General information on satellite technology

History of satellite technology

The satellite age began on October 4, 1957 when with Sputnik 1 the first artificial earth satellite was launched into an orbit around the Earth. Only 3 months later, Sputnik 1 burned out in Earth's atmosphere, but already in 1962 the first telecommunications and television transmission satellite was launched. In 1983, the first directly receivable TV satellite took up its operation over Europe. However, in Germany direct satellite reception became popular only from 1989 with ASTRA 1A. Today, approximately 40 satellites supply Europe with TV and radio programmes. Modern satellites weigh up to 5 metric tons and have enormous solar panels in order to be able to generate the electrical power for up to 36 transponders. New satellites broadcast with up to 150 Watts transmitting power per transponder. Beside the solar generators, all satellites also have batteries on board in order to be able to maintain operation also during eclipses (passage through Earth's shadow). The service life of a satellite is usually assumed to be approx. 12 years. After that time, the solar cells, batteries, and transmission amplifiers have reached „the end of their useful life". Furthermore, usually the fuel for the navigational jets is used up and the satellite cannot be held in its position. With the final remainder of fuel, the satellite is catapulted from its orbit in order to free up a place for its successor.

ASTRA

ASTRA I at 19.2° east is the most important satellite constellation for the German-speaking countries. Since the launch of ASTRA 1A in December 1988, meanwhile altogether 7 individual satellites have been grouped at this position directly adjacent to each other. Owner of all ASTRA satellites is the privately owned company SES from Luxembourg. In the beginning, all signals were transmitted to the satellites from the SES headquarters at Betzdorf / Luxembourg; nowadays many television companies maintain their own uplink stations. There, the signals transmitted to the satellite are converted to another frequency, amplified, and afterwards transmitted back to Earth. Since 1998, SES owns a second orbital position at 28.2° east, known as ASTRA II. Here, 4 satellites are grouped at present. From this position mainly programmes for the English-speaking market are broadcast.

EUTELSAT

EUTELSAT is a transnational organization that had already been founded in 1977. In June 1983, the first EUTELSAT I F1 satellite was launched into space. In the meantime the EUTELSAT organization operates numerous satellites at many different orbital positions. The most well-known position is 13° east where at present 5 satellites are co-positioned under the name of HOTBIRD.

Co-positioning

Nowadays, often several satellites are positioned in very close proximity adjacent to each other so that from the earth they appear like only one satellite. The satellites then operate under a common name such as ASTRA I or HOTBIRD and are distinguished by index numbers or letters. The co-positioned satellites are located together in a spatial cube with ideally only 40 km edge length. Naturally the satellites must not touch each other which would result in total destruction. Therefore the accurate position is constantly monitored and corrected by navigational jets.

Footprint or coverage area

A geostationary satellite „sees" from its position almost half of the Earth's surface; however, the available energy is not sufficient to be able to supply the whole surface area with receivable signals. Therefore on the basis of economic criteria only certain surface areas of Earth are covered - the area where a certain signal can be received is called the „footprint" or coverage area.
The footprints officially published by the satellite operator are often somewhat pessimistic; that's why with a good reception system it is often possible to be able to receive sufficient signal strength also at some distance outside of the footprint. In truth, especially at the edges the footprints are not at all as symmetrical as represented in the pictures, but rather „frayed". In the peripheral areas therefore, trial-and-error is the only reliable method.

Orbital position or satellite position

The satellites are positioned on a geostationary or geosynchronous orbit at a height of approx. 36,000 km precisely above the equator. At this particular height, they are always positioned over exactly the same point of the Earth's surface. The geographical degree of longitude of this position is thus the distinctive criterion between the satellites. ASTRA I at 19.2° east is thus positioned approximately over the city of Mbandaka / Congo. The degree specification alone, however, says nothing about the proper alignment of the antenna towards the satellite!

Transponder

Modern satellites have up to 36 transponders.
Either an analogue or up to 10 digital TV programmes can be transmitted on a single transponder. The transmitting power of a new, modern transponder is up to 150 W, but in the course of the years it decreases ever more. Older satellites have transponder powers of partially less than 50 W. In principle, ‚old" analogue transponders can also be re-used digitally, but usually then fewer programmes are transmitted than with newer transponders, and the coverage area is smaller.

