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The main contractor was the consulting firm SpaceTec Partners (Munich/Brussels) with the involvement of the law firm BHO Legal (Cologne/Munich).



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This summary contains the main core statements of the overall study, which is available at <http://www.bmwi.de/DE/Mediathek/publikationen.html>. The long version of the study explains the concepts presented and the specialised terminology.

N.B.

We would like to point out that the statements and recommendations contained in the studies do not necessarily reflect the opinions of the Federal Ministry for Economic Affairs and Energy in its capacity of contracting authority. Errors and defects in the study are solely attributable to the study team.

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Rainer Horn



Dr. Norbert Frischauf

As a specialised independent business consultancy, we are at home in virtually all space disciplines. Our advisory activities are focused on navigation, satellite communication, earth observation together with overarching mobile services and security applications.

Our consultants have many years of experience in the provision of strategy advice and in the aerospace industry. Our core team has been working together since 2003 and some of our experts can look back on thirty years of experience in the space industry. Eight nationalities are represented in our international team. With offices in Munich and Brussels, SpaceTec Partners operates at an international level. We have excellent contacts on the international space scene and are represented in various groups of experts.

We advise clients in strategic, organisational and regulatory matters. Our public clients include the European Commission, space agencies as well as federal and regional authorities. We support industrial companies in business development, internationalisation of financial transactions and project funding. Our certified coaches accompany small and medium-sized enterprises in business development and alignment.



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BHO Legal advises public and industrial clients in European and national technology projects. Our range of advisory services is focused on procurement law, IT law, R&D law, contract law, aviation and space law, as well as relevant European and international law. We support all types of space projects at a national and European level, including major projects such as Galileo, EGNOS, Copernicus or SatcomBW. We advise companies in the participation in procurement procedures or grant applications, in the drafting and negotiation of contracts, in the foundation of project companies and project syndicates, and in all questions of judicial project management. Outside of the space industry, we primarily support projects in the areas of geo-information, UAVs, security and defence and in all aspects of IT and R&D projects.

Our law firm was founded in 2008 by the lawyers Dr. Ingo Baumann, Dr. Oliver Heinrich and Dr. Roderic Ortner. In 2010, BHO Legal was awarded the first prize in the nationwide law firm founders competition of the Hans Soldan Foundation of the German Chambers of Law, the German Lawyers Association and the Frankfurter Allgemeine Zeitung.

BHO Legal has its headquarters in Cologne with a branch in Munich. We are members of the International Institute of Space Law (IISL), European Centre for Space Law (ECSL), the Space Committee of the International Bar Association (IBA), the European Association of Remote Sensing Companies (EARSC), BavAIRia e.V., UAV DACH and UVS International.

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1. BACKGROUND AND CONTENT OF STUDY

The space strategy of the German Federal Government of 2010 identified the main trends in the international space sector and in its guidelines set important priorities for the positioning of Germany. For example, it already took into consideration the impact of the US space policy on the intensified commercialisation and government use of private providers for carrier systems and satellite services. Commercialisation is making fast progress particularly in the USA. The foundation of new companies with a high private capital deployment, the use of new technologies and approaches, and the convergence with the information technology sector are forming the basis for what has been referred to for some time in the professional world as "**NewSpace**".

The importance of information technology in space is growing at a steady pace. Fifty years ago, it was space that paved the way for the ICT industry. It is now the ICT industry which is setting the pace in the space industry. The dynamism of the ICT sector is far higher than in the traditional space industry, driven by a short generation cycle of 2-3 years, high competitive and innovative pressure in mass markets, and the **increasingly broader digitalisation of the global economy** and the private world.

There have already been two IT generations over the last six years. In this period US\$ 2-3 billion has been invested in companies and projects such as SpaceX, SkyBox, Spire, PlanetLabs or OneWeb in the USA. The globally **unique combination of venture capital and entrepreneurship** on the US West Coast has become the pacesetter for the commercial space industry. US government agencies support the trend through massive investments and as anchor clients for the new systems and services.

Mega-constellations on the basis of **mini-, micro- and nano-satellites** ("CubeSats") are the icons of the NewSpace scene. They have the potential for diverse commercial applications, particularly in earth observation, for broadband connections and for the Internet of Things. Inspired by internet entrepreneurs, new Big Data and geo-information business models are developing. Mini-, micro- and nano-satellites require different launch systems than a five-tonne geostationary communication satellite.

New carrier rockets are being designed and built worldwide in order to provide NewSpace companies with a more favourably priced access to space. Launch systems must also be available more flexibly and at distinctly shorter intervals than has been the case up to now. Elon Musk has created precedents with SpaceX and Falcon-9. The

visionary internet entrepreneur has pursued one goal since his childhood: to get a man to Mars. SpaceX is an element of the required interplanetary transport infrastructure. The promise to create a favourably priced access to space brought Musk early and lasting support from authorities and satellite operators. NewSpace will also be of utmost relevance to institutional stakeholders.

