The introduction of digital television, albeit with only modest pretensions to glitz, is bound to invigorate competition among manufacturers and broadcasters.

**Digital TV comes down to earth**

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Contributing Editor

FOR THE SECOND TIME in history, Britain is cast in the role of television pioneer. The first occasion was in 1936, when the British Broadcasting Corporation (BBC) started the first regular TV service in the world intended for home viewing: a 405-line, all-electronic system developed by Marconi-EMI. This winter the BBC and commercial TV companies in Britain will launch what looks to be the world's first terrestrial digital TV (DTTV) service intended for nationwide viewing.

Of course, European satellites have been transmitting digital programs for a couple of years, just as DirecTV has been doing in the United States. But the British services will be the first to use ground transmitters to send digital pictures and sound to an ordinary Yagi roof antenna of the type used for analog TV in Europe or even to indoor rabbit ears. Plenty of digital receivers should be in the shops, and pay TV services, both satellite and terrestrial, will be wooing hesitant viewers with special incentives.

Most other countries in Europe are also getting ready to launch DTTV services over the next year or so [see “A different picture in Europe,” p. 26]. Sweden and Finland were quick to release frequencies for digital service, while Germany lags a little, largely because the country is well...
served by cable TV. Countries in the former Eastern Bloc will be slower, too, because of cash constraints. In Italy, where all available channels have been occupied by wildcat transmitters, in a deregulatory free-for-all, the authorities are scrambling to find frequencies for DTV by the end of this year.

All European countries have agreed to adopt a common standard called DVB, after the industry-led Digital Video Broadcasting group, which is based largely on MPEG-2 (for Motion Pictures Experts Group) video compression [see "Chiariglione and the Birth of MPEG," IEEE Spectrum, September 1997, pp. 70–77]. At last, Europe will have a single TV standard instead of the medley of incompatible analog systems associated with Secam and PAL—the French and Anglo-German television systems respectively, used in all the various parts of Europe and the former Soviet bloc.

Timing the end of analog

European governments are already debating when the analog switchoff should occur—preferably as soon as possible, because the released frequencies can then be sold off, probably to mobile radio and cell phone services, at immense profit to the governments. The electronics industry wants the cut-off date to be firm, to encourage anyone buying a new TV set to choose digital rather than analog.

In Britain, as an added incentive to switch, broad-
casters will simulcast all their analog programs as digital services. It now seems likely that the British government will announce, before the end of 1998, that analog transmissions will end at the latest by 2010. By then, adapters that convert digital signals into analog feeds for use by old TV sets will be cheap enough to give away to the few old and poor viewers still clinging to analog receivers.

In the United States, preparations for digital terrestrial TV also are under way, but with a difference [see "DVB vs. Grand Alliance standards," p. 28]. The U.S. approach has taken off from a high-resolution platform based on computer screen standards, whereas Europe's DVB system picks up from the existing 625-line, 50-Hz analog TV standard used in both the PAL and Secam systems. High-definition television (HDTV) will be simulcast in European countries when and only when enough consumer demand materializes.

Further, the U.S. Federal Communications Commission (FCC) has allocated 6-MHz channels for digital HDTV, whereas European broadcasters have the luxury of 8 MHz—the current analog allocation needed to accommodate Europe's 625 lines. In terrestrial broadcasting, each 8-MHz channel can carry a data stream of about 24 Mb/s, using today's coding technology, that can be divided into 4-Mb/s streams for simultaneous programs—or perhaps twice as many in the future, aided by statistical multiplexing.

Europe's terrestrial services will benefit from use of channels in the existing UHF band that are taboo, or off limits to analog transmissions because of interference problems. Digital terrestrial TV needs less power than analog, and the noise-like signal gives greater leakway to shared channel use.