Transmission method

Analogue technology

The analogue transmission method Had been the standard in the past. Germany is one of the few European countries that still uses this technology today - in parallel to the new digital technology. The main disadvantage of analogue technology is that only one TV programme and, as the case may be, 4 radio programmes per transponder can be transmitted at the same time.
At present, there are still almost 50 analogue transponders active on ASTRA I, but during the next few years they will most likely become appreciably fewer. The state-owned programme providers of Germany, however, still want to maintain analogue broadcasting until 2010. Analogue transponders on ASTRA I have a noticeably smaller reception range than digital transponders.

Digital technology

Already today and still much more in the future, digital transmission technology will play the most important role in satellite TV. The fundamental benefit for the programme providers is to be able to transmit several channels over a single transponder. Thereby the allocation is completely freely selectable. Instead of up to 10 TV programmes, also only radio programmes or any mix of TV and radio programmes can be transmitted. Also internet data or any other type of data services are feasible. Apart from flexibility, there are of course cost benefits involved for the broadcasting stations.

Transport stream

The totality of the digital data that are transmitted over a transponder is called the transport stream. It includes the individual TV and radio channels. The transport stream is what the receiver actually receives. The specifications of frequency, polarization, and symbol rate that you can often read always refer to a transport stream.

Bandwidth

With analogue transponders, the bandwidth was defined as approx. 27 MHz. Digital transponders can be operated with almost any bandwidth. Thus it has become possible to operate older, weaker transponders with lower bandwidth and nevertheless to achieve a still larger reception range. Furthermore, several mutually independent signals (transport streams) of low bandwidth can be transmitted on a single transponder - a technology which is gladly taken advantage of in particular by broadcasting transmission vans. As a general rule it can be said that signals with large bandwidth (MCPC - multiple channels per carrier) are rather appropriate for reception by the final customer while signals with low bandwidth (SCPC - single channel per carrier) usually serve for transfers, the so-called „feeds". On ASTRA there are almost exclusively MCPC signals to be found.

Symbol rate

A parameter that is important to be known for digital transponders because it must be entered correctly into the receiver for a successful programme search if specific channels are searched. The larger the symbol rate, the larger also the bandwidth and the more channels can be transmitted over a transponder. However, with digital technology there are very many possibilities of configuring the transport stream beyond the symbol rate. Some providers use this to squeeze very many channels into a single transponder which then results in low image quality, small reception range and significant errorproneness.

Range with digital reception

Strictly speaking, each individual transponder achieves a somewhat different reception range. Often this is intended in order, e.g., to serve only a certain regional area, but sometimes this occurs more or less coincidentally. Apart from the transmitting power, naturally the used satellite plays a role, but also the configuration of the transport stream and the bandwidth of the signal. Therefore it is quite normal that at the edges of the footprints some channels can still be received while others already cannot be received any more. Modern automatic systems naturally search exclusively digital and therefore still find the satellites also in areas in which only few programmes can be

received. Systems that are still set to analogue search of course waste many 100 kilometres of reception range. German digital programmes have special benefits as compared to analogue programmes in southern Italy, Greece, and northwest Africa, but also in the eastern regions of Europe.

Interferences with digital reception

Normally, in case of a bad signal the picture „disappears" almost suddenly. Interferences usually show up by a roughly screened picture or by a stationary, unchanging picture. In these cases usually the signal is too weak. However, there might also be errors on the side of

the transmitter or overload of the transport stream.

On HOTBIRD there are frequently typical examples of channels that are always noticeably disturbed despite a very strong signal.

Free line-of-sight to the satellite

This is the most important criterion of all in order to have good reception. Solid buildings in the signal path always prevent reception. In rare cases, trees can be permeable for the signal, but one should not rely on this under any circumstances.
With the choice of location, geography should be taken into consideration - the further north you are, the flatter the signal comes in. In the high north even topographic obstacles such as mountains can prevent reception of the satellite programmes due to Earth's curvature.

Antenna size

The larger the antenna, the larger will be the footprint (the reception range) of a certain transponder and the reserves in relation to bad weather conditions. Damaged (bent, dented) dishes reduce the reception range drastically. Particularly good LNBs can bring to bear their benefits only at the limits of the footprint. In the centre of the reception area, e.g. in Germany, the satellite operators already recommend a minimum size of the antenna in order to enjoy trouble-free reception also in bad weather.