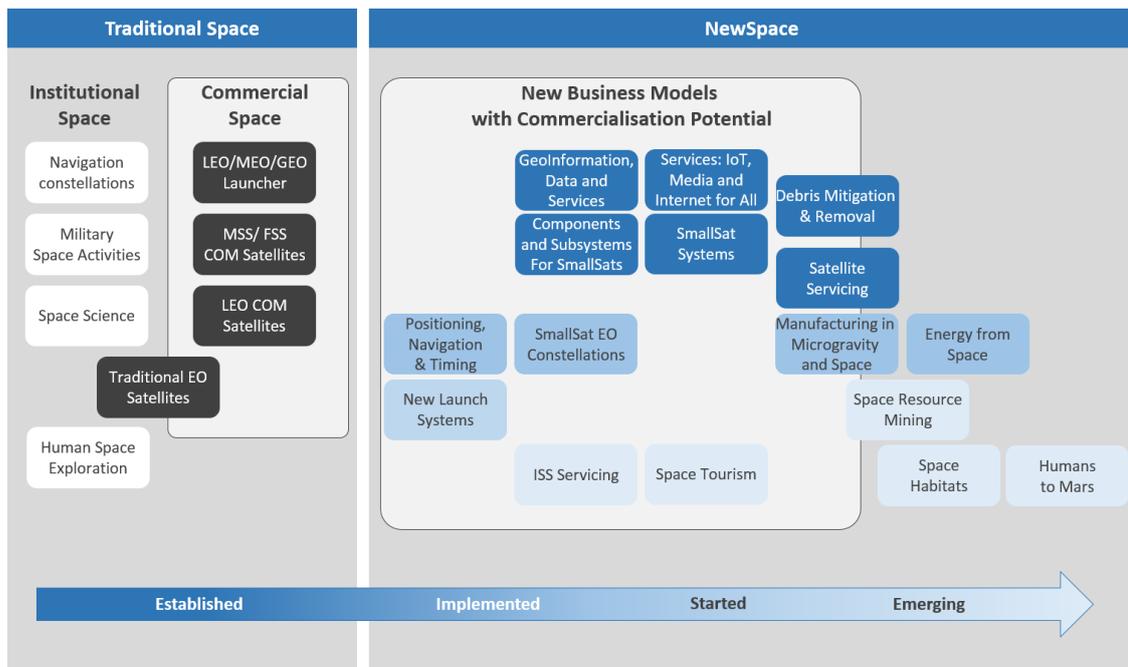


Figure 1: Current and future NewSpace business fields

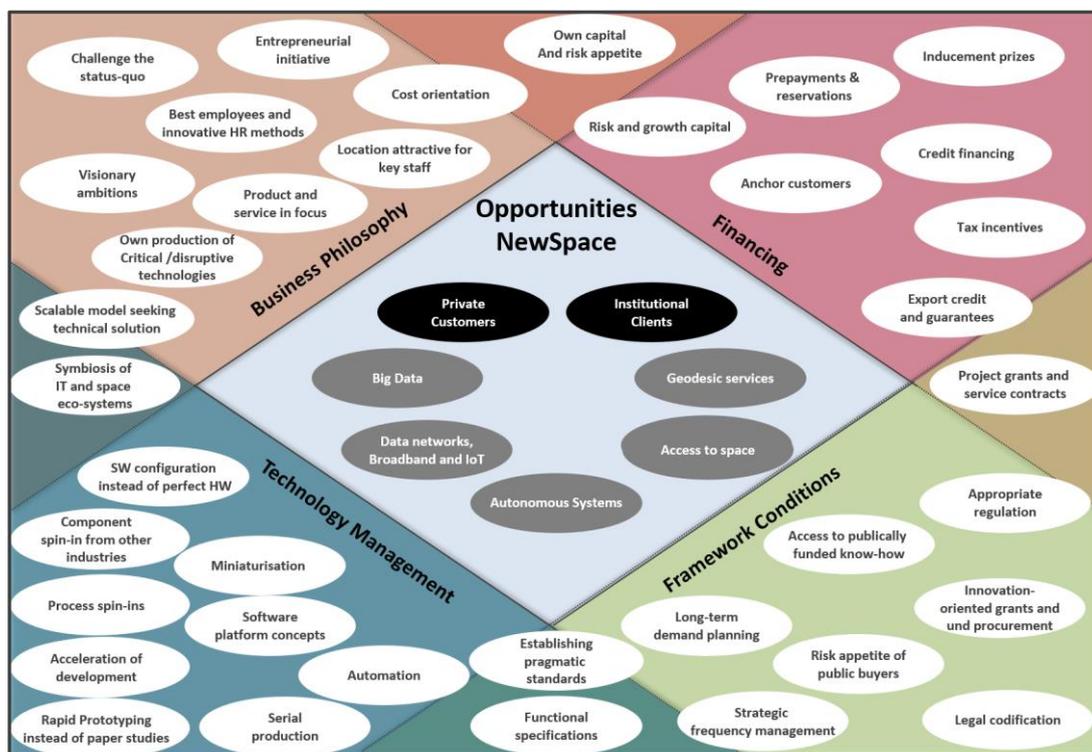
Figure 1 shows today's diverse and most economically important business fields of the traditional space industry and various NewSpace business models. **NewSpace is gradually developing new commercial fields beyond the traditional commercial space sector.**

This study is part of an action plan of the Federal Ministry for Economic Affairs and Energy/DLR Space Administration, Federal Association of the German Aviation and Space Industry (BDLI) and the German Industrial Union of Metalworkers (IG Metall) to review the German framework conditions in the face of current and future developments - particularly the rapid development of the commercial space industry in the USA.

With this study the Federal Ministry for Economic Affairs and Energy has taken up the NewSpace thread. In an effort to better understand the driving forces behind NewSpace and thus to generate advantages for German industry, **the study examines** the following areas:

- **Business and finance models** of NewSpace in context
- Approaches for using the resultant **opportunities** for the German industry, and
- The requisite **framework conditions** and **political fields of activity**.

The success factor dimensions have been prepared iteratively and used for the study layout. All in all, 37 success factors have been identified, described and analysed in terms of their relevance for Germany:



An overview of the issues of relevance for NewSpace is provided with respect to the legal framework conditions. Focus is placed here not solely on international and national space law; rather, a broad as possible evaluation of the aspects important for NewSpace from the different legal areas was called for.