As yet, international agreement has not been reached on all the taboo channels. As a result, at least initially, probably no digital service in Europe will provide the near 100-percent cover currently available from analog terrestrial TV. Up to a quarter of all the homes in the United Kingdom, for example, may be unable to receive digital terrestrial signals because the necessary frequencies cannot be cleared without risking interference from French broadcasters. In fact, a move is afoot to make terrestrial signals also available by satellite, and the BBC has already leased satellite space for this end.

Even before the services begin, the technical quandaries associated with interference have generated anticipated legal and political problems. When buying programs, national broadcasters in Europe acquire the right to transmit in their own country alone, the spillover at their borders with neighboring states is slight and regarded as acceptable. But once the terrestrial broadcasters start using satellites, their programs become available in many countries. To avoid breaching copyright, therefore, the broadcaster must encrypt the signals and give access to only national viewers. In the United Kingdom, this is true even of the four regions known as Scotland, Northern Ireland, England, and Wales. English viewers must be prevented from watching Scottish football matches, for instance, because the Scottish broadcaster has exclusive rights.

Transmission-system trinity

The main DVB standards are for cable, satellite, and terrestrial broadcasting. All are based on MPEG-2 coding, the international digital compression standard set by the Moving Pictures Experts Group of the International Electrotechnical Commission and the International Organization for Standardization. The prime differences among the standards are in the way the compressed signal is packaged for transmission.

The DVB standard for satellite transmission is based on quadrature phase-shift keying modulation, whereas cable uses quadrature amplitude modulation. Both resemble the systems used for sending high-speed electronic mail over analog phone lines, in that the analog wave is switched through several levels to represent blocks of bits. At the same time, the wave is duplicated, and its replica transmitted out of phase with the original. The replica is independently switched in level or phase to increase the total number of bits conveyed. For digital terrestrial TV, the name given to the modulation is coded orthogonal frequency-division multiplex. The system was originally developed for transmitting digital radio in accordance with another European standard, Eureka 147. Here, the signal is spread over several thousand narrow channels, so each channel carries a low data rate. Unwanted reflections arrive in the wide gaps between the segments of direct signal code, so the receiver rejects them.

The BBC at first believed that 8000 subchannels would be needed to make digital terrestrial signals robust enough in cities and valleys. Electronics companies argued that 2000 channels would be enough and that the microchips needed for "8k" reception would be too complex and not be ready until the year 2000.

The DVB group finally compromised by leaving the choice up to individual countries. As so not to delay its service launch plans, the BBC has agreed to use a 2k system. Some other countries, such as Spain, seem likely to wait and use 8k.

This decision is far-reaching. Although 8k receivers will be able to receive 2k transmissions, 2k receivers will never be able to pick up 8k transmissions. The next generation of decoder chips will, for economy of production, very likely be of dual 2k/8k standard.

Economizing on data rates

The DVB standard definition format calls for the same 625 scanning lines, interlaced at the same 50 fields per second, as are used in the PAL and Secam analog systems across Europe. For HDTV, resolution is doubled to 1250 scanning lines, with an option for the progressive scan employed by all computer displays.

With error correction, 38 Mb/s can be delivered in each 8-MHz channel in cable and satellite transmission systems, versus 24 Mb/s in terrestrial systems [above]. T-Mobile, a modification of the terrestrial system, makes heavier use of error correction, so that the signal may be received in moving cars, trains, or buses. The user-data-rate is then reduced to 15 Mb/s. Recently, DVB-T Mobile was tested in Cologne, Germany, in trains and racing cars driving at up to 300 km/h.

For high-definition transmission, the DVB data rates are four times as demanding, since there are twice as many picture lines, each with twice as many pixels. Last December the DVB team demonstrated high-definition operation in Australia, laying to rest the question of whether its standard was adaptable to HDTV.

