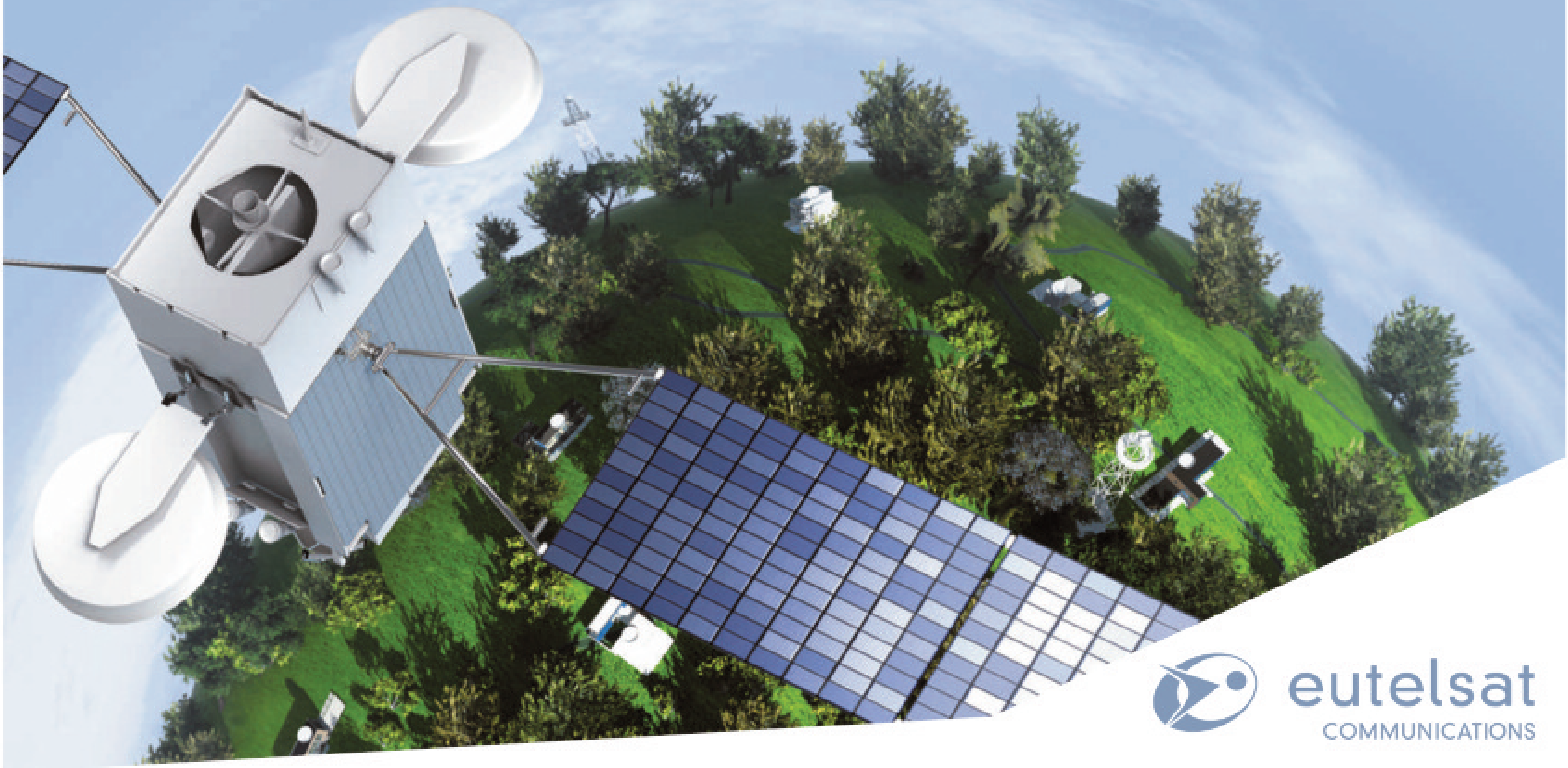
A **guide** to **communications satellites**



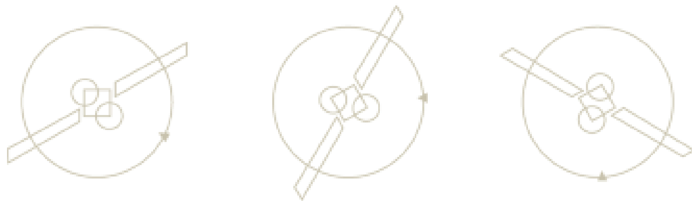
eutelsat
COMMUNICATIONS

SO **NEAR**, YET SO FAR

The once familiar on-screen message "brought to you by satellite" disappeared from our television screens over 25 years go. If it was still used today it would be on-screen virtually all the time as it is now so unusual for a programme or a news report not to have made at least one return trip to geostationary orbit.

Outside broadcasts are regularly sent by satellite to a TV studio and then by satellite again between broadcasters within the framework of international programme exchanges, and yet again for reaching TV viewers via Digital Terrestrial Television (DTT), cable or to Direct-to-Home satellite antennas.

On land, at sea and in the skies, satellites provide the link between people and embody the famous 'global village' concept created by Marshall McLuhan.



Viewers now take it for granted that images are delivered as quickly and easily from the other side of the world as they are from the next street. Yet, without satellites, it would be difficult to provide live broadcasts of most of the events of global interest constantly taking place around the planet.

Television wouldn't be the only sector affected by a world without communications satellites. Many may not be aware, but they are an essential component in virtually all key telecommunications networks, whether for voice telephony or high-speed Internet access. As the highest relay point yet invented by man, they are uniquely placed to distribute content to millions of users across entire continents, or to interconnect two specific sites – irrespective of distance – with no need to dig up roads to lay cable or to route signals through numerous switches.