2. OPPORTUNITIES PRESENTED BY NEWSPACE TRENDS

NewSpace is driven both by new markets for services and applications and by the development of disruptive technologies and products. However, the **focus** is not placed on technologies as it is in the traditional space industry but **on the market success to be had from innovative applications**.

Many founders of the American NewSpace companies come from the IT industry and use the experience and financial means generated from their previous start-ups. Their business philosophy is characterised by the **focus on developing products and services in line with demand**, challenging the status quo, promoting innovative ideas out of the box, strictly adhering to costs, and on company locations which are attractive to highly qualified employees from all over the world.

The **increasing convergence of space with the IT sector** is reflected at several levels: on the one hand, the IT sector is producing great demand for global systems and services to cover the demand for broadband, for the Internet of Things, for location-based services or for Big Data. On the other hand, business models (e-commerce), services (cloud computing) and approaches (agile software development) are being transferred from the IT to the space sector.

Preference is given to producing critical elements in-house whilst remaining open to sharing ideas according to the "Open Source" principle if there is a strategic benefit. In the same way as IT, **technical solutions are sought for scalable business models**. Instead of insisting on customised and therefore expensive individual products - as is usual in the space industry - use is made of commercially available components where possible, e.g. from the aviation or automotive sector.

One characteristic of the entrepreneurial initiative of the stakeholders is the **willingness to assume the risk of initial funding**. The foundation for this is provided by the physical proximity to **venture capital investors** who provide the main share of funding. Government aid is also leveraged, e.g. export loans from state-owned banks, long-term service contracts with authorities or purchase guarantees, traditional R&D grants, the transfer or use of state infrastructures and also tax relief.

A favourable aspect in the USA is the **legal framework conditions which are geared to commercialisation** and reviewed for efficacy in short cycles. After commercialisation of satellite communication and earth observation was regulated at an early date, the Space Act 2015 represented a further step, preparing the way for commercial projects aimed at the extraction of raw materials in space.

A characteristic feature of NewSpace companies is the **primary alignment of their business model to market opportunities**. These result from:

- **Institutional customers** such as space agencies, security authorities or the military
- **New private customers**, primarily from the ICT sector, and increasingly also from other industrial sectors.

Opportunities in NewSpace

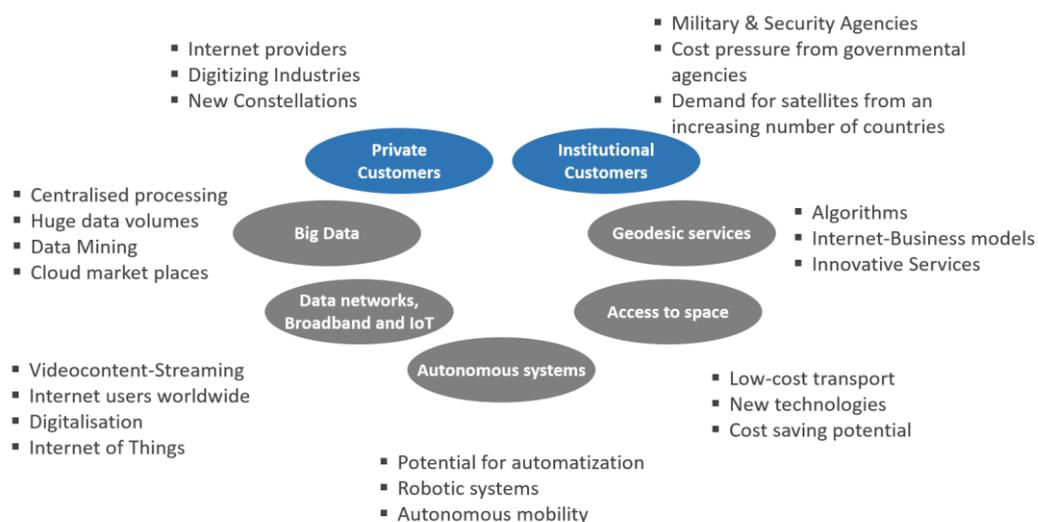


Figure 2: Opportunities and market drivers of NewSpace

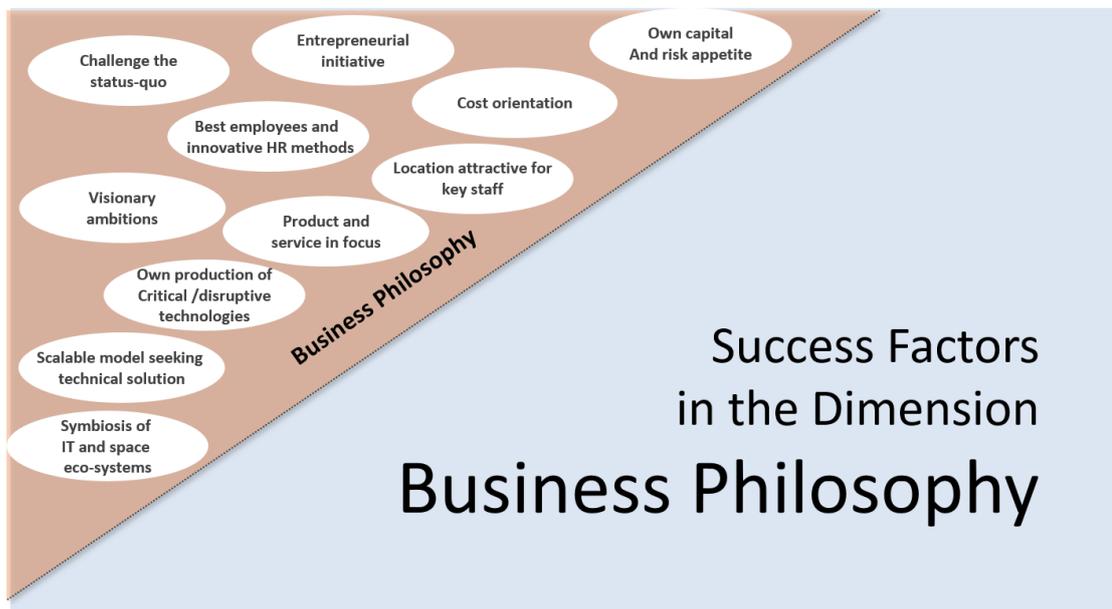
The market drivers are primarily in the following fields of application:

- **Global data networks, broadband coverage, and the Internet of Things**
- **Geo-information services** for applications in the private sector, e.g. in the insurance sector or in the oil and gas industry
- **Big Data** applications which capture data with the assistance of satellites
- **Autonomous systems** which are based on satellite navigation and communication for the purposes of steering and control.

3. SUCCESS FACTORS FOR NEWSPACE IN GERMANY AND RECOMMENDED ACTION

Our analysis of the trends and drivers of NewSpace showed that the **US model cannot be transferred 1:1 to Germany**. The differences in the characterisation of the four success factor dimensions are too great:

3.1 Business philosophy – promote more entrepreneurship



The North American NewSpace eco system à la Silicon Valley is unique in terms of entrepreneurship, innovation, willingness to take risks, HR policy, communication culture and global market ambitions. Germany lacks the entrepreneurial spirit to break free from the traditional system and to systematically focus on new markets and customers.

There are also hardly any founders or investors from other industries due to the rigidity of the space sector and the required high initial investment. The species of the "Serial Entrepreneur" is not very widespread in Germany (and Europe). The "business philosophy" dimension will be difficult to emulate for the German space industry, let alone replicating it. However, sooner or later it will have to react to the approaches and cost pressure of NewSpace.

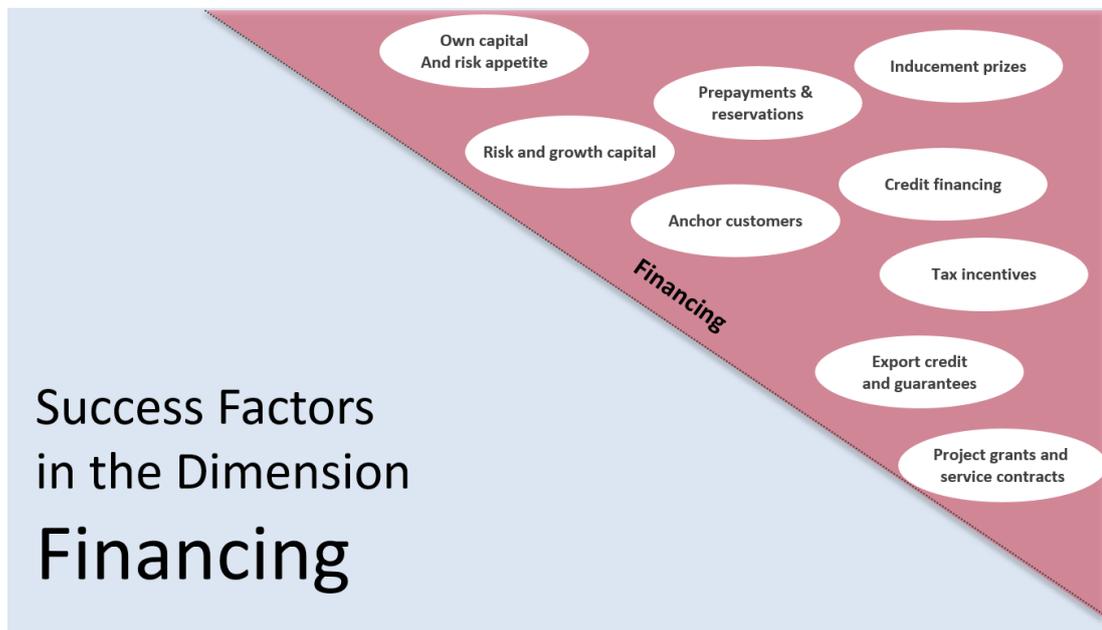
- NewSpace entrepreneurs are driven by an unconditional orientation to applications, markets and costs.
- Space technology is frequently no more than a means to an end in "Think Big" scalable business models.
- Entrepreneurial approaches from the IT sector facilitate a speed for dynamic corporate development which has so far been unknown in the space sector.
- The status quo is systematically questioned time and again, 'make or buy', 'in- or outsourcing' is decided according to purely pragmatic principles.
- The Silicon Valley has a unique pool of human resources with great attraction for talent from all over the world.
- Successful NewSpace companies are able to win and keep the best people by giving them the feeling of being somebody special whilst offering salary packages which reward maximum commitment and loyalty.

The accelerated commercialisation of space needs new entrepreneurial spirit - amongst all parties concerned: in the established space industry, in young companies and also in the relevant institutions. Entrepreneurship cannot be prescribed by the state; but the state can provide incentives and create framework conditions for the successful formation of new companies and the development of new markets. Industry must adapt to the market situation which has altered by digitising space and develop an understanding for NewSpace customers or their markets (e.g. the internet economy). Only in this way can new customer groups be won.