The DVB system is not backwardly compatible, however—that is, if high-definition transmissions are broadcast, they cannot be received on ordinary sets. The DVB group decided on this policy to economize on spectrum. It argued that broadcasting all channels in high definition with downwardly compatible coding would waste more spectrum than broadcasting them all in standard resolution with just a few being simulcast in high definition.
Competing audio standards

In most of Europe (but not Germany, Austria, or Italy), today's analog terrestrial TV relies on a digital stereo system called Nicam. For surround sound, a single channel of rear information is mixed, or "matrixed," with the stereo pair by phase-shifting the extra channel. In the home, a Dolby Pro Logic decoder recognizes the phase shifts and sends the sound to loudspeakers at the rear of the room. But the location of reproduced sounds is not as precise as in true stereo.

For a far more accurate effect, the Dolby Digital system, formerly called AC-3, records six discrete sound channels. The system was chosen by the U.S. Advanced Television Standards Committee (ATSC) for the Grand Alliance standard. Canada and South Korea followed suit, and Mexico and Taiwan are expected to do the same.

But Europe's DVB group chose the MPEG-2 sound system rejected by the ATSC. While the MPEG-2 sound can provide six channels of sound, and recent demonstrations suggest its fidelity is high, there are no multichannel MPEG decoders for consumers to buy, broadcasters have no plans to transmit multichannel sound, and first-generation digital TV receivers have no socket for connection to a multichannel decoder. So digital TV in Europe will launch with digital stereo, with matrixed Pro Logic sound being an option, but not the multichannel sound desired by hi-fi audio buffs.

A different picture in Europe

In the United States, as ground-based transmitters get ready to broadcast high-definition digital television, DTV has become synonymous with HDTV—implying a wide screen and resolution based on computer standards, not on the standard 525-line, 60-Hz interlaced analog system. In Europe, the situation is very different.

In the early 1990s, national governments and state broadcasters tried—but failed miserably—to coordinate the launch of a hybrid analog-digital HDTV system called HD-MAC. Since that unhappy experience, DTV has meant only a digital TV service with the same "standard" resolution as the 625-line, 50-Hz interlaced analog systems used throughout the continent. HD-DTV is just an option for the future.

There is also a basic difference in the way broadcasters earn their revenue. European countries have state territorial stations, which transmit from ground-based masts and are funded by compulsory license fees of around US $130 a year. These stations carry little or no advertising and are largely free from government influence.

There are also commercial stations, which broadcast from the same masts and carry advertising. All these stations are called free-to-air—that is to say, they are not encrypted.

Some countries in Europe, such as the Netherlands, have extensive cable TV networks, which re-broadcast the terrestrial channels and offer extra pay-TV programs for viewers who pay a monthly subscription. Some other countries, like the United Kingdom, have only recently started to lay cable.

Over the last 10 years, a series of satellites has been launched by a private company in Luxembourg, called Société Européenne des Satellites and popularly known as Astra. Commercial broadcasters use them for direct-to-home analog transmission of subscription pay-TV programs. (So far there have been only a few experiments with U.S.-style pay-per-view, where viewers make a phone call and pay by credit card to watch, say, a title fight, concert, or recent movie.)

Canal+ in France, and the Kirch and Bertelsmann media groups in Germany, are now transmitting digital pay TV from the latest Astra satellites, Rupert Murdoch's BSkyB (Sky) network, which offers the most extensive analog service, was due to launch a digital satellite service in June, but shortage of receivers has delayed marketing until late 1998.

"Broadcasters like to talk about better sound and pictures from digital TV," said Tony Spath, director of market development at Dolby Laboratories Inc., San Francisco. "But if the sound part is only two audio channels, they are giving people nothing better than they have at present."

"Broadcasters are now presented with a unique opportunity to make a real change," Spath continued. "These do not come often. Not preparing now for multichannel audio will lead to a blind alley. We've been here before in Europe, with MPEC-2 the original standard for DVD digital video disk) sound in Europe but no MPEG decoders available and scores of facilities round the world producing Dolby Digital programs."