> In today's digital society, geostationary communications satellites are more than ever synonymous with exchange, diversity and choice.
>
> Michel de Rosen
> CEO, Eutelsat Communications

Could the British writer Arthur C. Clarke, who in 1945 was the first to propose placing telecommunications relays in geostationary orbit, have imagined that just twenty years later his vision would have become reality?

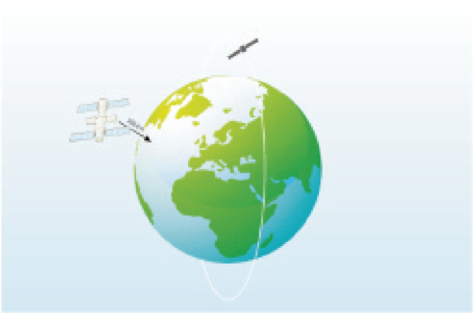
Did the designers of Early Bird, the first geostationary satellite, realise in 1965 that another twenty years later, satellites would enable television to be broadcast absolutely anywhere, regardless of frontiers? Who could have predicted the explosion of digital video and data services that began in the 1990s with the multiplication of channels and the emergence of the Internet? This digital network around the planet was largely woven in orbit, with satellites reinforcing undersea cables and linking isolated locations to the Internet backbone.

In this guide, we aim to bring you closer to this technology, which has become such a fundamental element of our everyday life, and to the workings of satellites, which discreetly carry out their mission 36,000 km above us, providing a rich variety of services without, most of the time, anyone even realising it.

Each to its **own orbit**

Satellites obey the physical laws of universal gravity. They move along elliptical trajectories – orbits – around the centre of the earth, and their speed depends on their altitude.

A satellite in orbit at 35,786 km above the earth's surface will go around the earth in one day. This is the same time it takes for the earth to make a complete revolution on its own axis. The satellite is therefore in geosynchronous orbit.



The International Space Station (ISS) is located in low orbit approximately 350 km above the earth. It takes about 90 minutes to complete a single rotation of the earth. Satellites in polar orbit pass above both poles of the planet on each revolution. Since they have a fixed orbital plane perpendicular to the planet's rotation, they will pass over a different longitude on each orbit.

The complete Galileo system will be made up of thirty satellites spread over three circular orbits 24,000 km above the earth.

If a satellite's orbit is perfectly circular and in the equatorial plane, the satellite is geostationary because it appears to be perfectly fixed in the sky to an observer on the ground. In fact it is moving at more than 3 km/s.

As fixed points in the sky for us, geostationary satellites are excellent telecommunications relays able to connect two points thousands of kilometres apart and to deliver data to fixed antennas.

How are **satellites anchored** in space?

Following launch, it takes on average three to four weeks for a satellite to reach the position in orbit from where its capacity will be commercialised.

Once placed by a rocket into geostationary transfer orbit the satellite's solar panels, which were folded at launch to fit into the rocket's faring, are partially deployed. This partial deployment is sufficient to supply energy to the electrical equipment as the satellite progresses towards its designated orbital position.

The satellite's trajectory is brought from a highly elliptical orbit to a circular orbit through a series of firings of an onboard apogee motor.

Once in geostationary orbit, the solar panels are fully opened, giving the satellite a span of approximately 40 metres (about the length of four buses). The on-board antennas are deployed and the satellite begins its drift to its allotted location in geostationary orbit for a series of tests, which are followed by its entry into commercial service.

The highest **microwave link**

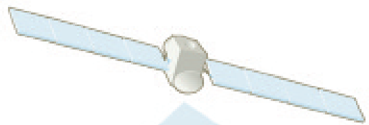
Since public television broadcasting first began in Europe in the 1930s, networks of broadcast transmitters have been built to deliver channels to homes in urban areas, flat plains, isolated valleys and distant islands. However, many communities in mountainous regions, near frontiers or with low population density still remained without coverage from terrestrial networks, thereby missing out on new services.

Until the 1970s the bulk of programme material from abroad was delivered to broadcasters on tapes, which meant there was virtually no live coverage of events of global interest. The potential to broadcast to vessels at sea was simply inexistent.

Geostationary satellites have completely transformed this environment by removing all barriers. In addition for making the global television experience possible, they form the backbone for a whole range of consumer and professional digital services.

The belt 36,000 km above the equator is roughly equivalent to three times the earth's diameter. A satellite located at this altitude is visible by almost half of the planet. Arthur C. Clarke, who in 1945 was first to propose the practical use of satellites in orbit, theorised that three satellites would be sufficient to cover the whole planet, with the exception of polar regions.

From its bird's-eye view, a satellite can reach any number of antennas within its coverage zone.



