studios of the opposition broadcaster Imedi. As the officers pushed their way in, an anxious anchor stayed on the air, telling viewers of shouts in the control room and denouncing the takeover as the act of a dictatorship.[43] A phone call to the duty officer at a multiplex control center instructing that a station's signal be turned off might be faster and less visible, and might make tottering presidents more likely to opt for this extreme measure.

Digital broadcasting is more than just a replacement for analog. Its inherent flexibility opens the door to new kinds of operations.

Digital broadcasting is more than just a replacement for analog. Its inherent flexibility opens the door to new kinds of operations. Interactive services is

Case Study: Kenya

Kenyans first got television in 1962, when the state-owned Kenya Broadcasting Corporation (KBC) diversified beyond its roots in radio and began sending TV signals from a transmitter set up at a farm house about 15 miles northwest of the capital, Nairobi. Television remained an exclusive government service until 1989, when the first private broadcaster, Kenya Television Network (KTN), was licensed. Television ownership expanded, growing to 39 percent of all households in 2007. [44] As of the end of April that year, 23 TV broadcasters had been licensed for more than 110 channels.[45]

But private broadcasters and government have often had an uneasy relationship. In March 2006, hooded police raided the studios of KTN and an affiliated newspaper. Officials later said the officers were acting on allegations that journalists had been paid to fabricate articles that could harm national security. The officers confiscated tapes and computer hard drives and ordered that transmitters be turned off. The station went back on the air later that day. [46]

The country's private stations are now largely self-sufficient in transmission. Under digital TV that is going to change. Legislation passed last year establishes centralization as the model for the future: broadcasters will rent capacity on one or more national transmission networks. A government task force on digital TV listed more than a half dozen benefits that would accrue from this: lower transmission costs per broadcaster, more efficient spectrum management, lower setup costs for new broadcasters, reduced environmental impact, lower receiving equipment costs for consumers because they could use single aerials, uniform coverage area for signals and less signal interference.[47]

Kenya Broadcasting Corporation is shaping up to be the first and perhaps the sole distributor of digital signals in Kenya.[48] The cost of building a centralized system is huge, noted Mbugua Njoroge, KBC's corporate affairs manager. "The best way to go about it is through public service, because we can still ask the exchequer to give us money," he said.[49] To address potential claims of favoritism and cross subsidies, KBC's transmission network will operate as a subsidiary separate from the broadcaster. Government policy requires that transmission companies offer service on an equitable, non-discriminatory basis.

Kenyan law provides for privately owned transmission systems to be licensed, but it is uncertain whether such systems will be built. Private broadcasters in Kenya have traditionally been highly competitive with each other. And the global recession has made it harder to raise capital.

The plan has created serious concern among some Kenyan journalists. Centralization "is a big danger, because we could return to the old era, where broadcasting is controlled by one section, one authority," said Tervil Okoko, a former Kenyan print journalist who is now regional coordinator for media freedom, research, and advocacy for the Djibouti-based Eastern Africa Journalists Association. Government could use the system to influence content, politics, and the geographic reach of signals, he said. Shutting down a station through a multiplex would be "an easier way than sending the police to raid the studio." Officials, he explained, could "unplug the connection from the transmission mast, thereby plunging the broadcasting station into darkness."[50] Okoko acknowledged the potential benefits of centralization that the government cites. But he said that new legislation is needed to assure that the system is not abused.

Linus Gitahi, chief executive officer of Nation Media Group, owner of the Kenyan broadcaster Nation Television (NTV), said he has no concerns that centralized transmission would facilitate a politically motivated shutdown. In his view, the new system will give the government no power that it does not already have. Frequencies are licensed by the Communications Commission of Kenya, a government agency. "Sitting in their office, they can interfere, they can jam the signal if they wanted," he noted. In any case, he claimed, "Kenya has moved on" from times in which such things could happen. Concerning a private network, he said, "We are at the moment talking with the other broadcasters, and we are hoping we can pull together and do that." He noted that a foreign company had also shown interest in building such a network. [51]

Case Study: India

Some passengers on New Delhi buses can now do more than talk or text on their cellphones. They can watch TV. India's national TV system, the state-owned behemoth Doordarshan, is experimentally broadcasting 16 of its channels using the mobile capabilities of the European digital television standard, DVB. Officials say it is too soon to know how many people are watching—receiving the signals requires a DVB-capable phone—but for now the purpose is to test such things as signal propagation in New Delhi's busy urban environment.

