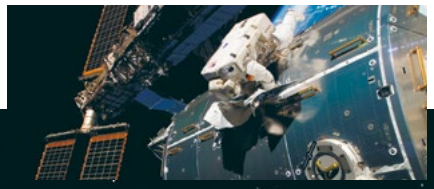
SPACEWALK

THE CUSTOMER MAGAZINE OF THE OHB GROUP

Ten years in orbit: both SAR-Lupe and Columbus recently celebrated important anniversaries.

Back to the future: Dr Fritz Merkle explains in an interview why OHB has its roots in NewSpace.

Start-up: flexible access to space, launchers and their optimisation are part of our core business.



Groundbreaking: OHB's successful arrival in GEO

2018

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OHB SE, Unternehmenskommunikation
Karl-Ferdinand-Braun-Straße 8
28359 Bremen
Tel.: +49 (0)421 2020-8
Fax: +49 (0)421 2020-700
www.ohb.de

Editorial team
Günther Hörbst // OHB SE, V.i.S.d.P.,
Julia Riedl // OHB System AG,
Sabine von der Recke // OHB SE,
Danela Sell // PR & Redaktion

Cover
ESA (Earth), OHB / CCMeyer (satellite)

Images
AntwerpSpace 09
Bettina Conradi 02,04
ESA 15, 19, 20
ESA / AOES 28
ESA / P. Carril 19
ESA / CNES / Arianespace 23
ESA / S. Corvaja 24
ESA / Donges SteelTec 11
ESA / Foster & Partner 08
ESA / NASA 15
Sara Lünemann 25
LuxSpace 09, 11
NASA 14, 18
NASA:2Explore. 12
NASA / JPL-Caltech SwRI MSSS G. Eichstädt 28
OHB Italia 06
OHB System 17 (2x), 22, 27 (Hans Thiele)
OHB / CCMeyer 10 (2x), 16, 17, 21 (2x), 22, 26, 28
OHB Sweden 10
Danela Sell 11
Shutterstock 07, 29
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Concept
Danela Sell & Sara Lünemann

Layout
Sara Lünemann // Konzept & Kreation

Translation
Synonym Translations

Proofreading
Textgärtnerei

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Dear Reader,

These days, space systems are an essential part of our daily lives. Whilst we may not always be aware of this, we all heavily depend upon the services that satellites provide. Quite simply, we cannot shape our future without space technology. This may only be dawning on the general public, but it has long been clear in our minds at the OHB Group.

This future will be defined by a huge wave of digitalisation moving at a tremendous pace. The rising torrent of data that defines our private and working lives will not abate: what was uncharted territory yesterday is a hotbed of value creation and innovation today. Precise, reliable and independent data are vital for telecommunications, positioning and navigation. However, we cannot neglect the environment in the process and this is something that the public is vehement about: the next industrial revolution must be clean and sustainable.

Our space applications support and advance the digital transition. They facilitate reliable communication and navigation. They observe and measure the changes in the Earth and thereby enable us to protect our environment. We engage in space technology on principle for the benefit and utility of humankind; in short,

we.create.space.

Best regards,
Marco Fuchs

CONTENTS

Back to the future

OHB began pursuing the NewSpace approach more than 20 years ago. It had its big breakthrough with the concept of building satellites for constellations in a significantly smaller size. Dr Fritz Merkle, member of the Management Board of OHB SE, explains in an interview with OHB Head of Communications Günther Hörbst where the company has come from and where it is heading.

NewSpace is all the rage. So where does that put 'Old Space' and where does OHB stand in relation to both?
Fritz Merkle: NewSpace emerged in recent years without there ever having been an 'Old Space' as such. But the idea behind NewSpace is a very applications-driven one. Indeed, this is the exact approach that OHB took 30 years ago when it developed satellites for specific applications. In that respect, OHB was embracing the principle of today's NewSpace during the days of 'Old Space'.

To go one step further: how does a company like OHB preserve and retain the old while embarking on the new?
This is the challenge we're facing. OHB promoted the NewSpace principle more than 20 years ago by building much smaller satellites to form constellations. This presents a challenge for traditional satellites, especially for the large institutional satellites in communications, telecommunications and navigation. New technologies and materials are being developed for these smaller microsatellites. Naturally, this has an enormous impact on the traditional satellites.

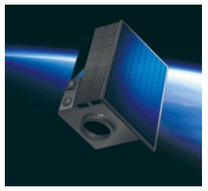
Space technology is becoming increasingly commercial. But OHB's core business is still heavily reliant on institutional contracts. How can the company continue to benefit from both the old institutional and the new commercial?
Space technology originated as an institutional business, funded essentially out of tax revenues. However, applications gave rise to technologies that are used in everyday life. For example, there has been a huge shift in the world of communication. Therein lies the major challenge for OHB in the coming years. We have to play a bigger role in this shift towards the commercial. Currently, institutional contracts make up around 75 percent of our order volume. We will see a shift in this and OHB will work towards benefiting from this trend.

What are OHB's main objectives in this area?
We are looking closely at small satellites, which will complement and augment our large satellites in terms of concept. Since it is better to work on small satellites in smaller working groups, this is our objective mainly in the subsidiaries in Luxembourg, Sweden and Italy.

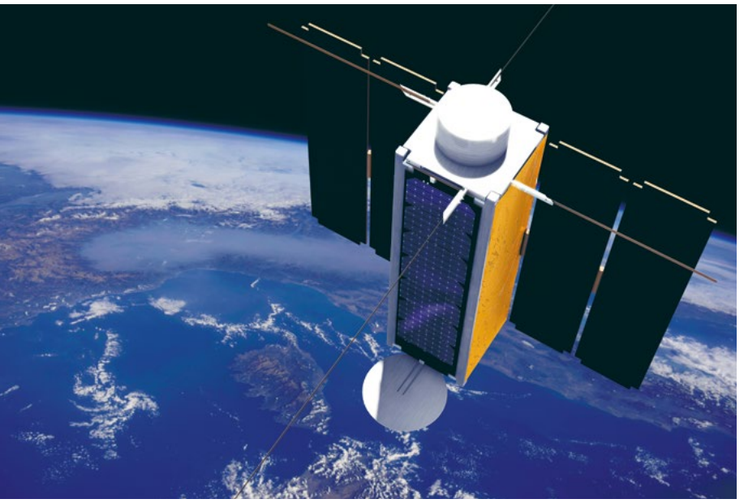
Can you give us an example?
Triton-X in Luxembourg, which is being developed in three different sizes. Innosat in Sweden. Then there's Eaglet in Italy, a satellite based on the CubeSat concept, with dimensions of 10 x 10 x 30 centimetres.

What will Eaglet be used for?
This satellite will be used for Earth observation. Though its resolution will be slightly lower, it will be the maximum that is physically possible for a satellite of its size. Such satellites complement the product range that includes EnMap and Earth observation.

What role do the large programmes play in this strategy?
They are the heart of satellite infrastructure; their purpose is the reliable provision of time signals, navigation signals and images. There is no room for compromise here. The provision of everything within the sovereign remit must be reliable and, above all, safe and secure. NewSpace principles



The first mission to be realised with OHB Sweden's InnoSat platform (under 50 kilogram class) is the scientific mission MATS.



The Eaglet-1 is a satellite in the under ten kilogram class. The satellite based on the Cube-Sat was developed and built by OHB Italia.

are slightly more difficult to implement in this respect. However, they complement these core elements in the areas of observation, communication and navigation.

How quickly does OHB intend to integrate the principles of NewSpace into the corporate strategy and, above all, use them as a business model?
We have decided to step up our activities in the services sector. We already offer satellite operation services and satellite launch services. However, we have not regarded them as a separate line of business. As space business becomes more commercial and privatised, we will operate these services as a separate line to generate growth. To provide these services we do not have to launch satellites of our own, rather we aim to offer such services to the space community. To this end, we recently founded OHB Satellitenbetrieb GmbH.

Is this partly due to the fact that, these days, one has to talk about space technology in the context of its benefit to humans, for which services need to be provided?
Exactly. Historically, space flight grew out of the conflict between the East and the West. It was a demonstration of power. Development in the arena of communication was born of the need for defence, then it was commercialised and nowadays there are satellite dishes on every house, which receive radio and television signals from space. It has become an indispensable part of the infrastructure of our communication society. The same goes for navigation, which was originally purely for military purposes. Today, civilian uses are the driver behind navigation systems. All of these are now inextricable from the modern economy.

Does OHB believe the public is sufficiently aware of how vital space applications has become in our daily lives?
The general public definitely is not. Space technology is still viewed as something that we can basically do without. It's fine when there's enough money for it, otherwise not. People still have an image in their heads of travelling to distant planets. Compromise in this sector, which satisfies human curiosity through exploration, is possible in times when money is tight. But when it comes to infrastructure that is necessary for our daily lives to function, satellite technology is indispensable. Such areas include Earth observation, navigation, communication and time synchronisation in the global financial system.

To what extent do Elon Musk's activities help?
I think what he's doing is a good thing. One effect he is having is to challenge an industry whose clients are mainly publicly funded to become much more cost-effective. In that respect, the way he goes about his business puts pressure on others but is an attractive prospect at the same time. The pressure is there nonetheless, however: on the competitors and on the public contracting authorities.

In the US you have Elon Musk and Jeff Bezos; in the UK you have Richard Branson. Why are there no astropreneurs in Germany?
Musk and Bezos are really children of Silicon Valley: they grew up with the Internet which in turn made them rich. Branson is from England. He entered the sector through his airline. His idea is to make it possible for anybody to fly to space. Greg Wyler at OneWeb is also taking the Silicon Valley approach, which requires an environment of start-ups, investors willing to take risks and research institutions. This combination is the ideal breeding ground for the principles of NewSpace. No one knows how long it will last but even in the US this mindset is not universal. It tends to be concentrated in California.

So, it will remain a Silicon Valley movement for a while yet. Do you think there will ever be a more commercial, billionaire-led space flight endeavour in Europe?
I'm sure it will emerge in some form in Europe. It would be wrong to copy the Californian model to Europe. The circumstances and mentalities are different here. We have to see what can be taken and look creatively at what we can do to find our own solutions.

Marco Fuchs recently said that SpaceX's development of the Falcon Heavy took immense courage. And Europeans could learn a lot from this courage. What did he mean by that?
The decision took courage, especially the decision to take on the technical and financial risks. We are very safety-conscious in this part of the world. Plus, when a mistake is made here, we go looking for who's at fault and we resolve not to do the same thing again. The opposite happens in California: people learn from their mistakes by trying the same thing again right away. They try to learn the lesson rather than punish the wrongdoer.