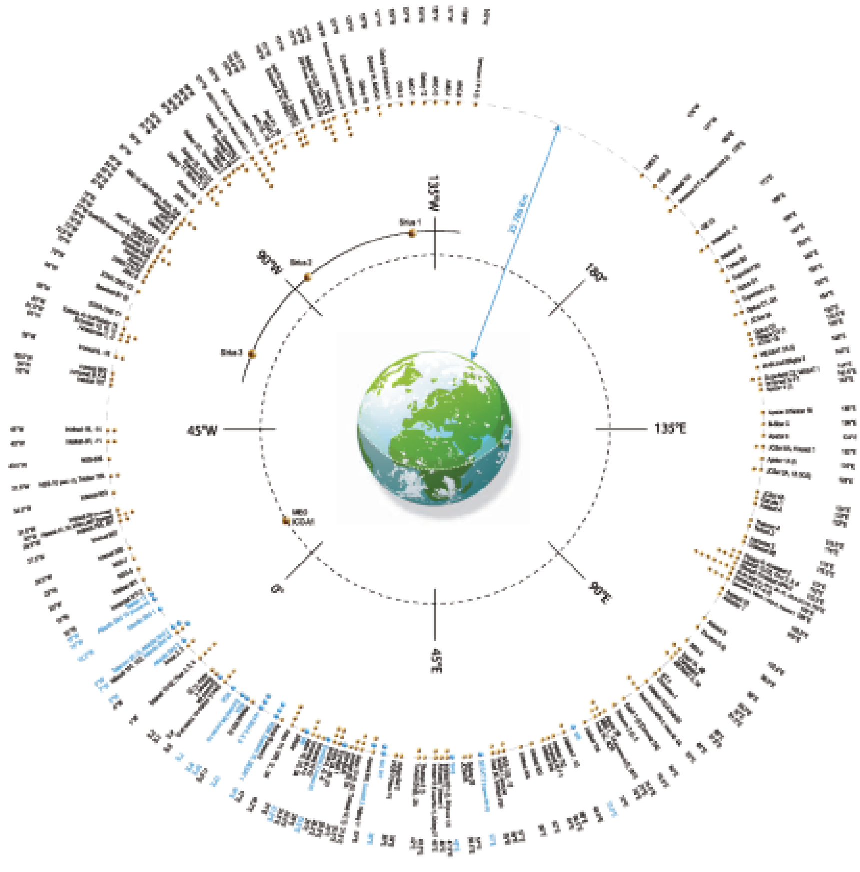
A satellite's power enables it to deliver hundreds of television and radio channels as well as data services to any number of antennas within its coverage zone. It can serve users directly or deliver programmes to Digital Terrestrial Television (DTT) transmitters, cable headends and mobile telephony networks. Coming down from space, the signals it transmits are indifferent to borders and can be received by antennas on the ground, on ships at sea and on aircraft in flight. For many expatriate communities around the world satellites are a unique link to a country of origin.

To each **their own frequency**

The geostationary orbit forms a 265,000 km belt around the earth along which satellites are placed at precise positions, with their antennas pointing towards the earth. There are approximately 350 commercial satellites in geostationary orbit, with some slots hosting multiple satellites.

In order to avoid signal interference, use of orbital positions and frequencies is controlled. Frequency coordination between operators is managed within the framework of regulations drawn up by the International Telecommunication Union, a United Nations agency based in Geneva.

In order to receive signals transmitted by a satellite, receivers on the ground are equipped with antennas whose size depends on a number of factors: the frequency band used, the strength of the incoming signal and the need to differentiate signals transmitted by other satellites in nearby slots using the same frequency bands for the same coverage zone. Signals are either transmitted by a satellite in the clear for reception by all antennas pointed towards it, or they are encrypted, with the rights owner of the content able to limit access to clients equipped with the relevant decoder.



Commercial satellites in geostationary orbit.
Source Boeing, 2010

Depending on how they will be used, on-board satellite antennas are designed to cover precise zones which can range from a single country to several continents.

Climate conditions in the area served will also condition the use of certain frequency bands. Lower frequencies offer better resistance in areas with heavy rainfall while higher frequencies enable use of smaller receive antennas on the ground.

UHF-Band	S-DAB-Band	L-Band	S-Band	C-Band	Ku-Band	Ka-Band
235 MHz to 400 MHz	1.452 GHz to 1.492 GHz	1.518 GHz to 1.675 GHz	1.97 GHz to 2.69 GHz	3.4 GHz to 7.025 GHz	10.7 GHz to 14.5 GHz	17.3 GHz to 30 GHz
Military mobile services	Television and radio broadcasting	Civilian mobile services	Television and radio broadcasting to mobiles	Television, radio and data Internet connection	Television, radio and data Internet connection	IP applications, radio and data Internet connection

Frequency bands and their principal applications.

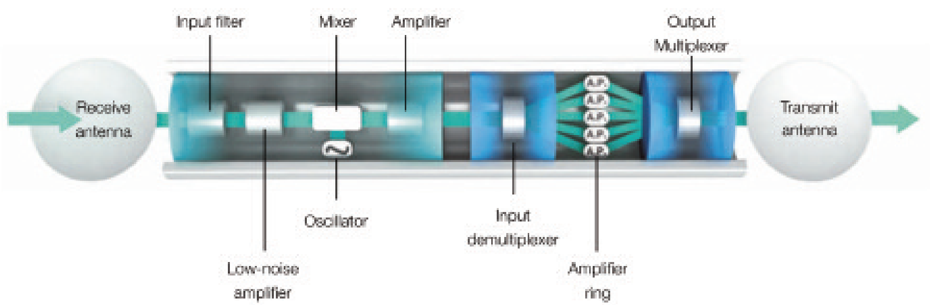
Anatomy **of a satellite**

The majority of today's communications satellites share a basic design which optimises manufacturing, the process of entering into orbit and each satellite's commercial mission. They are high technology devices designed to operate for 15 years or more in a hostile environment, in the vacuum of space, which is subject to radiation and extreme thermal conditions ranging from -150°C to +150°C.

A satellite is comprised of a central case accommodating most of the equipment, the propulsion system and associated tanks. This system enables trajectory correction in the event of disruption related to the attraction of the sun and moon and irregularities in the earth's gravitational field, thereby enabling the satellite to be kept on station. Propellant is the main component which determines how long a satellite can remain operational. Solar sensors are used to identify the position of the sun, which is the principal point of reference for satellite stationkeeping. Inertia wheels provide the necessary pointing stability. The propulsion system used to keep the satellite on station is made up of a dozen nozzles fed by tanks of liquid gas (combustible and combustive) located inside the central casing. Aluminium panels with a radiative surface are used to evacuate the heat generated by the electronics, while external thermal protectors insulate the ambient environment.

Solar panels provide the electrical energy and rechargeable batteries take over when the satellite passes into the earth's shadow at each equinox. Inside the satellite, the equipment dispersing the most energy (transponders, power, control…) is attached to the radiative surfaces which evacuate the heat externally while the other equipment is fixed to carbon panels.