With this service, digital TV is spurring some unusual innovation and risk-taking from a large and historically set-in-its-ways organization. TV was a government monopoly in India until liberalization in the 1990s. Today the country has a vibrant private TV sector, with companies foreign and domestic offering sports, news, Bollywood films—almost every imaginable kind of programming. But by law those channels are limited to cable and satellite. Over-the-air broadcasting remains the preserve of Doordarshan, which has a lineup of about 30 generally more sober-sided channels. Its signals reach almost the entire country, providing the only programming viewed in roughly 40 million of the country's TV-equipped households. An additional 80 million or so Indian TV households get service through cable or satellite. [52]

Doordarshan is also moving to convert its traditional broadcasting to digital. Its timetable calls for digital signals in all of India's big cities in 2010, in smaller cities in 2012-13, and for the job to be completed everywhere by 2017. Facing a need for huge sums of capital, it has opened its mind to some kinds of public-private partnership in terrestrial TV, but continues to resist the outright licensing of private broadcasters. Still, through such partnerships an important taboo of Indian television would be broken, courtesy of the digital transition. Potentially, more diversity could come to the Indian airwaves.

one. A person might use an Internet link or cellphone connection to signal a digital station that certain financial or entertainment information is desired. The data would then be sent over the air with encoding that would ensure its display on that person's TV screen alone. In the 1990s, as digital TV technology and regulations were being crafted, U.S. broadcasters expressed strong interest in offering these types of service. For the most part, that did not happen, as the Internet blossomed and interactivity found a home on computer, not television screens.

But with the traditional business of over-the-air TV being eroded by the plethora of electronic communications technologies that are available today, broadcasters will do well to look to offering something new, whether they are big state-run organizations or small privately owned regional channels. Even if they have a stable viewership, many will still need to find ways to work off the cost of buying expensive digital equipment. Broadcasters in some countries are trying to exploit the technology's interactivity features. But the new service that is drawing the most interest is mobile television, the beaming of programs to the tiny screens of cellphones and other handheld devices. That may not sound particularly hard, yet it requires a whole new set of data processing tricks. A cellphone that is screening a soap opera to a streetcar passenger must sort out a blizzard of signal echoes that change instant by instant as the vehicle rolls past buildings, trees, and bodies of water (their surfaces can reflect signals). The processing must be accomplished within the tiny physical confines of a handheld device. In comparison, a digital TV set in a home has a simple job. Some countries already have analog mobile TV, but there is

consensus that the digital kind offers better picture quality and longer battery life.

The Big Day Arrives

Eventually the deadline will come: analog must end. Countries have taken a mix of approaches on whether everyone should make the jump at once or do it in groups. Finland, for instance, pulled off the substantial engineering feat of ending all analog broadcasts on the same day—140 analog main transmitters and 600 relay stations. Other countries, such as the United Kingdom, have opted to shut down analog region by region, learning as they go. Still another approach is to end commercial analog but leave state broadcasters on the air for a while longer to give final instructions to viewers. The Digital Terrestrial Television Action Group (DigiTAG), a Geneva, Switzerland-based trade group that promotes Europe's DVB standard, advises against a winter switch in countries where that season is cold, in view of the extensive work required on outdoor equipment and towers. And a summer switch, it says, may mean that people are away on vacation at the time and return to find an unpleasant surprise.[53]

Many countries are forming public-private councils to oversee the switch—composed of government officials, broadcasters, equipment makers, and civil society groups.

Many countries are forming public-private councils to oversee the switch—composed of government officials, broadcasters, equipment makers, and civil society groups. Much of their work is aimed at making sure that citizens are prepared. The United States started about three years in advance, with broadcasters donating airtime for digital-is-coming messages and Web sites offering advice on how to obtain and install set-top boxes. Sweden ran an awareness program with pink as its theme color, including a pink bus that toured regions of the country where the switch was almost due. Banning the sale of analog sets in advance of the switchover is another tactic that can protect consumers and catch their attention.