A start-up eco-system can support young companies, spin-offs and technology transfer, and promote a culture of entrepreneurship. More dialogue with the entrepreneurs in the IT and internet industry and the strong industrial software sector could provide a new stimulus for NewSpace in Germany.

Institutions supporting NewSpace and wishing to use the new possibilities should provide the new companies with entrepreneurial leeway to develop creative solutions instead of confronting them with technical specifications down to the very last detail. New possibilities provided by budgetary and procurement law should also be exploited here, including the use of contractual drafting options.

3.2 Financing – create financing attuned to NewSpace



The possibilities provided by the combination of wealthy entrepreneurial personalities and well-networked venture capital investors in the Western United States, supported by a space policy oriented to commercialisation and the huge demand from the military and security authorities are extraordinary. Spectacular success stories (SkyBox, SpaceX, etc.) are attracting new founders, incentivising the VC scene and facilitating the financing of so-called "disruptive" technologies and business models.

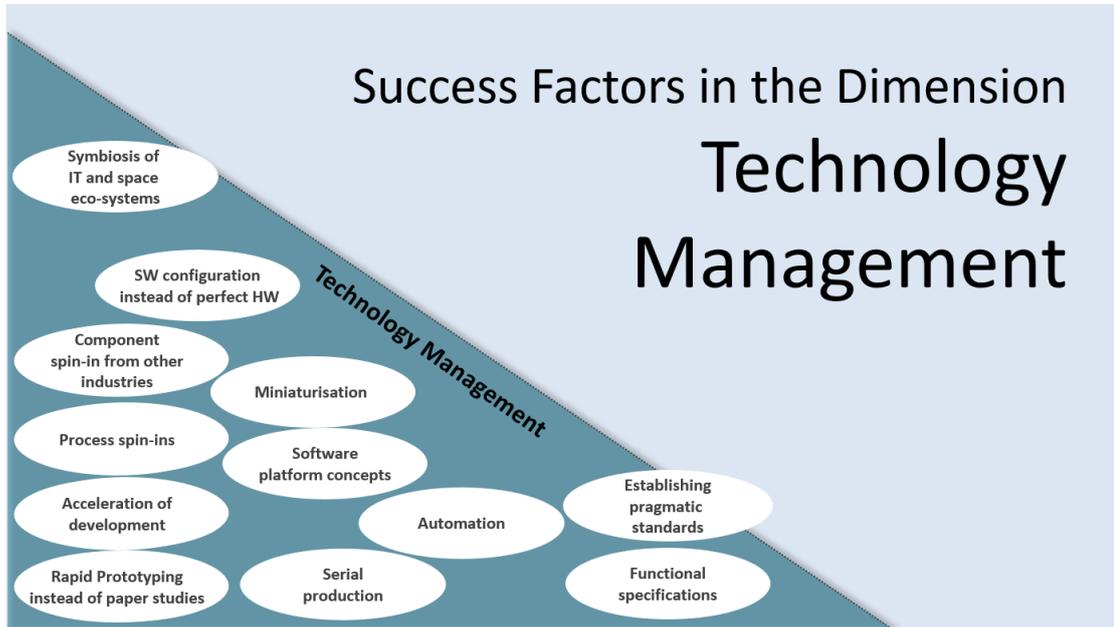
A comparable continuous finance chain with fast and risk-taking decision culture does not yet exist in Continental Europe. For German banks, space is fraught with risk and is exotic per se; the long development and project cycles deter the few private lenders there are. Whilst venture capital companies are highly committed in the USA, little of this commitment is noticed in Europe.

- NewSpace entrepreneurs in the USA are not afraid to invest initially their own capital and to attract thus additional financing sources.
- The finance chain in the USA works. Business angels, venture and growth funds cooperate closely, supported by the physical and frequently also personal proximity of high-tech companies and investors.
- The investors are primarily motivated by money. However, a few of the larger venture capital companies also invest in NewSpace out of a certain personal own interest.
- 25 billionaires have so far invested in NewSpace.
- Over 60 venture capital investors are active in NewSpace. A few venture funds regularly invest in NewSpace and frontier technology.
- In the NewSpace finance mix, venture capital is combined with traditional financing instruments of space (public contracts, the government as anchor customer and export support).
- Publicly tendered incentive competitions with precisely formulated objectives can mobilise global creativity; the financial factor is of secondary importance here.

Germany has a unique density of initiatives for the early phase, diverse high-tech hotspots and powerful state banks. This provides the potential to support NewSpace in diverse ways and **gradually close financial gaps**. The aim should be to tap a broader pool of entrepreneurs whilst at the same time creating a continuity in financing by **multipliers** advocating the "NewSpace idea" at every level of financing: prominence amongst Business Angles, systematic use of existing (semi-)state early phase investors and strengthening of by the venture capital eco-system through specialised funds. State guarantees and well prepared model examples could help to mobilise the banking industry for space topics.

Project funding in NewSpace should be provided **in proximity to the market**, e.g. by financing of targeted projects which promise a successful entry to market. Instruments such as inducement prizes can additionally promote innovation whilst at the same time sparking a broad-based effect. To maintain the export strength of the German space industry and extend it to NewSpace, international competitive disadvantages due to a lack of export finance instruments should be avoided. An institutional unit responsible for the export development of German companies could be beneficial here.

3.3 Technology management – live digitalisation



NewSpace is not so much about developing new technologies but rather systematically implementing business models and approaches of the ICT sector ("patching and releasing"), making use of tried and test products from other areas of technology ("spinning in"), and focusing on market opportunities ("surfing the trend wave").

With NewSpace the cards in the space industry are being reshuffled. A supplier of today can have system competence tomorrow and rise to be a global player. The strict market orientation of NewSpace permits growth of a kind which is so far unknown in the space industry.