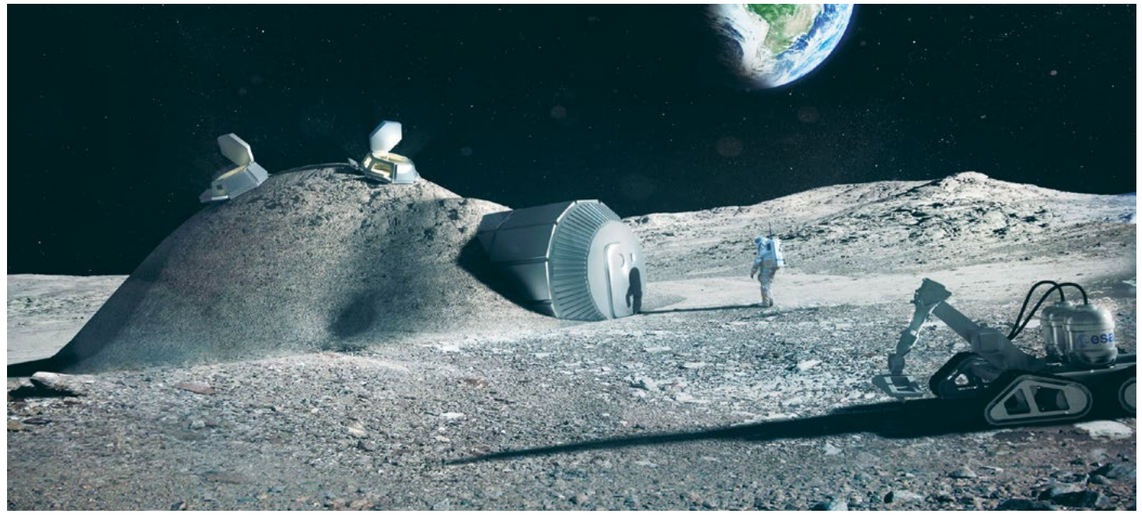
What are the most important upcoming projects that OHB has to get on with?
We have to continue to stabilise our core business. It will be the same for decades to come; incidentally, in the US as well. NASA's budget is three or four times that of Europe's. Then we have to look closely at whether NewSpace affects our core business and make a smart decision about how we apply these principles to new lines of business to complement OHB's business. This could mean good acquisitions or start-ups.

Looking at OHB's history, one can't but notice that, be it start-ups or NewSpace principles, OHB has already been there before.
True, a good 30 years ago we were designing and building satellites for specific applications. OHB was ahead of its time. There was no market for these applications at the time. High-speed Internet, smartphones and the like has changed all that. Space applications are now relevant for the individual consumer. When OHB entered the market with the first communications and Earth observation systems, the average person on the street was not a potential customer. Rather, it was about superseding the traditional providers.

So the plan is back to the future?
You could say that, yes.

In automated stock exchange trading, every microsecond counts. Accurate time information, such as that sent by satellites, for example, is also essential for navigation and logistics.

NEWS



BREATHING ON THE MOON

The exploration and colonisation of the Moon has always been a compelling goal for the OHB Group. Now, with the European Space Agency (ESA) facilitating industry research on a number of technologies for future Moon missions, it is gaining traction.

For instance, the ESA has selected our OHB Italia team – in conjunction with OHB System, the OHB spin-off BlueHorizon and the Polytechnic University of Milan – to define a payload that enables components of the Moon's soil to be converted in-situ into breathable oxygen and drinking water. The mission is part of the European Exploration Envelope Programme (E3P). It aims to demonstrate what ISRU (In-Situ Resource Utilization) technologies are necessary to convert resources on the Moon into vital substances. In other words, what ISRU technologies play a key role in the sustainable provision of consumables that will be required for future manned missions on the surface of the Moon.

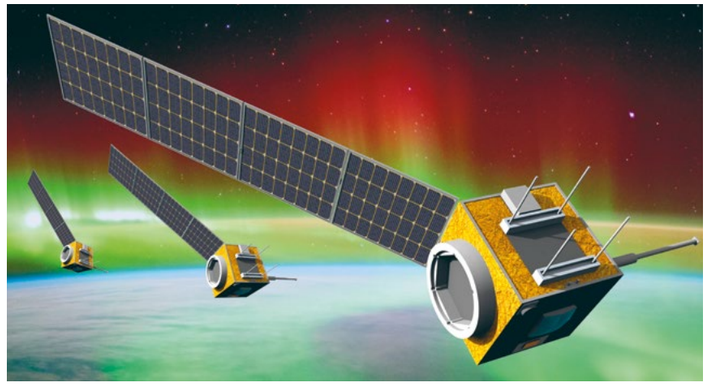
The ISRU Demonstrator mission is scheduled for 2025. A lander will deliver the payload to the Moon. Its robotic arm will collect soil samples (regolith), which are treated with chemical reagents in the unit at temperatures in the region of 900°C, in order to extract the oxygen, the end products being water or oxygen. This will be the very first time that chemical substances will be produced off Earth and using non-terrestrial matter. Various organisations have previously explored ISRU methods and systems but so far none have trialled them in space.

3D PRINTING IN SPACE

The ESA has also contracted OHB System with the investigation of 3D printing techniques for building a lunar base. OHB System and its partners Comex, Liquifer and Sonaca will do a cost analysis of using 3D printing for construction, operation and maintenance of a lunar base. Printing for space is already in use today, for example, 3D printing technology is employed to make space flight components lighter and to make them cheaper to manufacture. The purpose of this study is to investigate the principle of printing in space; that is, how essential items of equipment can be produced on a lunar base – in space – with the aid of 3D technology. The rationale is that transporting payloads into space is one of the biggest obstacles to overcome on long-term space missions.

The sustainable presence of humans in space therefore hinges on the ability to manufacture the required structures, objects and replacement parts in-situ. 3D manufacturing technologies are one possible solution to achieve this objective because they shorten the lead times between design and realisation and can reduce production waste. At the same time, more materials can be recycled and the production of parts can be optimised based on needs.

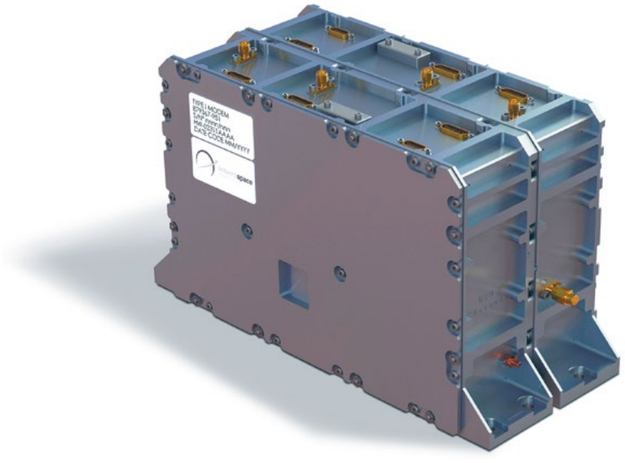
MICROSATELLITES FOR NEWSPACE



Under the proven OHB motto "smaller, lighter, cheaper", LuxSpace is developing the microsatellite platform Triton-X on behalf of ESA. Upon completion, it will weigh around 80 kilograms and be able to bring up to 30 kilograms of payload into the near-Earth orbit at an altitude of between 250 and 700 kilometres. OHB is thus setting itself up to meet the requirements of the NewSpace market as Triton-X will be comparatively inexpensive, quickly available and versatile. Satellite communication, Earth observation, the testing of new technologies in space and the development of satellite constellations are all possible areas of application. LuxSpace is developing and building the platform and also designing a production line for subsequent series production. Work on setting up the system architecture and selection of the industrial core team together with ESA began in August 2017. The platform will then be developed and prototypes built. At the end of 2019, the third phase of the programme will commence, this will include the maiden flight of a Triton-X satellite platform.

BETTER LIVE STREAMS FROM THE ISS

ARGO is a highly innovative modem from AntwerpSpace. MacDonald, Dettwiler and Associates (MDA) will integrate it into a next-generation space-based communications terminal. However, in 2018, the modem will be used for the first time on the International Space Station ISS. It will be mounted on the outside of the European Columbus module. For the astronauts and the control centre on the ground, this means the transmission of more scientific data and higher quality live streams from the station. The ISS is an ideal test field for this new technology. Nevertheless, the target market goes far beyond the ISS. It includes all operators of satellites orbiting around the Earth at low altitude.

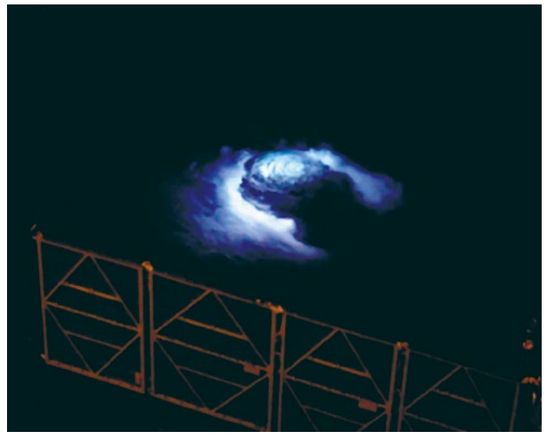


TEN ARIANE 5-SHIPSETS COMMISSIONED

MT Aerospace is also producing the metallic booster cases, tanks and other lightweight structures for the last ten Ariane 5 ECA launchers. In two years' time, launch operations for the future European Ariane 6 launch vehicle are to commence step by step at the Kourou spaceport. To ensure a smooth transition, contracts for the PC series batch for ten Ariane 5 launchers were awarded to industrial suppliers in January.
By the time it ships the final set in mid-2020, MT Aerospace will have worked on a total of 93 Ariane 5 launch vehicles. The company is also playing a crucial role in the development and industrialisation of the Ariane 6 launcher system with an industrial share of around 10 percent.

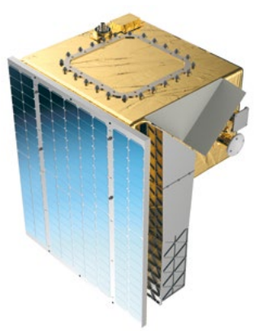
GETTING TO GRIPS WITH BLUE JETS & CO.

For the ESA mission ASIM (Atmospheric Space Interactions Monitoring), which has been on the ISS since the beginning of April, OHB Italia was not only responsible for the Data Handling and Processing Unit, but also for the integration of the payload, all tests and safety at system level. ASIM will be installed outside the European space laboratory Columbus to monitor electrical events at great heights. The existence of these elusive electrical discharges in the upper atmosphere bearing names such as red sprites, blue jets and elves has been the subject of debate for years. Satellites have already taken a close look at them and observations from mountain peaks have also been made, but the angles of view for the ASIM on the ISS are better suited for collecting data on a large scale.

