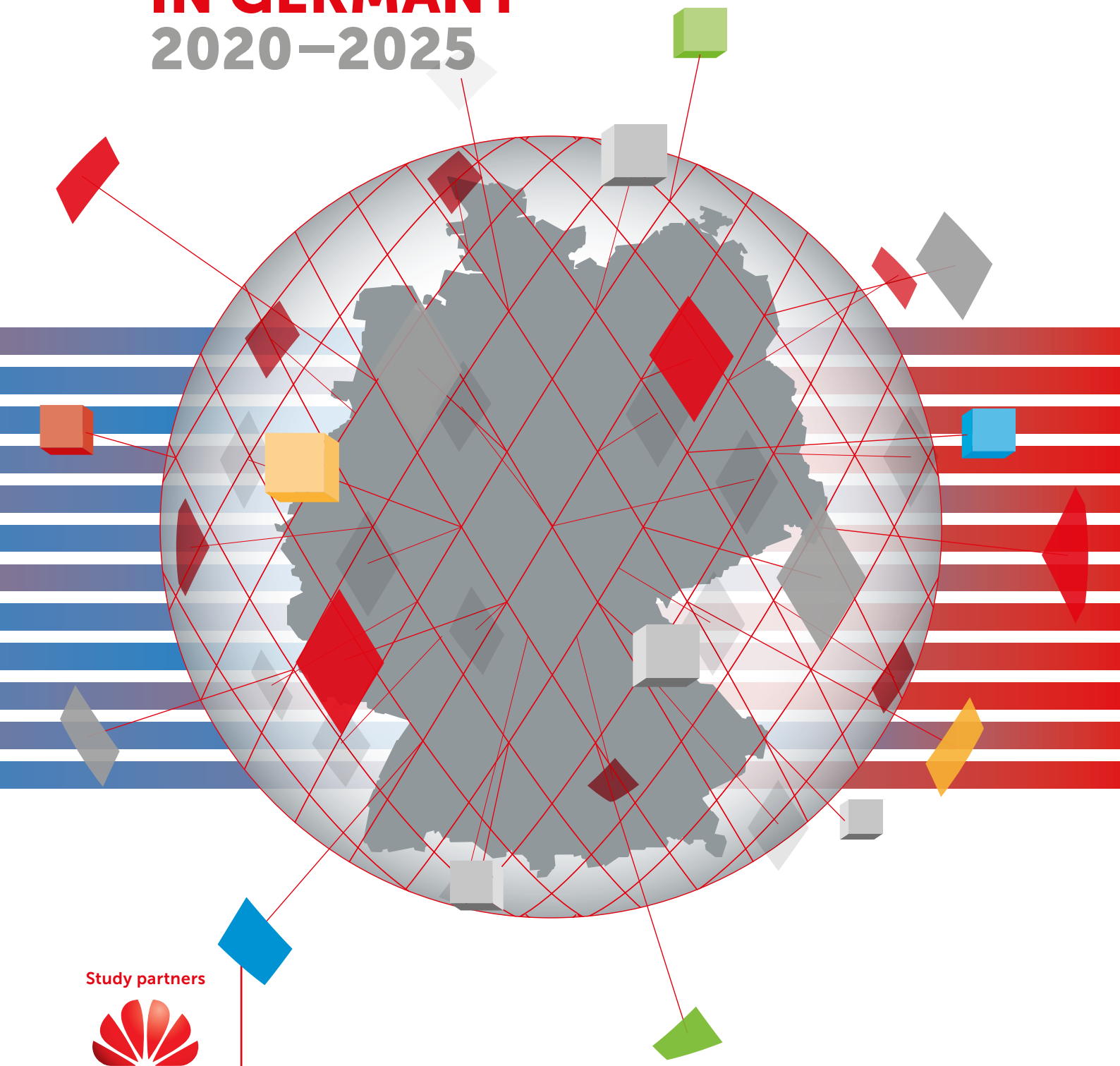
THE INTERNET INDUSTRY IN GERMANY 2020–2025



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eco
ASSOCIATION OF THE INTERNET INDUSTRY

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Preface

Oliver J. Süme
Chair of the Board,
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Board Member for IT Security
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Internet Industry 2020-2025: Launch Into a Digital Decade of Superlatives

Dear Readers,

Since 2008, the eco Association and Arthur D. Little have been coming together to analyse the developments of the Internet industry in Germany. Over the past five years, the industry has repeatedly thrown light on just how massive and successful its development dynamics are. In this time, the IT industry recorded an annual growth rate of more than 10 percent. This was a trend that the last study from 2015 had forecast with a high degree of accuracy, with this prediction based on an Internet industry model which has since been further developed.

In 2020, this growth spurt could have been continued or even further accelerated – a pace of development that the entire Internet industry was probably banking on. But the global Covid-19 pandemic has also hit the IT industry. As the present study shows, despite a discernible upswing in digitalisation, the Internet industry as a whole is expected to experience a 1.2 percent decline in revenue in 2020, owing to slumps in certain large segments which are largely contingent on the overall economic situation. A damper on the digital decade? Definitely not!

The figures of the new study make it clear that the current crisis is far from being a cause for despair: Even in 2020, the Internet industry in Germany is expected to generate around 145 billion Euro and will recover quickly in most areas after the initial "Corona shock". And not only that: By 2025, revenues are expected to have increased by almost 75 percent to approximately 253 billion Euro. What's more, at that point, around half a million people in Germany will then be employed in the Internet industry. In 2019, the Internet industry accounted for 4.2 percent of German gross domestic product (GDP). In 2025, the GDP will be significantly higher at a probable 7 percent. The Internet industry is therefore gaining increasing importance for the economy as a whole.

This is a prognosis that we should keep in mind, especially in these times: Despite a global pandemic that is affecting almost all areas of life, in the long term, the Internet industry will emerge from the crisis in a stronger position. One reason for this is that it has been able to ease the economic and social impact of the crisis through functioning home workplaces and videoconferencing over the Internet. Over the past few months, the Internet industry has impressively demonstrated its importance and capabilities for the economy and the development of society as a whole. Although the volume of data has increased significantly, the Internet has proven to be flexible and robust. It has thus enabled learning, working and social life to take place in remote mode.

As the Association of the Internet Industry, we recognised the current situation from the word go as also representing an opportunity for our members and the entire industry: Digital transformation – as not only the pandemic shows – will continue to play an increasingly important role within the German and European economy in the future and, in the long term, the part played by the Internet industry will increase in all sectors. This is why a rethink in companies – from big players to small and medium-sized enterprises, from digital infrastructure

providers to smart industries – should at the very latest take place now, a rethink which acknowledges that the Internet industry will play an increasingly important role for the wellbeing of our society. Alongside our members, we want to take on responsibility and together ensure the growth of bandwidth, availability, cybersecurity and trustworthiness. This is the only way we can achieve acceptance for the further digital transformation of the economy and society.

Our association has been committed to this goal since its foundation 25 years ago. No wonder, then, that our anniversary in 2020 is being celebrated with the slogan "Internet with Responsibility". We want to continue to play an active role in shaping the Internet in the future by promoting new technologies, digital infrastructures and markets, and by representing the interests of the industry in politics and in international bodies.

Speaking of the future: What will the year 2020 yield for the next decade? This is the question we address in the last chapter of the study, where we draw up two different scenarios for Germany's digital infrastructure. One thing that's worth divulging to you upfront: The Internet industry will experience further successes and increased performance from 2030 onwards, especially if we invest massively in a high-performance ecosystem of digital infrastructures now, thus enabling the progress of innovative technologies such as artificial intelligence and digital transformation.

Let's shape the Internet of the future together!

Special thanks go at this point to our members and sponsors Huawei, Toplink and Leaseweb, who have made a key contribution to the fact that we can now present you with this study. On the following pages, you can read guest contributions from the three companies, as well as a foreword from the German Federal Minister for Economics and Energy.

We wish you a stimulating read and are happy to be working alongside you in shaping the Internet for the benefit of our society!

Oliver J. Süme **Prof. Dr. Norbert Pohlmann**

Foreword

Peter Altmaier
German Federal Minister for Economics and Energy

Dear Readers,

Since 2008, the eco study on the Internet industry's development in Germany has been acting as a yardstick for the status of this extremely dynamic economic field. In a year such as this, such a study is of particular significance.

This year, the Covid-19 pandemic has posed unexpected challenges for everybody. Right from the start, the Internet industry has recognised the current situation as an opportunity. Because in times of shutdowns, home office and distancing rules, communication can only be maintained on the basis of digital offers and stable networks.

While the study does forecast a dip in Internet industry revenue of 1.2 percent in 2020, it also indicates that, in spite of the pandemic, the Internet industry will quickly recover and, with an average growth rate of 12 percent per year, will thrive as one of the most dynamic industries in Germany. These are encouraging signs.

But it's not just the Internet industry itself; the whole of Germany must emerge from the pandemic as quickly as possible and in a strengthened mode. To this end, in the train of Germany's history, our extensive recovery programme is set to ensure that civilians and the economy are adequately supported. We're helping small to medium-sized enterprises with bridging assistance, we're providing relief for civilians, and we're setting the focus on future-oriented fields. In total, we're investing 130 billion Euro to bring about a rapid and sustainable upturn, with 50 billion Euro dedicated to future-oriented technologies alone. Digitalisation plays a massive role here, as it is of central importance for a modern and strong Germany.

With the recovery package measures, we want to contribute to the maintenance of the current digitalisation impetus. Every third measure relates to the digital sphere – from investment in artificial intelligence, to digital assistance for small and medium-sized enterprises, through to the digital transformation of education and administration.

Where I see particularly strong growth potential is in the area of key technologies. This means that we're significantly topping up the resources for artificial intelligence. We want to develop AI ecosystems of international magnitude and to thereby set the basis for a European AI network. We want to promote development and production of quantum technologies in Germany, and through this, to develop a new industrial pillar, so that Germany is also capable of competing at the world's pinnacle when it comes to quantum technologies. And finally, a more rapid advancement of the roll-out of 5G is of major relevance. We've set the course for this with 5 billion Euro for the stated-owned federal mobile infrastructure company.

Overcoming the Covid-19 pandemic also plays a central role at European level and in the context of the EU Council Presidency. Together we will derive the most important lessons from the crisis and will commit to bringing Europe forward as an industry location fortified with a new degree of strength. We wish to secure and improve the competitiveness, innovation and resilience of both the European and the German economy in a sustainable and future-oriented manner. To this end, we will strengthen our digital sovereignty and drive digital transformation forwards.

The coronavirus pandemic will in all likelihood still be with us for a while.

The recovery package is paving the way to regeneration, especially in the area of digitalisation. Let us move forward together on this path.

I warmly congratulate the eco Association on the occasion of its 25-year anniversary and look forward to our ongoing cooperation for the wellbeing of the German and European Internet industry!

Peter Altmaier

1. Introduction

Lars Riegel, Partner, Arthur D. Little

Dr. Nejc Jakopin, Principal, Arthur D. Little

In the ongoing Covid-19 pandemic, the Internet industry is revealing its considerable relevance to our economic and societal systems. Despite short-term negative effects, the Internet industry continues to develop dynamically and its share of the gross domestic product (GDP) in Germany will rise from 4.2 percent in 2019 to around 7 percent in 2025.

The strong growth in mobile and stationary networks is continuing unabated: Since 2015, data traffic per SIM card in Germany has been growing by almost 50 percent annually, and per fixed network connection by approximately 37 percent annually. This development will receive an additional boost in 2020 as a result of the Covid-19 pandemic. In some areas, the use of services in the first quarter already exceeded the growth rate for the whole of 2019. The Internet has become an indispensable infrastructure in everyday and working life – not only in times of lockdowns or (partial) shutdowns and "social distancing", but also in what is now becoming the "new normal".

Despite the positive benefits of the Covid-19 crisis on the use and accepted adoption of a whole range of services and applications in all fields, the Internet industry in Germany is also being hit by the pandemic. In 2020, the macroeconomic stagnation is also having a knock-on effect on enablers, transaction and advertising markets. However, we expect a recovery in most segments of the Internet industry between 2021 and 2022, and in some cases, envisage long-term positive effects. In view of the undeniable importance of the Internet, the following study helps to clarify the effects and developments in the entire Internet industry and its segments.

In comparison to the 2015 study, in which we determined market volume, employment, market dynamics, competitive situation and profitability of the individual segments, this year's study looks at the specific effects of the coronavirus pandemic as well as the long-term effects of baseline infrastructure scenarios for Germany. In addition to the analyses carried out to date, a greater focus is being placed on the impact of societal changes and dependencies on other economic sectors during the pandemic. In this year's study, the main focus is still on the four-layer model of the Internet industry presented in the first publication (2009) and expanded upon in subsequent studies in 2013 and 2015. However, due to the dynamic nature of the market, the 2020 model has been expanded upon significantly.

The compiled facts and figures are based on a detailed market model and comprehensive assessments by renowned experts. A resulting detailed presentation and explanation of the individual figures and results for the respective layers and other parameters can be found in Chapter 2. Chapter 3 provides a detailed presentation of the four layers and 23 segments of the Internet industry model. In addition, Chapter 4 presents overarching infrastructure scenarios up to 2030 and identifies their impact on the Internet industry and beyond.

In light of eco's 25th anniversary, Chapter 5 is dedicated to the development and the activities of Europe's largest Internet association. Chapter 6 of the study provides a summary and conclusion, and offers an outlook on the future. Finally, the last chapter describes the methods and definitions used in the study in detail.

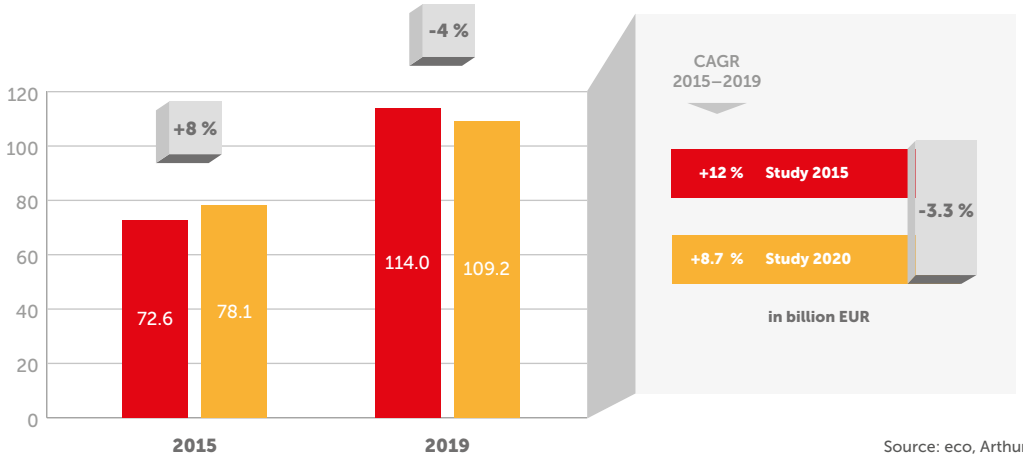
Arthur D. Little wishes you an interesting read!

Your

Lars Riegel **Dr. Nejc Jakopin**

1.1 Reality Check of the Findings and Forecasts of the Previous Study

Fig. 1 **Internet Industry Revenue in Germany – Comparison of the Study Results of 2015 and 2020**



Source: eco, Arthur D. Little

In the current study, the market sizes and growth trends set out in our 2015 study can be largely confirmed. In order to quantify the value contribution of the Internet industry even more precisely and to take into account the rapidly advancing market dynamics, the definitions of some segments have been slightly adjusted. On the one hand, the market volume for 2015 was slightly underestimated, as it is now calculated to be 8 percent higher than expected, coming in at 78.1 billion Euro. On the other hand, contrary to expectations, the Internet industry in Germany grew between 2015 and 2019 at an annual rate which was around 1 percent slower than forecast in 2015. This led to a market volume of 109.2 billion Euro in 2019, which was 4 percent below the predicted volume.

A detailed examination of the individual layers compares the projected growth rates from the 2015 study with the developments of the years up until 2019 and explains the adjustments made.

In **Layer 1** ("Network, Infrastructure & Operations"), the prognosis of a 7.3 percent annual revenue growth was slightly exceeded. Compared to the 2015 study, the Colocation & Housing segment in particular grew at an annual rate of 24 percent, significantly faster than forecast in 2015. The other segments were predicted very precisely, with deviations of a maximum of 1 percent.

In **Layer 2** ("Services & Applications"), the continuous growth trend has been confirmed, particularly in the attractive market segments classified as Public IaaS, PaaS and SaaS. The 2015 study forecast the high growth rates until 2019 very accurately, with deviations of less than 3 percent in all segments. New additions to the current study are Cybersecurity and Edge/Fog Computing, two segments which are excluded from the presented reality check. Cybersecurity and Edge/Fog Computing have gained in momentum and relevance in recent years and are described in more detail in the following chapters.

Layer 3 ("Aggregation & Transactions") continued to generate by far the highest revenues, accounting for a total volume of 64.7 billion Euro in 2019. Growth rates in the Online Advertising, Portals & Classified Marketplaces, Billing & Payment, and E-Commerce B2C segments were correctly forecast, with just marginal deviations. By 2019, the E-Commerce B2B segment hadn't managed to take on the digital transformation at the speed predicted, and had grown only moderately at an annual rate of around 6 percent. The use of the Internet and the digital possibilities in procurement have grown, but not to the extent we had anticipated.

Layer 4 ("Paid Content") bore out the high growth trend of 16 percent per year predicted in the 2015 study. With

an annual rate of 23 percent, the gaming sector has grown at a significantly higher rate than that estimated in the 2015 study. The Music & Radio division also exceeded the forecasts with its dynamic growth of 20 percent. As expected, the TV & Video segment showed strong growth of 26 percent annually, and in 2019 overshot the predicted one billion Euro revenue mark.

Newly included in Layer 4 are Digital Business Models in User Industries, which we refer to as Smart Industries. These are not included in our comparison. Smart Industries have gained in dynamics and relevance in recent years and will account for an increasing share of the Internet industry in the future. The Smart Industries are described in more detail in the following chapters.

1.2 Infographic to Explain eco and Arthur D. Little's Model of the Internet Industry

The layer model of the Internet industry, which has been further developed by eco and Arthur D. Little as part of the fourth joint study on the Internet industry in Germany, serves as the basis for the infographic and for the calculations of the analyses presented in Chapter 2, "The German Internet industry in Facts and Figures". In order to present the relationships between the individual segments or layers in a simple and visually clear way, we have adapted and expanded the layer model from the first study from 2009. In doing so, some new segments were created and some existing segments were extended in order to reflect the dynamics of the Internet industry and advancing digitalisation.

According to the layer model, the Internet industry consists of four layers that build on each other:

Layer 1: Network, Infrastructure & Operations

This layer represents those parties who enable stationary or mobile access to the Internet through transmission paths and access points. This infrastructure is the basis for all kinds of Internet services, and is employed by private users and businesses as well as providers in other layers of the Internet industry. Companies in this layer include colocation and housing providers; providers of fixed Internet access networks; providers of mobile Internet access networks; Internet backbone/transit and CDN providers; and, last but not least, operators of Internet exchanges.

Layer 1 also includes the newly designated segment of satellite broadband access. Satellite connections can also be used to provide stationary or mobile access to the Internet.

Layer 2: Services & Applications

The parties in this layer build on the network infrastructure and enable the provision of diverse services and content for companies and private persons on the Internet. Related business models include the administration of Internet addresses and the uploading of Internet pages, as well as the provision of a wide range of public cloud services. Hosting and domain providers can be found in this layer, as can providers of public cloud services.

New segments which are now included in Layer 2 are those of Cybersecurity and Edge/Fog computing. The importance of these segments has climbed significantly since the last study was undertaken and will continue to rise as part of advancing digitalisation. In 2019, Cybersecurity will have a market volume of over 5.6 billion Euro. Edge/Fog Computing is still in the market introduction phase with a total turnover of 82 million Euro in 2019, but it displays a very high growth potential for the coming years.

Layer 3: Aggregation & Transactions

The parties in the third layer use the services of Layers 1 and 2 in order to aggregate content for Layer 4 and make the content accessible. They are also responsible for initiating and implementing transactions with other products. B2B E-Commerce businesses are in this layer, as are numerous providers of B2C E-Commerce platforms. Providers of subscription-based portals and classified marketplaces, advertisers and online marketing companies, and transaction services are all in Layer 3.