There is even the risk that the results may be inferior to current Nicam stereo. The MPEC standard has two options: a data rate of 256 kb/s for "true stereo" and one of 192 kb/s for "joint stereo." Joint stereo exploits the fact that some of the sound in a pair of channels will be the same and therefore needs be recorded only once. In theory, that permits the bit-rate to be reduced from 256 kb/s to 192 kb/s without quality loss; but in practice, the surround effect can be spoiled. The phase shifts introduced by matrix encoding ride roughshod over the assumptions underlying a joint stereo encoder. BBC engineers have now tested and rejected the idea of using joint stereo, and will broadcast all digital TV sound in true stereo at 256 kb/s. But pay TV stations are under commercial pressure to transmit as many TV channels as possible, and they do this by using the lowest possible bit-rate for pictures and sound.

The good news for Europeans currently receiving satellite TV signals is that the sound from digital services will usually be better. Existing analog satellite transmissions in Europe rely on analog stereo, but the new digital services will provide high-quality digital stereo.

Gatekeeping

The DVB group also set a standard for encrypting or scrambling the MPEG-2 signal, to keep programs from being seen by those who have not paid to view them. But no standard was agreed on for a conditional access (pay-per-view) system, where a smart card logs the viewer's requests to view pay programs, and a modem and telephone line relay the log to the broadcaster's central billing station.

Unfortunately, therefore, one company could become a "gatekeeper" by establishing a 'de facto' standard for conditional access and then charging everyone else exorbitant rates for deploying compatible technology. The DVB group foresaw a similar risk of gatekeeping from the use of electronic program guides. This is the name given proprietary software chosen by the broadcaster and embedded during manufacture in receivers, which use broadcast codes to display a menu of all the programs available over the air. The software can be written to favor programs viewers want to promote, so that viewers can be unwittingly led to watch the broadcaster's programs.

With this in mind, the DVB group recommended what it terms a common interface, in practice a computer standard socket on the receiver. This socket lets it connect with whatever nonstandard electronics are needed for the conditional access system and the program guide chosen by the broadcaster.

The DVB group has in addition endorsed a system called simucrypt. A broadcaster can use this system to transmit codes enabling more than just one conditionally encrypted program to appear in a receiver's menu.
al access system to authorize decryption.

Still, broadcasters are not compelled to offer interoperability between rival services, and none has done so to date. The system common interface will come into its own if any one service falters and its subscribers are forced to migrate to another.

Competing digital services

Although the UK is leading Europe in introducing terrestrial DTV, Germany has had a satellite service providing digital television for two years. The German media conglomerate Kirch GmbH, Ioming, owns the DF-1 digital and cable satellite station. Launched in July 1996 with Formula One car racing, it offered viewers six alternative views of the action. The competing Premiere satellite and cable station already runs a successful analog service, and has rights to European soccer. The two services want to join forces with backing from Deutsche Telekom, the national telephone company. But European Community officials in Brussels fear the union creates too large a monopoly.

In France and Italy, Canal+ already runs a highly successful analog cable station. In fact, it is now the largest European pay-TV company, with services in Belgium, Spain, Poland, and Africa. Canal+ also transmits digitally by satellite in France, Spain, and Holland.

In Britain, where only one in 10 homes subscribes to a cable TV service, a straight fight is developing between digital satellite and digital terrestrial delivery. Setting a pattern likely to be followed throughout Europe, the British government licensed digital terrestrial transmission on six multiplexes—8 MHz channels into which the broadcaster can squeeze as many, or as few, programs as desired.

The fear is that broadcasters may try to cram video compression farther than the 4 Mb/s per program, recently privatized, currently regarded—perhaps optimistically—as a safe tradeoff between picture quality and program choice. Push it much further, and viewers may become aware of a loss of detail in the picture and an odd mosaic effect on moving objects. A grassy landscape can become a green wash and athletes disintegrate into a checker-board of multicolored squares, rather than the effect used to protect the identity of criminal suspects when interviewed on TV.

