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FROM EARLY COMMUNICATIONS SATELLITES TO SWARM INTELLIGENCE

EARTH FROM SPACE: Tandem satellite mission on course for success

REPORTING LIVE: It takes two to tango

STORY: A way around the volcanic ash cloud

FROM EARLY COMMUNICATIONS SATELLITES TO SWARM INTELLIGENCE

By Bernadette Jung and Susanne Haas

In the early years of space exploration, Germany planned to launch its own research satellite – AZUR. From 1964 onwards, a group led by Philipp Hartl worked intensively on this large-scale project. In 1966, this led to the foundation of the Institute of Satellite Electronics, the predecessor of today's Institute of Communications and Navigation. Fifty years later, the technologies are very different, but the drive to conceive better communications and navigation capabilities and develop new technologies remains unchanged.

Since its foundation in 1966, the Institute has been involved in groundbreaking developments. One highlight was Symphonie, the first European communications satellite, launched in 1974. The Institute played a major role in developing the satellite. In 1974, radio signals were the only means of transmitting information between satellites and ground. Today, the Institute works on methods that use optical signals instead. Initially, voice and images were transmitted by analogue means. For decades, scientists at the Institute in Oberpfaffenhofen contributed to the development and introduction of digital communications – from the first trials using coded modulation to the design of the future aeronautical digital communications systems.

DLR also played a leading role in the area of satellite navigation. One of the very first European GPS receivers was built at DLR in 1982. Today, the Institute of Communications and Navigation designs the world's most robust receivers. Early work in ionospheric research dates back even further – more than one century ago, scientists and engineers at the present-day DLR Neustrelitz site were already working in this field. The first algorithms to forecast the electron density in the ionosphere were demonstrated at this site not long ago.

For Christoph Günther, who has been in charge of the Institute for more than a decade, being a pioneer in new technologies is both an aim and a claim. He wants to explore new territory and push the boundaries of what is possible. His motivation is to obtain results that are both highly relevant and have never before been achieved.

Satellite systems remain at the heart of numerous research activities. However, the Institute's 170 employees also devote their time to topics in the fields of aerospace, transport and security. Their work covers a broad spectrum – from answering fundamental questions to demonstrating technologies. The projects are geared towards five missions, which are outlined below. One of the Institute's particular strengths is the combination of theory and experiment in its work. Theory supplies the foundations for algorithms and defines what is feasible in terms of data rates or position accuracy, for example. The purpose of prototypes is to demonstrate the practicability of the new approaches and to identify and overcome hurdles to their implementation. Furthermore, the experiments are an opportunity to develop models and thereby continuously improve the theory. The Institute places particular emphasis on transferring the results into industrial applications. It is involved in the development of standards, and cooperates with businesses and supports spin-offs.

Mission 1 – Global networking

Networking has dramatically increased in our daily lives. Many systems are dependent on Internet access and most people would not want to be without a broadband connection. Satellite systems are the most cost-effective means of establishing communications networks in sparsely populated areas and the only means at sea and in the air. There are two options – constellations of several hundred to several thousand satellites at an altitude of around 1000 kilometres, or a handful of extremely powerful geostationary satellites at an altitude of approximately 36,000 kilometres. Low-flying satellites enable short transmission times between ground terminals; however, the mechanism for their disposal after approximately five years in operation is not yet determined. Geostationary satellites require capacities in the range of terabits per second. For these satellites, the Internet connection presents the greatest challenge – and it is precisely that challenge that the Institute intends to tackle using optical communications, as the available bandwidths with this form of communication are 1000 times greater than that which can be achieved using radio signals. However, both clouds and the fluctuating refractive index of the atmosphere impede transmission. The careful positioning of ground stations makes it possible to switch to an alternative station in cloudy conditions. New approaches are being pursued at the Institute to overcome other forms of atmospheric interference. The first transmission tests began in the first half of 2016. If they are successful, transmission rates comparable to those of fibre optic networks will, for the first time, be possible for space applications.