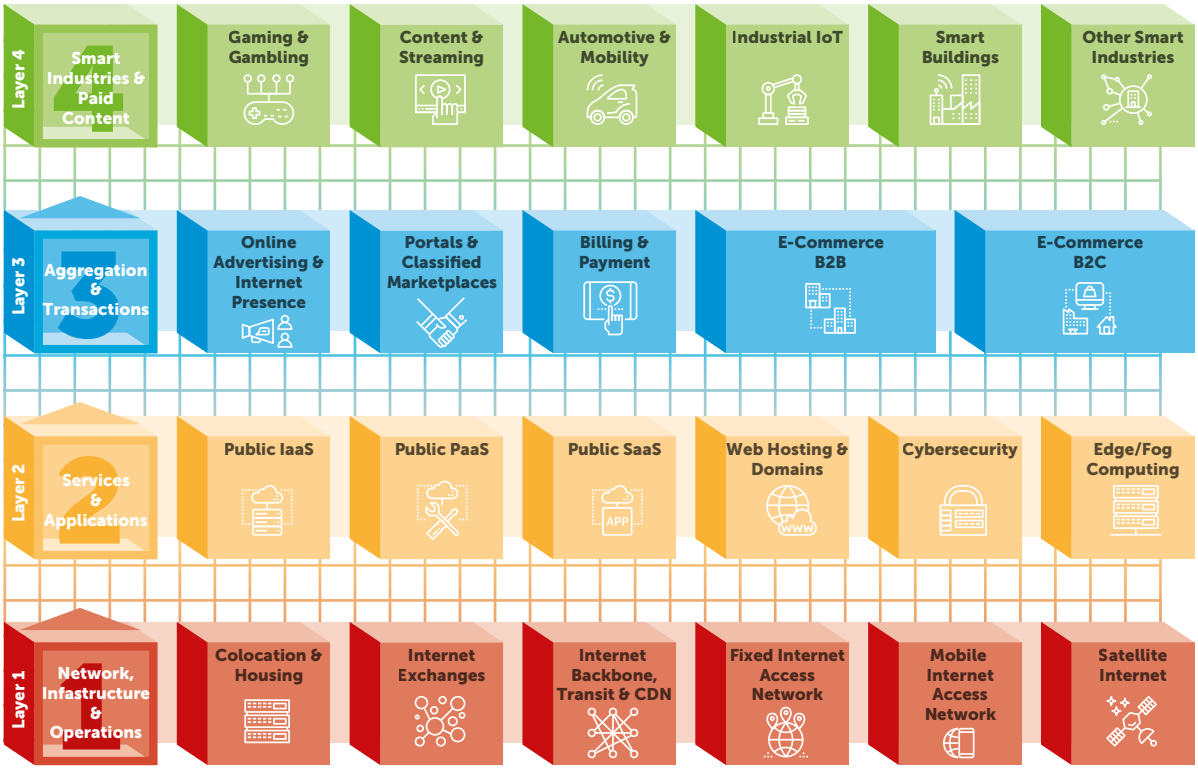
Layer 4: Digital Business Models in User Industries

The upper layer in the Internet industry model comprises of two segment groups: The first of these groups generates revenues through the marketing of digital content (Paid Content). The second segment group markets digital approaches to solve a problem in a user industry (Smart Industries).

The Paid Content segment group comprises of parties that generate or buy in content and use it for marketing purposes or offer it online for a fee. Internet content includes all forms of media content accessible through the Internet. The content is web-based or reuses offline media and content for the various platforms and services. Companies that can be found in this layer include gaming and gambling providers; TV, video and music streaming platforms; and e-publishing companies.

The Smart Industries segment group comprises of parties who, on the basis of digital business models, market solutions to address a wide range of problems in user industries. As a result of technological, demographic, political and socio-cultural changes, the German economy is experiencing increasing dynamism, in which existing approaches must be constantly scrutinised and rethought. Digital business models make use of existing network infrastructure, services, applications and aggregation mechanisms in order to offer new, effective and comprehensive problem-solving approaches. In recent years, digital solutions such as the Internet of Things (IoT) have gained relevance and dynamism in almost all sectors of the German economy – from automation in Mechanical Engineering ("Industrial IoT"), to digital innovations in the field of Mobility, through to smart concepts in the Education or Healthcare segments.

Fig. 2 **The Model of the Internet Industry by eco and Arthur D. Little: The Four Layers and Their 23 Segments**



Source: eco, Arthur D. Little

2. The German Internet Industry in Facts and Figures

2.1 Projections 2018–2025

Fig. 3 **Revenue and Growth in the German Internet Industry 2018–2025e (in billion EUR)**

Source: eco, Arthur D. Little

The market volume of the Internet industry in Germany will amount to 145.1 billion Euro in 2020. In the wake of this growth, by the year 2020 the revenue level will have increased to approximately 253 billion Euro. In the near term, due to the Covid-19 pandemic, the Internet industry is experiencing a negative shock effect. As a result of the macroeconomic restrictions in many areas and industries, and due to the general uncertainty affecting consumer behaviour, the revenue of the Internet industry in Germany will contract by 1.2 percent in 2020 compared to the previous year. In Chapter 2.2 and Chapter 3, the effects of the pandemic on the Internet industry in Germany are examined in detail at both layer and segment levels.

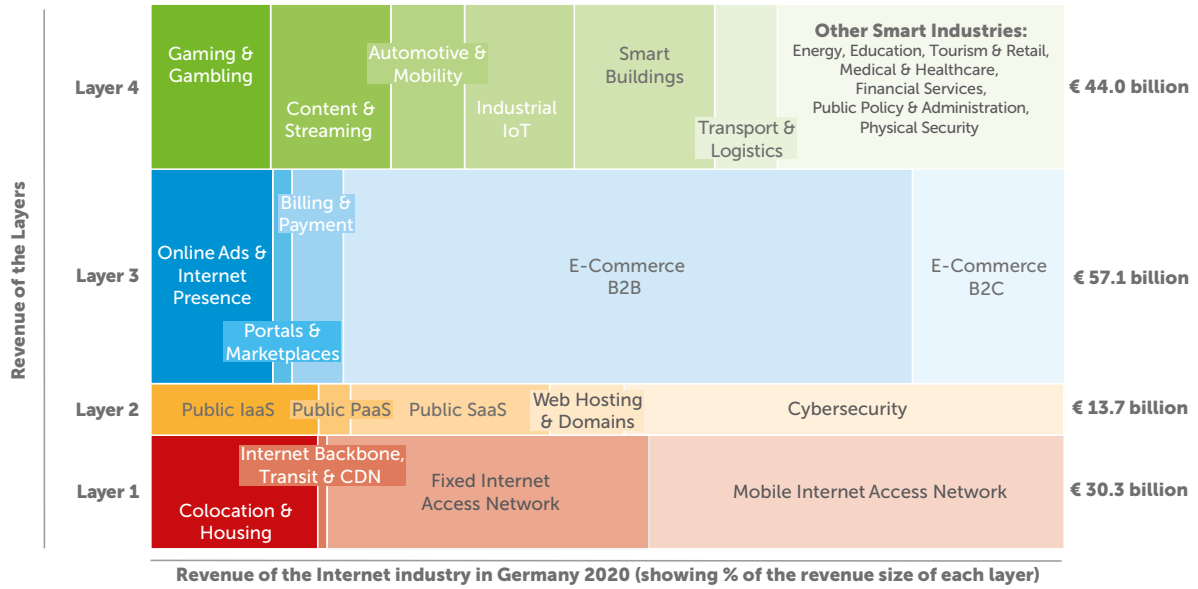
However, as the Internet industry recovers from the initial crisis, it will return to its existing growth path and will also experience catalyst effects in some fields in line with the rising significance of digitalisation and virtual collaboration. Across all market segments, this will result in strong revenue growth of 11.8 percent for the period 2021 to 2025. The market as a whole will therefore continue to be extremely dynamic in the future – in the 2020 to 2025 time-period, we project an annual growth in revenue of 9.5 percent. This means that the Internet industry will remain one of the most dynamic industries in Germany in the coming years.

Between and within the layers, the distribution and the forecast growth in revenue varies substantially. Around 40 percent of the revenue – 57 billion Euro – will be generated in the "Aggregation & Transactions" layer in 2020. With an average annual growth potential of 10.3 percent, this layer will remain a dominant source of revenue for the Internet industry in Germany in the 2020 to 2025 time-period – accounting for a revenue of around 93 billion Euro in 2025. A further third of the total revenue will be generated in 2020 by Digital Business Models in User Industries (Smart Industries), and by the marketing of digital content (Paid Content).

With a high growth rate of 14.9 percent per year, we expect the revenue in Layer 4 to double from 44.0 billion Euro in 2020 to 88.1 billion Euro by 2025. With revenue of around 13.7 billion Euro in 2020, Layer 2 "Services & Applications" has a comparatively small share of the total volume. However, due to the dynamic development of

demand for public cloud services (IaaS, SaaS and PaaS), Services & Applications will experience a strong growth spurt of more than 17 percent annually until 2025, more than doubling the revenue from 13.7 to 30.3 billion Euro. While double-digit growth rates of between 10 and 17 percent can be forecast for Layers 2 to 4, single-digit growth rates of around 6 percent can be expected for Layer 1 (Network, Infrastructure & Operations) due to its advanced level of maturity and saturated markets, leading to a development in revenue from 30.3 to 41.4 billion Euro.

Fig. 4 **Overview of the Distribution and Size of the Segments and Layers in 2020**



Source: eco, Arthur D. Little

This depiction offers an overview of the distribution and size of the segments and layers of Germany's Internet industry in 2020.

In **Layer 1**, more than 80 percent of the revenue volume in 2020 will be generated by the marketing of Internet access in the mobile and fixed network segments. A large part of the remaining 20 percent will be generated by leasing data processing capacities in the form of Colocation & Housing. Layer 1 is generally the most advanced in terms of market penetration and is therefore already in a development phase which is experiencing lower growth. Nevertheless, in this arena, what is required for successful digitalisation is the extensive implementation of innovations such as new broadband technologies in fixed and mobile networks or sustainable, more efficient data centres.

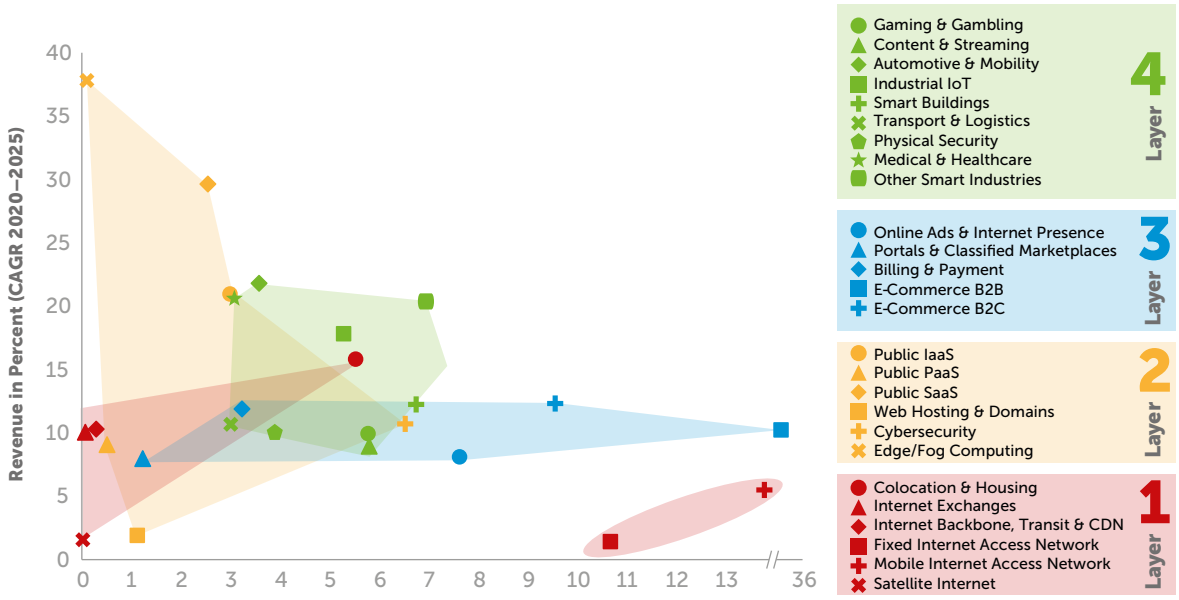
In **Layer 2**, the total revenue of 13.7 billion Euro in 2020 is distributed relatively evenly between important enablers of digitalisation – public cloud services and cybersecurity solutions. Within the market for public cloud computing, infrastructure and software services are dominating in 2020. Amounting to 8 percent of 2020's revenue, the Web Hosting & Domains segment plays a comparatively small role in Layer 2 in terms of value. Overall, Layer 2 is in the central growth phase with regard to the market life cycle and thus records the highest growth rate of the four layers.

In **Layer 3**, around 80 percent of 2020's market volume is attributable to online trade in goods and services. Within the e-commerce market, trade between companies (B2B) dominates; from this, we estimate that 35.6 billion Euro is attributable to the Internet industry as a proportion of the total volume. This is followed by the end-customer business (B2C), whose respective contribution to revenue we estimate at 9.5 billion Euro. With a revenue of 7.6 billion Euro, the Online Advertising & Internet Presence segment is the third largest segment after the two dominant segments of E-Commerce.

In Layer 4, the addition of Smart Industries results in a broadly diversified revenue structure, which will become increasingly important in the future. The marketing of digital content such as TV, music, e-books and games will generate around a quarter of the market volume in 2020, with the remaining three quarters of the market being generated by digital business models in user industries.

The largest segments here are Smart Buildings, Industrial IoT, Physical Security, Transport & Logistics, and Automotive & Mobility. A detailed comparison of the segments by revenue size in 2020 and annual growth from 2020 to 2025 is shown in Figure 5.

Fig. 5 **Revenue and Growth of the Internet Industry Segments in Germany**



Source: eco, Arthur D. Little

Within Layer 1, two segment groups stand out in terms of projected market volume and growth up until 2025. The traditional business area of Mobile and Fixed Network operators equates to that segment group which has a high volume and which is growing at a moderate rate. In contrast, a second group is characterised by comparatively smaller volumes and higher growth rates. These include Internet Exchanges, Colocation & Housing, and Internet Backbone, Transit & CDN. The Colocation & Housing segment is increasingly taking on the role of the "rising star" in Layer 1 due to its having the highest growth rate and the third largest market volume.

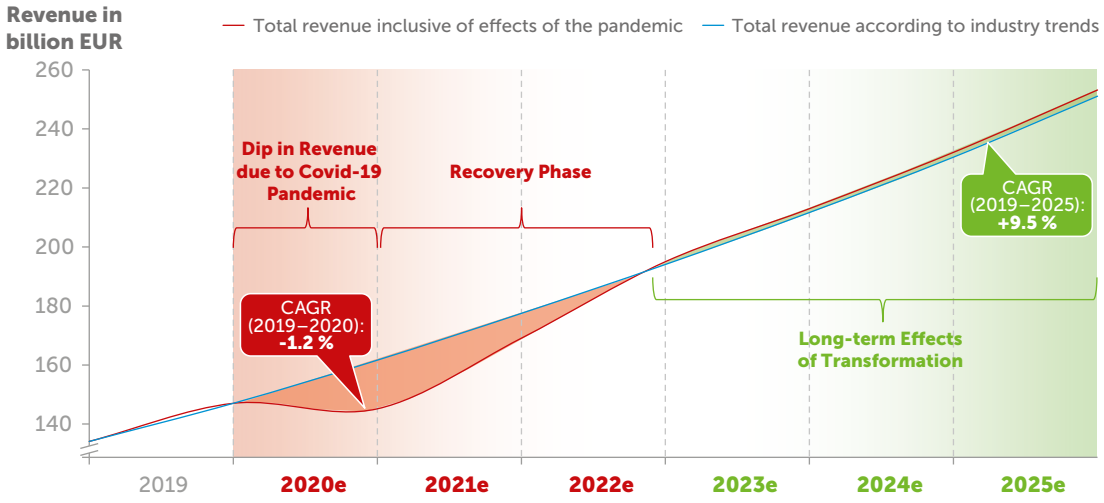
Layer 2 combines segments that are in an early growth phase and at the same time have a very high growth potential. The public cloud segments SaaS and IaaS will be among the fastest growing segments of the Internet industry up to 2025, with growth rates of 21 and 30 percent respectively. Only the Edge/Fog Computing segment will achieve an even higher growth rate in the next few years. This segment, currently still considered a niche market for IoT applications, will grow exponentially at a rate of 38 percent per year until 2025 and will thus take on a central role in Layer 2 in the long term. By contrast, the Web Hosting & Domains segment is in a mature stage of market development, which is why only marginal growth can be expected in the medium term. The Cybersecurity segment is of particular importance in terms of acceptance of digitalisation, and will continue to play an important role, with growth of over 10 percent.

The segments in Layer 3 show moderate growth rates of 8 to 12 percent annually. Due to their high volume and growth rates of 10 and 12 percent respectively, the E-Commerce segments (B2B and B2C) in particular are considered to be key drivers of value with further potential – both within the layer and for the entire German Internet industry.

Layer 4 includes numerous segments that are in the midfield of the matrix in terms of growth and market volume. While segments from the area of Paid Content are in the lower section of the midfield, with moderate growth rates of between 8 and 11 percent, some Smart Industries such as Automotive & Mobility and Medical & Healthcare stand out with a very high growth potential of over 20 percent and are set to become an increasingly important part of the Internet industry in the future.

2.2 The Impact of the Covid-19 Pandemic on Germany's Internet Industry

Fig. 6 **Total Impact of the Covid-19 Pandemic on Germany's Internet Industry**



Source: eco, Arthur D. Little

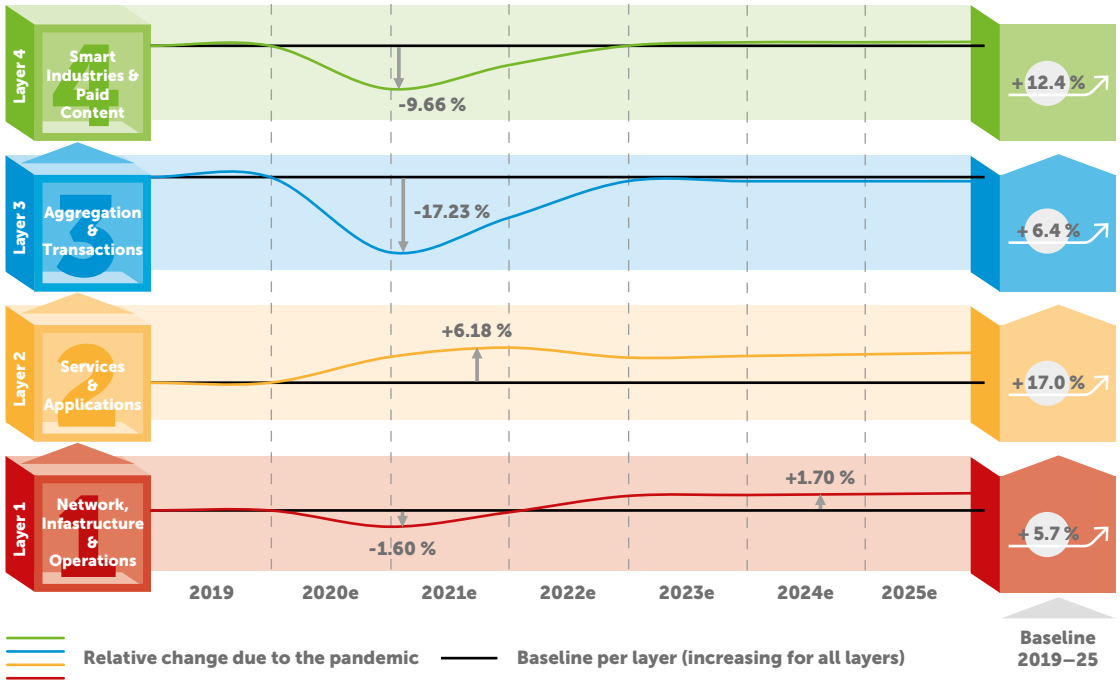
Figure 6 illustrates the predicted Impact of the Covid-19 pandemic on the revenue development of the Internet industry in Germany. In macroeconomic terms, this simulation is based on the estimates of the baseline scenario compiled by the ifo Institute and the International Monetary Fund (IMF) in April 2020. This scenario assumes a GDP decline of around 5 percent, an easing of the lockdown in the summer of 2020, and a macroeconomic recovery in the course of 2021 and 2022.