One multiplex was given by the Government to the BBC for its noncommercial (advertising-free) broadcasting, and another to the three existing analog commercial TV stations, ITV, Channel 4, and Channel 5. A new commercial station, called British Digital Broadcasting (BDB), and jointly owned by the Carlton and Granada media groups, has been set up to provide a digital terrestrial pay TV service. The remaining multiplexes are divided among regional broadcasters.

Media mogul Rupert Murdoch already runs a successful analog satellite service in the UK and Ireland. His BSkyB will introduce a digital service with over 100 channels before the end of the year. For this, BSkyB will use a conditional access system developed by another of Murdoch's companies, News Data Systems. BDB has chosen the Seca system, developed by French pay broadcaster Canal+.

Although both BDB and BSkyB use smart cards, they are incompatible, so that once a customer signs up with one and installs a set-top box, switching to the other broadcaster will require expensive new equipment. The two services will also use different program guides.

BSkyB is also committed to the launch of an interactive service using Internet links, which promises viewers the chance to bank, shop, and book tickets from their armchairs. The service will be run by British Interactive Broadcasting, a joint venture between
BSkyB, British Telecom, the Midland Bank, and the Japanese company Matsushita. Together they will spend £265 million (about $160 million) on subsidizing the manufacture of a million set-top decoders with built-in 28.8-kb/s modems. Record chain HMV, food chain Sainsbury, and the Midland Bank have said that they will help provide the services for viewers to interact with.

As BSkyB and BDB will be competing for pay viewers, there is little incentive for them to join forces and make it easy for viewers to switch from one service to the other. There is vague talk of so-called sidetar adapters, which viewers will supposedly be able to plug into their Common Interface sockets to use more than one proprietary system. But by mid-1998, not even a prototype has been demonstrated.

The manufacturers also promise what they term integrated TV sets, which will have all the necessary digital circuitry built in. But most viewers will initially use a set-top box that connects between the aerial and an ordinary set. Europe has a standard 21-pin connector developed in France and called a Scart socket. This allows easy connection of all video and TV equipment.

**DVB vs. Grand Alliance standards**

In September 1993, European manufacturers and broadcasters formed the voluntary Digital Video Broadcasting (DVB) group. Their object was to set standards for a TV system driven not by political whim but by commercial market need.

The DVB group was fiercely independent. Though headquartered in Geneva, it got no official funding. Indeed, its members quickly voted to reject a grant offered by the European Union in Brussels. The DVB group agreed on standards, which it then passed to the European Telecommunications Standards Institute (ETSI) for rubber-stamping.

Clearly, DVB differs politically as well as technically from the American Television Standards Committee’s (ATSC’s) Grand Alliance, which operated under the aegis of the U.S. Federal Communications Commission (FCC). The main technical differences between the standards formulated and adopted by the two groups may be summarized as follows:

- **DVB** is based on standard-resolution TV, 625-line, 50-Hz interlaced pictures, and relies on the Moving Pictures Experts Group’s (MPEG) 2 video compression and MPEG-2 digital sound—initially stereo only, but upgradeable to multichannel surround. The wide-screen variant has an aspect ratio of 16:9.

- **DVB** sets a common standard for encryption, but broadcasters are free to use a conditional access system of their own choice to control de-encryption in response to payment either by monthly subscription or on a per-use basis.

- In the optional high-definition mode, the number of lines is doubled, to 1250 interlaced, and the number of pixels per line is also doubled, so as to quadruple resolution and bit-rate requirements. DVB allows for no direct compatibility between high-definition and standard-resolution modes. High-definition pictures are to be simulcast alongside with standard pictures. Future receivers will convert interlaced transmissions into a 625, or 1250, progressive format.

- **ATSC** is based on computer display standards that call for pictures to be transmitted at a rate of 24, 30, or 60 Hz to match cinema projection standards (24 frames per second) and the 60-field/60-frame National Television Standards Committee (NTSC) analog TV system.