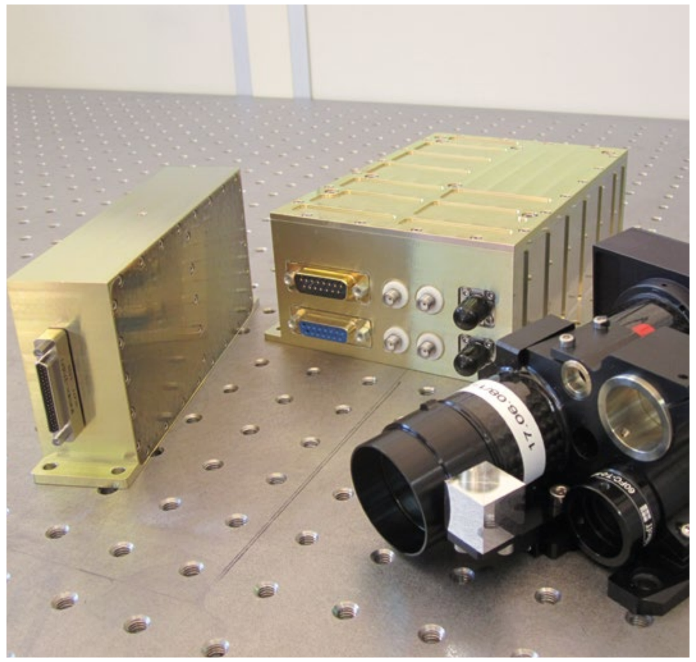
Conventional radio transmission remains the method of choice for communication between users on Earth and satellites due to potential cloud cover in the skies. The Institute has also undertaken pioneering work in this area, developing new low-loss methods to enable the uncoordinated access to radio channels. It also developed the world's most effective error protection codes. On the experimental side, it has demonstrated 'network coding' via satellite for the first time, potentially halving the required bandwidth and satellite power. Several hundred million euro can be saved for every communication satellite not required.

Following the powerful submarine earthquake in 2004 and various other natural disasters, global warning systems became an important and very specialised aspect of global communication. With Alert4All, researchers at the DLR Institute of Communications and Navigation succeeded in designing, implementing and demonstrating the functional capability of such a system. Alert4All is able to inform every individual via a multitude of channels: satellite-controlled sirens, terrestrial and satellite-based television, satellite navigation receivers, building security systems, the Internet, as well as through mobile radio using apps on a smartphone or tablet.

Mission 2 – Communications solutions for science, exploration, and reconnaissance

Every photographer wants a camera with higher resolution. The same is true of scientists who use cameras to observe Earth or distant planets. High-quality images are also of great value in disaster management or peacekeeping missions. However, in these situations, the cameras are installed on aircraft and satellites. Consequently, transmission systems that are capable of sending the largest possible amounts of data in a short time are required. Optical transmission offers extraordinary capabilities, enabling higher transmission rates while requiring smaller equipment. In 2008, the Institute demonstrated the first optical connection between an aircraft and the ground. In 2013, it was followed by the first demonstration on a German Air Force Tornado aircraft. These developments are being implemented industrially by the DLR spin-off ViaLight Communications GmbH.

Researchers from the Satellite Networks Department in front of the optical ground station on the roof of the Institute building in Oberpfaffenhofen. The Transportable Optical Ground station, TOGS, is visible on the left.



Components of the OSIRIS system – using the miniaturised laser transmission terminal, data from the BIROS satellite will be sent to the ground by laser for the first time in 2016.

First journey with an anti-collision system for trains. The public demonstration of the Railway Collision Avoidance System, RCAS, conducted in a real train on a test track at the Bayerische Oberlandbahn in 2010 was successful. Since then, the system, which was designed at DLR, has been implemented by industry.

The DLR BIROS satellite is scheduled for launch at the end of May 2016. It is equipped with a terminal weighing just 1.65 kilograms that is capable of transmitting one gigabit per second from near-Earth orbit. Further developments of the associated technology are also suitable for connecting communication satellites from 'mega constellations' to the Internet.

Mission 3 – Safe and efficient air, sea and land transport

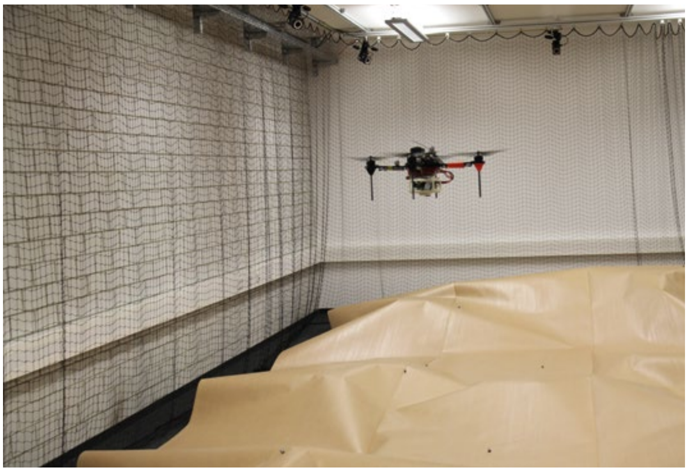
Aircraft and ships lack visual orientation in foggy and cloudy conditions. This is why, in the 20th century, radio navigation systems and radar were developed. GPS was the first globally available system that could be used almost everywhere, for almost any purpose. With the increasing number of satellites and systems, it will be possible to overcome more and more of the remaining limitations. This is one of the aims that the Institute has set itself. It would then be possible to reliably land aircraft or berth ships with marginal support. To achieve this, all the natural causes of error must be investigated and eliminated. In addition, it is becoming increasingly important to suppress deliberate interference caused by humans. For this purpose, the Institute is developing the most robust receivers in the world. The article 'Antennas with character' discusses these developments.