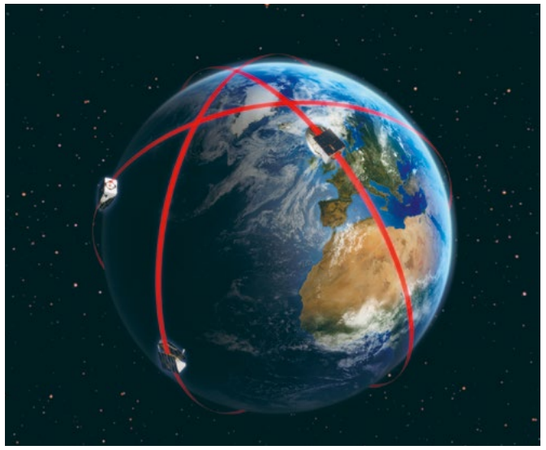


EARTH OBSERVATION WITH SMALLSATS

Together with our partner Omnisys Instruments, OHB Sweden has been selected by ESA to study future Earth observation microwave instruments for small satellites. Thanks to miniaturisation of, for example, synthetic aperture radars (SAR) and microwave instruments for weather and climate monitoring small, low-cost satellite systems can perform tasks that previously were only possible with big satellites. Omnisys is leading the study and OHB Sweden will contribute its expertise in small satellite systems, for example based on the novel Innosat platform that OHB Sweden is currently developing.

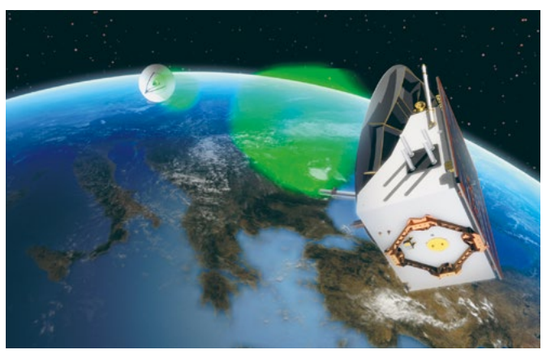


THE "SERVICES" DIVISION IS GROWING



With the foundation of OHB Satellitenbetrieb GmbH, the OHB Group has further expanded its "Services" division. The purpose of the new company is to pool the Group's numerous activities and to continue specialising in the operation of satellite systems and related ground stations. Ultimately, OHB Satellitenbetrieb GmbH will also manage satellite constellations and provide associated services. A preliminary contract which will, for the most part, be executed by the new company entails the continued operation of the SAR-Lupe system up to 2020. OHB System has been operating this system very successfully for more than ten years for the German federal armed forces.

"By pooling our service activities, we will also be able to offer our customers cost benefits and other advantages," says Dennis Winkelmann, Managing Director of OHB Satellitenbetrieb. "We are seeing rising demand in the market for integrated systems together with the related operation services," explains Klaus Hofmann, a member of OHB SE's Management Board and Managing Director of OHB Satellitenbetrieb. "Looking ahead over the next few years, we see enormous growth potential. Additional possibilities will arise from the operation of reconnaissance systems and with telecommunications and navigation systems," Hofmann continues.

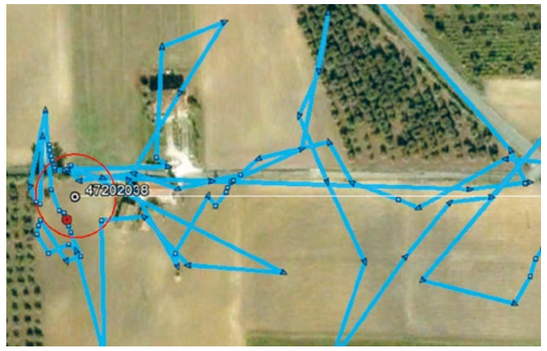


LARGE PRECISION SYSTEM FOR THE ARIANE 6 LAUNCH PAD

Construction of the new launch facilities for the Ariane 6 launcher in Kourou, French Guiana, is progressing swiftly. MT Mechatronics is playing a material role and has now prevailed over the European competition with the receipt of a contract for the delivery of the precision system for the mechanical ground support equipment MGSE. This is an alignment platform for the final integration (EFF, ESR Finishing Facility) of the P120 boosters on the launch site. The technical challenge of this EFF dock project is no less than to position the 226-tonne load of the booster with its pallets with an exacting degree of precision before it is integrated with the central body of the launcher on the launch table, which is also being supplied by MT Mechatronics. Weighing in at 800 tonnes, the launch table has already been shipped to Kourou, as have the first parts of the umbilical tower. The EFF-Dock is scheduled to arrive in July 2019.

The launch table for the Ariane 6 during the inspection in November 2017. Since the beginning of 2018 it has been at the launch site of the Ariane 6 in Kourou.

MEASURING EUROPE



How is land use changing in the European Union? To get to the bottom of this question, the EU's statistical office, Eurostat, collects extensive data every three years. OHB Luxspace has been entrusted with the validation and quality assurance of this information for the fourth time in succession. Under the project name LUCAS (Land Use and Cover Area frame Survey), around 700 field surveyors are deployed throughout the EU to collect information at just under 250,000 sites. In addition, there are around 80,000 positions that are determined by photo interpretation. A good 4.5 million square kilometres are thus mapped. This provides information on both the changes in socio-economic land use and biophysical soil cover. In addition, LUCAS information is used to classify data from the Copernicus Earth Observation Programme.

OHB TEAMS WORKING ON BIOMASS ENVIRONMENTAL SATELLITE

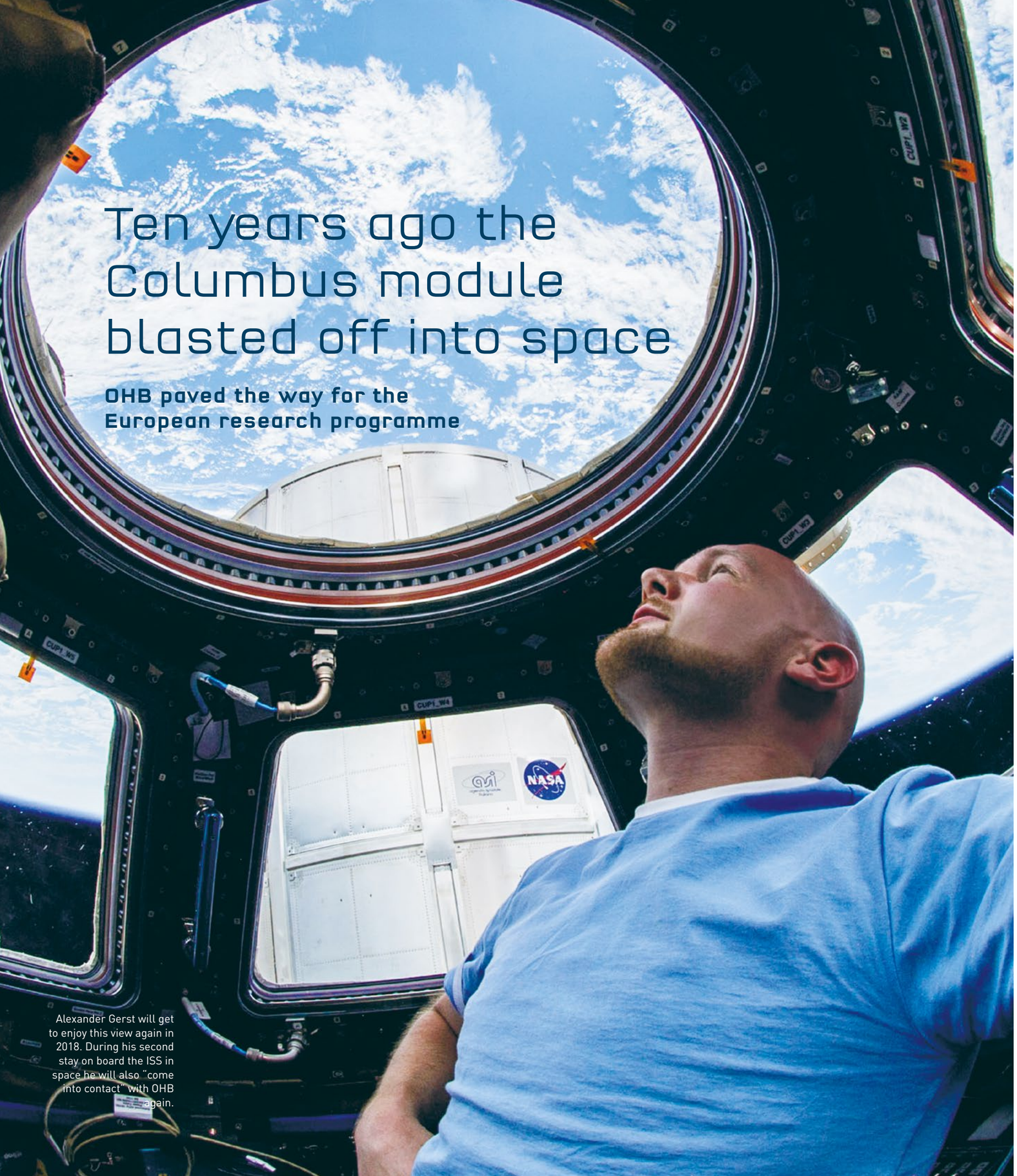
The Biomass satellite from the 7th ESA Earth Explorer mission is due to be launched in 2021 and will provide important information on the state of our forests, their changes and their role in the carbon cycle. Both OHB Italia and OHB Sweden are participating in the programme on behalf of Airbus Defence and Space UK.

The Milan-based team was selected as the prime contractor for the structural platform of the satellite weighing in at 1.2 tonnes. OHB Italia is managing a team of European subcontractors and is responsible for the design, development, production, integration, verification and testing of the satellite structure.

OHB Sweden, with its many years of experience as a propulsion supplier, is developing the reaction control system. The monopropellant system for Biomass builds, in particular, on the experience which OHB Sweden is currently collecting from the development of the propulsion system for the EUCLID mission.

Ten years ago the Columbus module blasted off into space

OHB paved the way for the European research programme



Alexander Gerst will get to enjoy this view again in 2018. During his second stay on board the ISS in space he will also "come into contact" with OHB again.

On 7 February 2008 a large-scale European project literally got off the ground: the Columbus module took off on its journey into space and, just days later, successfully docked with the International Space Station ISS. Since then, humankind's farthest outpost has included a European research laboratory.