- ATSC resolution ranges from 1280 to 1920 pixels per scanning line, and scanning lines number from 720 to 1080. Provision is made for progressive scan display of 60 full-resolution pictures per second, instead of 60 interlaced fields. Like DVB, the ATSC standard hinges on MPEG-2 video coding. But it uses Dolby Digital AC-3 stereo and multichannel surround sound, rather than MPEG audio.

**Getting equipped at home**

Most TV sets used in Europe have screens with a width-to-height aspect ratio of 4:3. The DVB standard provides for 16:9 transmission, and the long-term aim is to broadcast all digital programs in this wide-screen format. But because only a few people will initially have wide-screen sets, some programs will be broadcast in the compromise format, 14:9, at least in the UK. Viewers with 16:9 sets will see black borders at the sides of the screen; others with 4:3 sets will see narrow black borders at the top and bottom. These letterbox borders are already seen on many of today’s TV broadcasts, and viewers in Europe are getting used to them.

Because of the geography and topology of Europe, many homes there are able to use UHF roof aerials to receive terrestrial analog TV. Those aerials will often be able to pick up the new digital terrestrial signals. But the same is not true for the five million or so homes that have 60-cm dish aerials to receive BSkyB’s analog satellite services.

BSkyB currently broadcasts these analog programs at frequencies around 11 GHz from four satellites stationed at 19 degrees east, which are owned by Astra, a private Luxembourg company. BSkyB’s new digital service will be broadcast at frequencies around 12 GHz, from a new satellite at 28 degrees east.

Because of launch delays, Astra hatched an extraordinary plan. Since it has spare satellites at 19 degrees east that cover frequencies in both the 11-GHz and 12-GHz bands, it is using this backup to launch the new digital satellite on time.

One of the dual-band satellites has been moved from 19 to 28 degrees east, by puffing gas from the thrusters routinely used to keep the satellite in exactly the right place at 19 degrees east. The transmitters on the moved satellite were then switched to work at BSkyB’s digital frequencies. At the same time, the transmitters on another of the dual-band satellites at 19 degrees east were switched to cover the frequencies lost with the departing satellite.

Few analog viewers noticed any break in their service from BSkyB’s analog programs from 19 degrees east, and the company was ready to start transmitting its digital service from 28 degrees east by the promised launch date in June. Nonetheless, the full service launch has been delayed until autumn because of a shortage of receivers and the daunting logistics of switching existing subscribers from analog to digital reception, and from one satellite to another.

All existing dish aerials are sighted on the Astra satellites at 19 degrees east, and to receive the new digital services, they must be re-sighted on 28 degrees east. Also many analog dishes do not have low-noise block (LNB) converters that can cover the higher digital frequencies. Most satellite viewers will therefore need new, or modified, aerials.

**What price set-top boxes?**

The real purchase price of a digital set-top box for satellite or terrestrial reception will start at around US $600. The DVB decoder has the complexity and memory capacity of a Pentium PC, and the manufacturer must pay at least two sets of patent royalties. British company Pace Micro Technology, Shipley, West Yorkshire, recently told shareholders that it has set aside more than $10 million to pay for patent royalty settlements on digital decoders it makes.

The DVB receiver is covered by two separate patent pools. One protects the MPEG video compression and
is managed by MPEG LA, in Denver, Colo. That company's lawyers studied over 8000 patent abstracts owned by over 100 companies and inventors and then selected 35 key U.S. documents connected with over 100 international filings. New patents are being added all the time as they are granted by patent offices around the world. After clearance from the U.S. Department of Justice for "non-discriminatory, reasonable licensing," the pool is now claiming a royalty of $4 on every decoder and 10 percent interest on back royalties.

The DVB group is now building its own pool of patents, which cover the modulation, channel coding, and other technology used to transmit MPEG images. The group's plan was to have the DVB pool ready by early this year. But the task has proved tougher than expected and will take much longer.