Robust and reliable satellite navigation will enable completely new procedures for aviation and shipping that will greatly improve efficiency while offering at least the same level of safety. However, transport users must be in accord with this. As the radio systems in aviation and shipping are largely speech-based and analogue, new and robust digital communications systems are required. For aviation, the Institute has successfully designed a system that does not require new frequencies (this is introduced in the interview with Michael Schnell entitled 'Revolutionising aeronautical communications'). The International Civil Aviation Organization started a standardisation procedure for this technology. The fact that this system's communication signals can also be used for navigation makes it even more interesting. This allows for a backup system that can be used in the event of disruption of satellite navigation systems. Inertial sensors, radars, and sonar (on ships) are used for this too.

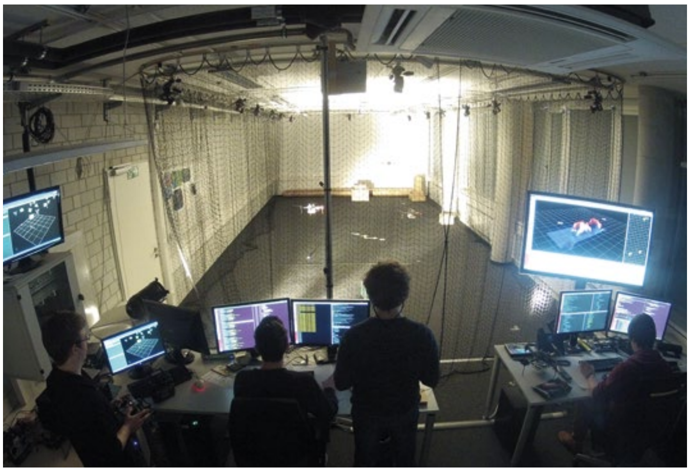
In aviation, collision avoidance systems are already being used with success to prevent collisions. Researchers from the Institute of Communications and Navigation are seeking ways of coordinating anti-collision systems at an even earlier stage and intend to extend them to other modes of transport. Of particular note is the 'Railway Collision Avoidance System', which was designed at the Institute and is now being developed by the start-up company 'Intelligence on Wheels GmbH'. The system will warn of impending train collisions on branch lines and in shunting situations.

Mission 4 – Navigation systems

Galileo will soon be introducing its first services, and the DLR Space Applications Company (Gesellschaft für Raumfahrtanwendungen mbH; GfR) is playing a pivotal role. The Institute of Communications and Navigation is supporting the deployment of the system by measuring signals – a task for which it is using the 30-metre antenna at DLR's Weilheim site. Precise knowledge of the signal distortions is particularly important for safety-critical navigation, as the techniques use measurements on the aircraft and on the ground, and distortions typically affect these receivers differently. Investigating the influence of the ionosphere on the signals and, in particular, predicting the ionisation state play an important role for many services; this capability is currently undergoing further development on behalf of ESA, so that warnings can be issued and reliable forecasts made, even during solar storms. Moreover,



This autonomous multicopter is part of a swarm. Each swarm member autonomously maps its surroundings using ultrasonic sensors. During testing, ground profiles are simulated with a tarpaulin. The individual measurements are communicated to other swarm members so that an overall picture of the environment is created.



The researchers in the 'Swarm Exploration' group verify their algorithms in the 'Holodeck', a special laboratory at the Institute.

characterising the ionisation state was crucial to the approval of GPS-based aircraft landing procedures (Ground-Based Augmentation System; GBAS) in Germany.

Developments for the next generation of the Galileo system are a new focus of the Institute's work on navigation systems. These developments address a new timing system, new signals, automatic calibration on the satellite and on the ground, and communication with the satellite and the user. Algorithms that further increase the availability of high precision and safety are a central aspect of this.

Mission 5 – Autonomous navigation and exploration

GPS and the Galileo system are not available everywhere. Position information is also of great interest inside buildings and subway systems. For this purpose, DLR researchers developed the Simultaneous Localisation and Mapping (SLAM) method, which enables localisation in buildings using low-cost sensors. If a person is wearing one of these sensors when walking around a building, it records data such as accelerations and turn rates, magnetic fields and radio signals. What makes it unique is that the sensor itself does not have the capability to visually record the environment. However, the data obtained can be used to estimate the route taken and produce a map that is accurate to within a few tens of centimetres. A team of researchers working on this topic moved to Google in 2014.