The blue line depicts the simulated revenue development in line with the industry trends which, before the beginning of the pandemic, was forecast to occur until 2025. The red line shows the expected revenue trend, taking into account the macroeconomic crisis effects of the pandemic in Germany. The areas between the two lines can accordingly be interpreted as the impact of the Covid-19 pandemic. For the year 2020, this results in a decline in revenue of around 1.2 percent in the Internet industry in Germany, when compared with the previous year. This decline is the result of the temporary down-slide in demand and investment activities in digital infrastructures and solutions, as well as a subdued consumer climate.

We forecast the beginning of a strong digital economic upswing with an easing of the lockdown in the summer of 2020 and a recovery of the overall economic situation that will begin in this context. With growth rates of between 15 and 16 percent in the years 2021 and 2022, a rapid recovery is predicted to take place, so that the Internet industry in Germany will be able to compensate for the revenues lost in the context of the coronavirus pandemic by the end of 2022.

In addition to catching up on the digital potential that already existed before the pandemic, some areas of the Internet industry are benefiting from the catalysing effects of society's positive experience of digitalisation. Accordingly, from 2023 onward, the intensified expansion of digital infrastructure and a higher market penetration of digital services and applications will lift the Internet industry in Germany to an overall higher revenue level than anticipated before the crisis. Between 2023 and 2025, the German Internet industry will continue to grow at this higher revenue level at an average rate of around 9 percent per year.

Fig. 7 **Impact of the Covid-19 Pandemic on the Internet Industry Layers**



Source: eco, Arthur D. Little

The outlined overall development of the Internet industry in Germany until 2025 is the result of an aggregation of individual, divergent developments in the underlying layers and segments of the Internet industry model. Figure 7 illustrates the impact of the Covid-19 pandemic on the individual layers of the Internet industry. The black line represents a standardised reference gradient which excludes the influence of the pandemic (corresponding to the blue line in Figure 6). The coloured lines indicate the effect of the Covid-19 pandemic on the respective layer. Figure 8 supplements this perspective with a detailed view of individual segments. The axes depict the direction and strength of the influence of the pandemic, while the radius of the circles indicates the relative revenue volume of the segments in 2020.

Layer 1 shows the divergent effects of the Covid-19 pandemic on revenue. While the revenue volume at the end of 2020 is expected to be 1.6 percent below the reference gradient, from 2022 there will be a catalyst effect that will lift the layer to an overall higher revenue level. The short-term slump in revenue in 2020 will be caused by declines in revenue in the segment of mobile Internet access and data connections to smartphones and the like. The segments Colocation & Housing, Internet Exchanges, Internet Backbone & Transit, and Fixed Internet Access Network will contribute a subsequent sustained growth spurt. Essentially, these developments are based on a short-term downturn in demand for mobile Internet, alongside a sustained surge in demand for digital fixed network infrastructure and flexibly scalable data centre capacities, with the latter required to successfully continue the implementation of digitalisation.

Layer 2 is the only layer of the Internet industry in Germany that can benefit in its entirety from the Covid-19 pandemic both now and in the long term. With a total increase in revenue of 6.2 percent compared to the reference gradient, Services & Applications are experiencing a sustained growth spurt. This growth is being driven by the increasing demand for public cloud services such as PaaS, SaaS and IaaS. Cybersecurity solutions are also in greater demand overall as a result of the pandemic.

In contrast, **Layer 3** will record the greatest relative revenue declines. At the end of 2020, the revenue volume is anticipated to be 17.2 percent below the reference gradient. In 2021 and 2022, the layer is expected to largely recover. However, the negative effect of the pandemic will linger, meaning that revenue losses compared to the reference gradient will not be fully compensated for in the subsequent years, 2023 to 2025. The temporary dip in demand and investment activity will significantly reduce the volume of trading transactions. As a result,

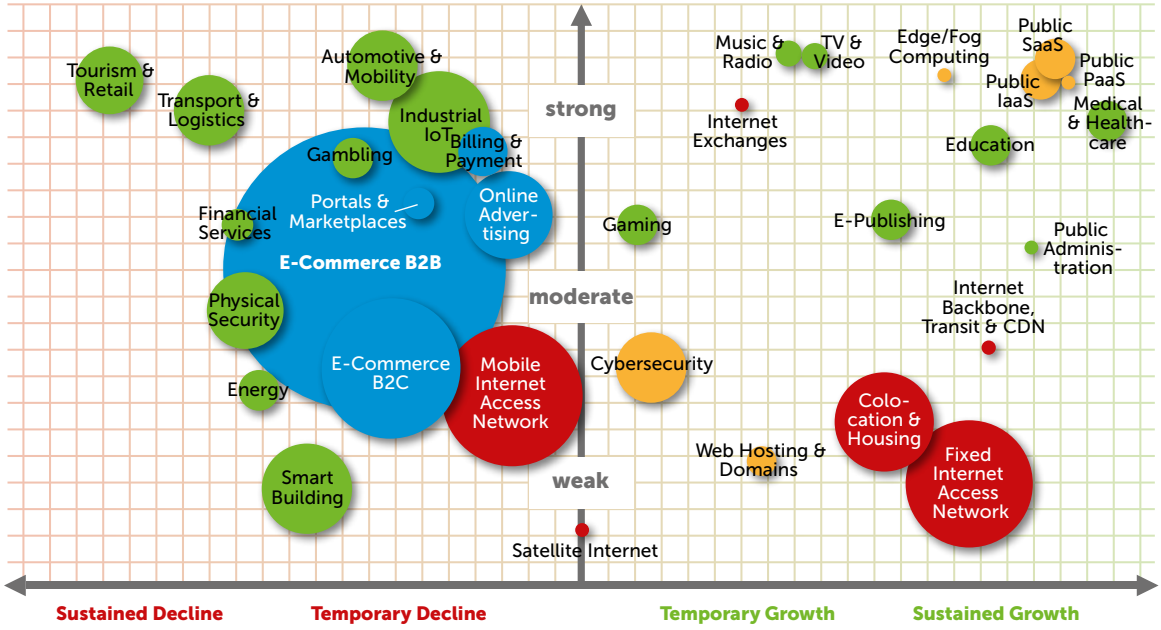
all segments in the layer will temporarily generate less revenue, with the E-Commerce B2B, Billing & Payment and Online Advertising segments being hit particularly hard.

For Layer 4, a different picture emerges. While the total revenue volume between the years 2020 and 2021 will be down to 9.7 percent below the reference gradient, from 2022 onwards there will be catalyst effects in some segments, which will raise the layer to an overall slightly higher revenue level. The effects of the Covid-19 pandemic on the individual segments of the layer range from a strong sustainable growth spurt to a long-term drop in revenue. Among the beneficiaries of the pandemic are segments from the area of Paid Content such as gaming, e-publishing or TV & Video, as well as digital business models in system-critical user industries such as Medical & Healthcare, Education, and Public Administration. In the latter segments, the pandemic will lead to catalyst effects which will stimulate and accelerate the digital transformation in the industries in the long term.

Where the Covid-19 pandemic is having a particularly negative effect is on user industries in an industrial context, such as Automotive & Mobility and Industrial IoT, as well as on user industries in the Transport & Logistics sector. Here, economically paralysing factors such as mobility restrictions and production shutdowns tend to prevail.

In Chapter 3, the causal relationships between the Covid-19 pandemic and revenue development in the respective segments of the Internet industry are discussed in detail.

Fig. 8 **Impact of the Covid-19 Pandemic on Germany's Internet Industry**



Radius of the Circles = Relative Revenue Volume of the Segments in 2020

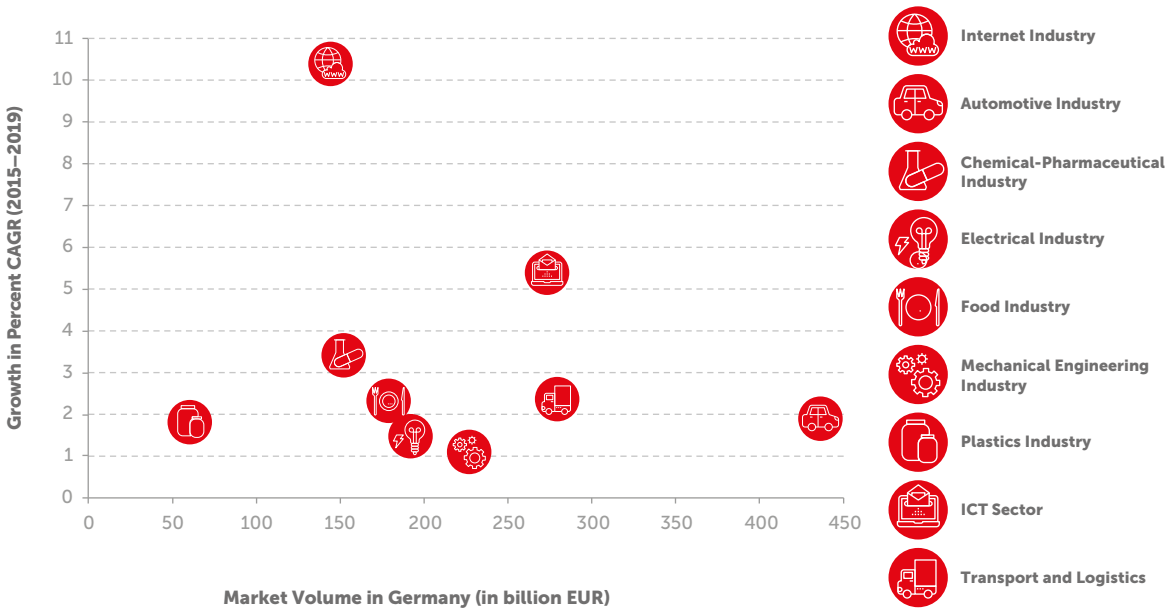
Source: eco, Arthur D. Little

2.3 The Impact of the Commercial Internet on Germany as an Industry Location

The Internet industry accounts for an increasing share of GDP in Germany and is by far the most dynamically growing sector in the German market. The Internet industry is already about as large in scale as the chemical & pharmaceutical industry, and is set to catch up with the electrical & food industry in the coming years. Compared to other industries, the size of the Internet industry is even more important in terms of revenue for Germany, given the fact that, in sectors such as the automotive industry, a considerable proportion of revenue is generated by exports (in the case of the automotive industry, this figure is around 65 percent). This means that, by 2019, the Internet industry in Germany was already roughly on a par with the automotive industry.

While the Internet industry grew by more than 10 percent annually between 2015 and 2019, other large German sectors grew by only 1 to 5 percent in the same time period. If a comparable growth of all sectors, measured by revenue volume, is also assumed in the future, the Internet industry in Germany would overtake the chemical & pharmaceutical industry in 2021, the electrical & food industry in 2023, and the mechanical engineering industry in 2025.

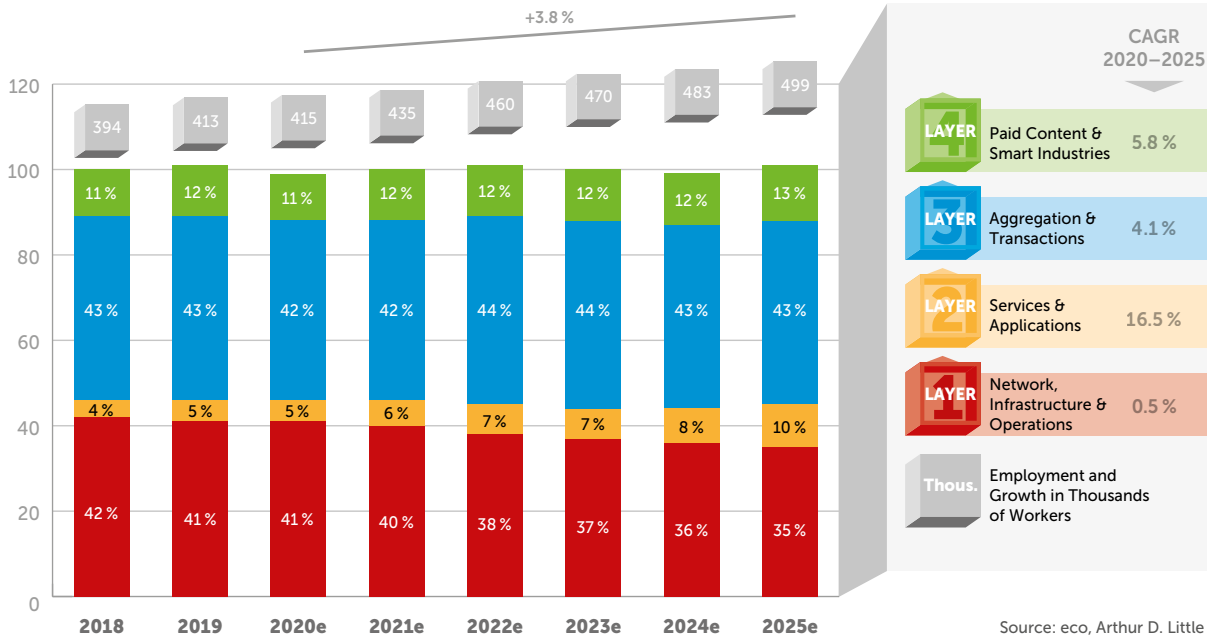
Fig. 9 **Revenue and Growth of Selected Sectors in Germany**



Source: Verband der Chemischen Industrie, Zentralverband Elektrotechnik und Elektronikindustrie, Bitkom, EITO, VDMA, BMWi, Statista, Destatis, DSLV, Bundesverband der deutschen Ernährungsindustrie, eco, Arthur D. Little
*including exports (in manufacturing industries such as the automotive industry, equivalent to up to 65%)

Based on April 2020 estimates by German economic institutes (e.g. Sachverständigenrat der Wirtschaft, Institut für Weltwirtschaft (IfW) Kiel, ifo Institut Munich) of how GDP will develop in light of the Covid-19 pandemic, the Internet industry in Germany will continue to gain in importance for the economy as a whole between now and 2025. While the Internet industry will account for 4.2 percent of GDP in 2019, this share will increase to just under 7 percent by 2025. The Internet industry will continue to create jobs in Germany over the next five years. By 2025, half a million people will be employed in the Internet industry.

Fig. 10 **Employment in the German Internet Industry 2018-2025e (in Thousands of Workers)**



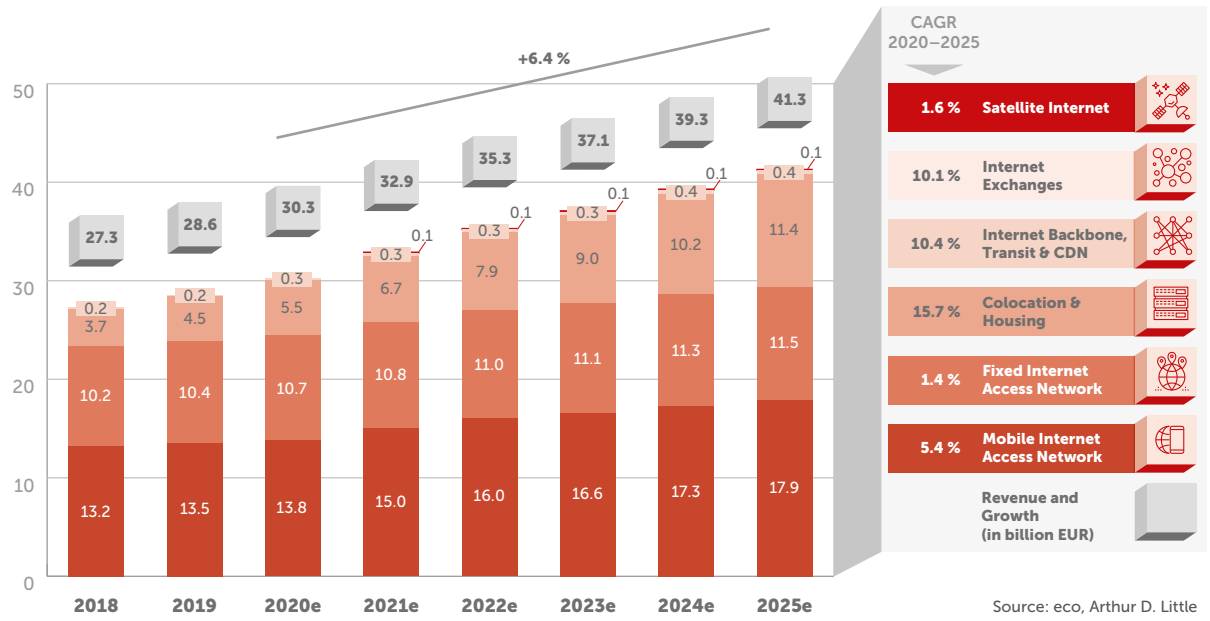
Source: eco, Arthur D. Little

The number of employees in the Internet industry in Germany will rise from 415,000 in 2020 to 499,000 in 2025. This corresponds to an annual increase of over 3.8 percent. It is to be expected that increasing productivity will counteract a stronger increase in employment. All in all, even in the pandemic year 2020, we do not expect an absolute decline in employment in the Internet industry, but only slower growth rates. More than 83 percent of employees in the Internet industry will be working in Layers 1 or 3 in 2020. Even with the moderate growth in Layer 3 of 4.1 percent by 2025, the dominance of this segment will largely remain intact. Due to a low growth in Layer 1 of 0.5 percent, and a rapid growth in Layer 2 of 16.5 percent, "Services & Applications" will gain 5 percent of the share of total employment volume by 2025. Meanwhile, the relative share of the Network, Infrastructure & Operations layer will fall from 41 to 35 percent, as it is growing less strongly than other layers, and as further efficiency enhancement measures are expected to be introduced by large operators.

3. A Detailed Look at the Layers and Segments

3.1 Network, Infrastructure & Operations

Fig. 11 **Revenue and Growth in Layer 1: Network, Infrastructure & Operations (in billion EUR)**



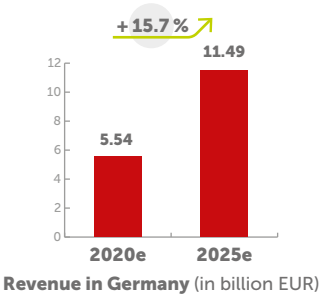
Source: eco, Arthur D. Little

The Network, Infrastructure & Operations layer of the Internet industry model comprises of parties that enable stationary or mobile access to the Internet through the provision of transmission systems and access points. This infrastructure forms the basis for all kinds of Internet services and is employed by private users and businesses as well as by providers in other layers of the Internet industry.

- Between 2020 and 2025, the Network, Infrastructure & Operations layer will grow by an average of 6.4 percent per year, increasing the market volume from 30.3 to 41.3 billion Euro.
- The Colocation & Housing segment is the main driver of this growth. With an annual growth rate of 15.7 percent, it will outpace all other segments in the layer; with 11.5 billion Euro, it will exceed the revenue volume of fixed Internet access networks by 2025; and it will then assume the position of the second-largest segment in the layer.
- Measured by market volume, the Mobile Internet Access Network segment has established itself as the segment with the highest revenue in recent years. With moderate growth of 5.4 percent per year and a market volume development of 13.8 to 17.9 billion Euro, it will maintain this position in the next five years.
- Due to stagnating prices and growth rates, the Fixed Internet Access Network segment – which was still the strongest revenue segment in the 2015 study – will fall back to third place with a market volume of 11.4 billion Euro by 2025.
- With a growth rate of approximately 10 percent per year, the relatively small segments of Internet Backbone, Transit & CDN, Internet Exchanges, and Satellite Internet are growing faster overall than the other segments, and are forecast to reach a market volume of 0.5 billion Euro.

Colocation & Housing

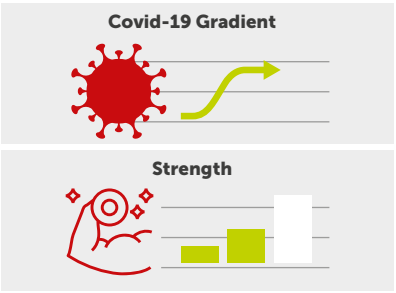
Segment Development in Germany



Revenue in Germany (in billion EUR)

Source: eco, Arthur D. Little

Impact of the Covid-19 Pandemic on the Segment



Source: eco, Arthur D. Little

Due to the ongoing trend towards outsourcing and the increasing need for additional data storage and computing power capacities, revenues in the Colocation & Housing segment of the Internet industry model will grow by 15.7 percent per year between 2020 and 2025. The continuous increase in data traffic will create a high demand for additional data centre capacities. In addition to video streaming and a variety of entertainment services, this growth is being driven by new digital business and application fields such as connected cars, smart buildings, industrial IoT and 5G. Colocation & Housing enables companies to meet the additional demand in a scalable and reliable way. For such reasons, large industrial companies are increasingly relocating their central data centres to long-established and highly-equipped locations, especially in Frankfurt.