A TYPICAL PAYLOAD



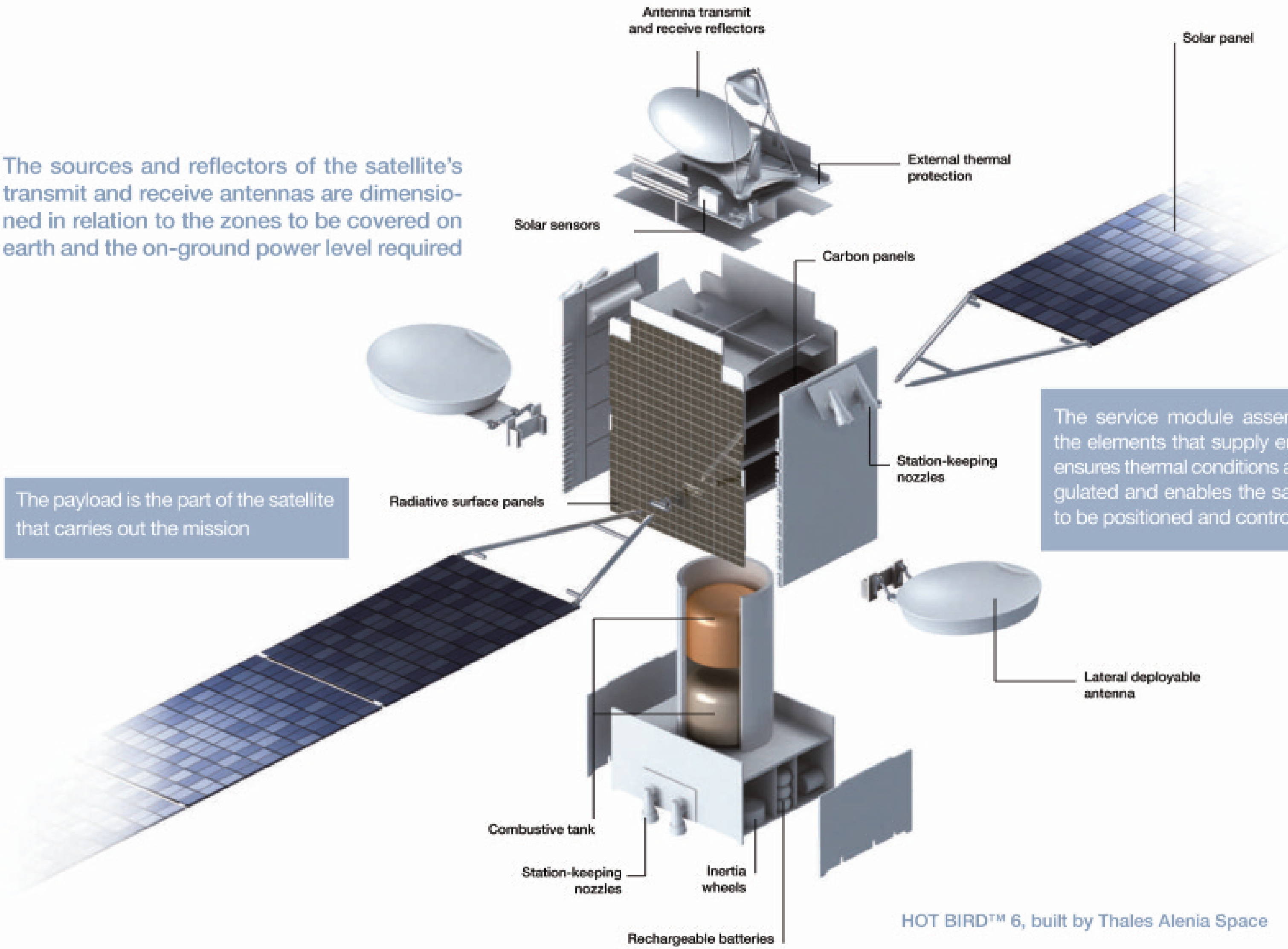
A TRANSPONDER IS THE UNIT OF CAPACITY

The payload of a communications satellite consists mainly of transponders which operate like magnifiers. They receive signals from earth and retransmit them back to earth after changing their frequency and / or polarisation and amplifying them. Transponders operate in entirely transparent mode to all technologies, which means that they relay analogue or digital signals of varying bit rates, compression and encryption formats.

The sources and reflectors of the satellite's transmit and receive antennas are dimensioned in relation to the zones to be covered on earth and the on-ground power level required

The payload is the part of the satellite that carries out the mission

The service module assembles the elements that supply energy, ensures thermal conditions are regulated and enables the satellite to be positioned and controlled.



HOT BIRD™ 6, built by Thales Alenia Space

From one generation **to another**

Technology has come a long way since 1965 when Early Bird, the first geostationary satellite, was launched weighing a mere 39 kg, carrying two 6 watt transponders and with a life expectancy of 18 months.

Modern satellites have massively benefited from the progress made in miniaturisation, and as a result are bigger, more powerful and can operate for over 15 years in orbit.

Thanks to the increased lift capability of launch vehicles, today's satellites weigh from 2 to 6 tonnes and can generate electric power of 6 to 12 kW. This increase in size and power has enabled an increase in the number of transponders and therefore expanded their commercial capacity. This progress has also led to a reduction in the diameter of receive antennas on the ground.

The way satellites are used has also evolved. By collocating several satellites at a single orbital position, each of which transmits at a coordinated set of frequencies, operators have created the equivalent of a single virtual satellite with the benefits of inter-satellite redundancy in the event of a technical disruption to service. Depending on their mission, today's satellites can carry over 60 transponders, each capable of transmitting up to ten digital television signals.