"The research that can be done on board the space station in zero gravity gives scientists brand new insights. For me, space flight is at its most beneficial when human utility takes centre stage," said Marco Fuchs, CEO of OHB SE and OHB System AG. "What's more, major space projects like the ISS and Columbus play a unique role in fostering enduring understanding between people, countries and continents."

For Marco Fuchs, the Columbus module also holds another, personal significance, as his father was one of those who paved the way for the Columbus programme. OHB founder Manfred Fuchs, who died in 2014, Professor Ernesto Vallerani and Professor Gottfried Greger were honoured by the German space agency (DARA, today the DLR) at the end of 1982 for their roles as initiators of the Columbus programme. "My father really pushed for Europe to develop and build its own research module. Because the original launch date was 1992 – 500 years after Christopher Columbus's discovery of America – he suggested calling the module Columbus and it was. So, of course, we identified strongly with the Columbus programme as a result" recalled Marco Fuchs.

IMPORTANT MILESTONE FOR OHB

"At the turn of the millennium, the workload at OHB System AG in Bremen was predominately projects for the ISS and the Columbus module," said Dr Marco Berg, lead of the Human Spaceflight and Exploration team at OHB. "More than half of OHB's 100-odd employees at the time were working on the infrastructure or on experiments for the space station. I see these activities as a sort of wellspring because it was here that the first larger projects were realised for the European Space Agency, the ESA, before OHB started developing and building satellites for the ESA. This makes it all the more gratifying for me that human spaceflight more or less set the scene for

Safe arrival: the European research module Columbus docked to the International Space Station ISS in 2008

OHB's success and our experience in human spaceflight can be applied to projects such as Lunar Orbital Platform Gateway."

OHB ON BOARD COLUMBUS

OHB was substantially involved in many activities on the Columbus project, both on Columbus itself and the nodes – that is, parts of the mechanical structure as well. So, there is a whole, diverse array of contributions by OHB to be found on board the space station and in the Columbus lab. They range from kilometres of cabling and thousands of connections, electronic units such as boards for the on-board computers through to various life support systems and complete experimental units and research racks.

"Work on Columbus started in the mid-1990s. First, it was mainly cabling. Then, in 1999, we got the contract for a whole rack in the Columbus module. This was a big deal for us because it was the first main contract we secured with the ESA," recalled employee Dr Matthias Boehme. This was the Columbus EPM (European Physiology Module) rack, one of ten racks inside the module that were designed for conducting research. "Even after ten years of intensive use for numerous experiments, our EPM rack still works perfectly and, going forward, it is at full capacity for new experiment sessions," explained Dr Berg with visible pride.

"I will never forget how exciting it was when, at 12:02 UTC on 16 February 2008, our EPM rack was the first scientific payload in the Columbus module to be switched on. Nor how happy we all were when it started up successfully!" recalled Dr Boehme. Since then, the rack which was originally designed for conducting experiments in human physiology has been used to conduct 16 different in-orbit experiments and has been successfully adapted to altered requirements in space on multiple occasions.

FULL SERVICE FOR THE EPM

The small OHB team provides an all-in service of sorts: giving technical advice on the diverse uses of the rack and on adaptations to new configurations. When it comes to integrating new experiments into the rack, the team is involved in the design phase to ensure that all interfaces are used correctly and the experiment later runs without a hitch in the EPM rack on the ISS. Of course, the OHB team is on hand when an in-orbit experiment is started up for the first time but also during operation, if necessary; that is, when experiments are running in the EPM rack. Before going into space, the astronauts practice carrying out the experiments on the EPM training model at the European Astronaut Centre in Cologne. "For me, supporting the astronauts first in training on the EPM rack and later with the use of the EPM in-orbit model for that experiment remains a special highlight," said Dr Berg. "If an experiment goes off smoothly in the EPM rack, then, naturally enough, we are proud of our facility and look forward to the results, just as the cosmonauts or astronauts and scientists must look forward to the data produced."

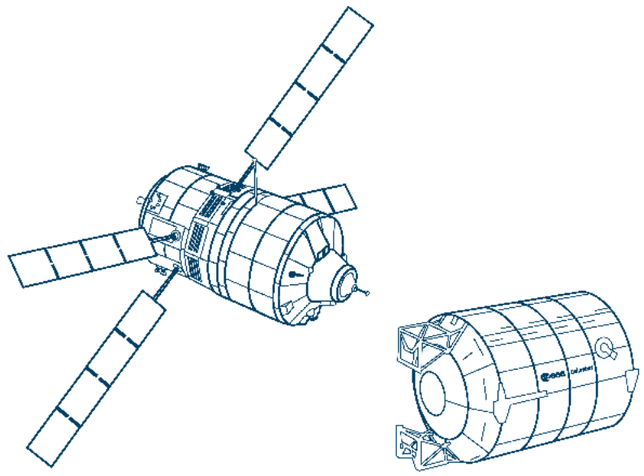
The EPM also houses the German-Russian plasma crystal laboratory PK-4, for which the ESA charged the experts at OHB in Oberpfaffenhofen with responsibility for all system tasks. "The visible universe is 99.9% plasma. Plasma is a physical state that is not a solid, liquid or gas. PK-4 experiments study the properties and physics of plasma in detail," explained Dr Boehme.

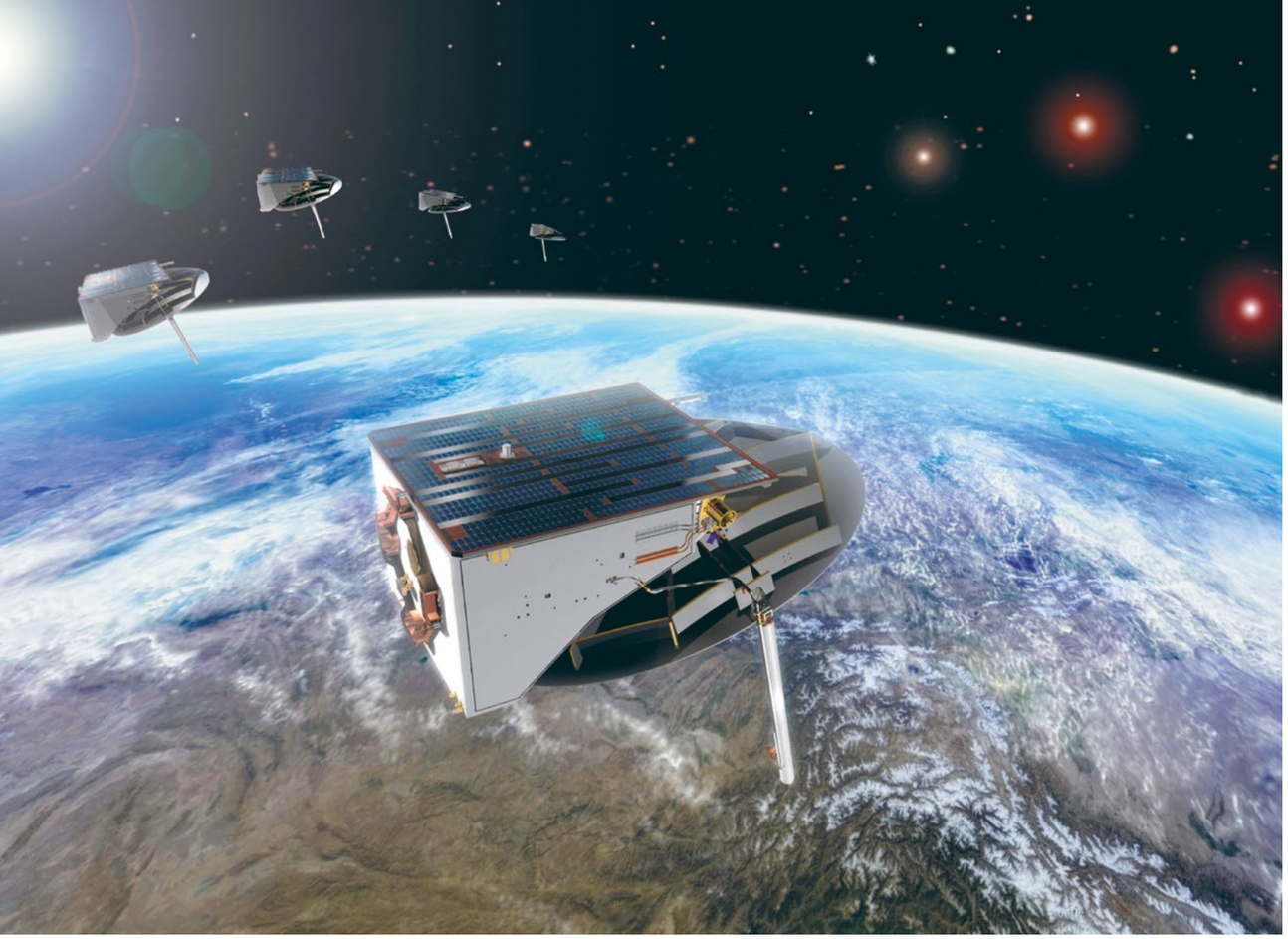
OHB QUALIFIES EQUIPMENT FOR SPACE

OHB is also contracted to investigate whether third-party experiments are suitable for use in zero gravity and provides support with the necessary modifications. "We lent our expertise to the SKIN experiments in human physiology for measuring skin hydration and Thermolab for measuring core body temperature non-invasively. Our workout device, the FlyWheel, helped to reduce muscle atrophy in astronauts. Soon we will have an OHB-qualified device called Myoton for measuring muscle tone on board non-invasively, which ESA astronaut Alexander Gerst will use during his upcoming second mission," said Dr Boehme.

The OHB Human Spaceflight and Exploration team, like countless people in Germany and the whole world, is looking forward to Alexander Gerst's second mission to the ISS and his fascinating reports from humankind's farthest outpost in space. The team especially can't wait for the moments when he will be using the EPM rack for various experiments.

European science in space. Alexander Gerst photographed the Columbus module in 2014 while on his Blue Dot mission, commenting: "Our powerful European science lab in space. What we investigate here cannot be done anywhere on Earth!"





Happy birthday, SAR-Lupe!

OHB celebrated a very special anniversary at the end of 2017. The project that gave the company its first big break has been working reliably round the clock for ten years: the SAR-Lupe reconnaissance system.

"The German armed forces and the Federal Ministry of Defence took a leap of faith and gave OHB the break it needed to become a German systems integrator," said Marco Fuchs, CEO of OHB SE. At a reception in Bonn specially organised by OHB to celebrate ten years since SAR-Lupe went live, Lieutenant General (ret.) Kurt Herrmann, Commander of Strategic Reconnaissance for the armed forces and therefore the first person to use SAR-Lupe said, "What I remember most is the positive, cooperative relationship not just within the team but with the Fuchs family as well. It was excellent." SAR-Lupe was the first time OHB was the prime contractor on a satellite programme. The company developed and built the satellite system and shares responsibility for its operation with the German armed forces. "It was a project that meant a great deal to us," said Dr Fritz Merkle, member of the Management Board of OHB SE. "The programme was the Federal Republic of Germany's first national space-based reconnaissance programme and a springboard for OHB's success today."