Global internet companies (Google, Amazon, etc.) with the imagination to inspire new business opportunities are absent in Europe and Germany. By contrast, we have possible synergies with other sectors (automotive, mechanical engineering, etc.) in which Germany leads the world. Intelligent transport systems, self-driving cars and the Internet of Things offer huge opportunities. It is important to act quickly here. The effects of scale of NewSpace go hand in hand with large hurdles to market entry if one or two companies have already filled a niche.

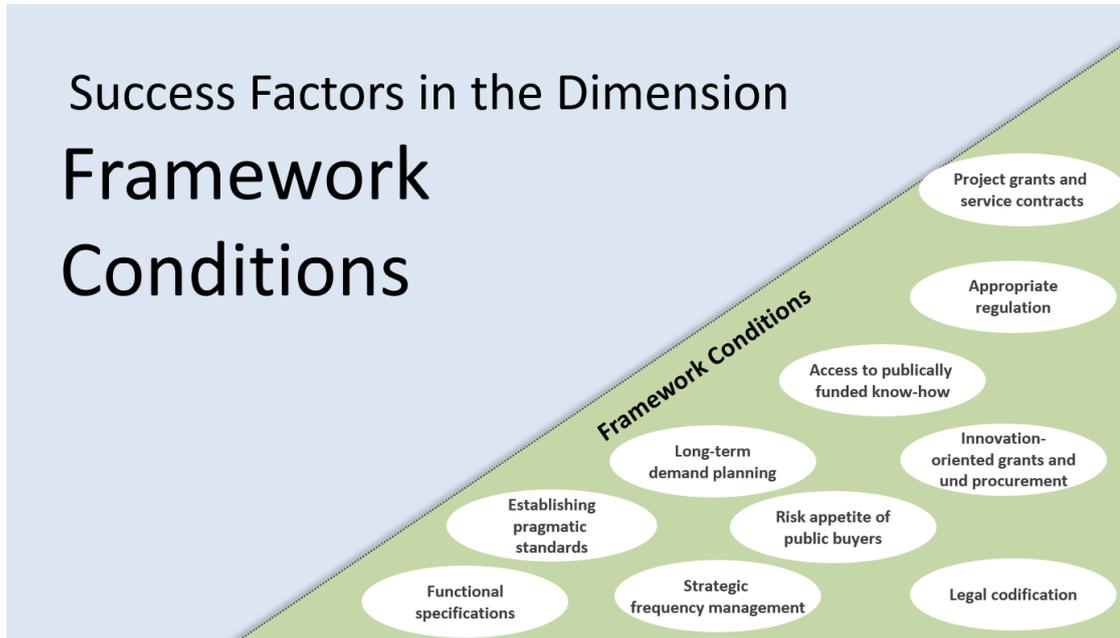
- The symbiosis of the space industry and the IT sector as technology provider, source of processes and market potential is an important success factor for NewSpace (in the USA).
- The use of components which are already commercially available in other sectors is cheaper and more efficient than expensive special developments.
- The capabilities and adaptability of modern software permit the use of hardware which is not perfect.
- Higher performance computers facilitate Artificial Intelligence (AI) algorithms which permit a greater degree of autonomy and savings in satellite operating costs in the two-digit range would appear to be possible.
- The establishment and use of pragmatic standards reduces the time from paper to orbit considerably.
- Additive manufacturing (also referred to as 3D printing) permits faster development as a result of rapid prototyping and higher flexibility in series production, helps to save on weight, and reduces the supplier risk.
- Miniaturisation is and remains one of the great driving forces of NewSpace because it permits stakeholders with great ambitions but small budgets to gain a foothold in the space sector and to supply it with innovations.

In order to be successful in NewSpace the German space industry should open up to innovations and processes from other industries and be consistently guided by application and customer requirements. More than technology is required here. Speed is decisive to be successful in the competitive environment of NewSpace. Runners-up today may not even have a market tomorrow.

In view of the rapid technological and market developments with shorter generation cycles, development must be accelerated and closely interlinked with production. The requisite instruments - rapid prototyping, agile software models and 3D printing technology - are available.

This type of thinking may be new for traditional space companies but it has already become established in other sectors. An overarching exchange is therefore necessary throughout industry which should go in both directions, including mentoring by non-space companies but also incorporating applications-oriented NewSpace promoters in Industry 4.0 working groups. This permits an out-of-the-box approach and promotes innovation which can be successful in the market.

3.4 Framework conditions – secure competitiveness



Both the political and the legal framework for the commercialisation of space were put into place in the USA back in the Eighties. Private operators of communication satellites were established, thereby breaking the worldwide monopoly of the international satellite organisation Intelsat. As a next step, earth observation was opened to private companies. Through long-term service contracts, the US authorities enable companies such as DigitalGlobe to maintain the capital to develop and maintain efficient commercial earth observation systems. The Space Act 2015 set the legal framework for further commercialisation, primarily with launch systems, space tourism and the exploitation of raw materials in space. The strict export control law was amended to strengthen the international competitiveness of American companies. The government credit institution EXIM is used to support large export deals of American companies. Some European countries have already reacted to NewSpace in terms of legislation, particularly with respect to the adjustment of approval procedures, liability regulations and insurance duties for small and micro-satellites.

- The space industry is subject to a very complex international and national regulatory framework. In some respects, NewSpace leads to a new need for regulation particularly for small and micro-satellites.
- The scarcity of available frequencies is exacerbated by mega-constellations and generally by the large number of planned satellites. States must secure rights of use for their own requirements and those of their industry.
- Easier and cheaper access to government-assisted research results and state research infrastructures promotes the development of commercial products and services from innovative companies.
- Within the scope of the possibilities afforded by law, the government as customer must accept higher risks to bring new companies with their products and services to market.
- Long-term demand planning by state customers provides incentives and investment security to industry
- Specifications with functional requirements promote innovation on the corporate side.