TECHNOLOGY PROGRESS FROM 1985 TO 2009

Year	Satellite	Number of transponders	Electrical power	Launch mass	Life expectancy
1985	EUTELSAT I	9	~1.0 kW	1.2 tonnes	7 years
1996	HOT BIRD™ 2	20	5.6 kW	2.9 tonnes	12 years
2001	ATLANTIC BIRD™ 2	26	6.5 kW	2.9 tonnes	15 years
2006	HOT BIRD™ 8	64	13 kW	4.9 tonnes	15 years
2009	W7	70	16 kW	5.6 tonnes	>15 years

Multi-beam High Throughput Satellites (HTS) enable reuse of frequencies, thereby significantly increasing bandwidth efficiency and cost-effectiveness for broadband applications.

Extensive frequency reuse by groups of spotbeams serving areas sufficiently far from one other to avoid interference can enable up to 900 Mbps of capacity to be provided by each spotbeam, shared between the forward and return link. Each user's access to the Internet is routed via an individual satellite terminal to a gateway which is connected by a fibre ring to the Internet.

While Ku-band frequencies and broad footprints are particularly adapted to the one-to-many feature of television broadcasting, a multiple spotbeam architecture, using Ka-band frequencies, represents the breakthrough for cost-efficient mass-market broadband connectivity.

KA-SAT multi-beam satellite, built by Astrium

Everything under **control**

It takes about two years to build a satellite. The last phase of the construction process comprises an intensive series of tests to check that it will be able to withstand the launch process (vibration tests) and that it will fully satisfy its mission (tests in vacuum, tests to ensure resistance to thermal conditions and radio-electric transmissions).

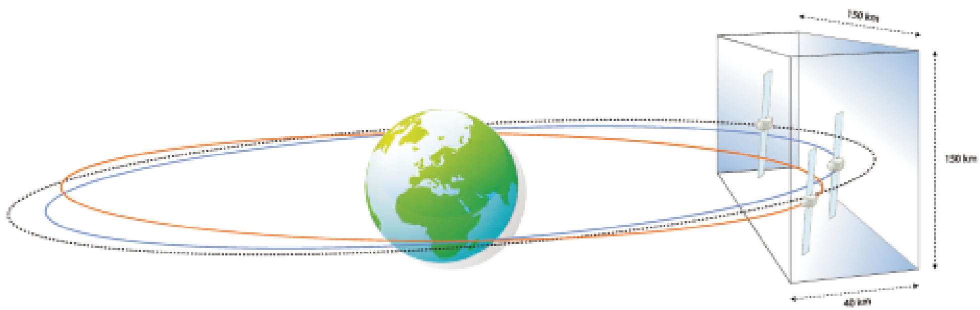
Once delivered into transfer orbit by the launch vehicle, the satellite transmits telemetry data back to earth which enables controllers to analyse and check the performance of each of its systems on-board. Defaulting systems can be replaced by means of on-board redundancy.

Control of a satellite within the orbital window it has been allocated and also of its antennas which are pointed towards the earth, are also permanently monitored. Ground controllers carry out routine manoeuvres every two weeks to correct any drifting off course by activating the satellite's propulsion system. One or more inertia wheels inside the satellite provide stabilisation through a spinning effect.

A Communications Satellite Control Centre monitors proper use of the satellite. This includes coordinating the power and frequencies of uplinking antennas so that there is no interference to other users. Engineers also monitor the quality of the signals transmitted by the satellite back to earth.

COLOCATED SATELLITES

In the case of colocated satellites, such as the HOT BIRD™ satellites at 13 degrees East, Eutelsat Satellite Control Centre permanently monitors the slight eccentricity and inclination of the trajectory of each satellite in relation to the others so that two satellites can never be at the same time in the same part of the box they share.



Artist's impression of amplified trajectories

Orbital window

The orbital position of a geostationary satellite is expressed in degrees longitude, East or West of the Greenwich Meridian.

The position of Eutelsat's HOT BIRD™ neighbourhood of satellites corresponds to the vertical line to the equator at an angle of 13 degrees to the East of the Greenwich Meridian. This information enables users to point their antennas towards the satellite broadcasting the signals they want to receive.

Artist's impression of Eutelsat's fleet (July 2011)

A window on the world, **in real time**

Over 15 years since the launch of digital broadcasting, which triggered a multi-channel broadcasting environment for millions of viewers, today's satellites are already broadcasting High-Definition television channels and trailblazing transmissions to cinemas and public viewing sites of spectacular stereoscopic 3D content.

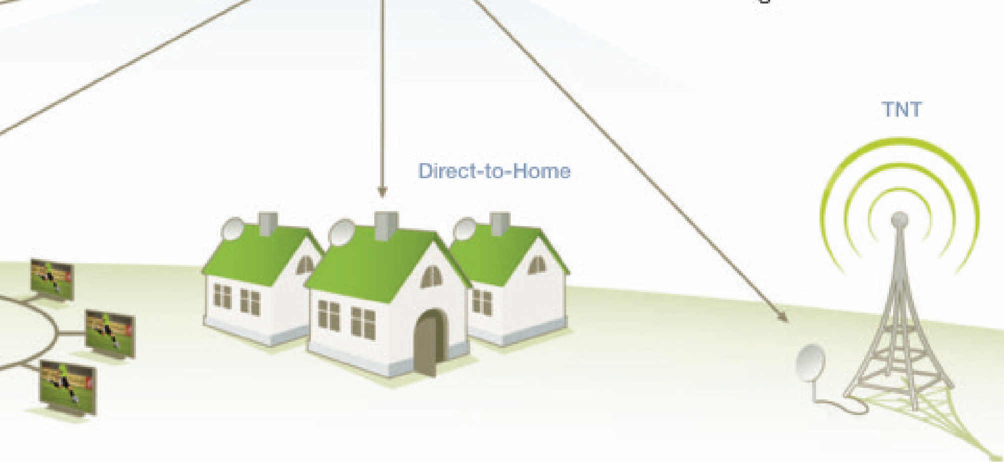
In 1962, Telstar 1 was launched, the first satellite able to amplify the signals it received. It was a non geostationary satellite and provided transatlantic links for about 100 minutes per day. Telstar 1 ushered in the era of satellite transmissions, the first applications being interconnection of telephony networks between five continents and the first live

broadcasts of events of global interest, beginning with the Tokyo Olympics of 1964.