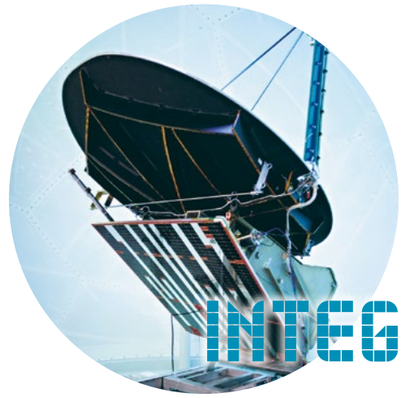
The five SAR-Lupe satellites have been circling the Earth for ten years, reliably transmitting up-to-date images of almost every single corner of the planet. No matter whether it's day or night, cloudy or clear in the territory in question, the images from the identical microsatellites received by the ground station in Gelsdorf near Bonn are always of excellent quality and therefore of immense value to the armed forces for global reconnaissance. For example, when it comes to identifying emerging crises, satellite images are obtained without infringing on territorial sovereignty and possibly aggravating an already critical situation.

Furthermore, SAR-Lupe has been expanded to the extent that it can be used in conjunction with the French optical reconnaissance system Helios II and thus serves as a common European satellite system for strategic reconnaissance.

The Galileo proposal was written based on the company's experience with the satellites in the SAR-Lupe series, of which all five have an identical build. "SAR-Lupe promoted OHB from a lower division to the premier league," said Merkle. Dr Ingo Engeln, member of the Management Board of OHB System AG and SAR-Lupe project manager at the time, added, "OHB learned a great deal from SAR-Lupe. Many people who were on the team back then are today in managerial positions at OHB."

But SAR-Lupe is and was important not only for the employees: the company itself benefits from the good working relationship with the client and the excellent quality it delivered. "Our work today ties in with the programme back then. Right now we are working on developing further systems for the Federal Republic of Germany. Since 2013, OHB has also been the prime contractor on SAR-Lupe's follow-on programme SARah", says Marco R. Fuchs.

The team in Bremen is responsible for the realisation of the system as a whole, which consists of three satellites and the dedicated ground infrastructure. Just like the name SAR-Lupe, the first three letters of SARah stand for the imaging technology Synthetic Aperture Radar. While the two SARah satellites built by OHB System are an upgrade of the SAR-Lupe models and are based on reflector technology, the satellite provided by Airbus DS features phased-array technology. Both technologies have been tried and tested in space. The system facilitates better resolution, faster data download times and noticeably shorter system response times. The first-time combination of the two different technologies – reflector and phased array – and the use of another receiver make SARah much more powerful than SAR-Lupe.



And now the weather forecast ...

What do snowdrops and satellites have in common? They are valuable sources of information for increasingly precise weather forecasts. Plants herald the changing season when they flower in springtime. Satellites create a global, three-dimensional map of the weather systems on Earth and in space.

Almost every country in the world has its own national meteorological service. The enormous volume of data from 191 member states and territories of the World Meteorological Organization (WMO) is gathered in the WMO's headquarters in Geneva. More than 10,000 manned and automatic weather stations, upwards of 7,000 ships, over a hundred moored and 1,000 drifting buoys, hundreds of radar stations and more than 3,000 planes as well as weather balloons and drilling rigs measure the key parameters on land, on water and in the air all around the world. Satellites in polar and geostationary orbit complete the network. They are needed to keep an eye on the complex weather system as a whole.

UNIQUE ADVANTAGE OF MTG

Meteorologists are looking forward to MTG, the third generation of the Meteosat weather satellites. The European Meteorological Satellite Organisation EUMETSAT, together with the ESA, has contracted six satellites from Thales Alenia Space: four imagers and two sounders. OHB System in Bremen is responsible for the six satellite platforms and systems integration of the two sounders. The imagers use optical cameras to take images of the weather in considerably higher resolution than previously possible and transmit them to Earth faster. Weather forecasting is becoming far easier and more precise as a result. The two sounders have infra-red cameras and, for the first time, can sample the individual layers of the atmosphere from geostationary orbit. The measurements indicate the air temperature, wind speed and moisture in the different layers. "The meteorologists are looking forward to the results of the instruments that are being developed and built by OHB in Oberpfaffenhofen above all because they are new to European satellite meteorology. They are the highlight of the mission and give Europe a unique meteorological advantage," explained Dr Rüdiger Schönfeld, MTG project manager at OHB in Bremen. While the first two generations of satellites were spinning satellites that took images of Europe, Africa and the Eastern Atlantic in strips, the MTG satellites, in geostationary orbit, will point constantly at their dedicated regions. They perform full scans every ten minutes and rapid scans every two and a half minutes. Plus the lightning imagers can detect storms. They also identify atmospheric trace substances. The first MTG imager is slated for launch in 2021, followed by the first MTG sounder at the beginning of 2023. It is hoped that they will improve local forecasts and long-range forecasts in particular. This is of great interest not just for private individuals but entire branches of industry rely on the meteorologists' forecasts. Indeed, it can be a matter of life and death; for instance, in the case of hurricane warnings. Farmers plan when to sow their crops based on the forecasts, renewable energy companies are interested in wind patterns and solar radiation, airlines and pilots rely on warnings about foggy conditions and wind at altitude. While it is unlikely that weather forecasting will ever be 100% accurate, the ultra-modern MTG system will take the practice of weather forecasting a good deal closer to the goal of providing people and businesses with ever more precise and reliable forecasts.

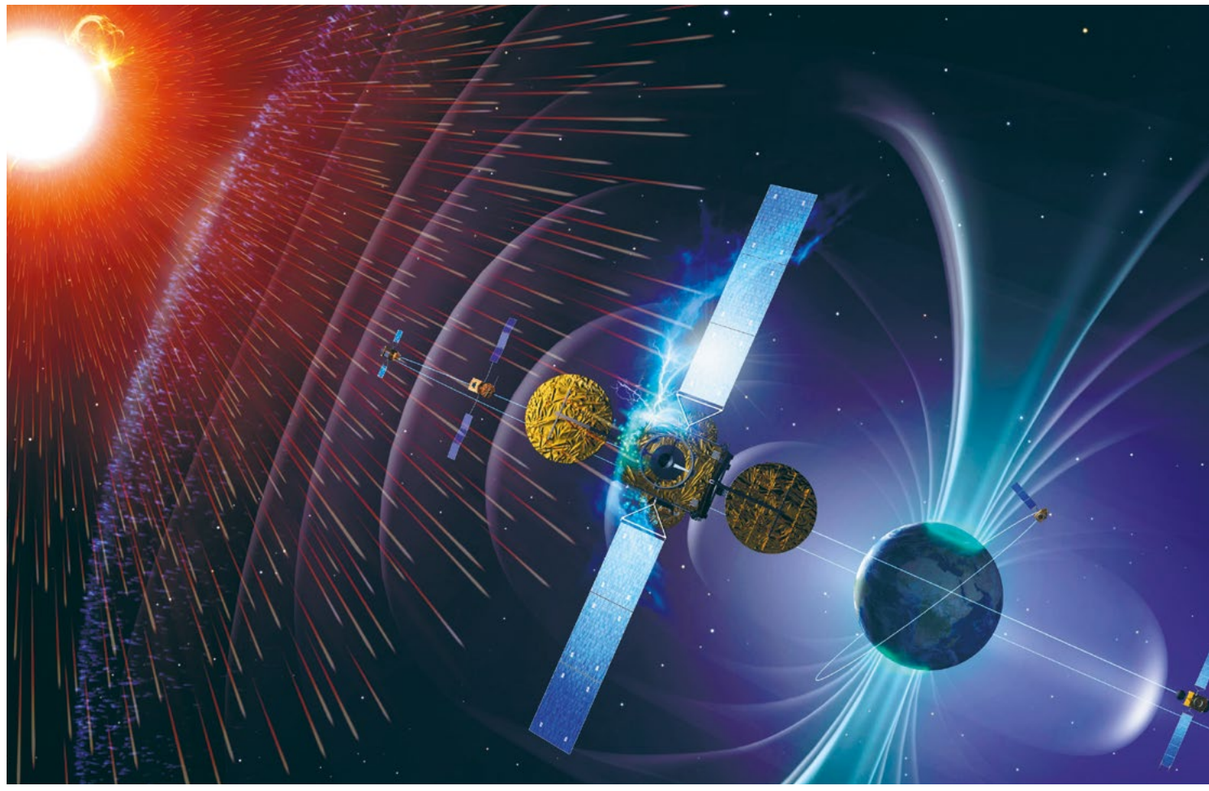
EFFECTS OF SPACE WEATHER

Not only is the weather on Earth hugely important, but weather events in space are too. Under its Space Situational Awareness programme, the ESA has commissioned the definition of mission architectures enabling research into and the utilisation of space effects. As part of the Distributed Space Weather Sensor System D3S, the OHB Luxspace team recently evaluated on the ESA's behalf which microsatellite constellations and instrumentation could be useful to research near-Earth space weather phenomena. In the context of the Enhanced Space Weather Monitoring System, the purpose of the D3S is to monitor the effects of space weather events, such as heightened solar activity, on the Earth's environment, while a special spacecraft at Lagrange point L5 observes the sun.

This is also the starting point of the study that OHB in Bremen is currently working on with the aim of improving the forecasting of space weather phenomena for the ESA.

The European Space Agency is planning a joint mission with NASA which envisions the placement of an American satellite at Lagrange point L1 and a European probe at Lagrange point L5. This allows the high-energy particles after solar storms to be viewed from the side, so to speak, and for their speed to be determined more accurately. "The satellite constellation would extend the warning time for space weather effects from a few hours at present to four or five days," said OHB project manager Marc Scheper. "The sun's activities have huge effects on sensitive satellite electronics and can also interfere with telecommunications and electricity networks on Earth," added Scheper. Given a couple of days' warning, satellite operators would, depending on the scale of the phenomena, at least have a chance to save their satellites by folding the solar panels or switching off the satellites altogether.

Meteosat Third Generation uses both imager and sounder satellites for considerably more accurate weather forecasts.



GROUNDBREAKING:
OHB goes GEO

Satellite communication is omnipresent these days: we take for granted that we can watch live transmissions of major sporting events, surf the Internet via satellite and can access virtually all goods from anywhere in the world 24/7 thanks to sophisticated logistical operations. We barely stop to think about the technological and economical feat this requires. However, it is part of everyday life at OHB.