Another trend within the segment is the regionalisation of data centres and the development of infrastructures for Edge/Fog computing. Access points are increasingly being located closer to the immediate consumer in order to minimise any latencies, to relieve the strain on networks, and to more easily ensure data security. The continuing technological progress and miniaturisation of devices is being overridden by the high growth in data traffic. Capacity usage in data centres in Germany is high and will continue to increase over the next few years, so there is a need to build new data centres and expand existing ones.

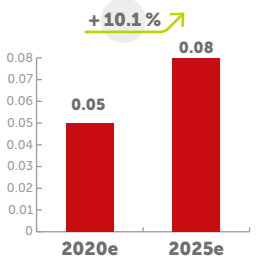
The Colocation & Housing segment consists primarily of long-term business models that are relatively unaffected by short-term fluctuations in demand. Nevertheless, the segment will benefit in the medium term from the growth in central services triggered by the pandemic in 2020. In particular, the rising demand for cloud services is largely evident in Colocation & Housing.

In order to prepare for possible further pandemic waves in Germany, companies will tend to outsource their data and applications to external data centres, thereby driving up demand. In comparison, the Colocation & Housing segment is experiencing a positive impact in terms of sustainability and sovereignty, which is why we are positive in our assessment of its further transformation and a corresponding expansion. Due to the long-term nature of contracts and a time lag in the planning, the approval and the construction of data centres, the additional growth of the segment caused by the pandemic will only materialise after a time lag of one to two years. There is also a shortage of skilled workers in the segment: the demand for qualified STEM professionals and, for example, electrical engineers and cooling specialists to operate data centres exceeds the current supply on the labour market. The options for linear scaling of the supply of Colocation & Housing in line with the growth in demand are therefore limited. The liquidity bottlenecks of some SME customers will weaken the overall positive impact.

Training incentives and attractive conditions for skilled workers are crucial for Germany as a business location.

Internet Exchanges

Segment Development in Germany

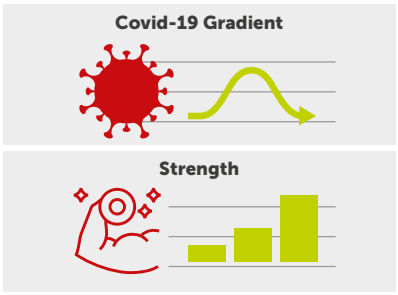


Revenue in Germany (in billion EUR)

Source: eco, Arthur D. Little

The increasing data throughput is also a significant revenue driver for public Internet Exchanges. The DE-CIX Internet Exchange in Frankfurt is the world's largest in terms of data throughput. However, the high growth rates in data volume over the next five years will not translate linearly into revenue growth for Internet Exchanges, given that prices in this mature market segment are stagnating.

Impact of the Covid-19 Pandemic on the Segment



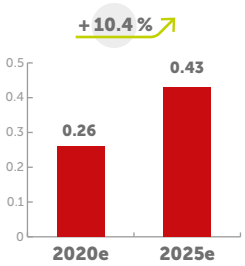
Source: eco, Arthur D. Little

The political measures in Germany to contain the coronavirus have fundamentally changed the user behaviour of Germans in both their private and professional lives. "Users are now online more often and for longer periods during the day, a development that we can see very clearly." (Thomas King, CTO, DE-CIX). On the night of 11 March 2020, the world's largest Internet Exchange in Frankfurt set a new world record with traffic of more than nine Terabits per second.

The temporarily strong increase in data throughput in Internet Exchanges increases the capacity utilisation and revenues of Internet Exchange operators. The largely automated system can scale the additional data throughput without significant additional costs, with the segment's profitability increasing accordingly. It is to be assumed that the increased digital usage behaviour of Germans will remain a reality after the pandemic, and that this will deliver a sustained growth spurt to the segment.

Internet Backbone, Transit & CDN

Segment Development in Germany

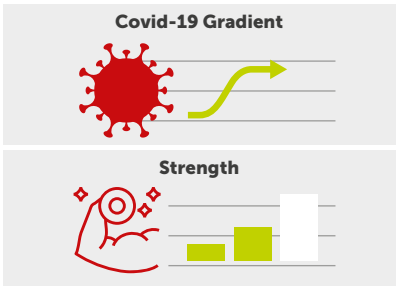


Revenue in Germany (in billion EUR)

Source: eco, Arthur D. Little

Within the segment, the current role of the CDN (Content Delivery Networks) sub-segment will continue to gain in dominance until 2025 with moderate growth, while the sub-segment Internet Backbone & Transit will continue its downward trend. Despite a drop in price per Gigabyte, CDN will continue its growth trajectory, driven by the rapidly growing data volume of mobile and fixed networks. By contrast, the market for Internet Backbone & Transit is becoming increasingly unappealing due to high price pressure. Digital giants such as Google, Amazon and Facebook are increasingly setting up their own infrastructure and CDNs to avoid transit prices and to bring content closer to customers.

Impact of the Covid-19 Gradient



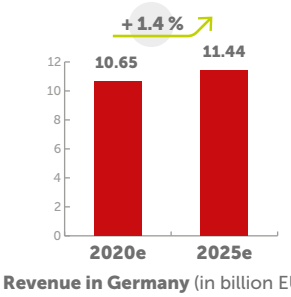
Source: eco, Arthur D. Little

The increased use of online and cloud gaming as well as social media platforms is also leading to an increase in data traffic of over 50 percent in the largest global networks for the distribution of media content (CDN). This means an overall increase in data traffic of several 100 Gigabits per second (Gbit/s). Due to the increased demand for data and the resulting network bottlenecks, content

providers will opt for CDN over transit. Nevertheless, rising total revenues due to increased data traffic could temporarily slow down the negative growth trend in the Internet Backbone & Transit sub-segment.

Fixed Internet Access Network

Segment Development in Germany



Revenue in Germany (in billion EUR)

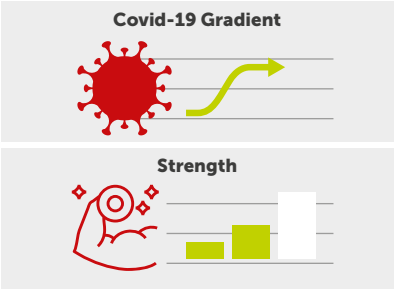
Source: eco, Arthur D. Little

With the increasing proliferation of 4K and UHD TV as well as low-latency gaming, the demand for bandwidth in private households will rise to several hundred Megabits. By 2022 alone, 44 percent of all German households will have TVs with 4K or UHD. The resulting data traffic will reach a total volume of 2,960 Petabytes per month in Germany and 176 Gigabytes per month per UHD TV set (see Cisco, OVUM, Arthur D. Little). Added to this is the increased demand for home office connectivity and, in particular, the adoption of video conferences as the "new normal". In line with this strong growth in demand, until 2025, the speeds of broadband products for home use will increase by an average of 49 percent annually. High-end service packages will have speeds between 500 Mbit/s and two Gbit/s by 2025 and will account for more than 50 percent of all broadband subscriptions by residential customers. The share of broadband products in the medium and entry-level categories will have contracted from 33 to 16 percent by 2025.

This enormous demand is being met by the supply of a dynamic market. Due to the competitive situation that is to be expected and the frequently applied "more for the same price" strategy in marketing these products, the total revenue volume in the market will only grow moderately until 2025.

Additional drivers of demand are of considerable importance for reducing investment risks.

Impact of the Covid-19 Pandemic on the Segment



Source: eco, Arthur D. Little

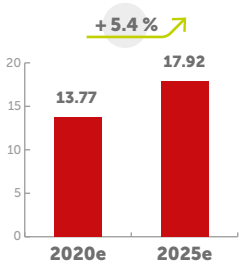
The Covid-19 pandemic has meant that the vast majority of the population has spent more time in their own four walls, both privately and professionally. This means that the features of fixed broadband connections for domestic use have become more important. Customers are adapting their demand behaviour to their increased need for speed and data volume. The consumer segment will continue to experience a sustained upswing in growth, since even after the macroeconomic situation stabilises in 2021, some of these changed usage patterns will remain in place and, from a societal perspective, should also be retained.

The overall economic crisis caused by the coronavirus is exerting no significant short-term impact on the revenue volume of fixed network Internet connections in the business segment in Germany. The emergency aid of over 50 billion Euro promised by the German federal government in March 2020 for small companies and the self-employed will cover short-term operating costs in the business segment and prevent insolvencies. Nevertheless, in the long term, pandemic-related insolvencies and customer closures could have a negative effect on the revenue volume in the business segment. At the same time, some large companies will place a greater focus on connectivity and digital infrastructure through the increased use of cloud services, thus boosting demand for Fixed Internet Access Networks.

Overall, the impact of the Covid-19 pandemic can therefore be assessed as moderately positive in the long term.

Mobile Internet Access Network

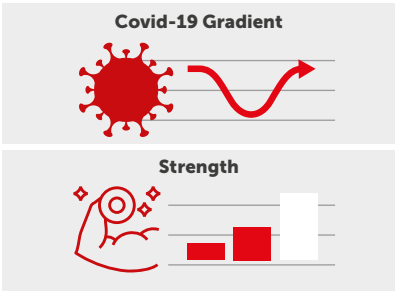
Segment Development in Germany



Revenue in Germany (in billion EUR)

Source: eco, Arthur D. Little

Impact of the Covid-19 Pandemic on the Segment



Source: eco, Arthur D. Little

In addition to data throughput via fixed network connections, data traffic in the mobile phone segment is also increasing rapidly. The introduction of the new 5G mobile communications standard has made new technical solutions available that enable significantly higher download volumes on mobile devices in a shorter period of time (even though this is not initially planned for nationwide). In 2019, more than 140 million SIM cards were in use in Germany.

While the population figure in Germany will remain largely stable over the next five years, the number of mobile data tariff agreements will continue to rise. This is to be accompanied by a further increase in the SIM card penetration rate from 170 to 180 percent between 2020 and 2025. The price level for data tariffs in Germany is very high by European standards. However, the average revenue per SIM card (ARPU) will continue to decline until 2025 due to the continued strong price pressure (CAGR = minus 1.0 percent). Overall, this segment will continue to grow at a moderate level.

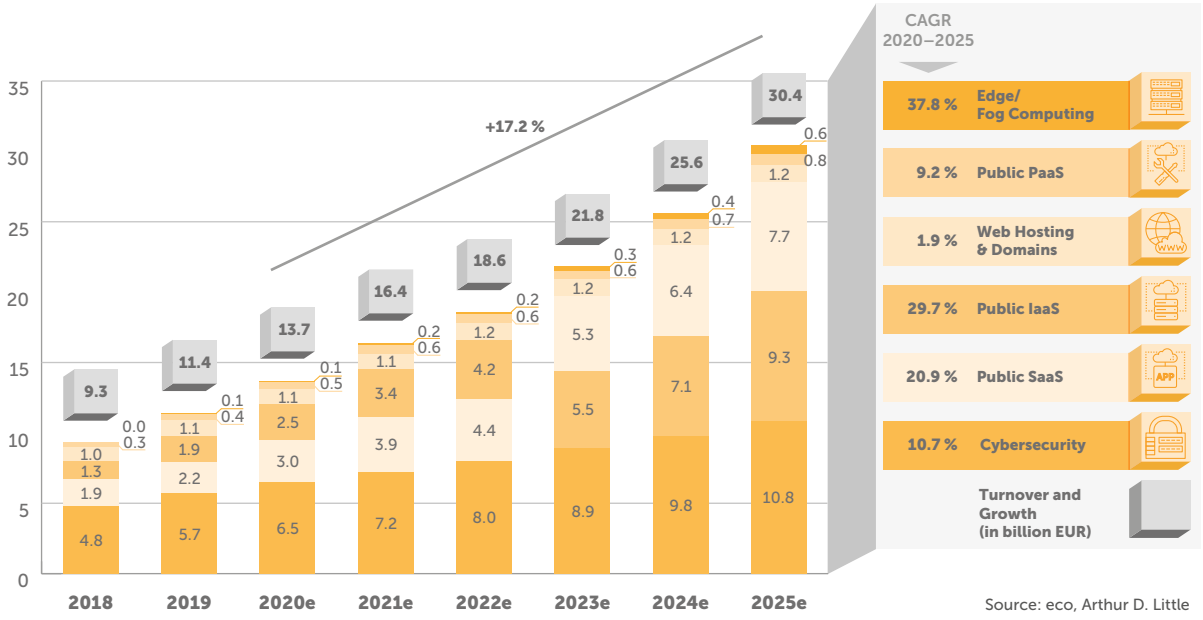
The mobile communications market for residential customers has proven to be less resilient than the fixed network market in past economic recessions. Compared with previous crises, the trends caused by the Covid-19 pandemic have also been accompanied by reduced mobility for large sections of the German population. As many people are making greater use of their fixed network lines, mobile data use is declining in relation to total data traffic. Due to the reduced purchasing power of consumers caused by the pandemic, mobile network operators are finding it more difficult to upsell to higher data packages. In addition, a temporary decline in the revenue volume for new equipment is expected, which will slow down the migration to 5G. Pre-paid revenues will be more affected by the crisis overall than the contract customer business. Revenues for data roaming outside the EU will decline sharply due to mobility and travel restrictions. The business customer market is proving to be more resilient in the short term, as revenue declines from low business travel will be offset by the provision of new mobile phones for home office employees.

Overall, the pandemic will slow down the segment's growth. Nevertheless, a return to a growth path at the pre-pandemic level can be expected in the medium term. A positive indicator of this is, in this segment as well, not least the higher (data) usage during the ongoing Covid-19 pandemic.

The conditions for expansion and cooperation across under-served application areas and usage scenarios must be improved.

3.2 Services & Applications (incl. Cybersecurity)

Fig. 12 **Turnover and Growth in Layer 2: Services & Applications (in billion EUR)**



Source: eco, Arthur D. Little

This layer of the model of the Internet industry represents companies that build on the network infrastructure and enable the provision of varied services and content for companies and private individuals on the Internet. Their business includes managing Internet addresses, "feeding" Internet sites, providing a wide range of public cloud services, and establishing and maintaining cybersecurity.

- The Services & Applications layer is the fastest growing area of the Internet industry in Germany. Between 2020 and 2025, it will grow at an average of 17.2 percent per year, more than doubling its market volume from 13.7 to 30.4 billion Euro.
- The Public Cloud Services segment is making a particularly strong contribution to this growth. With a growth rate of almost 30 percent per year, Public IaaS will grow very strongly until 2025 and will establish itself as the second largest segment of the Services & Applications layer from 2023.
- The top-selling segment in 2020 includes digital products and services in the context of cyber security. With a growth rate of 10.7 percent, the segment will maintain this dominant role until 2025.
- The highest growth rate of any segment of the German Internet industry can be seen in the current market niche around Edge/Fog Computing. With an annual growth rate of around 38 percent, the segment will gain in importance up to 2025 – primarily due to the increasing demand for IoT solutions.

2020: The Winner of the Pandemic is the Digital Workplace

by Jens Weller, CEO, toplink GmbH

Within a very short time, companies had to adapt to a completely different situation in 2020 and give employees the opportunity to work from home. Telecommunications, mobile office applications and video conferences instead of meetings and quick discussions across desks are a challenge. The solutions range from small sub-areas to a completely digital workplace. Fully-integrated solutions from the cloud are the long-term winners of the pandemic and are catapulting the working world into a new age.

The year 2020 has quickly and unexpectedly developed into a massive challenge for companies. Established work structures are no longer usable, open-plan offices are obsolete, and home offices, collaboration tools and digital workplaces are the new heroes of the working world. However, the new structures had to be implemented in the shortest possible time – and not every company has the necessary know-how or infrastructure. Digital Workplace as a Service takes this burden off the shoulders of companies and IT departments and offers a full-fledged workplace with all necessary applications, telephony, and video conferencing. All you need is a broadband Internet connection. This also provides legal certainty, because not every tool for remote working also complies with German and European guidelines for data protection.

Digital Workplace as a Service refers to the provision of applications, information and services such as telecommunications for the digital workplace. With the help of these services, employees can work completely independent of location and end device. The control takes place via a central platform, which works and can be managed in accordance with data protection regulations. The trend towards a Digital Workplace as a Service was already noticeable before the Covid-19 pandemic of 2020, but more as a trend to optimise work-life balance and only for selected employees. Growth in this area, therefore, was moderate with an increase of ten to 20 percent per year.

As a result of the pandemic and initial lockdowns, the trend towards home workstations "to go" experienced a massive upswing. However, a distinction must be made as to whether this growth is more likely to be classified as Temporary Growth (= quick profits) or Sustainable Growth (= long-term profits).

Temporary Growth is the term used to describe the short-term sales peak of providers of rapidly deployable solutions. These are easy-to-use services that can be booked and used easily without requiring any special IT knowledge. One example of this is a solution for telephone conferences such as the myTelco service. This important element of the digital workplace can be easily implemented. Numerous companies took advantage of this offer during the Covid-19 pandemic and used myTelco telephone conferences during the home office phase for customers and employees. The simple implementation and usability of these and comparable solutions were quite convincing in the initial crisis situation. Due to the resulting customer loyalty, it can be expected that some of the customer and conference growth will be maintained after the pandemic.

Nevertheless, it can be assumed that the temporary products will not see sustainable growth, but will be replaced by professional services in the long term. The reasons are manifold: The professional services are compliant with data protection and are of high quality, as well as other service levels, which also allow for support. One of these services is Microsoft Teams, which works on its own European platform. The short-term growth in sales of individual services such as teleconferencing will therefore hardly be sustainable, but rather represents a brief peak due to the extreme levels of initial helplessness and the rapid search for tools during the initial national lockdown.

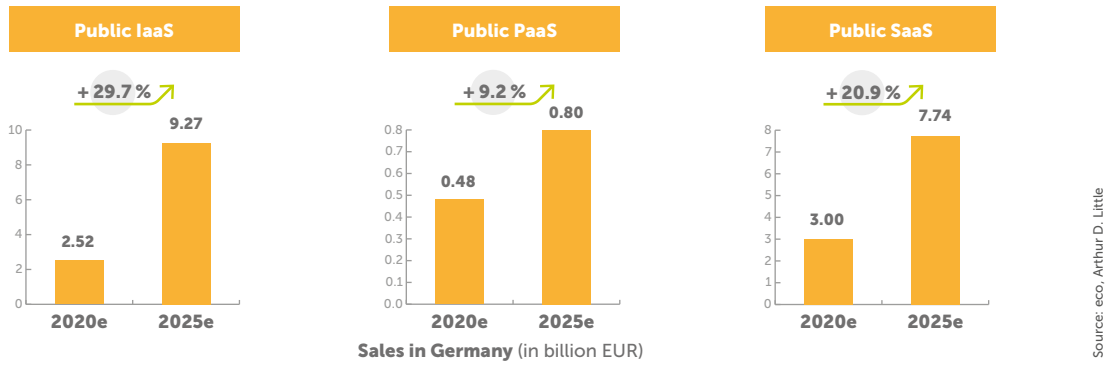
Sustainable Growth refers to sustainable sales growth and can be expected for the high-quality solutions of the cloud segment for the digital workplace. The special advantage of these providers is the complete coverage of all necessary services at a home office workplace: from telephony to communication via chat and other tools, collaboration and applications such as Office 365. The technical infrastructure includes not only a mobile work device such as a laptop, but also a comprehensive communication & collaboration tool for teamwork, linked to a digital telephone connection. To enable centralised data storage, these providers are independent of location, time and end device – the data is stored in a secure cloud and can therefore be made available on another end device at any time.

This independence has a lasting effect on customer lifetime value. While with on-premise solutions, the systems must be maintained and serviced in-house, with cloud solutions all systems are outsourced to the cloud, are stored there securely and are always up to date. German companies will probably continue to move into the cloud and reduce on-premise solutions – also due to the current pandemic. At the same time, it is to be expected that the number of employees working from home for German companies will remain at a significantly higher level than before the pandemic. However, the more employees work from home, the higher the risk of overload with conventional on-premise solutions.