But enough people opt to keep the old sets alive, with converter boxes and the new antennas that in some cases are necessary for the digital signals. Spending can be high enough to produce a measurable blip in the retail economy. A 2005 study estimated that consumers in Britain would make "involuntary" purchases of 572 million pounds worth of converter boxes, antennas, and other household equipment to stay on the air.[54] That is about $960 million at current exchange rates. "Typically changing the set-top boxes is much more expensive than doing the infrastructure changes," said Peter Siebert, executive director of the DVB Project, the European system's standards group.[55]

Around the world, governments have conceded that it is unfair to expect everyone to shoulder such expenses alone. The U.S. government underwrote a costly coupon program that took $40 off the retail price of converter boxes. Demand was so high that it ran low on funding toward the end.

In other countries, budgets constraints compounded by the world recession are also getting in the way. The poorer the country, the harder it generally is for the government to offer financial help, even if limited to low-income households.

Still, when analog finally ends, significant numbers of people are always caught unprepared. The Nielsen Company reported that when the United States ended analog signals, 2.5 million U.S. households, or about 2.2 percent of total TV households, were not prepared.[56] More than a month later, the figure was well down but still stood at about 1.3 percent of households.[57]

Councils overseeing the switch quickly learn that part of the reason is popular resentment. Many people question why the old-faithful TV set is being made obsolete, why they must learn a new set of technical skills. Anyone who has had the experience knows that some patience and savvy are required to set up and operate a set-top box. Where do the new cables plug in? The TV's remote or the converter box's remote—which to use? And a new antenna or a complicated readjustment of the old one may be needed to capture the new signal. Among the world's peoples, Americans are comparatively tech-acclimatized, living alongside laptops, Blackberries, ATMs, and electronic ID badges, and yet millions of them fumbled the transition. It is possible to imagine much larger dropout rates in countries where people are less familiar with electronics.

In some places, people will not be able to use converter boxes or new digital sets—they will be too far from the digital transmitters to get any picture at all.

In some places, people will not be able to use converter boxes or new digital sets—they will be too far from the digital transmitters to get any picture at all. This is due to one of the trademark characteristics of the new TV, the "digital cliff."

With analog TV, picture quality gradually fades the further the TV set is from the tower. In many parts of the world, people in outlying communities have grown accustomed to watching analog TV that is essentially snow and static, because there is nothing else. Digital TV, however, operates on the principal of all or nothing. A set is essentially meant to display a perfect picture or no picture at all. Reception is meant to be uniformly good up to a particular distance from the transmitter; then, in industry jargon, reception "falls off a cliff," with the picture freezing, pixelating or disappearing altogether. At this distance, the set cannot clearly receive enough of the data needed for the processing that creates the high-quality image and sound. So it gives up. (To be fair, it should be noted that perfect picture/no picture is paradigm, not necessarily reality. A TV equipped with a converter box and a good antenna and located close to a digital station may suffer picture freeze-up due to such things as signals bouncing off passing vehicles.)

What the digital cliff effect means is that people who used to make do watching a fuzzy analog picture from a faraway transmitter may get nothing when the

Case Study: South Africa

In 2008, the South African cabinet adopted a digital conversion timetable that was precise (three years exactly) and one of the shortest in the world. The country's first experimental digital signal went on the air on November 1, 2008. The last analog signal would end, the cabinet declared, on November 1, 2011. The approximately 7 million South African households that rely on terrestrial broadcasts would have a relatively painless switchover. A public education campaign would alert people to the change long in advance. Digital converter boxes would go on sale all over the country. Well-off people would pay the equivalent of about $90 (700 rand) for them, but roughly 5 million lower-income households would get a 70 percent discount through a government subsidy program.

Almost a year into this schedule, signs are mounting that the country faces either a postponement or a conversion with many homes and stations unready. Regulatory decisions concerning such questions as frequency allocations have been delayed. So far, no South African broadcaster has advanced beyond the experimental stage to air regular programming in digital. And a major private broadcaster, e.tv, has successfully challenged the timetable in court. In an August 2009 filing, an e.tv executive denounced the country's digital regulations for "procedural unfairness; a failure to consider relevant information; errors of law; irrationality; unreasonableness; and acting under unlawful dictation" and demanded that they be reviewed.[58] The Independent Communications Authority of South Africa, the key regulatory agency, later withdrew the regulations for reconsideration.