Viewers, however, will be protected from the real cost of their DVB decoders by a host of special offers and subsidies. The broadcasters know they can earn revenue only if viewers have receivers. So both BSkyB and BDB have done deals with the manufacturers so that people who sign up to a pay service for a year get a receiver for free. It is still unclear who will pay for replacing satellite dishes and for fitting the telephone sockets needed for the pay TV modem.

In Europe, especially Britain, many homes rent rather than buy their TV sets and videocassette recorders. One rental company is already offering a free digital set-top decoder to anyone who signs up to rent a new TV set for around $7.50 a week, with the promise of a free upgrade to an integrated wide-screen TV, with built-in decoder, after two years. But this kind of offer will usually be available only if the viewer subscribes to a pay-TV service for at least $15 a month.

**Europe's eyes on Britain**

It is not hard to see why the United Kingdom is seen as a test bed for digital TV. The country has a long history of high-quality TV programming with live terrestrial channels that can be viewed "free" in return for an annual license fee of around $150. Most TV sets are now equipped to receive teletext, a free service common to all European countries that displays news, weather forecasts, financial reports, and traffic information as computer-generated text on the TV screen.

When digital broadcasting begins, the BBC is to transmit several extra channels of news and entertainment free of charge. These free-to-air services will either be clear, with no encryption, or be encrypted, to prevent piracy to other countries. In the latter case, viewers will be able to view the material at nominal cost by purchasing smart cards to plug into their receivers.

Despite the abundance of free TV in Europe, there is a market there for pay TV. In France, Canal+ has ten million subscribers for its analog pay service. In Britain, over four million homes have been willing to install a satellite system and to spend around $50 a month to watch BSkyB's analog sports and movie channels.

But BSkyB now admits to a very high delinquency rate. Some 15 percent of subscribers to the analog pay service fail to pay after a few months and are denied further viewing electronically, by signals sent by the satellite to disable the receiver. BSkyB's hope is that the wider choice of sports and movies available from a digital service will rekindle interest in pay TV.

Terrestrial broadcaster BDB hopes that the chance to view pay TV without first erecting a satellite dish will attract a completely new raft of customers. The next 12 months should tell who is right. Broadcasters elsewhere in Europe will then be able to learn from their failure or success—and of course North American broadcasters, cable, and satellite transmitters also will be watching closely.

Meanwhile, the BBC remains in the happiest situation. It is paid by the public to broadcast, whether anyone watches or not.

To probe further

Rupert Murdoch's News Data Systems is located on the World Wide Web at www.ndsworld.com, while his BSkyB is at www.sky.co.uk.

Canal+ and Seca (Société Européenne de Contrôle d'Accès) are at 85-89 Quai André Citroën, 75711 Paris Cedex 15, France.

Information on the Moving Pictures Experts Group (MPEG) can be found on the Web at www.mpeg.org.

The Kirch Group's address is Robert-Burkle-Strasse 2, Ismaning, Germany 85737. Astra of Luxembourg maintains a Web site at www.astra.lu. The British Broadcasting Corporation (BBC) is at www.bbc.co.uk.

Information on digital terrestrial broadcasting and the DVB standard is available on the Web from the Digital Video Broadcasting Association at www.dvb.org; and also from the European Broadcasting Union at www.ebu.ch.

Details of the terrestrial digital TV (DTTV) licenses granted by the British Government through its Independent Television Commission are posted on the Web at www.itc.org.uk

The address of the Web site of the UK's Digital TV Group is www.dtg.org.uk.

As for the European legislation centers on the European Commission's Directive 95/47/EC, the transmission standards are defined by ISO/EC standard 13818 and the common scrambling algorithm (SCA) is defined by ETR 289. Contact the European Telecommunications Standards Institute, Route des Lucioles, F-06921 Sophia Antipolis Cedex, France.