Cloud services, in turn, can be adapted to changing load scenarios at any time and scale together with the customer's business. Through the pay-as-you-grow system, you can book as much as you like, however much you need – and what is no longer used can be cancelled on a daily basis. The tax perspective is also different: Hardware can only be depreciated once a year for tax relief, while monthly services can also be claimed monthly. The general flexibility offered by the Digital Workplace as a Cloud model is increasing, and the crisis has certainly shown how such services can be used and the added convenience they offer companies.

Public Cloud (IaaS, PaaS, SaaS)

Industry development in Germany



Sales in Germany (in billion EUR)

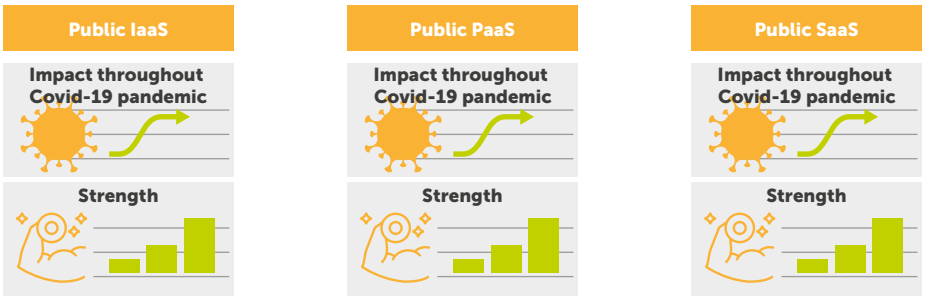
Source: eco, Arthur D. Little

The Public Cloud segment of the Internet industry model, consisting of the sub-segments Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS), has recorded strong double-digit growth over the last five years (CAGR = 28.7 percent). In 2019, it comprised a total turnover of 4.5 billion Euros. The fastest growing sub-segment was IaaS with 42.7 percent, followed by PaaS with 25.1 percent. The largest sub-segment in terms of sales volume, SaaS, also grew at a double-digit rate of 20.4 percent. This growth is due in part to changes in the regulatory framework between the EU and the USA (EUUS Privacy Shield) and the resulting increased confidence in cloud services.

The growth trend of public cloud will continue in the coming years until 2025 due to the attractiveness of the segment for a very broad customer base. Due to the high flexibility and scalability of solutions and the low capital commitment, cloud services are in demand from start-ups, medium-sized and large companies alike. A key growth

driver of the demand for public cloud services is the integration of smart devices within the framework of IoT. The currently growing fields of application of IoT include, for example, Smart Wearables, Smart Home, Connected Cars and Smart Meters in the energy sector. Another growth driver is the multiplication of storage capacity, which is constantly expanding the service spectrum of cloud solutions. Companies are increasingly opting to complete migrate from their own data centres to cloud service systems. Some experts predict the commoditisation of cloud services, which could reduce the segment's prices and profit margins. Nevertheless, we expect the strong growth to continue over the next five years, especially in the IaaS and PaaS sub-segments, and that the sales volume will more than double.

Impact of the Covid-19 Pandemic on the Segment



Source: eco, Arthur D. Little

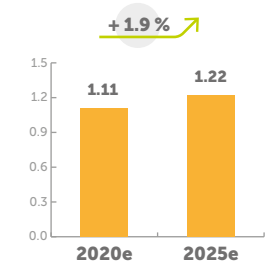
Since the start of the Covid-19 pandemic, cloud service providers have been considered the backbone of a global virtual learning and collaboration experiment. The digital collaboration tools now in high demand by businesses and schools, such as Zoom, Slack, Microsoft Teams, Cisco Webex, Canvas, Google Classroom and Google Meet, are all based on a public cloud infrastructure. Even previously conservative industries such as the public sector are showing high and rapid adaptation rates of cloud services due to the acute need for flexibly scalable solutions.

Against the background of current pandemic experiences, companies will focus their long-term IT strategy more strongly on flexibility and risk reduction in capital commitment. The adaptation rates for public cloud in companies are thus experiencing a sustained growth spurt. The increased use of video streaming services such as Netflix, Amazon Prime Video and Disney+ is also boosting demand from residential customers for the public cloud platforms on which these services are based. All in all, the pandemic has strengthened an already enormously growing market in the long term. Against this background, comprehensive projects such as GAIA-X are also gaining additional significance and relevance as a basis for many companies or entire segments of the Internet industry in Germany and Europe.

Sovereign infrastructure is the decisive basis for securing the long-term future of a location.

Web Hosting & Domains

Industry development in Germany

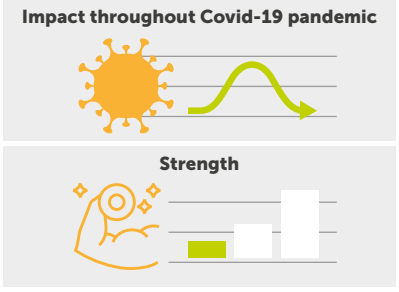


Sales in Germany (in billion EUR)

Source: eco, Arthur D. Little

The Web Hosting & Domains segment is in a very mature stage of market development. With a total of 16.4 million registered domains in 2019, ".de" is the third most frequent top level domain worldwide after ".com" and ".cn". The penetration rate for websites and domains for companies in Germany has continued to increase over the last five years. In 2019, 90 percent of all German companies had a website. Due to the already very high market penetration in Germany and a declining price development, web hosting is increasingly becoming a commodity product. In order to continue to differentiate themselves from the competition and to capture higher levels of payment, companies offer value-added services such as the complete management of web hosting. Additional services within this framework include system updates, managed backups and helpdesk services. The increasing demand for e-commerce and the growing number of start-ups in Germany will also ensure moderate growth in this mature market segment until 2025.

Impact of the Covid-19 pandemic on the segment

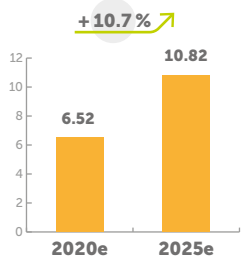


Source: eco, Arthur D. Little

The coronavirus pandemic has had a temporary, slightly positive effect on the Web Hosting & Domains segment. High pandemic-related information needs in society have had an influence on the number of newly registered domains. Since January 2020 alone, over 68,000 new domains with content related to the Covid-19 pandemic have been registered worldwide. In addition to the increased demand for information, the pandemic has also caused a short-term growth spurt in the penetration rate of websites: In order to maintain interaction with customers during the lockdown phase, companies that previously did not have a website have also been encouraged to rethink their approach. The complete market penetration of websites has been accelerated by this, sales have temporarily increased.

Cybersecurity

Industry development in Germany



Sales in Germany (in billion EUR)

Source: eco, Arthur D. Little

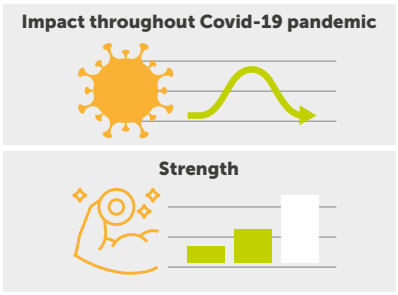
Cybercrime costs the German economy more than 102 billion Euro annually. Between 2017 and 2019, the damage caused by cybercrime in Germany almost doubled from 55 billion to 102.9 billion Euro. This means that Germany is currently shouldering the second highest costs caused by cyber attacks worldwide, behind the USA. Due to changes in the regulatory framework in Europe, growing awareness of online threats and the upswing in digital business models, demand for cybersecurity solutions in Germany rose significantly. With a turnover of 5.6 billion Euro in 2019, the German cybersecurity market is the second largest market in Europe after the United Kingdom.

The digital transformation of companies in Germany is driving the demand for cybersecurity solutions. The digitalisation projects in manufacturing industries such as the automotive industry, in particular, show very high potential for the future marketing of security solutions. Platform-based business models, Big Data, Advanced Analytics and autonomous driving are just a few examples of new digital application fields that increase the demand for secure management of data and applications.

At the end of May 2018, the provisions of the General Data Protection Regulation (GDPR) came into force in the European Union. The increased awareness of data protection throughout the German economy has helped the segment to achieve additional growth. The increasing demand for cloud services is another growth driver for cybersecurity. In particular, small and medium-sized enterprises in Germany are increasingly turning to cloud solutions to reduce their total cost of ownership.

Without cybersecurity, sustainable digitalisation will not succeed.

Impact of the Covid-19 Pandemic on the Segment



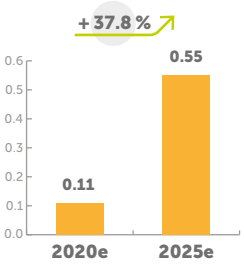
Source: eco, Arthur D. Little

The Covid-19 pandemic has exponentially increased the dependence of broad social strata on digital communication media in the short term. Within just a few weeks, the Internet became the primary channel for both professional and private interaction. To maintain operational procedures during the lockdown and at the same time protect against infection, companies increasingly offered their employees the option of working remotely. The shift of large parts of the corporate infrastructure to decentralised digital channels has been accompanied by increased exposure to cyber threats. The granting of private access rights to corporate applications, the use of private hardware and tools and the lack of physical social control increased the vulnerability to hackers and cybercrime.

To counter the increased risks, companies are investing more heavily in cybersecurity solutions in the short term. The segment is thus experiencing a temporary increase and will become even more important as the degree of digitalisation continues to grow.

Edge/Fog Computing

Industry development in Germany



Sales in Germany (in billion EUR)

Source: eco, Arthur D. Little

Edge/fog computing enables the relocation of data processing from a data centre to the periphery of the IT network (Edge) or into the network (Fog). Data generated by machines and sensors on site (IoT, Industry 4.0, ...) are collected, stored and immediately processed by a server at the network input node (Edge Server). Such decentralised data architecture has two major advantages:

First, edge/fog computing can accelerate data streams. Due to the local server structure (network input nodes), devices and intelligent applications can process data in real time (i.e. without latency) and react to it even during the generation process. High data transfer rates over the network to a remote data centre and the associated delays are eliminated. Real-time data is the basis for a number of applications in IoT, such as autonomous driving. Second, edge/fog computing allows large amounts of unstructured data to be pre-sorted, interpreted and prioritised at the point of origin. As a result, only derived knowledge is forwarded to servers or the cloud and the network load is reduced.

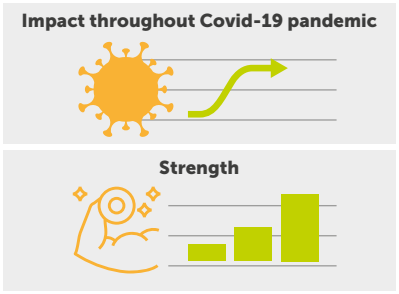
The demand for edge/fog computing is increasing in line with the requirements for quantity, speed, security, scalability and flexibility of the data to be processed. Due to the current relatively low market penetration of sophisticated IT applications, the German market for this segment is still very small. In 2020, the market segment will have a total turnover of approximately 111 million Euro. However, the volume of data to be processed and the relevance of real-time data will increase exponentially in the coming years. By 2025, the amount of real-time data generated worldwide is expected to exceed 163 Zettabytes, the equivalent of 16 billion of the twelve Terabytes of hard disk drives commonly used today (IDC 2018).

The increasing availability and application of IoT solutions will further increase the relevance of real-time data (even though we will not see any autonomous driving

to any relevant extent in Germany in the period under consideration). The market volume for edge/fog computing will therefore grow strongly up to 2025 and will increase almost fivefold within five years at a rate of 35 percent per year.

The increasing adaptation rates for public cloud services in companies due to the Covid-19 pandemic have a direct impact on the implementation of edge/fog computing. As complete, centralised processing of the very large amounts of data that arise in the cloud reaches technical and economic limits, companies will increasingly use edge/fog computing to prepare data for the cloud in the best possible way. The boom in demand for cloud services is also indirectly giving the segment a significant boost in demand, which is materialising in the form of larger infrastructure projects after the easing of the lockdown.

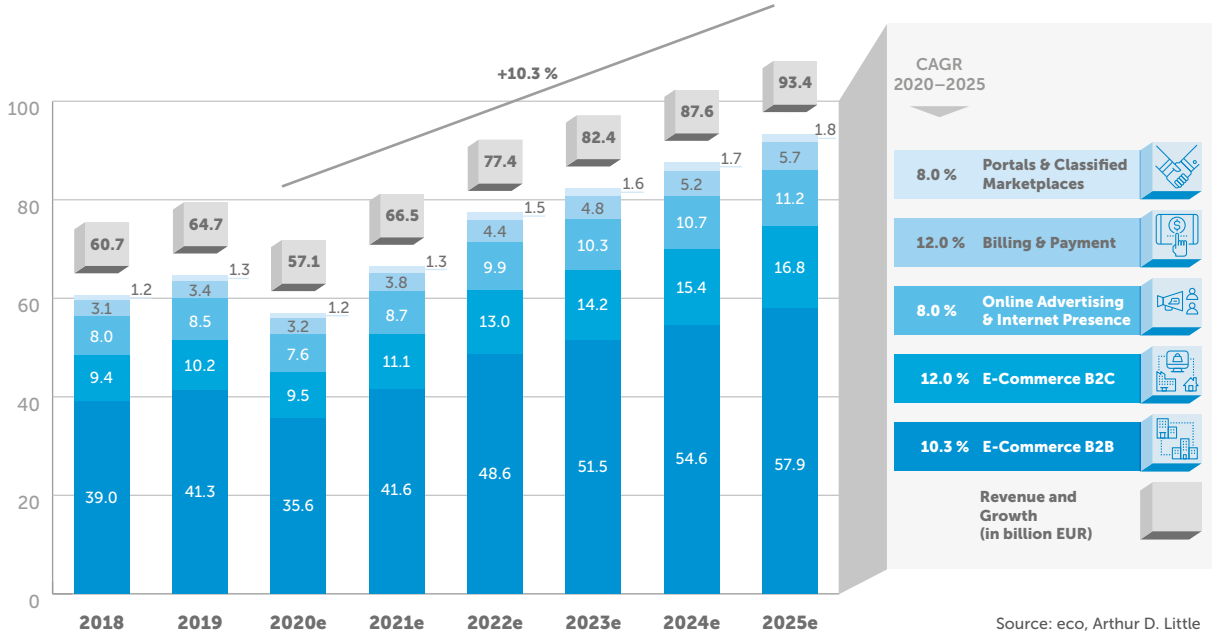
Impact of the Covid-19 Pandemic on the Segment



Source: eco, Arthur D. Little

3.3 Aggregation & Transactions

Fig. 13 **Revenue and Growth in Layer 3: Aggregation & Transactions (in billion Euro)**



Source: eco, Arthur D. Little

The players in this layer of the model of the Internet Industry partly use the services of layers 1 and 2 to aggregate the content of the downstream layer 4 and make it accessible. They are also responsible for initiating and conducting transactions relating to other products. This layer includes the B2B E-Commerce sector and several providers of B2C e-commerce platforms. Operators of subscription-based portals and classified marketplaces, advertising and online marketing companies, and providers of transaction services can also be found in layer 3.

- Aggregation & Transactions is the layer of the Internet industry in Germany with the highest revenues, with 65 billion Euro in 2019. At the same time, however, it has also been hit hardest by the slump in revenues caused by the Covid-19 pandemic: In 2020, the year of the pandemic, the layer will lose a total of almost eight billion Euro in revenues in comparison to the previous year. Starting in 2021, the layer can recover completely and continue its growth path at an average rate of 10.3 percent annually. In 2025, this layer will reach a revenue volume of 93.4 billion Euro.
- With annual growth rates between ten and twelve percent, the B2B and B2C E-Commerce segments will remain the main revenue and growth drivers until 2025. By 2025, close to 80 percent of this layer's market volume will be generated in these two segments (74.7 billion Euro).
- The Online Advertising & Internet Presence segment is also located in layer 3. With an average annual growth rate of eight percent, it will grow steadily and reach revenues of over eleven billion Euro by 2025.

The "New Normal" for Corporate IT Infrastructures

by Marcus Busch, Managing Director, Leaseweb Deutschland GmbH

The study shows a temporary slump in business, particularly in layers 3 (Aggregation & Transactions) and 4 (Digital Business Models). The Online Advertising and E-Commerce sector players of these layers have a significant influence on the Internet industry, so it is worth taking a closer look at both segments.

The fact that the expected slump in revenues will only be temporary makes it difficult for IT decision makers to steer their companies safely through the crisis. Despite a decline in business development, it may be necessary to maintain basic infrastructure at its original level: companies in the Online Advertising and E-Commerce sectors have to be able to adapt to short-term changes in developments – i.e. to cover "peaks" or accommodate renewed growth in the post-pandemic recovery phase.

For IT decision makers, now is THE ideal time to question their current infrastructure strategy! The assumption that the typical company in the Online Advertising or E-Commerce sector has to bear infrastructure costs of more than ten percent of its revenues clearly demonstrates that this is an equally critical and important topic. As Figure 14 illustrates, infrastructure costs can account for up to 30 percent of the entire IT budget – only personnel costs for Product & DevOps account for more (50 percent). Another important factor in the IT budget is software costs (15 to 20 percent). The question is not whether something has to happen. Rather, it is a question of finding out and prioritising which responses are possible to the changed framework conditions caused by the Covid-19 pandemic:

1. Can public cloud services/hyperscalers offer short-term flexibility at a competitive price, especially if sustainable growth is expected again in the long term? This analysis is of essential importance, particularly for companies that have already "scaled" in the past and now have to weather a (temporary) slump.

2. Can "traditional" hosting approaches be a way of reducing expenses in this area? Questioning the architecture and the associated cost models can reveal unexpected optimisation potential that is effective in the long term if cost-efficient architectures like bare metal, private cloud, or hybrid solutions are part of the analysis.

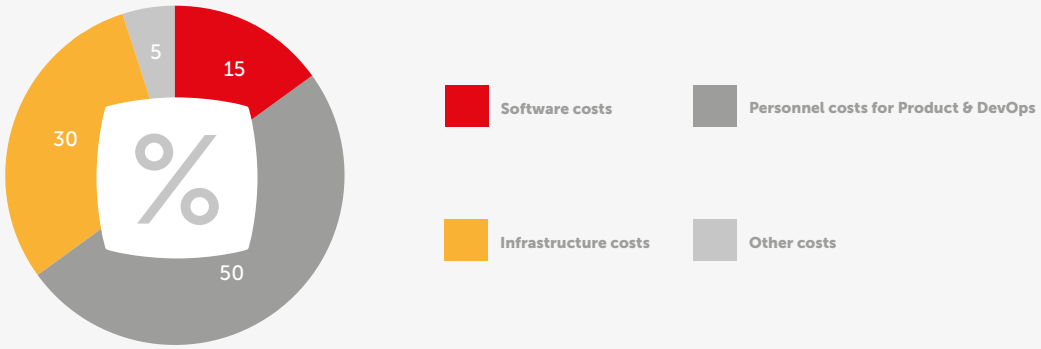
3. Is European data protection legislation being taken into account (e.g. GAIA-X compliance)?

4. How do network costs develop between peaks and sustainable, lasting growth? Far too often,

connectivity as a basis is not adequately considered, and varying traffic profiles can generate hidden costs. Renegotiating contracts or considering other connectivity models can have a significant impact, especially if the network is and will continue to be more congested as a result of people working from home.

5. Can changes in technology/architecture compensate for the temporary slump in earnings? And more importantly: Can they increase profitability in the long term?

Fig. 14 **Allocation of Costs in the IT Budget of E-Commerce & Online Advertising Companies (in percent)**



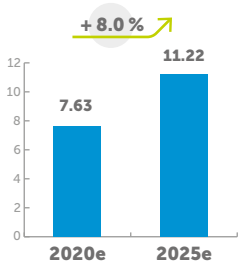
Source: Leaseweb, based on empirical data

Along with Online Advertising and E-Commerce, traditional segments like Education and Healthcare have also been affected. Even though, instead of a slump in revenues during the Covid-19 pandemic, we are seeing the opposite with short-term peaks and rapid, unforeseen growth, the essential need for action is the same. It is appropriate to question previous purchasing behaviour and IT architecture, and great changes are also expected here. The three to five-year contracts common in these sectors should not simply be extended or expanded. Rather, long-term flexibility and performance should be the dominant criteria when making decisions regarding IT architecture.

Questioning and analysing IT architecture, something which has become necessary because of the coronavirus pandemic, is expected to lead to changes in the purchasing behaviour and the priorities of the entire Internet industry. Digitalisation will accelerate and all IT architecture will be put to the test. The most important assessment criterion is value for money.