There is also concern about the timely availability of converter boxes. With subsidies likely to cost more than $300 million, the government wants that spending to advance a second social goal, economic development. So the boxes are to be built locally. And they will not be simple converter devices. They will contain enough intelligence and memory to handle interactive services that South African officials hope will follow at some point in the future. The design will also enable authorities to remotely shut off individual boxes that are believed to be stolen or traded on the black market. Companies have yet to manufacture a single box, as they assess the market and await final technical specifications and government cues as to how it plans to channel the subsidies.

The South African Public Service Commission, a government watchdog agency, warned in a 2009 report that even with subsidies, there will be social and political costs: "The fact remains that poor communities are going to be affected substantially by the migration and that they will still be expected to fork out money if they are to receive any television transmission after 2011. This whole process is fairly sophisticated but impacts directly on the poor. Unless government ensures that it is clearly communicated to the public in accessible language, it may result in some members of the public resisting the migration." [59]

To some people, South Africa's program is too hurried. "Everyone is being forced with the speed of light, because it's either you're part of the global digital migration or you are excluded," said Faiza Abrahams-Smith, director of the media NGO Media Institute of Southern Africa South Africa. "Sometimes we forget we are a third world country." She noted that analog-only TV sets were continuing to be sold in the country and that people buying them often had no idea that their proud new possessions were scheduled to become obsolete in 2011.[60]

In a speech in June 2009, South African Minister of Communications Siphiwe Nyanda acknowledged some of the apprehensions. "I am aware of the challenges of meeting some of the targets," he said, "due in part to the funding concerns and the economic downturn. I will, however, appeal to all role players to continue to work together … to realize the goal of this critical program." [61]

station goes digital, because they live beyond the cliff. TV stations of course want the biggest audience possible, so they put their engineers to work turning up the new transmitter's power or installing repeater towers to extend the digital signal to peripheral viewers in usable form. Digital TV technology can be a helpmate here, because its signals are inherently more efficient and interfere less than do analog signals. But things are never that simple. Population density, topography, and the number of other transmitters in the area all figure in the available options. "What you can do in Kansas is not the same as what you can do in San Francisco," the U.S. National Association of Broadcasters' Claudy said. Stronger signals, for instance, raise costs by consuming more electric power and may create interference for nearby stations.

In the end, a country's overall broadcast configuration is a complex set of compromises of transmitter power and location. Digital signals reach into some places where analog did not go and miss some areas where it did.

The U.S. experience is instructive. When the final switch took place on June 12, 2009, stories popped up in newspapers concerning people who had dutifully followed advice on making their sets digital-capable, but could not get a signal. Thelma DeVoogd, 76, of Applegate, Michigan was one such victim. "We've had television for 50 some years," she was quoted as telling a local paper, the *Times Herald*. "It wasn't always great, but there was something I could watch. Now, there's nothing."[62]

Elsewhere, digital brought in the old stations and more. That was the experience at the home of the author in Washington, D.C., where an aging TV and antenna hooked up to a new converter box in June received several stations that had been out of range before, as well as the new digital subchannels of stations it had received in analog. Measuring the scope of service losses and gains is a tricky and sometimes controversial task. Tweaks that engineers make to a station's transmitter may mean that the new signal reaches some neighborhoods that the analog signal did not, yet does not reach some neighborhoods that analog did. Apples-to-apples comparisons are further complicated because some stations moved their transmitters to new locations when going digital, while others were assigned new channels with frequencies that have different propagation abilities.

But studies by the Federal Communications Commission concluded that in the United States the new method of broadcasting has in most cases meant that stations reach more people. With digital, almost 1,320 stations achieved a net gain of 2 percent or more in the number of potential viewers, the commission estimates. The rest of the country's approximately 1,750 stations had a net gain of less than 2 percent of potential viewers, reached the same number, or had a net loss.[63]

The United States has some of the world's best engineers and a strong broadcasting infrastructure. Whatever its rate of signal loss, it seems reasonable to expect something bigger in countries that are not as technically advanced—or are vulnerable to political intervention to reduce the footprints of certain stations and expand those of others.

Recommendations

Broadcast television is different, then, in every country, so every country will need a different mix of remedies to assure that the digital transition does not undermine diversity, openness and access. What follows are recommendations that will not apply everywhere but hopefully will help form the basis for debate and ultimately policy decisions.

- Donors and media development implementers should work with broadcasters and broadcaster associations to help them understand the benefits and potential pitfalls of digital TV and mobilize well in advance to assure the public's interests are protected during the transition. Implementers should reach out to regulators to raise their awareness of digital's potential benefits and how to secure them.