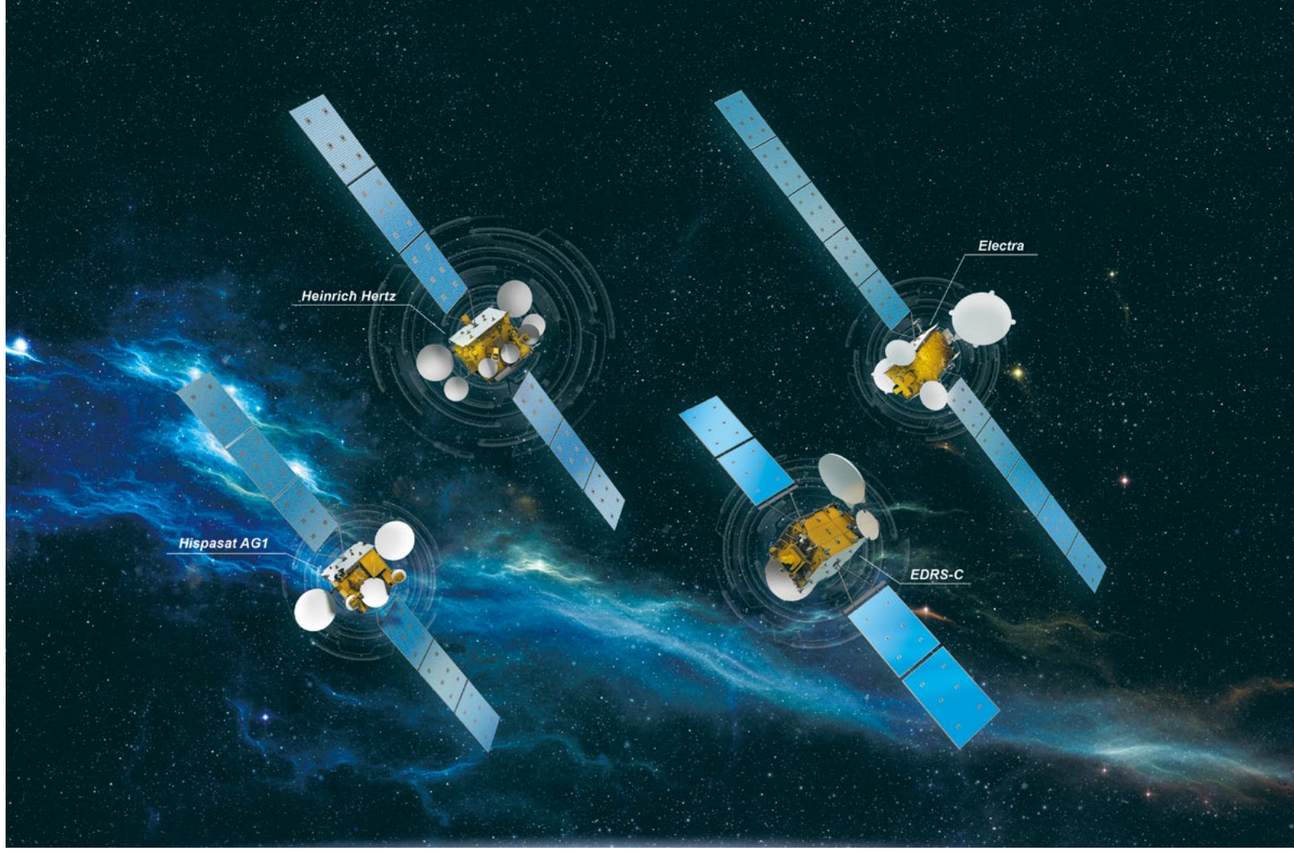
But this hasn't always been the case, a good ten years ago telecommunications satellites for geostationary orbit (GEO) were unchartered territory at OHB. The company had already established its reputation in terms of low Earth orbit thanks to the SAR-Lupe radar reconnaissance system and the contributions to the ISS, but it lacked experience in GEO systems. So, OHB set about gaining this experience strategically, first on its own initiative, then with the support of the DLR, before convincing the ESA to take up the development of small geostationary communications satellites called SmallGEOs as a separate line in their ARTES programme.

THE PIONEER H36W-1

The first SmallGEO from OHB, H36W-1 for the Spanish operator Hispasat, has had great success providing multimedia services to the Iberian Peninsula, the Canary Islands and South America since mid-2017 at an orbit of 36,000 kilometres. "Our SmallGEO débutante has impressively demonstrated its full functionality in orbit. This bore out the technical design of the new satellite platform," stated Dr Dieter Birreck, project manager in charge of the H36W-1 for OHB System. This success is equally gratifying for OHB's affiliates who contributed their expertise to this project: OHB Sweden supplied innovative sub-systems for the satellite electric propulsion system and the attitude and orbit control system. Luxspace provided telemetry and telecommand sub-systems and was involved in their validation at satellite level. Luxspace also played a part in the development of the satellite simulator. OHB Italia supplied the payload control unit and was involved in the development of the thermal control sub-system. H36W-1 created significant value in Germany too: OHB selected Tesat-Spacecom GmbH from Backnang as the main contractor for the telecommunications payload. Jena Optronik GmbH was contracted to supply the star trackers. In addition, many SMEs were involved in the project.

ELECTRA: SHE'S ELECTRIC

"The handover of a fully functional SmallGEO satellite marked another milestone in the company's history and our arrival onto the commercial market for telecommunications satellites. There are eight SmallGEO satellite projects under way, testifying to the future viability of the platform," explained Andreas Lindenthal, who is Chief Operating Officer at OHB System. "Project Electra, a SmallGEO configuration with fully electric propulsion, is the first of its kind and sets us on course to compete in the commercial market both now and in the long-term." Because of the lower mass of the electric propulsion system, this configuration can carry much more payload. Electra is being developed and realised by OHB in a public-private partnership with



ESA and the satellite operator SES S.A. from Luxembourg. OHB Sweden was tasked with the development and qualification of the electric propulsion system and with the provision of the attitude control software.

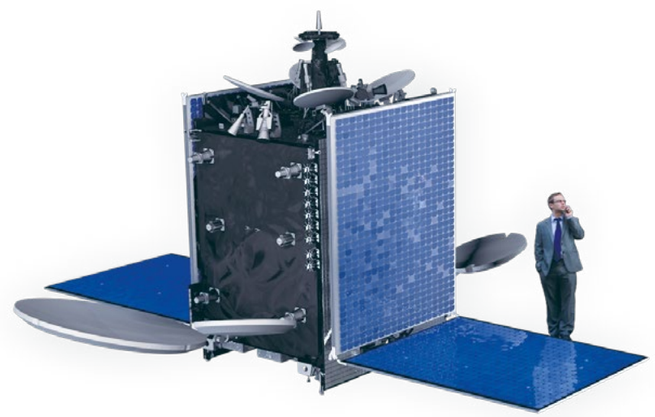
EDRS-C: THE NEW PRECISION

The second SmallGEO from OHB is the EDRS-C. It is the first dedicated satellite of the European laser-based data relay system EDRS with which a new standard of space-based communication is to be created to enable larger higher data rates to be transmitted more securely and in real time.

HEINRICH HERTZ: THE NEW STANDARD

This German mission is an extremely ambitious project to trial and verify novel technologies for satellite communication in space. "In this, the era of digitalisation and big data, it must be possible to transfer ever-larger volumes of data quickly and reliably. New technologies, such as those being probed in space on 'Heinrich Hertz', make this possible," said Dr Gerd Gruppe, Director of Space Administration, German Aerospace Center (DLR), who signed the contract with Marco Fuchs in mid-2017 for the development, construction and launch of the satellite.

The additional payload capacity on H2Sat is being used by the German armed forces to supplement their existing operational satellite communication via SATCOMBw. Germany is breaking new ground with this satellite because H2Sat is a joint initiative of the Federal Ministry for Economic Affairs and Energy (BMWi, leading role) and the Federal Ministry of Defence (BMVg). Heinrich Hertz plays a major role in the government's commitment to re-establishing German competitiveness in this field and and consolidating the recently regained systems expertise. OHB is pursuing this target by systematically developing small geostationary communications satellites.



One man's bid to secure a contract for two satellites

How OHB became the prime contractor for the FOC* satellites for the European satellite navigation system Galileo

"Secure one or two satellites" were Dr Ingo Engeln's orders from company founder and visionary Manfred Fuchs (1938 – 2014). No one would have predicted that, ten years later, OHB System AG would build 34 satellites for the navigation system.

Dr Engeln promptly set about carefully preparing the bid over the months that followed. He soon found the ideal partner in the guise of Surrey Satellite Technology Ltd. (SSTL). Together the two companies bid for the contract. "Our working relationship is governed by a document comprising just one page," revealed Dr Engeln, who today is Director of Reconnaissance Systems and Ground Stations for OHB System AG. "And the document essentially stands to this day. As manufacturer of the satellite platform and systems integrator, OHB is responsible for the satellite concept, the satellite platform, integration of the satellites and their verification. In addition, we provide the necessary support during the launch preparations and during in-orbit verification of our satellites. For each satellite, SSTL supplies the navigation payload and supports the integration and testing of it."

OHB THE HIDDEN CHAMPION

"At that time, we were newcomers to the ESA, at least in the field of navigation satellites. One advantage we had was that the SAR-Lupe contract had also given us experience of classified work. Besides, we really wanted to win the contract. At the end of 2008, we were one of two candidates who had qualified to bid for a FOC satellite," recalled Dr Engeln. "We managed to beat the other candidate hands down and, at the beginning of 2010, were awarded the contract for 14 FOC satellites. This took some supposed industry experts quite by surprise. We were all over the moon: the younger employees wanted to parade through Bremen in celebration..."

OHB also secured the contract in 2012 for the second batch of eight satellites. "By this point in time, we had proven our expertise and reliability in the two-year development and procurement phase," said Dr Engeln.

STEP-BY-STEP COMPLETION OF THE SATELLITE CONSTELLATION

In August 2014, the first two navigation satellites to be developed and built by OHB took off from the launch pad in Kourou. Initially, the OHB satellites were launched in pairs by a Soyuz rocket. At the end of 2017, a quartet of satellites was successfully launched into space for the second time on board an Ariane 5 ES launch vehicle. This brought the number of FOC satellites from OHB in space to 18.

"The next launch of four satellites in summer 2018 will not only complete the constellation but includes the first spares that will supplement the constellation," said Dr Wolfgang Paetsch, Director of Navigation, Earth Observation and Science at OHB System.