Online Advertising & Internet Presence

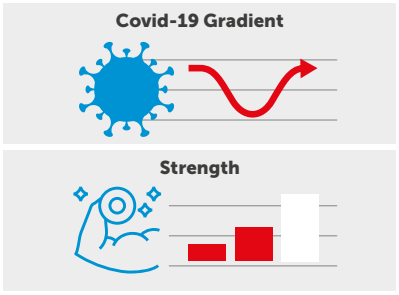
Segment Development in Germany



Revenue in Germany (in billion EUR)

Source: eco, Arthur D. Little

Impact of the Covid-19 Pandemic on the Segment



Source: eco, Arthur D. Little

The total volume of the German market for Online Advertising & Internet Presence has grown at an average annual rate of eight percent in the last five years and is estimated at 8.5 billion Euro in revenues in 2019. The main growth drivers were the sub-segments Mobile Internet Advertising and Video Internet Advertising with rates of 19.2 percent and 10.6 percent annually. Almost half of the total volume of the segment is generated by paid search: Revenues increased to 3.9 billion Euro in 2019; the share of total volume has, however, been decreasing slightly since 2015. Changed usage behaviour of end customers, new interaction channels, and the transition to the primary use of mobile devices ("mobile first") have created new data-driven advertising possibilities and a shift of the share of investments within the segment.

Over the next five years, mobile advertising will establish itself as a strong growth driver within the segment. By 2025, revenues in the area of mobile will have almost doubled, and will thus have grown to account for a quarter of the segment's total revenues. In terms of revenues, Mobile Internet Advertising will overtake Display Advertising as early as 2021.

In addition, moving images (videos) will become increasingly important compared to static advertising banners (digital displays) over the next five years. Falling thousand-contact prices in the video segment will be overcompensated for by an increasing number of short video-ads, meaning the revenue volume for videos will increase significantly faster than in the display area.

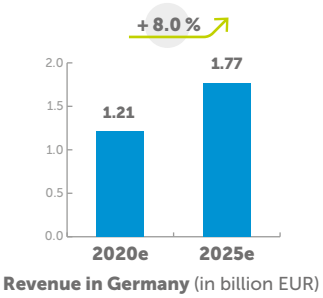
The Covid-19 pandemic has had a negative effect on the revenue volume of the Internet industry in the Online Advertising & Internet Presence segments. Because of effects associated with the virus, over 80 percent of all agencies in the Association of German Advertising Agencies (GWA) have suffered project cancellations and postponements. 54 percent of them are expecting slumps in revenues. Despite the massive social increase in the consumption of digital media and the resulting multiplication of customer contact points through online advertising, there is an overall revenue slump in the segment.

However, not every sector is equally affected by reduced advertising funds and marketing budgets. For example, advertising expenses for paid search increased by 167 percent in the fitness sector, by 71 percent for books and by 21 percent for food, cleaning and personal care products (FMCG) from February to March 2020. According to SEMrush, however, the – in relative terms – highest-volume industries for paid search like travel & hospitality and automotive have seen significant budget cuts. Hotel chains like Marriott and Hilton, for example, almost completely froze their marketing budgets for paid search. Google and Facebook are expecting a total loss of over 44 billion US dollars worldwide in advertising revenues.

Because of the pandemic, revenue generated by Online Advertising and Internet Presence will decrease by a total of almost one billion Euro (down 10.4 percent) from 2019 to 2020. In the successive years, we expect an upturn in the segment to go hand in hand with the recovery of the overall economic situation, with revenue volume in 2021 already exceeding that of 2019. The background to this growth will be advertisers considering how they can redesign their marketing strategies after the Covid-19 pandemic, focussing more on digital, data-driven and technologically-oriented marketing.

Portals & Classified Marketplaces

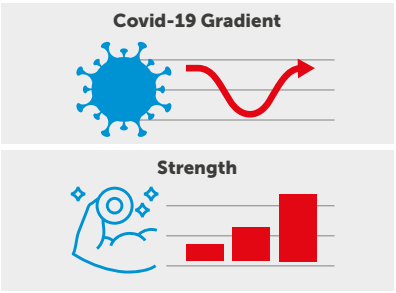
Segment Development in Germany



Revenue in Germany (in billion EUR)

Source: eco, Arthur D. Little

Impact of the Covid-19 Pandemic on the Segment



Source: eco, Arthur D. Little

Internet industry revenues generated by subscription-based portals and classified marketplaces has increased by 6.1 percent annually over the last five years and reached 1.3 billion Euro in 2019. Classified marketplaces like automotive or real estate platforms clearly dominated, with 75 percent of the volume. The major drivers within the sub-segment were automotive platforms (CAGR = 9.9 percent) and e-recruiting (CAGR = 7.4 percent). Automotive platforms are increasingly becoming a central point of contact for used car purchases. The trend towards implementing dynamic pricing models will result in better monetisation of the customer base in the coming years and will therefore lead to a sustained increase of ARPU in Germany. Automotive platforms will continue the growth trend and increase their share of the total volume. Digital personnel recruitment will also become increasingly important in the coming years. Revenues in e-recruiting – especially via job portals – will continue to increase moderately until 2025.

Subscription-based portals like dating sites and business networks will also continue to record moderate revenue growth, driven in particular by business networks. These are increasingly developing into a central contact point for digital B2B communication. In addition to further increases in membership numbers, the interaction of those members is also increasing. An increase in the number of postings, videos and company pages will ensure more interaction and longer time spent in business networks in the future. In the coming years, job advertisements, application processes and the interaction with potential applicants will increasingly be handled on portals like Xing and LinkedIn.

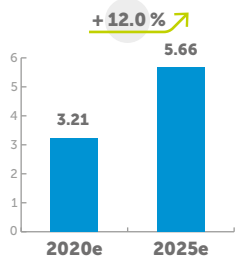
The initial national lockdown during the Covid-19 pandemic resulted in a temporary standstill in the labour, real estate, and automotive markets. Significant economic insecurities have strongly limited recruitment in the German labour market. Current application processes are often being paused, new job advertisements delayed or cancelled. This means that the overall interaction volume on job portals and in business networks has decreased. The real estate market has also been severely affected by the ongoing pandemic. The number of initial advertisements for properties has fallen sharply since the contact restrictions were introduced in mid-March (empirica-systeme 2020). In the medium term, rising interest rates, lower additional need due to mobility restrictions, faltering new construction activity, and lower demand from investors will reduce transactions in the real estate market.

The pandemic has had a similar effect on the German automotive market. According to a consumer climate study by the GfK, German consumer tendencies fell considerably in March 2020, especially in relation to purchases of capital goods like cars. In addition, the supply of new cars was temporarily reduced by temporary production stops by car manufacturers. The resulting standstill of the automotive market has had a direct impact on the transaction volume on automotive platforms.

Overall, the revenue volume of classified marketplaces and subscription-based portals will fall in 2020 because of the pandemic and, after a recovery period from 2021 to 2022, will see moderate growth of 5.7 percent in the successive years.

Billing & Payment

Segment Development in Germany

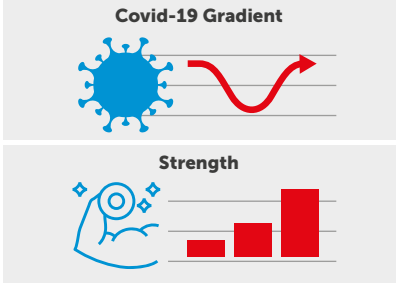


Revenue in Germany (in billion EUR)

Source: eco, Arthur D. Little

The Billing & Payment segment has increased by 12 percent annually over the last five years and in 2019 reached a volume of 3.4 billion Euro. 90 percent of all revenue in this segment is generated by transactions in the B2C E-Commerce sector. The remaining 10 percent are spread across revenues from smaller transaction volumes in the SaaS, Gaming, Gambling, TV & Video, Music & Radio, and E-Publishing sectors, as well as from portals and platforms. Because of the steady increase in the frequency and volume strength of online transactions in the B2C E-Commerce sector, the segment will continue to grow in the coming years. Improved billing processes and increasing availability are making it possible for online payment methods to penetrate the market to an increasing degree. Generation Z (born 1997 – 2012) will account for 40 percent of all online transactions by 2025. These consumers have changed usage behaviours and are placing new and higher demands on online payment methods. This includes, in particular, making payments with a mobile phone (for example Apple Pay, Google Pay, etc.) and using omnichannel payment methods like PayPal.

Impact of the Covid-19 Pandemic on the Segment

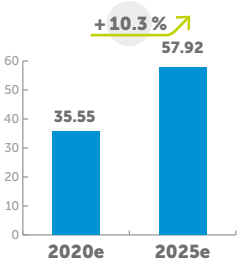


Source: eco, Arthur D. Little

Because the segment depends heavily on B2C e-commerce transactions, it is experiencing a revenue drop linear to the drop in B2C E-Commerce. The overall increased use of online payment methods during the pandemic cannot compensate for the reduction in the absolute e-commerce transaction volume. In 2020, the segment will shrink in comparison to the previous year. The improvement of the consumer climate and the recovery of e-commerce will put revenues from online payment methods back on its growth path at an annual rate of twelve percent.

E-Commerce B2B

Segment Development in Germany



Revenue in Germany (in billion EUR)

Source: eco, Arthur D. Little

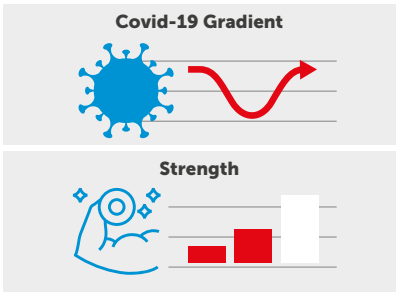
In 2019, close to 1.4 trillion Euro was transferred electronically between business customers in Germany. We estimate the value contribution of the Internet industry at just under three percent (41 billion Euro). This makes E-Commerce B2B the segment of the German Internet industry with the highest revenues. Procurement over the Internet has increased continuously in recent years. The average annual growth rate over the last five years was six percent. The most important growth drivers of the segment were the website, online-shop and marketplace channels. These channels are being used increasingly by companies, especially because of the advantages they provide with regard to addressing new target groups and internationalisation projects. B2B online marketplaces make it possible to test one's own product, price and marketing strategies at considerably lower implementation costs and risk levels compared to selling via one's own online shop. By 2025, the penetration rate of companies that conduct their procurement online will increase to 93 percent.

Despite moderate growth and the increased use of digital channels, E-Commerce B2B's digital transformation is still in its infancy. In 2019, almost three quarters of B2B e-commerce was handled via electronic data interchange

(EDI). The most frequently-offered payment methods in B2B e-commerce are still by invoice, payment in advance, and direct debit.

Because more and more shops are being established online, sellers will not be able to gain a competitive advantage in the medium term by merely offering a product in itself. Rather, there is an increasing demand for comprehensive platforms that offer personalised customer experience, reduce complexity, increase the variety of services that are offered, accelerate order and delivery processes, and make production chains controllable. Technological advances in the areas of big data analytics, IoT, artificial intelligence, augmented reality, voice assistants and gamification are the basis for this. This development will result in the continued and long-term growth of the Internet's value contribution to E-Commerce B2B, which we have not additionally taken into account in our projections for the period 2020 - 2025.

Impact of the Covid-19 Pandemic on the Segment



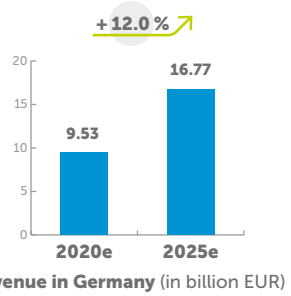
Source: eco, Arthur D. Little

The Covid-19 pandemic is having a temporary, strongly negative effect on B2B e-commerce transaction volume. The results of a survey of the more than 130 member companies of the German Federal Association of E-Commerce and Mail Order Business (BEVH) show that 84 percent of those surveyed had experienced concrete effects in their own online business as early as March 2020. 40.9 percent of the companies recorded fewer orders from their customers, while only eleven percent recorded an increase in order volume. A total of 59.8 percent suffered delivery delays or cancellations.

Over the course of the year, the companies surveyed expect the Covid-19 pandemic to have strongly negative economic consequences: 77 percent expect to experience delays in delivery and slumps in revenue. 31.9 percent expect to see their suppliers in insolvency difficulties, while 29.6 percent of the companies expect to experience financial bottlenecks themselves. Overall, large companies in the manufacturing sector with more than 50,000 employees have been particularly hard hit by a decline in purchasing activities (down 41 percent). The overall economic recession will temporarily lead to a reduction in platform transaction volume in the area of B2B e-commerce and thus to a sharp drop in revenue in the segment. In 2020, revenue volume will fall by 14 percent, from 41 to 36 billion Euro. In the long term, the Covid-19 pandemic will have a catalytic effect on the digital transformation of B2B trade. Once the lockdown is over and after a recovery period in 2021, the segment will be back on a stronger growth trend until 2025.

E-Commerce B2C

Segment Development in Germany



Revenue in Germany (in billion EUR)

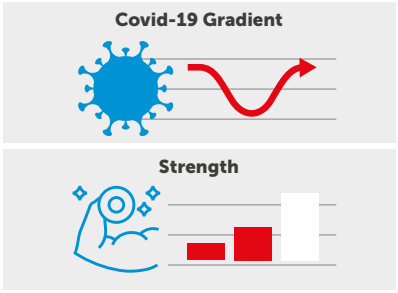
Source: eco, Arthur D. Little

The revenue volume in German E-Commerce for Private Customers (B2C) rose to over 100 billion Euro in 2019. This means revenues have increased at an average annual rate of 11.6 percent over the last five years. With a total volume of approximately ten billion Euro in 2019, the value contribution of the Internet to B2C e-commerce trade was around ten percent. Around 57 percent of this volume was accounted for by revenues from goods and 43 percent by revenues from services.

The major key industries of online retail, fashion, and consumer electronics still accounted for more than half of revenue in 2019. However, other industries such as consumer goods, food, DIY & garden, and home & furnishings recorded higher growth in relative terms, gradually gaining ground. According to the German Retail Association (HDE), for example, online trade in food products increased by nearly 18 percent annually between 2010 and 2018. Overall, the online share of the respective total market increased across all industries. Average online spending per online customer increased continuously and more and more older generations discovered online shopping. Because of the increasing popularity of e-commerce via mobile devices and the population's growing affinity for digital sales channels, the revenue volume in the segment is continuing to increase at high growth rates.

The online travel market and online ticketing are the two main growth drivers in the services sector. The share of bookings via digital channels has increased significantly in recent years for all forms of travel (e.g. package tours, individual accommodation, etc.) and types of travel (e.g. city trips, family holidays, beach holidays, etc.). In 2019, the majority of Germans booked their travel online. Continuously increasing frequency, regularity and intensity of travel will lead to an increase in e-commerce transaction volume and thus to sustained growth of the market until 2025.

Impact of the Covid-19 Pandemic on the Segment



Source: eco, Arthur D. Little

The Covid-19 pandemic has had a massive impact on consumer confidence in Germany – the consumer climate has collapsed heavily. Falling economic and income expectations and the threat of unemployment and reduced working hours have significantly reduced the likelihood for people to buy and consume. In April 2020, the GfK forecast a value on the consumer climate index of 2.7 points, which is the lowest value since the financial crisis in May 2009.

Despite the comparatively advantageous starting position of online trade compared to stationary trade, the crisis in consumer confidence has had a direct impact on e-commerce. According to the BEVH, revenues in e-commerce collapsed by 18 percent in March 2020. Because of international travel warnings, the widespread suspension of air travel, and the cancellation of major events, online trade in services virtually came to a standstill. In addition to the travel and ticketing markets, the Fashion (down 35 percent) and Consumer Electronics (down 21 percent) segments in particular have been hit hard by the Corona pandemic. The German online fashion retailer Zalando, for example, announced an adjusted operating result (EBIT) of minus 90 to minus 110 million Euro for the first quarter of 2020. Nevertheless, despite the losses, there are some product groups that have experienced high revenue growth. In particular, these include drugstore products, food, and medicine, with online revenue growth of up to 200 percent.

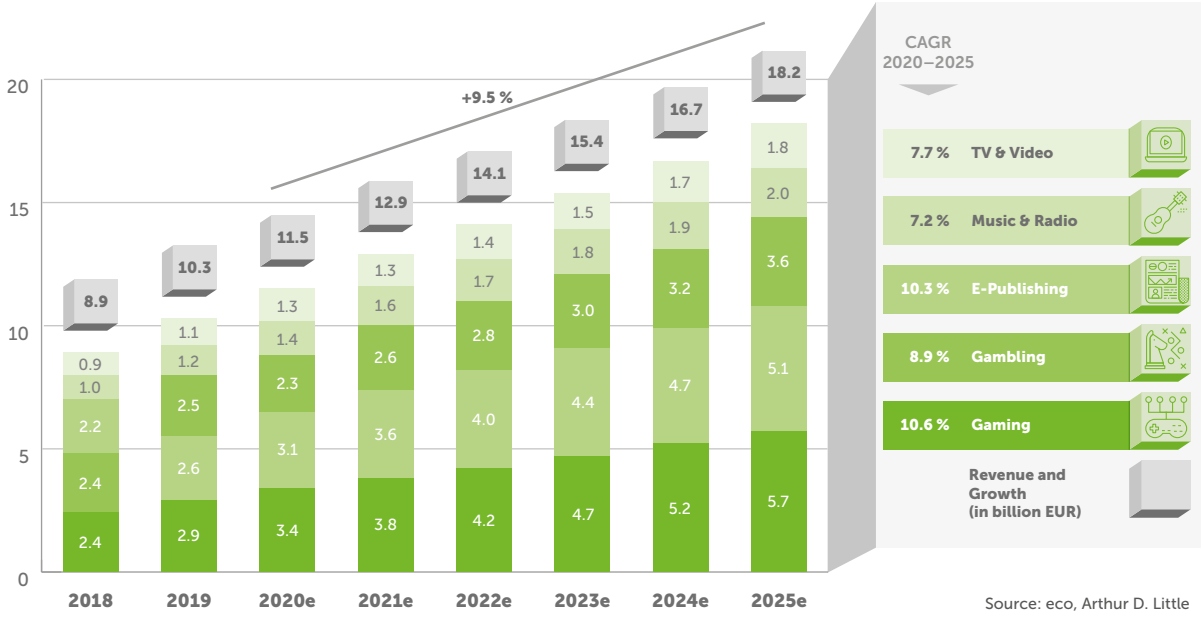
Depending on the product and merchandise group, revenues in E-Commerce B2C are expected to recover at different speeds and to varying degrees. For example, the first loosening of the lockdown in late April 2020 already led to a recovery of the online markets for clothing (revenues up 33 percent) and shoes (up 48 percent). According to the BEVH, revenues in the lockdown month April were already 17.9 percent higher than those of April 2019. Overall, there is a trend towards the market for low-priced product groups recovering faster than that for larger purchases. A recovery in revenues in the service sector, however, is not expected in 2020.

3.4 Digital Business Models in User Industries

The top layer of the model of the Internet industry is made up of two different segment groups. The first group generates revenues by marketing digital content (Paid Content), while the second market group markets digital approaches to solving problems in user industries (Smart Industries).

Paid Content

Fig. 15 **Revenue and Growth in Layer 4: Paid Content (in billion EUR)**

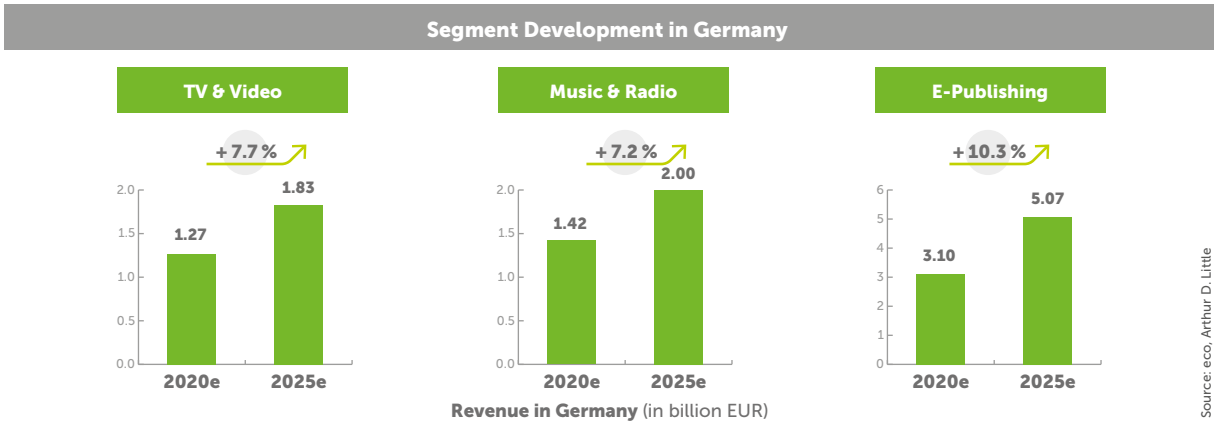


Source: eco, Arthur D. Little

The Paid Content segment group is made up of players that generate content or purchase it from third parties in order to market it or make it available via the Internet for a fee. Internet content includes any form of media content accessible via the Internet. This content, which can be web-based or reused offline media and content, is made available to different platforms and services. The companies that belong to this layer include gaming and gambling providers, TV/video and music providers, and e-publishing companies (Content & Streaming).