Future German space legislation could provide the foundation for new commercial systems and the establishment of NewSpace companies. Orientation is provided by the recent amendments to space legislation in other European countries. Liability and insurance duties are to be structured such that they do not inappropriately disadvantage national industry by European and international comparison and also include provisions for small and micro-satellites from the outset.

Based on the German Space Strategy and measures already taken, such as the Components Initiative of the German Space Agency, there should be a firm export strategy which also considers NewSpace. Tried and tested measures established in other industrial areas (delegation trips, representation at international trade fairs, bilateral cooperation agreements) should be used selectively and be specifically aligned with NewSpace. American and French companies have achieved visible competitive advantages through the massive support of EXIM and Coface. Thought should be given as to whether and how German institutes for the promotion of exports (KfW etc.) can be effectively used to facilitate exports of the German space industry.

Germany must be in a position to obtain adequate licences from the ITU for future public and commercial satellite systems. The scarcity of suitable frequencies is intensified due

to the large number of registrations for new mega-constellations. German licences should be maintained and extended where possible.

New innovation-oriented support and procurement instruments (PCP, PPI, innovation partnership) should be tested in the space sector. They can contribute to ensuring that new products and services are geared to the specific requirements of public customers and reach the market from the prototype stage without having to go through the "valley of death". Public customers can selectively control research and development in terms of their future requirements. Long-term and reliable planning is therefore called for.

A systematic aggregation of public demand for satellite-based services in Germany could be an important stimulus for commercialisation. Through common or coordinated procurements, a critical size could finally be achieved in which companies selectively develop and offer services to meet the requirements. Long-term service agreements according to the American NGA model would establish national authorities as anchor customers for German companies.

For new companies in the start-up phase it may be important to be able to use the infrastructure existing in research institutes for test and validation purposes, for example, without excessively high administrative hurdles and costs. This has been given particular emphasis in a recent study for NASA.

4. NEWSpace AS THE LINK BETWEEN SPACE STRATEGY AND DIGITAL AGENDA

New space applications offer broad fields of use in other sectors. In the industrial Internet of Things, NewSpace could win new groups of customers with more secure communication, surveillance and navigation systems precisely also for safety- and security-critical applications. In cooperation with Industry 4.0, Germany has the unique opportunity to counter the US NewSpace with something of its own.

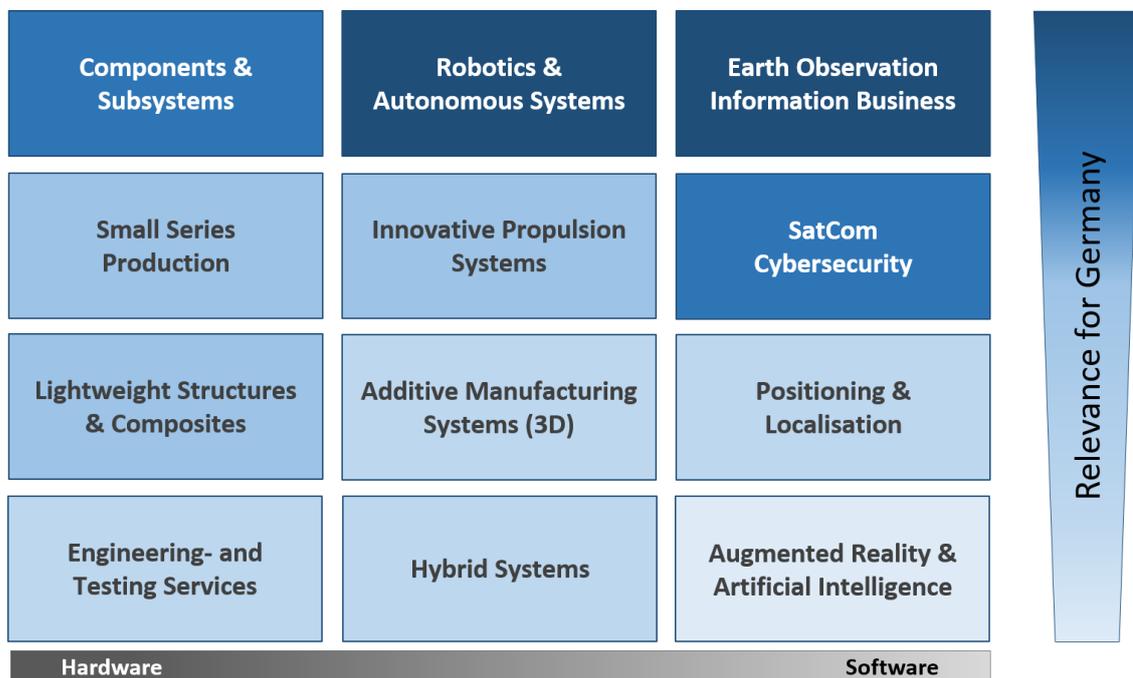


Figure 3: Industry capabilities as modules for a German NewSpace eco-system

Business models in the areas of geo-information and industry-oriented broadband communication are expected to be the most attractive NewSpace fields in Germany. Positioning and navigation services are primarily developed by companies outside of the space industry in the narrower sense but should nevertheless be attributed to NewSpace. They are of decisive importance above all in intelligent transport systems and self-driving cars. Further synergies result in the fields of robotics and artificial intelligence ("AI"). It is essential for NewSpace companies in Germany to seek partnerships with IT, automotive and other relevant industries and cooperate with them to exploit potential.