A high degree of autonomy is important not only on Earth, but also for exploring distant planets. This is where another element comes into play: the capability of deciding on the next step. At present, this decision is predominantly controlled remotely from Earth. This is a slow process, which is susceptible to communications outages. Hence, the Institute of Communications and Navigation is developing systems that use swarm intelligence, like that displayed by ants. Each element works for itself, but in concert with its neighbours. If a system breaks down, the other elements continue. With this, the Institute has found an extremely efficient way of determining an elevation profile using a swarm of quadcopters.

The DLR Institute of Communications and Navigation will continue to investigate and develop pioneering technologies of benefit to society.

Susanne Haas is responsible for, among other things, public relations at the DLR Institute of Communications and Navigation.
Bernadette Jung is the communications officer at the DLR site in Oberpfaffenhofen.

Large antennas maintain communications links between the ground and satellites. For the Galileo system, precise knowledge of the signal distortions is required. For this purpose, the Institute of Communications and Navigation analysed the signals. In this image, the 30-metre antenna at DLR Weilheim.

ANTENNAS WITH CHARACTER

GALANT – a robust receiver for satellite navigation

By Achim Dreher and Achim Hornbostel

Signals from GPS and Galileo are highly susceptible to interference because the received signal power is generally extremely small – about one tenth of a femtowatt; a number possessing 15 zeros after the decimal point! However, availability and reliability are critical for many applications. In aviation, maritime transport and autonomous driving, people and control systems must be able to rely fully on the estimated position and attitude. The GALANT receiver, developed by the DLR Institute of Communications and Navigation, is a system that meets the highest standards.

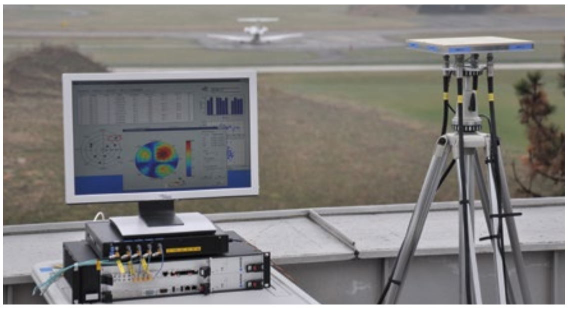
The development began about 10 years ago, in view of the construction of the European navigation satellite system Galileo – hence the name GALANT, which is the acronym of 'Galileo antenna'. Today, the system covers several frequency bands and is suitable for both Galileo and GPS signals. The basic idea is that the antenna characteristics are adaptively shaped in such a way that they spatially fade out interfering signals while improving the reception of the desired signals. This ensures an even more extensive use of satellite navigation for safety-critical applications in the future.

Fake signals exposed

Commercial navigation devices are based on receivers that work with a single antenna element. For safety-critical applications, this type of receiver has limitations. The advantage of a receiver with multiple antenna elements is that the reception characteristics of the array can be adaptively shaped using digital beam forming. The received signals from all antenna elements can be specifically combined and processed using a microprocessor so that the antenna pattern gets the desired characteristics, individually for each satellite. In this way, GALANT is able to adapt to different receiving situations. In addition, the direction of the incoming satellite signals can be determined through the application of suitable algorithms. By comparing the estimated direction with the known position of the satellite, the system detects deceptive satellite signals, such as those generated by spoofers or by the retransmission of received signals with a repeater (meaconing).

The DLR Institute of Communications and Navigation in Oberpfaffenhofen is continuously extending GALANT and adding new functions. One objective is the integration of the array into the surface of aircraft, vehicles and ships. A compact design is also essential to allow future applications in the automotive sector. Further projects to reduce the size of the antenna are currently underway in collaboration with partners.


Individual antenna elements combined in an array make navigation more reliable


Tests showed that interfering signals could be suppressed using GALANT technology

Successful deployment in the field

The capabilities of the antenna system have been demonstrated on multiple occasions. Experiments in the German Galileo Test and Development Environment (GATE) near Berchtesgaden have demonstrated the successful use of the GALANT technology for interference suppression. In particular, an interference situation that disabled a GPS-based landing system at Newark Airport (New Jersey, USA) was reproduced – the GALANT receiver reliably and precisely determined the location, whereas commercial receivers used for comparison either did not supply any positional data at all or experienced major errors. The GALANT system can also reliably detect interference caused by a repeater – for example, used for maintenance in aircraft hangars. Further test campaigns at sea, in the air and on the road were carried out. The medium-term goal for this technology is to cover a wide range of safety-critical services that guide aircraft when landing, assist ships with docking and keep vehicles on the road. The technology is also suitable for use in ground reference stations of the Galileo and EGNOS systems themselves.