- Between 2020 and 2025, the Paid Content segment group will increase by an average of 9.5 percent p.a. and its market volume will rise from 11.5 to 18.2 billion Euro. This increase is based on homogenous, high growth across all segments, at average annual rates of around seven to eleven percent.
- Gaming is the segment with both the highest revenues and the strongest growth. Because of the steadily increasing popularity of online games and technological advances in latency and bandwidth, the segment will grow at an average annual rate of 10.6 percent, reaching 5.7 billion Euro in revenues in 2025.
- E-Publishing overtook the Gambling segment in terms of market volume in 2019, and will continue this growth path at an average annual rate of over ten percent up to 2025.
- The reform of the German Interstate Treaty on Gambling (GlüStV) in 2021 will mean the Gambling segment, which has stagnated in recent years and has a market volume of 2.3 billion Euro, will cease to operate in a legal grey area. This will result in a growth surge in the segment, generating around 3.6 billion Euro by 2025.

Content & Streaming



The Content & Streaming segment consists of the sub-segments TV & Video, Music & Radio, and E-Publishing. With an annual growth rate of 20 percent, the revenue volume of the segment has increased to 4.9 billion Euro over the last five years. Around half of the segment's revenues are generated in E-Publishing. The remaining half is shared between revenues in TV & Video and Music & Radio.

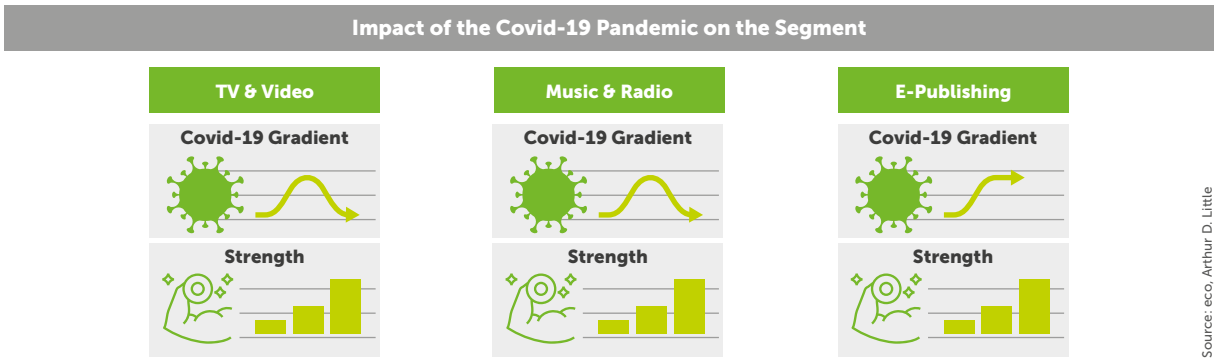
The E-Publishing sub-segment includes revenues from digital publications in the form of e-papers, e-magazines, professional/specialist e-books, consumer books, and school textbooks. In 2019, a total of 2.6 billion Euro was generated in E-Publishing. This corresponds to an annual growth rate of 16.5 percent since 2015. In 2019, the total share of e-books in the German book market was around 12 percent. This means that in global comparison, Germany was well under the international average of around 20 percent (PwC 2019).

While the share of consumer e-books will increase only slowly and at declining growth rates, the digitalisation of professional and educational books will progress considerably faster until 2025. By 2023, the share of e-books in the Professional segment will have increased to 35 percent. Based on consistent implementation of the German Digital Pact for Schools of 15 March 2019 and nationwide investments in the digitalisation of education infrastructure, e-book revenues in the Education segment will increase at an annual rate of over 45 percent.

The TV & Video sub-segment has grown at an average rate of 26 percent annually over the last five years and generated more than a billion Euro in revenues in 2019. Revenues include private consumer spending on video content through the Internet, available to customers on demand for a fee. When it comes to business models, one can differentiate between subscriptions (subscription Video on Demand – SVoD), individual access (transactional VoD – TVoD) and rental (electronic-sell-through – EST).

Increasing quality and variety of the video offers and a growing willingness of the German population to pay for them mean consumer spending on VoD offers will continue to increase in the coming years. Given that not only is the trend towards subscription models growing, but ARPU is increasing and new competitors with additional offers are entering the scene, SVoD will increase the most (CAGR = 11.3 percent).

With average growth of 24 percent, revenues in the Music & Radio sub-segment have doubled over the last five years, reaching 1.2 billion Euro in total in 2019. The increasing move from physical ownership to digital availability of audio content will continue the segment's growth trend in the coming years. By 2023, the share of digital business in music distribution will be over 82 percent. Increasing competitive pressure between the market leaders Spotify, Apple, Amazon and Google will significantly improve customer experience in the form of personalised listening experiences, compatibility with smart devices, and voice command functions. In 2025, we forecast revenues of two billion Euro in the sub-segment.



Because of movement and contact restrictions during the Covid-19 pandemic, the demand for home entertainment offers in Germany saw a sudden, sharp increase. Up until the national lockdown measures were enforced on 16 March 2020, daily television viewing time was still 231 minutes. According to measurements by AGF Videoforschung, this amount of time increased by eleven percent from the start of the lockdown and reached 257 minutes in the second half of March. Along with higher demand for television content, the number of multiple subscriptions to different VoD providers such as Amazon Prime and Netflix also increased. In the first quarter of the year, Netflix was able to increase its number of subscriptions by 15.8 million to almost 183 million worldwide, and is expecting an additional 7.5 million new customers in the second quarter. Because of the positive development of demand, new competitors are pushing into the market. The launch of Disney+, for example, was put forward by a week. Overall, the Covid-19 pandemic is causing a temporary surge in demand in the TV & Video sub-segment, which will gradually level off in the second half of 2020, following the relaxation of restrictions on movement.

The closure of schools and universities meant that sizeable portions of public education programs moved into private homes. Homeschooling is mainly based on the use of digital media like e-books and electronic communication platforms. The Covid-19 pandemic has pushed the potentials and challenges of digital education further into political focus. Digitalisation efforts are being stepped up in this context, especially with regard to e-books, which will increase demand in the long term. Furthermore, because of restrictions in movement and the closure of shops, consumers of specialist journals and books are increasingly tending towards considering digital versions. As a result of the overall positive effect of the Covid-19 pandemic, the segment is experiencing a surge in demand and will continue its growth trend at average annual rates of 7.7 percent in TV & Video, 7.2 percent in Music & Radio and 10.3 percent in E-Publishing until 2025.

Gaming & Gambling

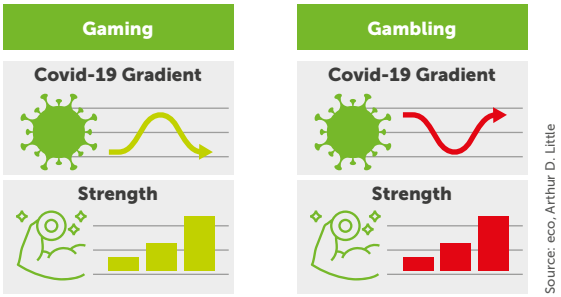
The Gaming & Gambling segment has grown continuously at an average annual rate of 12.2 percent since 2015 and reached a revenue volume of 5.4 billion Euro in 2019. This was shared relatively evenly between both sub-segments.

In 2019, the total revenue volume of online and browser games, gaming subscriptions, and in-game micro-transactions was 2.8 billion Euro (CAGR = 23.5 percent since 2015). The latter accounted for the majority of revenues in 2019. An increasing number of gaming business models are based on a free basic version and the sale of additional, paid digital goods that improve the gaming experience (item selling). Another trend is the increasingly strong establishment of subscription models resulting from the market entry of cloud gaming services. Gameplay and interaction with the user is processed externally on a server and streamed live by the user on any end device. Subscription model (Gaming as a Service) revenues will have increased most by 2025, raising their share of the total volume from 17 to 26 percent. Overall, we expect revenues in the Gaming sub-segment to reach 5.7 billion Euro in 2025.

Growth in the Gambling sub-segment has been considerably slower than in Gaming, with an annual rate of 3.7 percent since 2015. The online gambling market in

Germany includes sports betting, casino games, poker, and secondary lotteries. Of these, only sports betting providers and secondary lotteries were able to record a growth trend in 2019. Sports betting is subject to strong seasonal fluctuations, which are highly dependent on regular major sporting events. Between 2013 and 2018, the market for online sports betting almost doubled in size. This development will continue up to 2025, reinforced by future major events in professional soccer like the UEFA European Football Championship 2021. On the other hand, according to the gambling supervisory authorities of the German federal states, revenues from online casino and poker games declined. One of the reasons for this decline in revenues was the legal grey area in which online gambling currently operates in Germany. By reforming the German Interstate Treaty on Gambling in 2021, the federal states will create a uniform legal framework. As a result, the demand for gambling will continue to grow and is expected to reach revenues of 5.1 billion Euro in 2025.

Impact of the Covid-19 Pandemic on the Segment



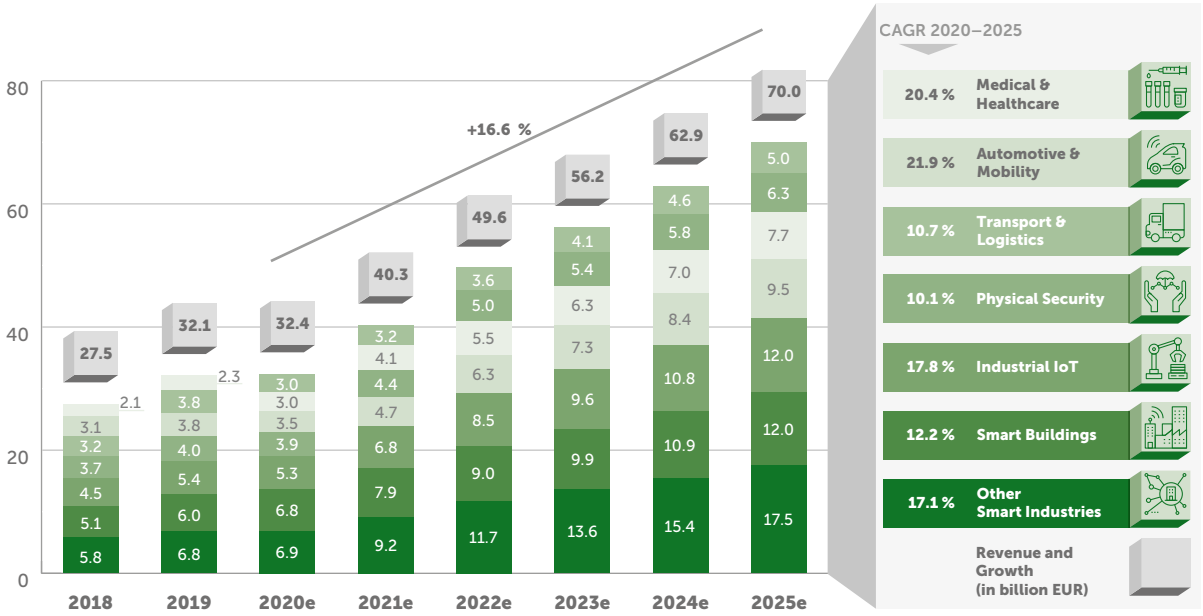
Source: eco, Arthur D. Little

The Gaming sub-segment has benefited significantly from the developments brought about by the Covid-19 pandemic. Online gaming platforms like Steam and Origin, for example, have reported record numbers of new users. Of these, Steam, a platform by the US-American software company Valve, is the first to record more than a billion user registrations (13 percent of the global population). On 16 March 2020, the first restrictions of public life were introduced in Germany, company employees started to work from home and schools were closed. At this point in time, Steam crossed the 20 million active users mark for the first time. The most popular game on gaming platforms in April 2020 was "Counter Strike: Global Offensive", with over one million new players a day (Newzoo 2020). This strong temporary surge in demand will further strengthen the already existing growth trend in the sub-segment in 2020.

The high dependency of sports betting on major sporting events means the Gambling sub-segment is suffering from a massive collapse in revenues in 2020. Within the context of the global lockdown, international sports business came to an almost complete standstill. With the exception of a few isolated marginal sports, all major sports leagues, associations and racing series ceased operations. As a result, the range of possible sports bets collapsed almost entirely. The value of shares in Germany's largest listed provider, bet-at-home.com, fell from an annual high of 54.50 Euro to 18.28 Euro in March (down 66 percent). However, the overall booming sub-segment will not be negatively affected in the long-term by the temporary lockdown. Growth trends will continue once sports business begins again, particularly in view of the amended German Interstate Treaty on Gambling.

Smart Industries

Fig. 16 **Revenue and Growth in Layer 4: Smart Industries (in billion EUR)**



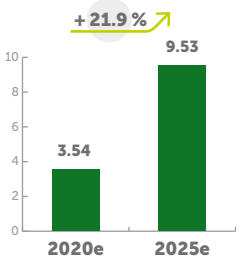
Source: eco, Arthur D. Little

The Smart Industries segment group is made up of players that, on the basis of digital business models, market solutions for a wide range of problems in user industries. Because of technological, demographic, political and socio-cultural changes, the German economy currently finds itself in a dynamic in which existing approaches have to be constantly questioned and rethought. Digital business models make use of existing network infrastructures, services, applications and aggregation mechanisms in order to offer new, effective and comprehensive problem-solving approaches.

- The market volume within the segment group is highly fragmented. In 2020, around 78 percent of revenue volume will be generated in the six largest Smart Industries. Growth is also relatively heterogeneous, with average annual rates of between ten and 22 percent.
- Overall, the segment group will grow strongly between 2020 and 2025 at an annual rate of 16.6 percent, more than doubling its revenue volume from 32.4 billion to 70 billion Euro.
- Smart Buildings is the segment of the group with the highest revenues. Its 2020 market volume of seven billion Euro will increase by more than twelve percent annually to over twelve billion Euro in 2025.
- The segments of the group with the strongest growth are Medical & Healthcare, Automotive & Mobility, and Industrial IoT, with annual growth rates between 17 and 22 percent until 2025.

Automotive & Mobility

Segment Development in Germany



Revenue in Germany (in billion EUR)

Source: eco, Arthur D. Little

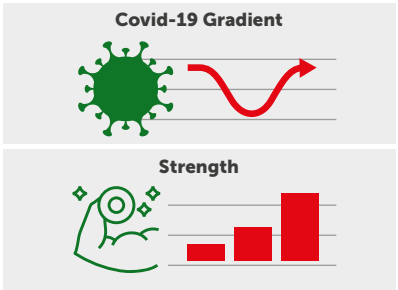
The Automotive & Mobility segment is comprised of revenues from IoT solutions for the automotive industry, the digital side of fleet management, and car sharing.

The segment has recorded strong growth since 2015, at an average annual rate of 25.3 percent. This means that revenue volume has more than doubled in size, from 1.5 billion Euro in 2015 to 3.8 billion Euro in 2019.

In the automotive industry, IoT applications are increasingly being used for automation in production and delivery processes. These include automated robotic systems and comprehensive remote monitoring of production facilities. Another example is Volkswagen's use of radio frequency identification (RFID), the so-called "glass prototype", which is currently the largest cross-company RFID project in the automotive industry. The cross-company roll-out of RFID technology ensures the tracking and tracing of test vehicles and prototype parts, which means that RFID-tagged prototypes can be identified automatically and within a few seconds by automotive manufacturers, even after the parts have been installed in a vehicle. As a result, many of the usual manual steps in production status documentation during vehicle and component testing are eliminated.

The German car sharing market more than doubled in size between 2015 and 2019, with an annual growth rate of 26.8 percent. According to the Bundesverband CarSharing (a federal association), the number of registered users in Germany increased to almost 2.5 million in the same time period. Car sharing benefits from overall conditions encouraging growth in Germany, including demographic change, urbanisation, and changing values with regard to car ownership. While today, at full fleet availability, around two thirds of the inhabitants of a core area can reach a vehicle within a three-minute walk, by 2025, this proportion will have increased to almost 100 percent. Accordingly, we expect market volume to have doubled by 2025 and segment share to increase by around six percent.

Impact of the Covid-19 Pandemic on the Segment



Source: eco, Arthur D. Little

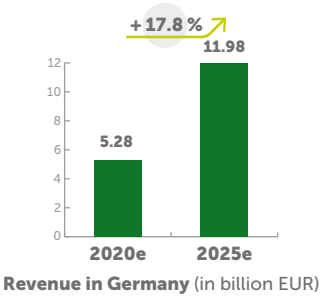
Within the automotive industry, pandemic shocks affecting both supply and demand have severely reduced production volume and temporarily brought value chains to a complete standstill. Industry experts predict for 2020 that after China, the demand for cars in Europe will also shrink considerably. According to the German Association of the Automotive Industry (VDA), sales figures on the international automotive markets had already fallen sharply in February 2020, evidence of which can also be seen in the dramatic slump in earnings for German manufacturers in the second quarter of 2020. At the same time, fewer cars are being built than originally planned. Experts expect 249,000 fewer vehicles to be manufactured in Germany and predict a loss in revenue of up to 80 billion Euro, the VDA reports.

Because of short-term liquidity bottlenecks, potential roll-outs of larger digital infrastructure projects in the context of IoT are being delayed, resulting in a significant temporary decline in revenues in this segment of the Internet industry. In the medium term, however, IoT applications in the automotive sector can be used to leverage increased efficiencies, reduced costs, and greater liquidity, and thus lead automotive manufacturers out of the pandemic. Examples include IoT-supported inventory management or real-time monitoring of procurement processes.

The national lockdown and restrictions in mobility have also had a strongly negative impact on revenues for car sharing providers. Since the start of the Covid-19 pandemic, most people have been working from home. They are forgoing business trips to other cities and are also less inclined to take advantage of offers from mobility service providers for private purposes. Overall, as a result of the Covid-19 pandemic, the Automotive & Mobility segment will suffer a significant short-term decline in revenues in 2020. However, the existing cost pressure in automobile production and future innovation support programs may have a catalytic effect on the digital transformation of the automotive industry and thus sustainably increase revenues in this area of the Internet industry until 2025.

Industrial IoT

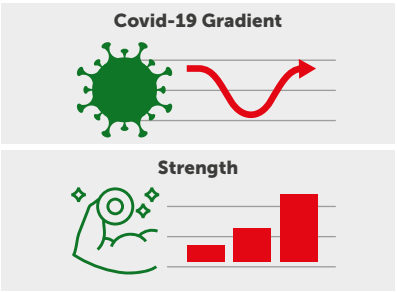
Segment Development in Germany



Revenue in Germany (in billion EUR)

Source: eco, Arthur D. Little

Impact of the Covid-19 Pandemic on the Segment



Source: eco, Arthur D. Little

The Industrial IoT segment comprises revenues from IoT solutions in all industries, especially in mechanical engineering and in the electrical & electronics, metal, and construction industries, as well as in agriculture and forestry. The market volume of the segment in 2019 was 5.4 billion Euro. This corresponds to average annual growth of 14.7 percent since 2015. The highest revenues are generated in the mechanical engineering and plant construction industries (48 percent).

As a result of increasing investments in the connection of objects (machines, products and infrastructures), users, companies, and partners, revenue levels will increase to around twelve billion Euro by 2025, and thus more than double in size. The main demand drivers are efficiency efforts in German industry (in terms of production, energy and resources) as well as faster reaction times and increasing flexibility (from product development to production and delivery). The variety and benefits of IoT platforms (e.g. Leonardo, MindSphere) as enablers and control centres for different systems and machines is steadily increasing. IoT platforms will continue to develop steadily in the coming years and increase the added value of industrial IoT solutions through data processing and the evaluation of collected information.