Four decades later, video accounts for more than half of the utilisation of capacity supplied by commercial communications satellites. Applications range from delivering live signals back to television studios, programme exchanges between broadcasters from around the world, direct broadcasting to satellite homes and cable and DTT (Digital Terrestrial Television) network headends.

By virtue of the universal coverage they offer, satellites play a key role in disseminating information, broadening channel choice for consumers and uniting dispersed expatriate communities. They also provide an invaluable complement to DTT (Digital Terrestrial Television), cable, fibre and ADSL networks by enabling homes beyond range of terrestrial transmitters and headends to receive digital content through Direct-to-Home satellite reception.

Broadcasting to Direct-to-Home antennas and terrestrial headends (DTT, cable, ADSL ...)



DID YOU KNOW?

> More than 210 million homes homes in Europe, North Africa and the Middle East receive television by satellite, either directly or through a terrestrial network. Almost 130 million homes are equipped for Direct-to-Home or community satellite reception and almost 90 million homes are connected to a cable network.

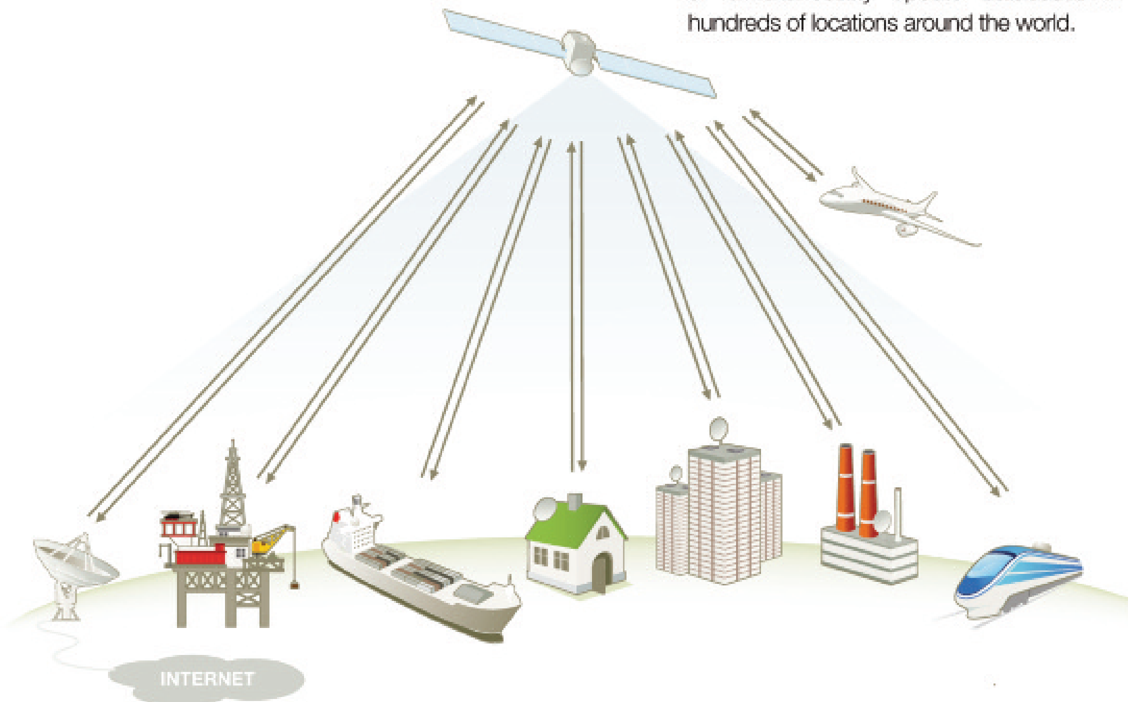
> From 30,000 channels in 2010, the number of satellite channels should reach 40,000 in 2019. HDTV is expected to account for 20% of this total (source Euroconsult).

> Current compression formats enable eight to ten standard digital channels or four HDTV channels to use the bandwidth used by one analogue channel.

> Almost 180 million homes worldwide are expected to be subscribing to satellite-delivered pay-TV by 2017, up from 95 million homes in 2007 (source Euroconsult).