- Broadcasters should recognize that their traditional business, one-way programming sent to fixed television sets, is in decline worldwide as satellite, cable TV, the Internet, and texting gain ground. Though entering an unfamiliar business is never easy, broadcasters should recognize that their financial futures may depend on offering some of the new services that digital technology enables.

Broadcast television is different in every country, so every country will need a different mix of remedies to assure that the digital transition does not undermine diversity, openness and access.

- Governments should be transparent in the lengthy proceedings that designate specific parts of the airwaves for different types of digital broadcasts and award licenses to specific broadcasters. Officials should engage in detailed consultations with broadcasters, civil society groups and individuals, following internationally accepted guidelines for openness.

- Governments should proceed on the assumption that all existing analog broadcasters will be licensed for digital signals. These broadcasters should not have to make the case from scratch for rights to be on the air. While preserving existing rights, governments should strive to use digital TV's additional channels to bring new voices to the airwaves.

- Countries that use centralized transmission networks for digital TV must put in place safeguards to assure that all broadcasters have fair and reasonably priced access and that the transmission networks are not misused for political purposes.

- Governments of countries that have low-power analog stations should consider exempting them from having to switch to digital. These stations often reach underserved

areas and would find paying for new equipment particularly difficult.

- Governments should provide for lengthy periods of simultaneous broadcasts in analog and digital to give viewers and broadcasters adequate time to adjust to the shift.

- Governments, broadcasters, and civil society groups should begin public education programs years in advance to ease disruption to viewers when the transition takes place.

- Broadcasters and governments should work to assure that digital signals carry at least as far as the old analog ones.

- In cases where viewers face significant financial burden in obtaining digital converter boxes, governments should consider subsidizing purchase of the boxes.

Glossary

Analog technology: A technology that expresses information as variations in physical media or electromagnetic waves. It is used in TV systems that are being phased out.

ATSC: The U.S. digital television standard, named after a group that helped develop it, the Advanced Television Systems Committee.

Band: A range of frequencies.

Datacasting: The provision of information services using a digital television signal.

Digital technology: A technology that expresses information as sequences of ones and zeroes. Used in the new TV systems.

DTMB: Digital Terrestrial Multimedia Broadcast, the Chinese digital television standard.

DTT: Digital terrestrial television. Sometimes rendered as DTTV.

DTV: Digital television.

DVB: Digital Video Broadcasting, the European digital television standard.

Electromagnetic spectrum: the full range of energy that radiates through the universe.

FAT: Frequency Allocation Table, a table showing the assignment of different types of services to specific bands on the radio spectrum.

Flash Cut: The simultaneous cut-off of an analog TV signal and start of a replacement digital signal.

ISDB: Integrated Services Digital Broadcasting, the Japanese digital television standard.

HDTV: High definition television. There is no official definition for this term, but it generally applies to TV systems that have significantly higher picture quality than conventional analog TV and have a wide screen. HDTV is often offered as a premium version of digital television, which can transmit standard definition programming as well.

Hi-Vision: a defunct analog HDTV system that Japanese companies developed in the 1980s.

ITU: International Telecommunication Union, the United Nations body that coordinates countries' use of radio frequencies and satellite orbits and works on technical standards and infrastructure development.

Multiplex: a collection of channels or services that are broadcast digitally on a block of spectrum that formerly would have accommodated just a single analog channel.

Multicasting: the broadcasting of multiple channels on a multiplex. Also known as multichanneling.

OTA: Over the air.

Radio spectrum: the portion of the electromagnetic spectrum that is used in communications.

Simulcasting: the simultaneous broadcast on different frequencies of identical programming in analog and digital form. This is typically done for several years during a transition period from analog to digital. When the analog signal is turned off, the transition is complete. In some parts of the world, the term "dual illumination" is used.

Subchannels: Multiple channels that are digitally broadcast in the spectrum space that in analog days accommodated just one channel.

Terrestrial Television: Television broadcast over the air from ground-based transmitters, as distinct from television delivered through cable or satellite dish.

UHF: Ultra High Frequency, one of the frequency bands used in television transmission. This band is located just above the VHF band.

VHF: Very High Frequency, one of the frequency bands used in television transmission. The band is located just below the UHF band.

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