Achim Dreher is Head of the Antenna Group at the DLR Institute of Communications and Navigation.
Achim Hornbostel heads the Algorithms and User Terminals Group.

REVOLUTIONISING AERONAUTICAL COMMUNICATIONS

DLR Magazine speaks with Michael Schnell

Air traffic is constantly increasing. Air traffic controllers are its backbone. For them – and for air transportation as a whole – efficient and secure communication is vital. Susanne Haas spoke with Michael Schnell, Head of the Aeronautical Communications Research Group at the DLR Institute of Communications and Navigation, about the future aeronautical communications system for air transportation.

About Michael Schnell

Michael Schnell has worked at the DLR Institute of Communications and Navigation in Oberpfaffenhofen since 1990. He heads the Aeronautical Communications Research Group and is Theme Coordinator for Aeronautics at the Institute. The main research topics of his group are the modernisation of communications and surveillance technology in civil aviation, and the integration of unmanned aerial vehicles (drones) into civil air space. He also advises the German air navigation service provider Deutsche Flugsicherung (DFS) on various committees at EUROCONTROL and at the ICAO. He is the designated chairman of the ICAO Working Group on LDACS Standardisation. From 2003 to 2014 he was also a lecturer at the Karlsruhe Institute of Technology (KIT). He is the author/co-author of over 100 publications, including 20 magazine articles.

How do air traffic controllers currently control and guide air traffic?

: The controllers are in constant radio contact with the pilots. In addition, they receive information about the real-time positions of aircraft in the airspace for which they are responsible. The positions of the aircraft are determined both passively – using radar – and actively, via automated queries sent to the aircraft. Thus, the air traffic controllers have a complete picture of the situation that enables them to guide air traffic. Any conflicts are identified early on and any changes to flight paths are made in a timely manner. At present, controllers exchange information – changes in direction, altitude and so on – with pilots mainly via analogue radio telephony, which works similarly to a walkie-talkie.

Why is this no longer adequate?

: The analogue technology upon which present-day radio telephony is based was introduced in the late 1930s; it is safe and robust, but outdated and complicated to use. The pilots have to sign on and off verbally and tune to different radio frequencies manually. In addition, because of its inefficiency, analogue radio telephony requires large parts of the available frequency spectrum and so ties up frequency resources. Those resources are, however, limited and sought-after; just look at recent spectrum auctions for mobile radio licences. But as the number of flight movements continues to rise, so will the demand for communication. To meet that demand, new communications technologies that make much more efficient use of the available frequencies than does the analogue radio telephony technology in use today are needed. The LDACS digital communications system guarantees the necessary spectrum efficiency. A further reason for introducing LDACS has to do with the modernisation of the entire air traffic management system currently underway. For increasing air traffic to be safely accommodated in future, new control and management procedures are being developed and introduced. These are significantly more efficient but also more complex than the previous ones, so they require the support of fast and secure digital data transmission. In the future, for example, aircraft will fly according to four-dimensional trajectories – for example, according to predefined time-stamped flight paths. Owing to their complexity, these trajectories can no longer be communicated by the air traffic controllers via voice using analogue radio telephony – digital data transmission is required.

What changes will LDACS bring about? What will the improvements be?

: LDACS will enable greater quantities of information to be exchanged between pilots and air traffic controllers more quickly and efficiently. What is more, LDACS supports the introduction of new procedures in air traffic management. LDACS is thus a key technology when it comes to integrating an aircraft into the information network for future air traffic management.

How does the new communications system work?

: In principle, it works similarly to mobile telephony, where the LDACS ground station would correspond to the base station and the radio device in the aircraft to the smartphone. The LDACS radio technology is based on modern communications technology, such as the one used for mobile telephony and WLAN transmission. But this technology had to be specially adapted to the requirements of aeronautical communications and the characteristics of the frequency band used. The L-band is already used by several radio services in aviation, particularly radar-based navigation services. Because of this, the LDACS signals had to be designed to not interfere with the existing L-band radio services or be affected by them.