Broadband **with everything**

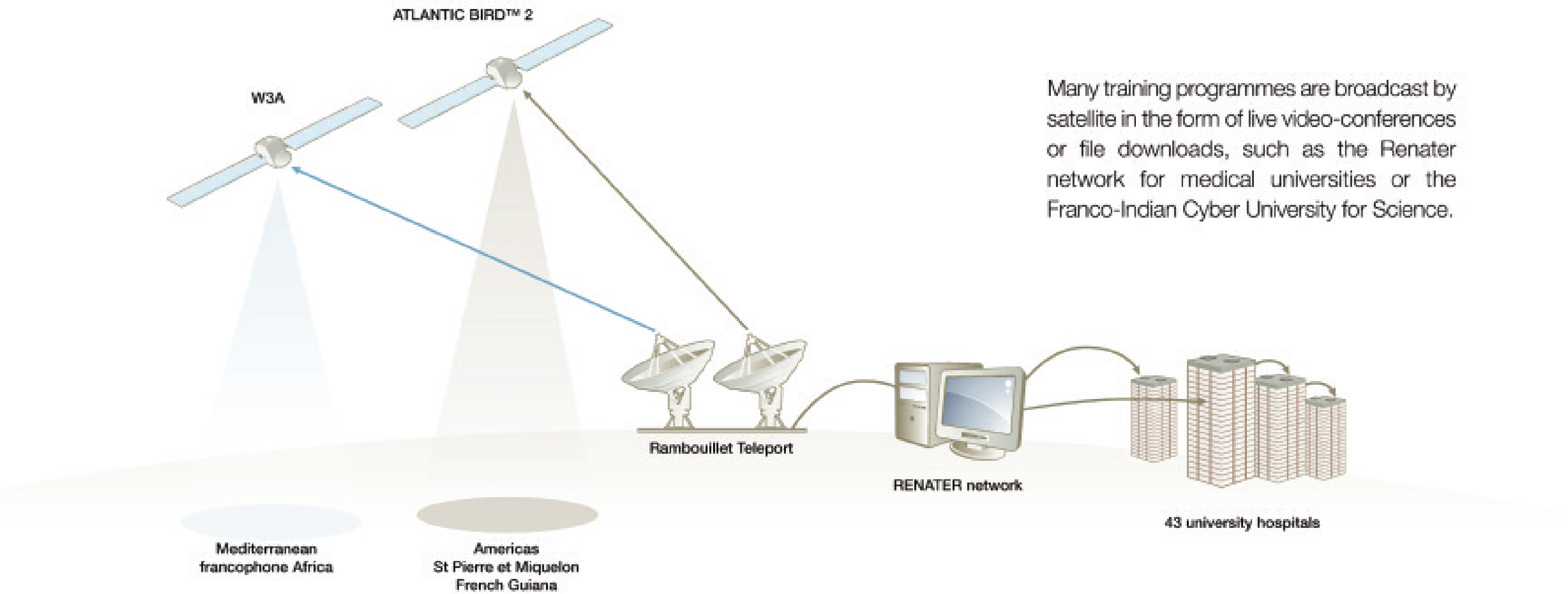
Satellites make broadband possible for all users beyond range of high-speed terrestrial infrastructure



Through small satellite terminals it is possible to have high-speed Internet access at any location in the world, including at sea and in-flight. Enterprises can establish a broadband connection with remote sites in deserts or simultaneously update databases in hundreds of locations around the world.

Satellites play a vital role for isolated communities by connecting them to digital infrastructure and supporting the development of business and employment in countries with underdeveloped industry. Operating completely independently of terrestrial infrastructure, satellite-based solutions also enable vital communications lines to be set up in disaster recovery or emergency situations.

Teleports directly linked to the Internet backbone make it possible for small terminals connected to a dish and modem to benefit from broadband access. With bit rates adapted to utilisation, a satellite link can serve a single work station, a corporate network, Wi-Fi hot spots, Internet cafés or Internet Service Providers.



Many training programmes are broadcast by satellite in the form of live video-conferences or file downloads, such as the Renater network for medical universities or the Franco-Indian Cyber University for Science.

DID YOU KNOW?

> Satellites are used by news agencies for delivering over 30,000 news reports every day, as well as stockmarket information from trading centres around the world.

> Satellites serve the retail profession, from tracking and monitoring delivery trucks, to broadcasting music, inventory and point-of-sale information to retail outlets across countries and continents.

>The installed base of VSAT terminals has doubled over five years to almost two million.

> Satellite networks enable medics and paramedics to consult specialists located thousands of kilometres away. This type of application is deployed in health centres, on boats and during recovery operations after a man-made or natural disaster.

Glossary

ANALOGUE SIGNAL
Used of a signal where a continuously varying physical quantity precisely describes the variation of the information it represents. This uses a considerable amount of bandwidth. One analogue television channel occupies the whole of a 30 to 36 MHz transponder.

BEAM
By analogy with a beam of light, indicates a unidirectional flow of radio waves emitted by an antenna and concentrated in a particular direction. The intersection of a satellite beam with the earth's surface is referred to as the footprint. A beam is steerable when it can be repointed in orbit towards another coverage zone by mechanical or electrical means.

COLOCATED
Describes a satellite that occupies the same control window on the geostationary satellite orbit as another satellite or satellites, such that the angular separation between them is very small when viewed from the ground. When a small receive antenna is pointed towards colocated satellites, the satellites appear to be at exactly the same position. In reality, they are kept at least several kilometers apart from one another through respective orbits that use slightly different values in terms of inclination and eccentricity.

COVERAGE
The geographical area where satellite signals can be received with sufficient quality when using appropriatelysized earth stations. Satellite coverages are usually communicated in the form of footprints displaying satellite G/T, e.i.r.p., or another parameter such as the antenna size required for good quality reception of a particular service.

DIGITAL SIGNAL
Describes a system where information is converted into numbers, instead of into a continuously-varying quantity (as in an analogue system), thereby reducing the necessary bandwidth. One 36 MHz transponder can carry a multiplex of eight to ten video channels in MPEG2 compression format.

DVB
Digital Video Broadcasting. A set of standards for the transmission and reception of digital video signals via satellite, cable or terrestrial means, formalised by the European Telecommunications Standards Institute (ETSI). There are many standards within the DVB family, including specifications for satellite (DVB-S), cable (DVB-C) and terrestrial (DVB-T) transmission and reception.

E.I.R.P.
Equivalent Isotropically Radiated Power. Measures the strength of the signal transmitted by a satellite towards the earth or by an earth station towards a satellite. It is expressed in dBW. The higher the e.i.r.p., the more the G/T can be reduced to obtain the same quality of reception (and the smaller the receive antenna can be).

EARTH EQUINOX (SATELLITE ECLIPSE)
During the equinoxes of March and September, the sun passes across the plane of the equator, which means that it is on the same plane as the geostationary orbit. Due to the rotation of the earth, this alignment means that the earth obstructs the sun for certain periods and the solar panels cannot generate energy. The duration of the satellite eclipse gradually changes as the equinox approaches, building up to a maximum of 70 minutes on the day itself. During these periods the satellite's storage batteries are used instead of the solar panels so that the satellite can continue to function normally.

EPG
Electronic Programme Guide. A graphical user interface generated by a digital satellite receiver and displayed on the user's TV set. It provides information about programme times and content carried on the digital signals received from the satellite. An EPG's main function is to help the viewer quickly locate and select programmes, but it can also be used for other interactive services.