There are also good opportunities for the German space industry as supplier of components and sub-systems for NewSpace systems. This refers to small and micro-satellite components and also to sub-systems which have been developed for the defence business and which now come into question for innovative carrier systems.

The following assumptions and approaches can be determined:

- The excellent technical expertise and technologies in Germany can be used for many of the NewSpace trends.
- The industrial Internet of Things and autonomous mobility on the ground and in the air are very promising for space applications from Germany.
- German companies are world market leaders in the automotive industry, in the mechanical engineering sector and in other relevant industries.
- Robotics and autonomous systems are essential for the automation of industrial processes and for many security-critical applications.
- The industrial software sector could be a stimulus for NewSpace.
- German earth observation companies are some of the best in the world. In cooperation with German IT companies (SAP, T-Systems) the potential of Big Data and Cloud Computing can be realised for new applications and markets for earth observation.
- Space entrepreneurs who work primarily with space agencies find it difficult to develop new markets. Capital is often lacking as is a willingness to take risks and entrepreneurial initiative.
- Entrepreneurial personalities tend to be rare in the German space scene and in particular there are no personalities with a "Think Big" mentality.
- Innovative business models are not thought out loud - more ambition is called for here.
- A close networking of entrepreneurs and companies from different sectors is necessary to break through the closed system of the space industry and successfully realise the potential presented by NewSpace.

The initial spark in the USA has provided industry there with the “first mover“ advantage. Germany must quickly take the necessary steps if it is to assume a relevant role in NewSpace. The commercialisation thrust in the space industry offers great opportunities for the export-oriented German industry, links space with general trends of the global economy (Digitisation/Industry 4.0, Internet of Things, global broadband access, autonomous mobility, etc.), and supports the meeting of the great social challenges such as environmental protection, climate change and security.

The German government has set important fields of political activity with its Space Strategy and the Digital Agenda. NewSpace could become the bridge between space and the digital economy. Great opportunities result from this for Germany and its industry.

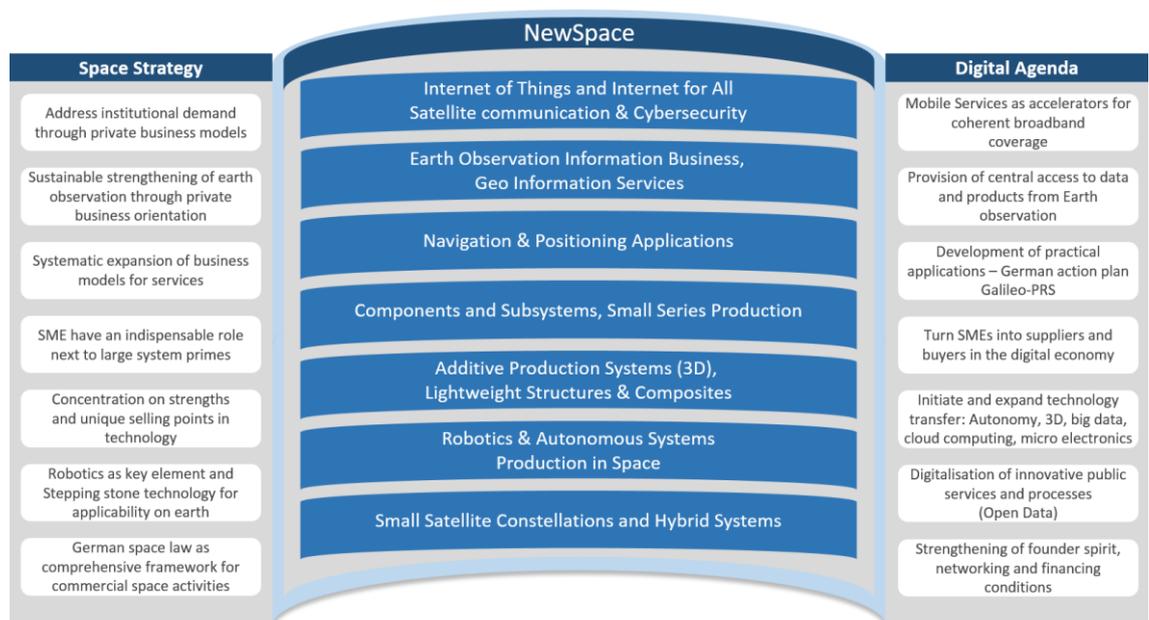


Figure 4: NewSpace as the link between space strategy and the Digital Agenda

Germany is well positioned to be successful in NewSpace. This existing industrial expertise must now be supplemented by specific digitalisation know-how and transformed for the space industry so that NewSpace can also be successful in Germany. The recommended action presented in this study is intended to serve as a first marker along this path. The right track must be taken now if it is to do so.

The commercialisation of the space business is rapidly advancing - in particular in the United States. The creation of new businesses with significant private capital investment, the deployment of new technologies and approaches, and the convergence with the information technology sector form the basis of what experts refer to as “NewSpace”. New companies are pursuing new approaches and business models. Fifty years ago, space activities were of pioneering influence on the emerging IT industry. Today, information technology seems to specify the clock speed for the space sector. NewSpace brings about opportunities and risks for Germany and its space industry.

Can this approach be adopted in Germany? What are the success factors for NewSpace? What are the underlying business and financing models? How does NewSpace relate to the age of Industry 4.0 and digitalisation? What policy options exist for industry and institutions?

These and many other questions were investigated in this study which was commissioned by the German Federal Ministry of Economy and Energy.