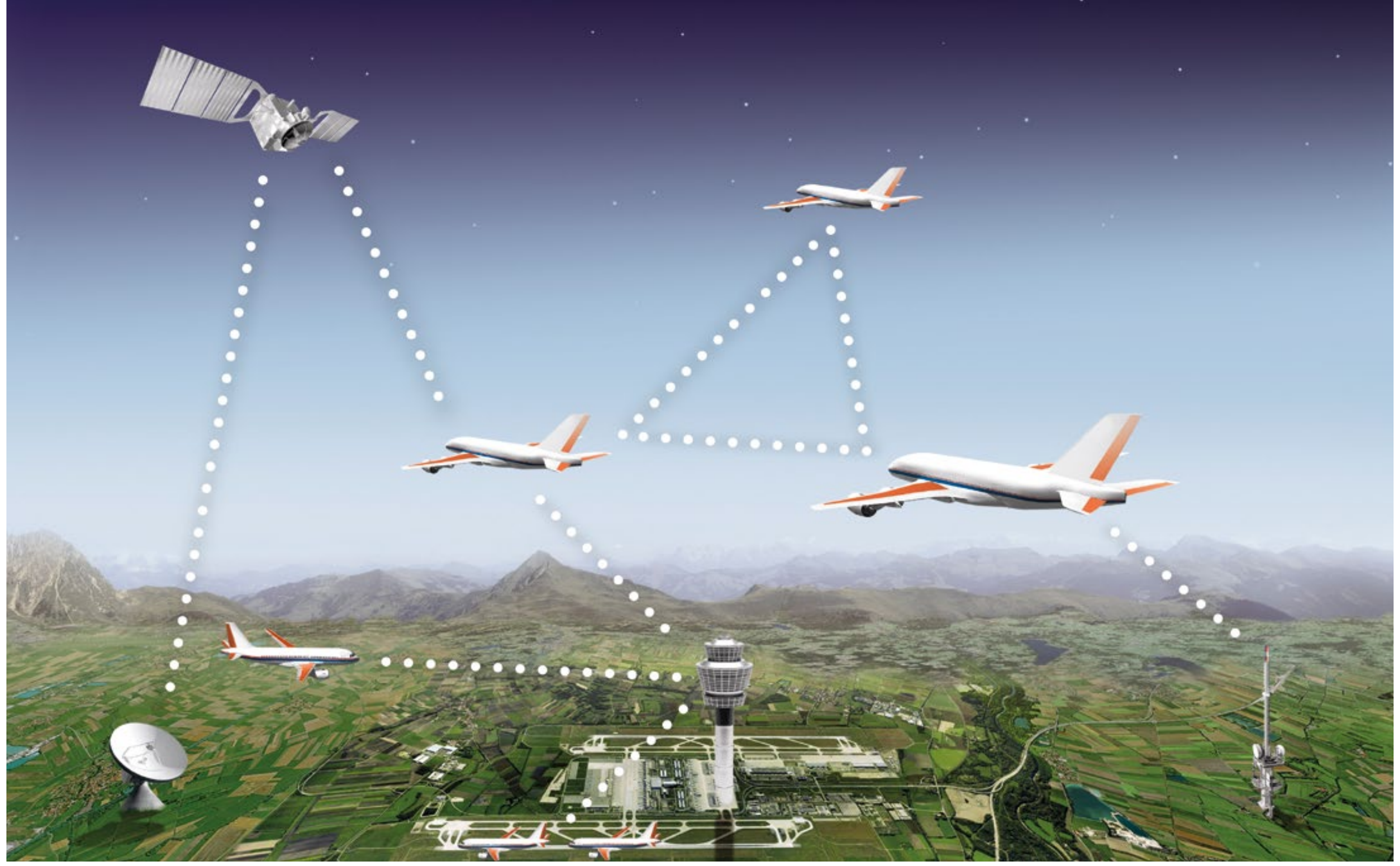


Image: DLR/ESA

Networked communications infrastructure with LDACS as the key component, supported by satellite communications: the aircraft is fully integrated into the information network for air traffic management.

What role does DLR play in the development of LDACS?

: DLR has played a leading role since the work began in 2007. In the beginning, the development of LDACS was driven forward together with two Austrian partners, Frequentis AG and the University of Salzburg and, since 2012, with the company Rohde & Schwarz as well. The DLR scientists carried out the first theoretical considerations on LDACS, designed large parts of the LDACS system, and verified the system design in subsequent computer simulations. The LDACS technology developed was implemented in hardware by DLR, and the world's first LDACS demonstrator was built, allowing the technology to be tested under laboratory conditions. Flight tests with a prototype created by Rohde & Schwarz are currently in the planning stage. We also actively support the standardisation and implementation of LDACS on all relevant bodies – primarily EUROCONTROL (European Organisation for the Safety of Air Navigation), EUROCAE (European Organisation for Civil Aviation Equipment), which deals specifically with the standardisation of aviation electronics and ICAO (International Civil Aviation Organization). The scientific results we have obtained have been published in various international conference papers and journals.

What are the next steps? When will LDACS be introduced?