FREQUENCY
Identifies the number of oscillations produced in a specified time, expressed in hertz. A hertz corresponds to one oscillation per second. Satellite transmissions are usually expressed in GHz (billion hertz). The term “frequency spectrum” is used to describe a continuous range of frequencies. The frequency spectrum of the Ku-Band allotted to satellite communications systems extends from 10.7 GHz to 14.5 GHz.

FREQUENCY RE-USE

A technique for using a specified range of frequencies more than once within the same satellite system so that the total capacity of the system is increased without increasing the allocated bandwidth. Frequency re-use requires sufficient isolation between signals using the same frequencies so that mutual interference between them is controlled and kept below an acceptable level.

Frequency re-use is achieved by using separate polarizations horizontal/vertical for linear or left-hand/right-hand for circular) for transmission and/or by using satellite antenna (spot) beams serving geographical zones which are sufficiently separated from one another.

HIGH DEFINITION

A digital TV picture's "definition" is expressed in millions of pixels per second and is essentially made up of the number of horizontal lines, the number of dots per line and the number of images downloaded per second. By multiplying the number of pixels per second by a factor of at least five, High Definition renders each plane extremely sharp, reproducing the 3D effect of the image originally captured.

LNB

The Low-Noise Block converter (or LNB) is located behind the feedhorn of a satellite antenna. Its function is to amplify signals received and to lower their frequency (typically into the 950 to 2150 MHz band) so that they can be processed by the receiver, DVB-S terminal or demodulator. A "universal" LNB enables reception of the full range of Ku-band downlink frequencies (10.7 to 12.75 GHz).

MPEG COMPRESSION

Motion Picture Experts Group. A group established by the International Organization for Standardization (ISO), which prescribes international standards for compression coding of moving pictures and audio programmes. MPEG2 (in 1995) was the first video compression format used for television, bringing digital TV to the general consumer by satellite and cable. On average, MPEG2 can carry eight digital channels in the same space required for a single analogue channel. MPEG4 was already being used to stream video over the Internet when it was launched commercially for TV broadcasting in 2006. Its role is vital to the development of HDTV programming because it uses significantly lower bit-rates. HD in MPEG2 format requires at least 18 Mbps whereas MPEG4 needs only 8 Mbps. Further gains in the order of 30 to 40% are expected over the next few years.

PARABOLIC ANTENNA

An antenna whose principal reflector is shaped like a parabola. It can reflect parallel incoming signals by directing them to a single point of focus where the source equipped with its LNB is located.

PAYLOAD

A satellite's payload is the element that enables it to fulfil its mission, i.e. for a communications satellite, the reception and processing of signals and their retransmission back to earth. The payload includes the satellite antennas and transponders but not the control, propulsion and electrical power equipment, which is part of the satellite platform (physical structure).

PLATFORM

The platform is where all the satellite pointing control, thermal regulation, propulsion and power supply functionality is located. The pointing control equipment has sensors to notify the satellite's orientation to the ground in order to maintain it correctly pointed to the earth. Steering usually employs a chemical or sometimes an electrical propulsion system. In a chemical propulsion system, the platform, in addition to the engines (nozzles), contains tanks of propellant and a pressurising gas (typically helium) which drives the propellant towards the engines.

The satellite is powered by photovoltaic cells to convert sunlight into electricity. The solar cells are situated on the satellite's "skin" (in the case of spin-stabilised satellites) or on deployable solar panels. The energy produced by solar cells is stored in batteries.

POLARISATION

Polarisation characterises the way a radio electric frequency propagates. It can be organised in more than one direction. Linear polarisation can be vertical or horizontal. A frequency can also propagate by turning like a corkscrew. In this case it is circular polarisation, either right or left.

Glossary

POWER
The amount of electrical energy fed into or taken from a device or system in a specified time, expressed in Watt or dBW. The signal strength on the uplink or downlink of a satellite communications system is quantified by the power of the radio wave radiated by the transmit antenna.

RECEIVE SENSITIVITY (FIGURE OF MERIT G/T)
The sensitivity of a receive system is described by its figure of merit G/T (gain/noise temperature). Sensitivity depends on the gain of the receive antenna (which increases with the surface area of the antenna and the frequency of the signal received) and the total noise of the electronic equipment used for reception (expressed in noise temperature). The higher the G/T, the more the transmit power can be reduced. Inversely, the higher the transmit power, the more the G/T can be reduced (i.e. the smaller the receive antenna required).

SET-TOP BOX
Used generically to describe any adapter that converts an external signal into content that can be displayed on a television screen. The Set-Top Box is connected to the TV set in the same way as a VCR, using a Scart socket, for example, or an HDMI…The first STBs were the decoders used to receive satellite and cable television.

STEREOSCOPIC IMAGE (3D)
Normally both eyes see the same object but from two slightly different angles, meaning that the two images are similar but actually different. Stereoscopic shooting replicates the vision of both eyes. A pair of cameras recordsthe same object from two views. Each of the views is projected to go independently and without interference to each eye. Once the left eye receives the left view and the right eye the right view, the brain creates a “tri dimensional, with depth” image. Different technologies exist to send the two views separately to the left and right eye. All make use of glasses based on differentiation on colorimetry, polarisation or timing (active glasses). The function of the glasses is to manage the differentiation between the left/right view.

TRANSPONDER
A transmitter-receiver device that transmits signals automatically when it receives certain pre-determined signals. The term “satellite transponder” is a signal processing unit which uses a single high-power amplification chain. Each transponder handles a particular frequency range (also referred to as "bandwidth") centred on a specific frequency and with a given receive polarisation for the signal. The transponder changes the frequency and the polarisation between reception of the signal from the earth station and its amplification and retransmission back to earth. There are multiple transponders on a satellite, each capable of supporting one or more communication channels.

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