SERIAL SUCCESS

"The quality of our navigation satellites has once again spoken for itself. I am very grateful to the European Commission and the European Space Agency for the trust they placed in us and our partners," said Marco Fuchs, CEO of OHB SE and OHB System AG. His fellow board member Dr Paetsch added, "We have also secured the third batch: in June 2017 we were contracted to build eight Galileo satellites before the European Commission exercised a contractual option in October 2017 and ordered four further satellites."

THINKING OF TOMORROW TODAY

"The ambitious time line ensures that reserve satellites will be available in future both in orbit and on Earth," said Dr Paetsch. "However, the 34 OHB satellites on order have not made us complacent: for some time now our experts have been working on concepts for the next generation of satellites and the other services they will provide."

The quartet floats in: Four navigation satellites developed and manufactured by OHB System AG are being prepared for launch with an Ariane 5 ES rocket at the launch site in Kourou, French Guiana.

INFO

The European satellite navigation system Galileo will offer people in Europe and around the world an array of useful navigation applications. 24 operational satellites arranged in three planes, plus reserve satellites and a global network of ground stations can provide satellite navigation with an unprecedented level of accuracy and availability. The system went live on 15 December 2016.

Suggested links: http://www.esa.int/esasearch?q=Galileo&r=lokale_nachrichten_deutschland; http://www.esa.int/Our_Activities/Navigation

*) The Full Operational Capability phase of the Galileo programme is managed and fully funded by the European Union. The Commission and ESA have signed a delegation agreement by which ESA acts as design and procurement agent on behalf of the Commission. The views expressed here can in no way be taken to reflect the official opinion of the European Union and/or ESA. "Galileo" is a trademark subject to OHIM application number 002742237 by EU and ESA.

START-UP: flexible access to space

Competent launch services are a highly competitive growth market worldwide. Systems must be flexible in order to deliver satellites of all classes into space in a service that is quick and cost-effective, regardless of whether they weigh 50 kilos or several tonnes. The OHB Group's efficient solutions are a competitive force to be reckoned with.

The history of the European Ariane rocket is closely linked to OHB SE and its subsidiaries. Back when he worked at Entwicklungsring Nord (today Airbus), OHB founder Manfred Fuchs did the groundwork for the successful development of the European launch system. Having reliable access to space is absolutely essential for a satellite manufacturer, so transport systems have always been a focus within the Group.

ENTERING THE LAUNCH BUSINESS

OHB entered the launch services business as far back as the 1990s when it established Cosmos International Satellitenstart GmbH. It began with Russian Cosmos launch vehicles. These were cheap, robust and powerful and gave the company considerable competitive advantages.

The purchase of MAN Neue Technologie – today MT Aerospace AG – meant that the OHB Group became the lead German supplier for the Ariane rocket in 2005. The Augsburg-based MT Aerospace has been involved in the European signature project for more than four decades now. Since 2005, therefore, OHB has played a part in ensuring Europe's independent access to space. The success of the endeavour is confirmation that this was the right strategic decision: MT Aerospace's turnover has doubled in the past twelve years and now, more than ever, it is an indispensable component of Europe's space industry.

EUROPE'S SIGNATURE PROJECT

MT Aerospace is also playing an important role in the development of the future Ariane 6, which is scheduled to make its maiden flight in 2020. The company from Augsburg is a main contractor, with a 10% work share, responsible mainly for the fuel tanks and metallic structural components. In addition, for more than 40 years MT Aerospace and MT Mechatronics have played a key role in the realisation of all launch facilities for the six Ariane generations at the spaceport in Kourou.

Firstly, technological advances in the Industry 4.0 era have made a tripling of productivity possible. Secondly, the Ariane 6 programme is a step-up in terms of finances, resources and flexibility: overall, the project is 40% cheaper and re-ignitable. Ariane 62 will launch payloads of up to six tonnes and will replace the europeanised Russian Soyuz launch vehicle. Ariane 64 is capable of launching up to twelve tonnes and is therefore intended for large missions.

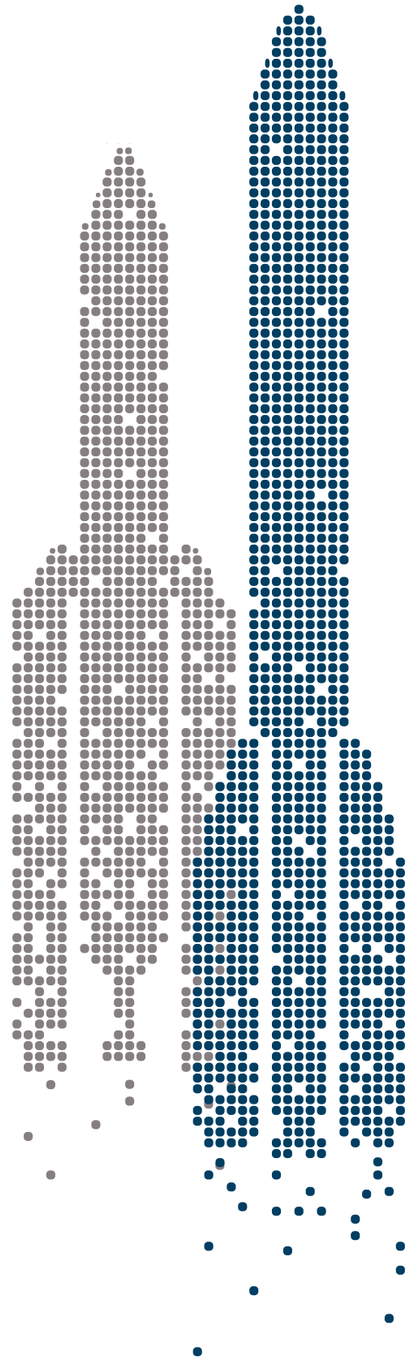
FLEXIBLE LAUNCHER SOLUTIONS

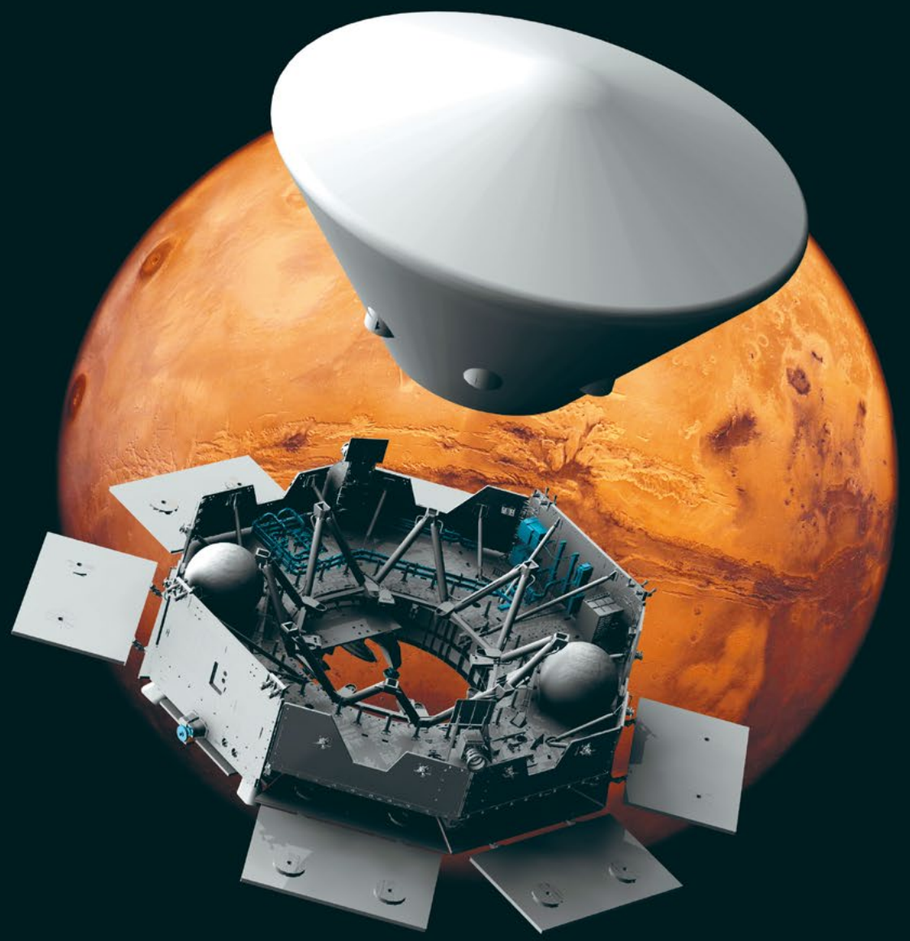
The ESA recently commissioned MT Aerospace to do a feasibility study on smaller launch vehicle systems. This is in response to the growing demand from companies looking for commercial launch service packages to launch microsatellites into low-Earth orbit. The study will develop three micro-launch concepts in collaboration with various partners, e.g., a two- to three-stage scenario for payloads up to 200 kilos, so that such companies will no longer be reliant on rideshares on large missions. "Launch vehicles and optimising the technology and cost aspects is part of our core business," said Hans J. Steiniger, CEO of MT Aerospace. In developing such systems, the OHB Group is playing its part in helping Europe to achieve and, indeed, maintain its pioneering role in space.

SPACE LAUNCH BROKER

It is extremely important for the space companies within the Group to have fast, flexible and cheap access to space. For this very reason, more and more OHB companies are entering the launch sector, OHB Italia among them. The Milan-based company recently played a leading role in the launch services for the satellite system OPTSAT-3000 for the Italian Ministry of Defence. 2018 will see the launch of another Italian mission, the Earth observation satellite PRISMA, which will be used in environmental monitoring and for national security applications. OHB Italia is responsible for the launch of the 900 kg satellite aboard the ultra-light Vega launcher from the spaceport in Kourou on behalf of the Italian Space Agency (ASI).

"Our aim is to provide access to space at competitive terms. To this end, we intend to establish ourselves as a space launch broker," said Marco Fuchs, CEO of OHB SE, commenting on the Group's plans for the future, which, with the new OHB Cosmos International, offers various in-orbit and launch services in an uncomplicated, customized and cost-efficient manner.