Receiver

Analogue

Still in use in large numbers; a new purchase, however, is not recommended any more. Actually only useful at all for Germans since meanwhile almost all other countries transmit exclusively digitally.

Analogue ADR

In addition to the normal receiver, there is a digital radio part (ADR = ASTRA Digital Radio) integrated that, however, only works on ASTRA I. ADR is absolutely not compatible to the new digital standards.

Digital (DVB, FTA)

The digital television standard is often also called ,,DVB" (Digital Video Broadcast). Sometimes also the abbreviation FTA (Free to Air) is used in this context. FTA designates unencrypted, freely accessible programmes. These terms can therefore frequently be found on digital receivers. Apart from TV operation, digital receivers naturally are also able to receive DVB radio programmes. Sometimes digital satellite receivers are also called DVB-S receivers whereby the „S" stands for „satellite".

Digital CI

Most countries of Europe encrypt (encode) their digitally transmitted programmes. In order to be able to receive such programmes, either a provider-specific receiver or a so-called CI receiver is required. With the suitable decoding modules and the pertinent Smartcards, CI receivers offer the possibility of being able to receive programmes in most of the used encrypting technologies. External decoder boxes as they were still in use in the analogue era cannot be used any more with digital TV.

Common Interface (CI)

CI receivers possess 1 or 2 card slots that can accept decrypting modules. Depending upon country and pay TV providers, different modules may be required. A CI receiver is thus nothing more than the platform which permits the use of additional decrypting modules in the first place. Only with a CI receiver it is possible to receive several different pay TV packages.

CI modules

Sometimes also called CA modules (Conditional Access). These modules decrypt the programmes concerned together with a suitable Smartcard (subscription card). Some modules work with only one technology (e.g. Viaccess), others again are able to master several different technologies. The CI module must be inserted into the slot of the Common Interface. Usually, depending upon country/provider, different modules must be used. Information is available from the respective programme provider. For German pay TV, use of the so-called Alphacrypt module is recommended.

Smartcards
can be obtained in specialized shops or directly from the program providers. However, the acquisition of such a smartcard is usually subject to paying a fee as well as to certain national regulations (place of residence, nationality).

Satellite information
The offering of available digital TV and radio channels that are broadcast all over Europe is not only unbelievably extensive but also subject to constant changes. A printed channel list would certainly already have become outdated the very moment of its publication. While the „important" stations usually remain unchanged and receivable for a longer period of time, very frequently small broadcasting stations might emerge with partially interesting programs on one of the satellites - and often disappear again just as quickly. At the magazine kiosks, there are a number of different publications dealing with television reception over satellite. More current, however, is the internet most of the time. Here, under www.lyngsat.com and under www.satcodx.com/deu, you can read the current channel allocations of all directly receivable satellites. With these data then the channelsearch function of a receiver can be fed to gain access to new channels.

Terrestrial digital television (DVB-T)

and digital cable television (DVB-C)
Terrestrial (ground-based) digital television, too, should be completely digitized until 2010 at the latest. Nowadays, however, DVB-T is only usefully receivable in some test areas like Berlin and Hamburg. Naturally the expansion process constantly progresses, but it can already now be seen that a complete area covering will not be achieved. Also the desire to be able to receive the terrestrial digital signal with a „small rod antenna attached to the back of the receiver" can be technically implemented only in direct proximity of the transmitter. The greatest disadvantage, however, is the reception range - German DVB-T will naturally only be receivable in Germany. Foreign broadcasting corporations will certainly not be prepared to make horrendous investments just to broadcast thereby „foreign" programs.
Cable-bound digital television is actually already available in all German cable systems today, and thus also on some German camping grounds. However, no real benefit is recognizable here since the program offering does not nearly approach the wide variety of programs available via satellite. Naturally, the same range problem applies as with DVB-T since certainly no German programs to any considerable extent will be fed into foreign cable systems. As is the case with DVB-S, both for DVB-T and for DVB-C always a separate receiver is required, whereby all
3 variations yet again require different receivers. Regarding number of channels and reception range, due to their operating principle both systems cannot even remotely compare to digital satellite TV (DVB-S).