: The ICAO Communications Panel decided to establish a working group on LDACS standardisation, which will start its work in 2016. Because of our expertise, DLR is nominated to chair this working group. A draft standard should be available in 2018. The target is to have a final standard by 2020. After that, industry, aircraft manufacturers and airlines will be required to embrace and implement the standard. Modern, efficient communication for civil aviation air traffic management – with all of the advantages it has to offer – could be a reality from as early as 2020. LDACS will undoubtedly remain in use for a number of decades because the radio technology upon which it is based is very flexible and scalable, and can easily be adapted to future requirements.

Implementing the LDACS design in a demonstrator for testing and measuring the characteristics of the LDACS system in a realistic environment

LDACS – AERONAUTICAL COMMUNICATIONS OF THE FUTURE

LDACS (L-band Digital Aeronautical Communications System) is the future of communication between air traffic controllers and pilots. It is a digital transmission system for air traffic control and management. Similar to mobile telephony, it enables both speech communication in CD quality and rapid data exchange. The L-band aeronautical communications system integrates the aircraft into the information network for air traffic management.

ON THE SAME WAVELENGTH AS LIGHT

Christian Fuchs – passion for free-space optical communications

By Elisabeth Schreier

Christian Fuchs is well aware that, to the layperson, free-space optical communications is a closed book. With a smile, the researcher acknowledges that, although friends and acquaintances are indeed very interested in his work, most of the issues do not have a connection with their everyday lives. But data transmission by laser will soon play an important role in our daily life – of that, he is confident. The 34-year-old communications engineer has been researching the development of this technology at DLR for almost 10 years.

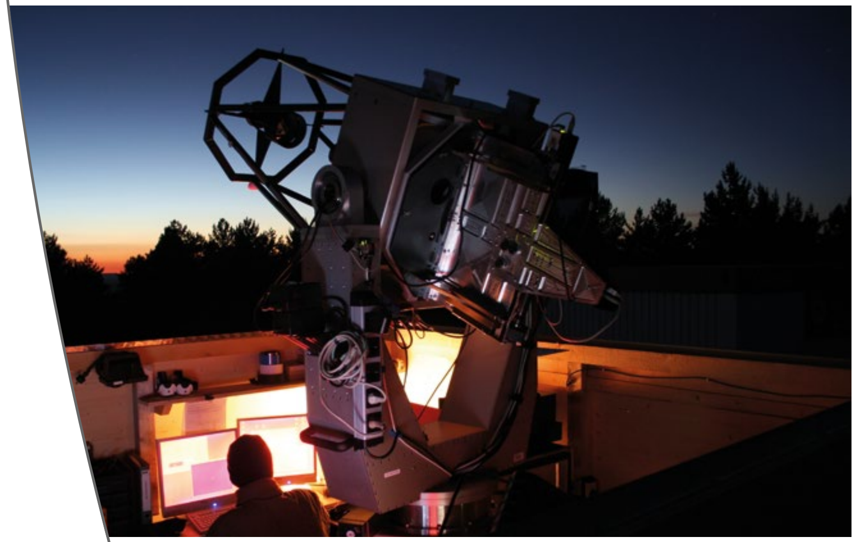
Since his first year, Fuchs has dedicated heart and soul to DLR. It all began when he was seeking a project for his Master's thesis. Various internship and university projects left him in no doubt – research is his passion and would be his future career path. "I truly wanted to work in space engineering," he says, remembering the time during which he was seeking out a career path. "It is more or less by chance that I am now working on free-space optical communications. But I have not regretted it for a moment." This passion for a subject that sounds rather complicated at first, arose when he was working on his Master's thesis in 2005/2006 – and it remained. Immediately upon completion of his thesis, he was offered a job at the DLR Institute of Communications and Navigation.

Fuchs has been the Leader of the Optical Communications Systems Group at the DLR Institute of Communications and Navigation since 2011. Together with his 10-person team, he is working on significantly increasing transmission rates between aircraft, satellites and the ground. "The benefits of laser communication lie in the concentration of the light beam, much as with a laser pointer. Because of this, a larger proportion of the power reaches the receiver than with radio communication," he explains. Laser communication enables the transmission of large amounts of data from high-resolution optical, infrared and radar satellites to the ground. Compared with the hitherto conventional process of sending and receiving radio signals, this light-based form of transmission is far more efficient – it allows for data rates of one gigabit per second or more. Data rates of more than one terabit per second are being envisaged for larger satellites.

Worldwide use

Through his projects, Fuchs has the opportunity to collaborate with colleagues at other institutions and organisations. For him, the OSIRIS project is particularly exciting; his team has developed an experimental laser communication system optimised for small satellites. The current generation has been integrated into the BIROS satellite – designed by the DLR Institute of Optical Sensor Systems – and will be put through its paces after its launch in 2016. The system will provide a data rate of one gigabit per second using a satellite terminal that weighs just 1.65 kilograms. "This is one order of magnitude higher than has been achieved with anything that has flown," he says.