“Space, the final frontier…”

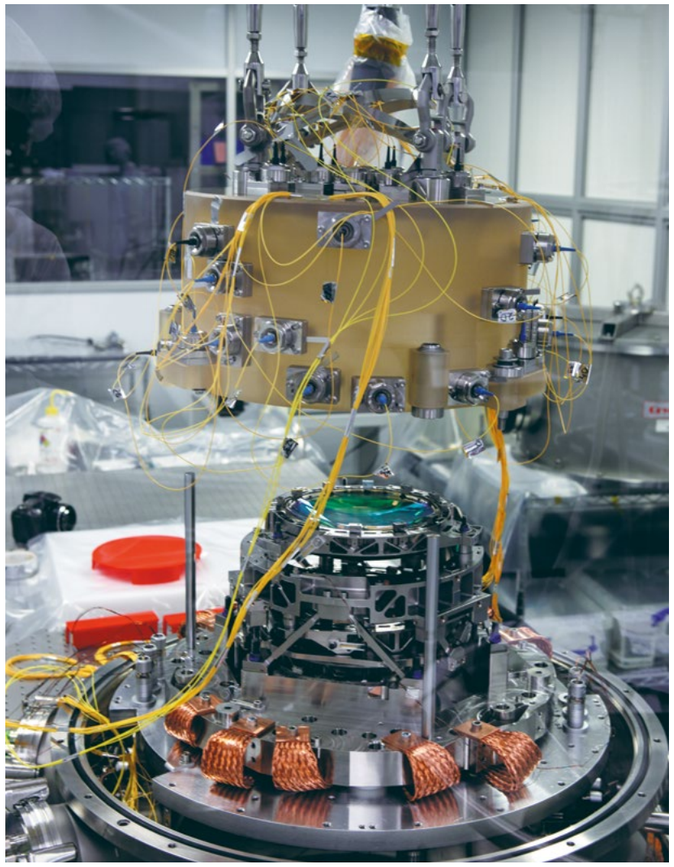
The legendary television series Star Trek was fascinating viewing. Yet just as fascinating is our human desire to explore the vast universe and its planets and phenomena.

When the US programme “Moon, Mars, and Beyond” gave the topic of space exploration a new lease of life at the beginning of the 2000s, the companies within the OHB group were already looking into potential mission scenarios in great detail. As a result, today the companies play a central role in European exploration projects. Take ExoMars as an example, whose mission is to explore the Red Planet.

IS THERE LIFE ON MARS?

The programmes comprises two missions: Part 1, a Trace Gas Orbiter (TGO) and a landing module, were launched in March 2016. The most important German contribution to the Orbiter comes from OHB System in Bremen: the propulsion system, the mechanics and the heat shield. The TGO began its scientific mission recently. Europe will embark on the second ExoMars mission in 2020, the aim of which is to try to answer the question: Is there or was there ever life on the Red Planet? A stationary Russian station and a mobile rover, transported by a carrier, will continue and step up the search for traces of life. Under contract from Thales Alenia Space, as before, OHB in Bremen will have overall responsibility for the carrier for this follow-on mission. The team in Oberpfaffenhofen in Southern Germany will deliver important elements for the rover – such as a high-resolution camera, a complex system for sample preparation and distribution – and will also contribute to the RAMAN/RLS laser instrument, which facilitates mineralogical examinations in-situ.

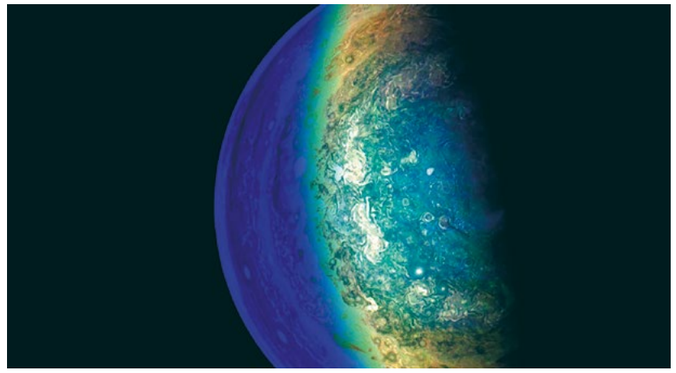
Antwerp Space is responsible for the communications system on board the carrier, which maintains contact between the ground station and the spacecraft throughout the mission to Mars. Last, but not least, the Antwerp team is supplying the scientific instrument LaRa (Lander Radioscience) for the ESA. LaRa aims to provide insights into the internal structure of Mars and, by doing so, to help us understand why Mars and the Earth did not develop in similar ways.

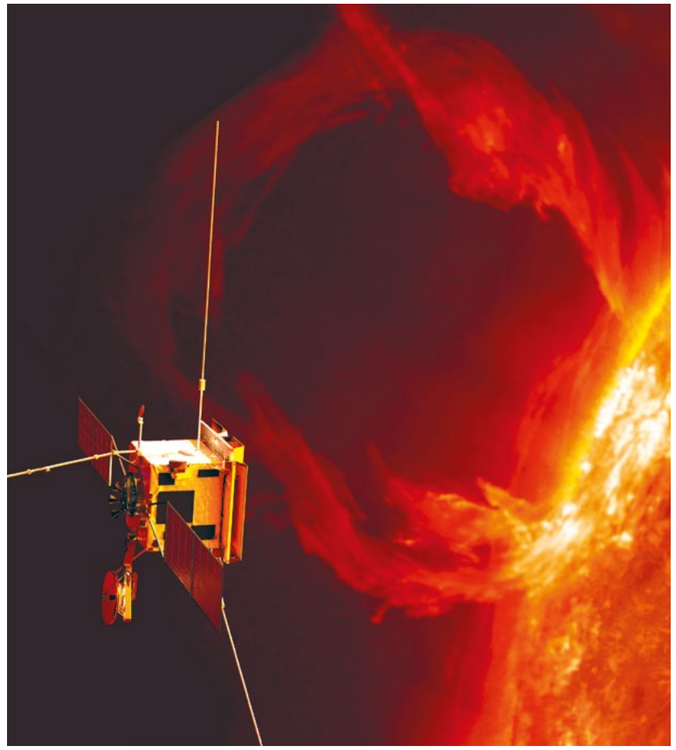


The flight model of the NISP lens for Euclid in the vacuum chamber at OHB in Oberpfaffenhofen shortly before the performance test.

WHY IS THE EXPANSION OF THE UNIVERSE ACCELERATING?

This is the fundamental question that the Euclid mission under the ESA programme Cosmic Vision 2015–2025 is endeavouring to answer. Dark energy is thought to be responsible for accelerated expansion. Dark energy and dark matter make up the vast majority of the universe. Both are mysterious and unknown forces, but they control the past, present and future evolution of the universe. It is hoped that, from 2020 onwards, the Euclid space telescope will shed some light on the matter. Two instruments – an optical imaging camera (VIS) and a spectrometer/photometer for the near-infrared spectrum (NISP) – will survey the universe with unprecedented accuracy. The companies in the OHB group are closely involved in Euclid. The optical system of the spectro/photometer NISP is being developed and built by OHB System in Oberpfaffenhofen in cooperation with the Max Planck Institute for Extraterrestrial Physics MPE. OHB Sweden has been commissioned with development of the propulsion systems.OHB Italia is developing and building the two data processing units for the scientific instrumentation.





ARE THERE EXOTIC LIFE FORMS ON JUPITER?

Another strand of the ESA's Cosmic Vision Programme is JUICE (JUpiter ICy moons Explorer) which is dedicated to the exploration of Jupiter and three of its largest moons: Europa, Callisto and Ganymede. Antwerp Space is responsible for the communications system, including development, integration and testing. The JUICE Com System engineering model will soon be installed in Antwerp Space's new cleanroom.

JUICE is slated to launch in June 2022 on board an Ariane 5. The journey to Jupiter will take almost eight years. From January 2030, the observations made by JUICE will provide insights into the origin of gas giants and their moons as well as into potential exotic lifeforms under their crusts of ice. The probe will also study the atmosphere and magnetosphere and Jupiter's influence on its moons and vice versa.

HOW DOES THE SUN CREATE THE HELIOSPHERE?

The ESA's Solar Orbiter aims to answer this and other questions. Work on the satellite, for which OHB Sweden is responsible for the Attitude and Orbit Control System and the Chemical Propulsion System and for which OHB Italia is contributing to the METIS telescope, is at an advanced stage. The Orbiter is scheduled to launch in 2020 and it will perform close-up observations of the Sun and its effects on the solar system. The spacecraft will carry a suite of complementary instruments that will measure the particles, fields and waves of the plasma through which it travels, and at the same time, make observations of the Sun's surface and outer atmosphere, the photosphere and corona.

SETTING OUR SIGHTS ON EXTRASOLAR PLANETS

OHB is also involved in the PLATO mission (PLAnetary Transits and Oscillations of stars) within the scope of the ESA's Cosmic Vision programme. PLATO is scheduled to get underway in 2026 at the latest and will seek out thousands of, as yet, undiscovered extrasolar planets within just a few light years of Earth. OHB has been commissioned by the DLR Institute of Planetary Research in Berlin with the coordination of the payload and construction of the 26 telescopes, including the associated electronics, for the PLATO instrument. Furthermore, the company is currently bidding to become system lead for the ESA and DLR satellite.

558

As of March 2018, the total number of people who have been in space since Yuri Gagarin and his legendary space flight on 12 April 1961.

1859

was the year in which a solar coronal mass ejection caused the largest ever geomagnetic storm observed by scientists on Earth. It caused huge disruption to the telegraph network, which had just been established worldwide. The phenomenon, named the Carrington event, also led to auroras that were visible as far as Rome, Havana and Hawaii.

25,000,000,000

virtual galaxies have been generated out of trillions of digital particles by researchers at the University of Zurich in a simulation of the formation of the universe using the supercomputer "Piz Daint". This catalogue is being used to calibrate the Euclid satellite that will be launched into space in 2020 with the objective of investigating the nature of dark matter and dark energy.

227.7

is the number of kilograms a person who weighs just 90 kilograms on Earth would weigh on Jupiter. Better to go to Mars, where the scales would read a more flattering 34.2 kilograms.

93

Number of Ariane 5 launch vehicles that MT Aerospace will have helped to build when the last shipset is delivered in mid-2020. This generation has been in operation since 1996 and is the most reliable, most powerful and most successful rocket ever.

1

The number of votes by which a 1993 bill to cut from the NASA budget an already much diminished version of the Space Station Freedom programme failed in the House of Representatives. This led to the US entering into talks with many other nations, which ultimately gave rise to the collaborative International Space Station ISS.

OHB Group Worldwide

OHB Sweden AB
Stockholm

ANTWERP SPACE N.V.
Antwerp

LUXSPACE SÀRL
Luxembourg

MT AEROSPACE Guyane S.A.S.
Kourou

MT MECATRONICA LTDA
Santiago de Chile

OHB System AG
Bremen

MT AEROSPACE AG
Bremen

MT MECHATRONICS GmbH
Mainz

MT AEROSPACE AG
Augsburg

OHB System AG
Oberpfaffenhofen

OHB Italia S.P.A.
Milan