Fuchs' group is also responsible for receiving the data. The scientists have built two receiving stations: the optical ground station in Oberpfaffenhofen, which is permanently installed on the roof of the Institute and the Transportable Optical Ground Station (TOGS), which can be used worldwide.


Christian Fuchs prepares the optical ground station before a campaign in southern Spain

However, there are a few things to bear in mind when using laser technology to transmit data – weather and atmospheric effects can complicate data reception. To ensure that trials such as OSIRIS are not adversely affected, Fuchs and his team have optimised the ground stations and measuring instruments. When communicating with BIROS, everything has to work. "It will be incredibly exciting to see how, after months of work, the first live data from BIROS is received at our terminal, and to see if all the systems and applications function as planned. The experiments carried out in advance during the first tests with a NASA system, which is currently installed on the ISS, have been promising. With the planned experiments, we will obtain data on the transmission behaviour of the atmosphere at an essential frequency. This will be vital to the design of future systems and the standardisation of the technology. It is a great feeling to contribute to the success of such a wide-ranging project," says Fuchs, with pride.

The researcher's projects are not just amongst the stars. To achieve faster results and gain valuable experience, many of his experiments use aircraft. After initial successes with a propeller-driven DLR research aircraft, the transfer to a German Air Force Tornado as part of a special development was carried out in conjunction with the spin-off ViaLight, who commissioned work from Cassidian (now Airbus). For project DODfast (Demonstration of an Optical Data link fast), a Micro Laser Terminal was integrated onto a platform on the Tornado. In addition to dealing with strong vibrations on board the aircraft, optimising the TOGS mobile receiving station was a challenge. It was necessary to track the aircraft at very high speed and with extreme accuracy to keep the received laser light focused on a small photodiode. This required optimisation of the systems and software, which was performed by the team during numerous ground tests prior to the main tests being conducted near Oberpfaffenhofen. Fuchs greatly appreciates getting away from his desk and working in the field with exciting flying objects.


Last adjustments for satellite downlink at the ground station

Highly versatile

When it comes to the use of optical space communications, Fuchs can reel off a list of possibilities. For instance, his department supports the VABENE++ project, intended to use tools, such as aerial images, to help workers deployed on disaster relief missions restore a functioning transport system. The images captured on overflights can be easily and quickly transmitted using laser technology. Laser communication is of particular importance to global Internet access, for which the connection between satellites and the Internet is established using lasers. Ground stations at various locations ensure that cloud-free conditions are sufficiently likely for at least one connection. The number of ground stations required is far fewer than for radio systems. The latter require these stations to provide capacity. "In radio communication, we measure available bandwidth in gigahertz, but in laser communication it is measured in terahertz. That's 1000 times more!" says Fuchs enthusiastically.

Christian Fuchs is a driving force behind ensuring that DLR plays a key role in global research into optical space communications. Because of this, he is determined to, over the next 10 years, promote the international visibility of his Institute, establish new contacts, and realise exciting projects with various partners. However, he does not want to give up being a researcher: "Of course one never stops growing into the role of project manager and dealing increasingly with coordination tasks, but in the future I would also like a mix of research and management. I don't want to lose the freedom to do some of my own technical work."

Of the projects planned in 2016, the launch of BIROS is the most exciting for Fuchs. As soon as it has reached orbit, valuable emote sensing data will be sent to the ground by laser. If this works, it would be a tremendous triumph for the scientist and his team. And Christian Fuchs, with his great passion for, and delight in his job and his subject, will have thoroughly earned such success.

About DLR

DLR, the German Aerospace Center, is Germany's national research centre for aeronautics and space. Its extensive research and development work in aeronautics, space, energy, transport and security is integrated into national and international cooperative ventures. In addition to its own research, as Germany's space agency, DLR has been given responsibility by the federal government for the planning and implementation of the German space programme. DLR is also the umbrella organisation for the nation's largest project management agency.

DLR has approximately 8000 employees at 16 locations in Germany: Cologne (Headquarters), Augsburg, Berlin, Bonn, Braunschweig, Bremen, Göttingen, Hamburg, Jülich, Lampoldshausen, Neustrelitz, Oberpfaffenhofen, Stade, Stuttgart, Trauen and Weilheim. DLR also has offices in Brussels, Paris, Tokyo and Washington DC.

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Cover image

The 30-metre antenna at DLR Weilheim. Researchers at the DLR Institute of Communications and Navigation have received and analysed navigation signals using the antenna.

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