The effects of the Covid-19 pandemic have had a direct impact on the revenue volume of the Industrial IoT segment. German industrial companies have increasingly suffered capacity reductions, a decline in orders, and cancellations. At the end of April 2020, 87 percent of the member companies surveyed by the German Mechanical Engineering Industry Association (VDMA) reported adverse effects, 32 percent even reported severe declines in orders and cancellations. Supply chains are currently at a standstill. During the lockdown, IT infrastructure projects were suspended at short notice because of liquidity bottlenecks and a lack of demand. This has resulted in a sharp drop in revenue in the segment.

One third of the companies expect to need one to three months or three to six months to return to normal capacity utilisation after lockdown relaxations. 20 percent even expect to need six to twelve months. As soon as production processes resume, Industrial IoT will play an important role as a key lever for efficiency and flexibility. Through the increased application of IoT solutions, industrial companies can better protect employees, increase liquidity, lower on-going costs, and increase their flexibility during the remaining uncertainties of the Covid-19 pandemic. Use cases range from IoT-supported employee collaboration tools to dynamic pricing. Overall, this crisis could become a catalyst for digital transformation in the mechanical engineering industry and sustainably increase revenues until 2025.

ARTIFICIAL INTELLIGENCE

ITS POTENTIAL AND THE LASTING TRANSFORMATION OF THE GERMAN ECONOMY

A study conducted in 2019 by eco and Arthur D. Little and supported by the Vodafone Institute examined the potential of artificial intelligence (AI) for the German economy in 2025. The comprehensive analysis of over 150 use cases across all relevant industries and all corporate functions shows that a total potential of around 488 billion Euro can be created for the German economy in 2025 if companies take full advantage of the potential of AI. This corresponds to a 13 percent increase in GDP compared to 2019, of which 330 billion are accounted for by cost-saving potential and around 150 billion Euro by revenue potential. These positive effects are subject to the condition that one percent of the GDP is invested in the development and implementation of AI.

The most important effects of and use cases for AI are, for example:

In production: a productivity gain of around 11 percent • predictive maintenance • automation of quality control • optimisation of production networks

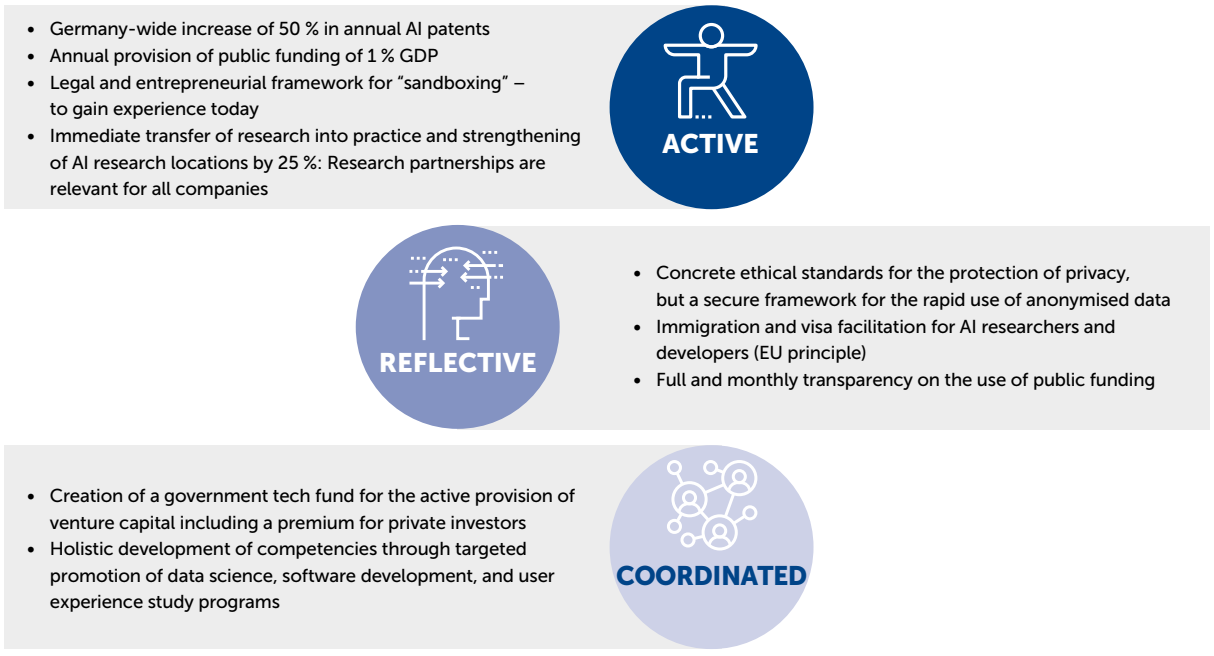
In logistics: a productivity gain of around 14 percent • automation of inventory management • autonomic warehouses

In sales: a productivity gain of around 23 percent • digital assistants to support sales staff • real-time market analysis • support in presentation and sales processes

In marketing: a productivity gain of around 15 percent • automated market analysis • knowledge management • recommendations for action

http://go.eco.de/ai-study

Fig. 17 **The Development of Artificial Intelligence in Everyday and Business Applications Must Be Active, Reflective and Coordinated**



Source: eco/Arthur D. Little, AI Study 2019

Artificial Intelligence and 5G are Transforming the Industry

by David Wang, Chief Representative, Huawei Technologies Germany

State-of-the-art technologies are accelerating the transformation of the economy. The fourth stage of the industrial revolution has been reached with the digitalisation of production processes and autonomous machines. Sensors can communicate when inventories are exhausted, components need to be serviced, or production processes change because orders have been modified.

The next step in the digitalisation process is the use of artificial intelligence (AI).

When it comes to Industry 4.0, AI has the potential to further improve fundamental challenges such as productivity, efficiency, costs, or specifications for quality and sustainability, and to turn a central control system into a decentralised, increasingly autonomous and self-learning control environment.

A successful dream team: AI and 5G

From AI-driven situation assessment to predictive maintenance and automated quality control, the real-time transmission of captured and analysed data requires advanced communication: 5G.

There are a range of advantages to the new standard for mobile communication. 5G not only saves 30 percent of the costs that would otherwise be incurred by a copper or fibre-optic cable connection to a machine. It also enables connectivity for a very wide range of applications in manufacturing environments, in particular for cloud and edge computing, data intensive IoT sensors, and image processing. 5G-capable image processing, for example, can be used to conduct automated quality inspections, which would significantly reduce the rate of false negatives.

One example of this is a waste sorting machine, or rather a robotic gripper that can – several thousand times per hour – separate, say, plastic and silicone packaging out from each other with high precision and speed, ensuring high efficiency and quality in the recycling industry. The sensors can scan the composition of waste products that are difficult to identify and then send the data to the robot's "intelligent brain", which is capable of learning. This computer can then evaluate the data in real-time and send the appropriate instructions to the robotic arm, which can then grip the object and transport it to the correct container.

The high bandwidth and real-time transmission capabilities of the mobile communication standard are also of great importance when collecting data for the training of AI systems and algorithmic inferences.

Chips like no others: High-performance and energy-efficient

In order to maximise a company's processes, detect planning errors more quickly, or better monitor and control production processes, both tangible and intangible objects can be replicated digitally using collected data and algorithms. These digital twins can then be linked to the real world with sensors. Digital twins are essential for the processes of Industry 4.0.

All of these processes require high computing power and a suitable architecture that uses as little energy as possible.

As a solution, Huawei has developed special chips that are based on the so-called Da-Vinci architecture and use a combination of computing units suitable especially for matrix multiplications, along with classic processor components. The architecture is optimised for requirements that arise from today's weak AI algorithms. These chips achieve new performance records on recognised AI benchmarks, with specifically low power consumption.

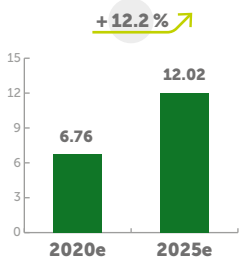
Into the future with open and cooperative ecosystems

Because of the complexity of intelligent computing in combination with 5G and the potential it has for the industry of the future, ecosystems that are global, open and cooperative are essential. It is for this reason that Huawei is investing in the further development and research of this ecosystem, together with partners from different industries, non-university research institutions, and the public sector. The focus is on creating both 5G connectivity products and AI computing resources, and providing development environments for the manufacture of IoT devices.

Huawei is facilitating AI development in the area of Industry 4.0 in Germany with the openness of Huawei hardware and the use of open source software, and is ensuring that local companies can benefit from the added value of these modern technologies.

Smart Buildings (including the Smart Home)

Segment Development in Germany



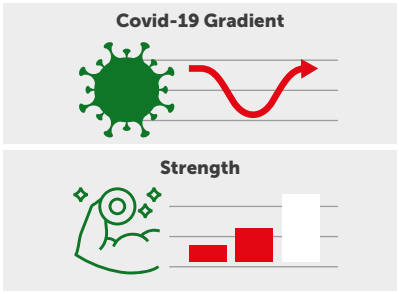
Revenue in Germany (in billion EUR)

Source: eco, Arthur D. Little

The Smart Buildings segment comprises revenues from digital solutions that increase automation, energy efficiency, security, control, and comfort, both in commercial buildings and in private households (Smart Home). In 2019, the market volume in this segment was six billion Euro. This corresponds with average annual growth of 23 percent since 2015. 60 percent of revenues were generated by digital solutions for private households (Smart Home). This includes, for example, the automation of thermostats or window blinds. Smart meters also belong to this segment. In addition, the market includes the "home cloud", which allows the management of private photos, videos and music, as well as emails, documents and contacts, and brings together various data from sensors in the house.

According to GfK measurements, around 49 percent of all households owned at least one smart home product in 2019. The increasing popularity of digital voice assistants like Amazon Alexa means acceptance and adaption rates for smart home products are continuing to grow. These days, smart TVs and multi-room audio streaming are already popular forms of entertainment media. Smart meters and smart lighting are also becoming increasingly popular. Increasing demand – especially in connection with the modernisation and construction of buildings – will result in a further increase of market penetration by smart home technologies, the revenue volume of which will have doubled to twelve billion Euro by 2025.

Impact of the Covid-19 Pandemic on the Segment



Source: eco, Arthur D. Little

The Covid-19 pandemic has put a severe damper on the consumer climate in Germany. Increasing uncertainty in the German population caused by an unstable employment situation and rising unemployment is leading to growing income pessimism. Falling income expectations translate directly into consumers' strong reluctance to purchase capital goods – including when it comes to connecting their own homes. Modernisation projects in commercial buildings like airports and factories are also being given a lower priority, due to liquidity bottlenecks and high cost pressure. On the whole, the Covid-19 pandemic is causing a temporary slump in revenue in the Smart Buildings segment. After the recovery of the overall economic situation from 2021 to 2022, revenues in the segment will return to their pre-pandemic growth trend.

Other Smart Industries

As value creation in the Internet industry now also includes parts of the physical security, transport & logistics, medical & healthcare, education, energy, tourism & retail, public policy & administration, and financial services industries, we will now briefly discuss individual aspects in these areas:

Physical Security

Increasing population density means the importance of intelligent security systems is also on the rise. These include digital access control and video security systems, among others. The demand for digital security solutions is largest in the police force, public institutions, the high-tech industry, and for private security service providers. With revenues of 3.89 billion Euro in 2020, physical security is already one of the user industries with the highest volumes. The segment will continue to grow at an average annual rate of 10.1 percent until 2025. Key drivers in this context are technological developments, the population's increased demand for security, and large new construction projects. The market for electrical and electronic security technology expects a temporary slump in revenue caused by the Covid-19 pandemic of up to seven percent in 2020. Shortfalls by suppliers, disruptions in the logistics chain, extended payment terms, and the postponement of new construction projects mean the demand for digital security solutions has temporarily declined.

Transport & Logistics

Digital solutions for transport and logistics chains are becoming increasingly important in the age of urbanisation and globalisation. Distributed supply chains and global production have led to the strong emergence of B2B logistics for all transport routes and means of transport. During the pandemic, logistics have been fundamentally impaired by border closures and radical production restrictions that prevailed at different times and for different lengths of time in the countries where branches or suppliers for the manufacturing industries are located. Companies will in at least some areas attempt to shorten or geographically reorganise their value chains, which will also lead to slower growth in the segment in the long term.

The urban mobility strategies of German cities are based on international flagships like Vienna and Dubai. They focus on the multi-modal linking of means of transport to create a comprehensive mobility concept. These and other mobility concepts are based on the increased use of digital technologies. The market for digital applications in the Transport & Logistics sector will reach volume of around three billion Euro in 2020. The volume will increase by an average of 10.7 percent annually until 2025, and thus cross the five billion Euro mark in 2025. The Covid-19 pandemic and the associated measures have led to a severe reduction in individual mobility in Germany. According to the German Automobile Club (ADAC), for example, the percentage of people who drive to their workplace or training location every working day halved from 66 to 32 percent in April. Two out of five people did not travel at all for these purposes, and around one in four no longer used public transport. As a result, the market penetration of digital mobility concepts slowed down considerably in 2020.

The segment will largely recover in 2021 and 2022 once mobility restrictions are relaxed, despite the lasting negative impact we expect as a result of changed value chains and more conscious travel behaviour – a development we would not have expected, were it not for the pandemic.

Medical & Healthcare

Processes and communication channels in the healthcare industry offer very high potential for new digital applications. Digital patient files, mobile health management,

telemedicine, and other digital innovations facilitate communication between hospitals, pharmacies, general practitioners, and patients. The market for digital applications in the Medical & Healthcare sector will reach a volume of around three billion Euro in 2020. The segment will grow strongly at 20.4 percent annually with a more than twofold increase in revenue volume, reaching 7.7 billion Euro by 2025.

The developments in the Covid-19 pandemic have increased transparency in, consciousness of, and openness towards digital solutions in the healthcare industry, and have thus had a catalytic effect on their market penetration. Objectives like preventing new infections, exchanging data in real-time, and reducing administrative documentation workloads can only be achieved if digital applications are used. As a result, the segment is experiencing a strong, sustained surge in demand.

Education

The Digital Pact for Schools of 2019 bundled and formalised investments in digital education infrastructure in Germany: The Federal Government is providing a total of five billion Euro up to 2025 to introduce and improve conditions throughout Germany for education in a digital world. E-lectures, massive open online courses (MOOC), the "flipped classroom", learning apps, and further digital solutions will help to make learning more flexible, efficient and successful in the future. Approaches to implementation of the Digital Pact remained very hesitant until early 2020. In January 2020, the 16 federal states had accessed only 20 million of the five billion Euro package. Reasons for this were the delayed design of media concepts and a late or inadequate definition of IT requirements.

Because education institutions were temporarily closed during the initial national lockdown, educational offers shifted exclusively to the digital world. Decision makers were under pressure to develop and implement digitalisation concepts at short notice. The pandemic has acted as a catalyst for digitalisation processes in the area of education and knowledge transfer, and is ensuring a sustained boost. The segment will increase at an average annual rate of 25.7 percent until 2025, when it will reach a total volume of over 6.75 billion Euro.

Energy

Energy supply in Germany has been an interesting field for digital solutions for quite some time. In order to increase efficiency in the generation, transportation and consumption of electricity, digital solutions such as "smart grids" and "smart poles" are increasingly being used alongside "smart meters" (which we have included in the Smart Buildings sector). Market volume in Germany will reach over 2.5 billion Euro in 2020. The segment will grow strongly at 18 percent annually and revenue volume will increase more than twofold by 2025.

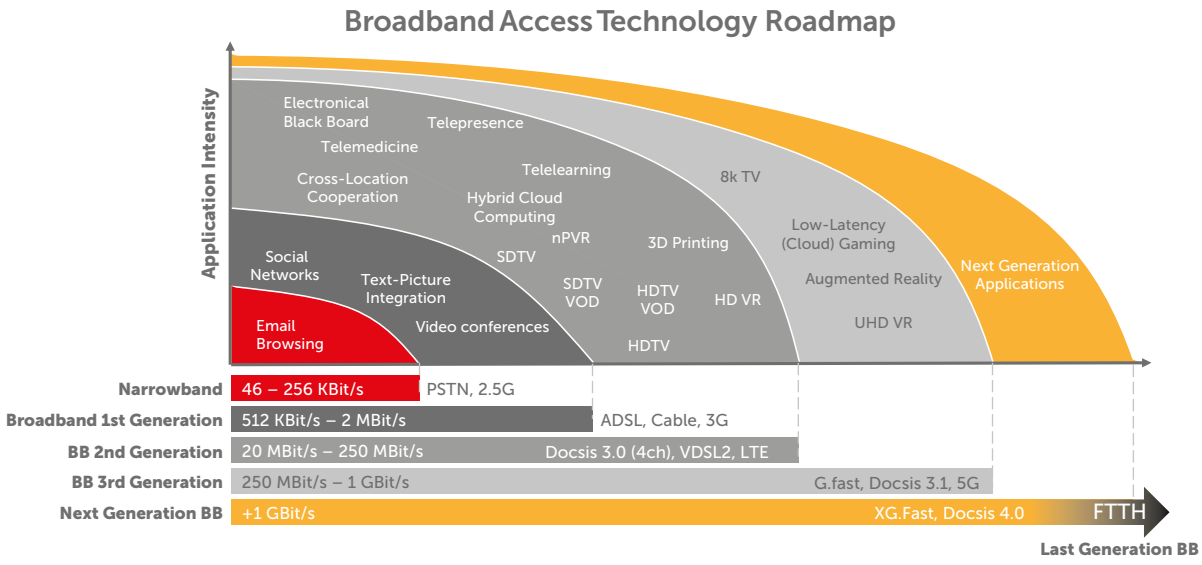
Vehicle construction, electrical engineering, mechanical engineering, and the paper industry account for around 20 percent of industrial consumption of gas, electricity and district heating. These industries have suffered a temporary slump in revenues due to production restrictions caused by disruptions in the supply chain during the Covid-19 pandemic. In addition, digital infrastructure projects are being postponed because of liquidity bottlenecks, which is also temporarily reducing, but will not permanently change demand.

4. Germany 2030 – Digital Infrastructure Scenarios

The growing demand for digital products and services in the Internet industry is accompanied by a continuous, disproportionately strong increase in the capacity requirements for sending, receiving and processing data. While the revenue of the Internet industry in Germany rose by an average of 10.3 percent per annum between 2015 and 2019, the data volume transmitted via fixed-line network connections increased by over 37 percent per year and via mobile networks by more than 48 percent per year during the same period.

With the increasing market penetration of video conferencing, augmented reality, cloud gaming, 4K streaming, video-based online advertising and other data-intensive applications, latency and bandwidth requirements will continue to grow exponentially in the coming years. According to a study by Arthur D. Little with the German Broadband Association (BREKO), demand for the download of data will increase seven-fold between 2019 and 2025, going up to as much as nine-fold for the upload of data. This means that upload speeds are also gaining in importance as a product feature, and symmetrical offers are becoming more attractive. In order to meet these increasing requirements, the infrastructure mix in Germany must be continuously developed and adapted. In addition to broadband Internet access via fixed and mobile networks, this infrastructure mix in Germany primarily includes other Layer 1 products and services such as backbone connections, transit services, CDNs, public Internet Exchanges, and servers in data centres, as well as increasingly cloud services and edge/fog computing, which are provided in Layer 2.

Fig. 18 **Broadband Infrastructure Needs by Technology Type and Use Case**



Source: eco, Arthur D. Little

The design of a country's infrastructure mix is a major factor influencing the economic success of companies, industries and the entire economy. The connection between the digital infrastructure mix (often illustrated in simplified form as the Internet or broadband penetration rate) and economic growth has already been examined at various levels and from various perspectives in more than 200 studies (for example, Crandall et al. 2007, Thompson & Garbacz 2008, Czernich et al. 2009, Koutroumpis 2009, Qiang et al. 2009, Zaballos & López-Rivas 2012, Bohlin & Rohmann 2012, 2014). Overall, a scientific consensus has emerged on a fundamentally positive correlation between the expansion of the infrastructure mix and economic growth.

The effects of the infrastructure mix include:

(1) Direct effects of large infrastructure investments that lead to increased economic activity in investment areas, for example, immediate increase in employment and purchase of raw materials,

(2) Indirect or long-term effects that stimulate innovation and productivity, for example through improved broadband speeds, and

(3) Spill-over effects on other sectors of the economy by providing access to, inter alia, entertainment, education, health care, financial services, and e-commerce.

Especially for a location with high wage costs such as Germany, the best possible performance of layer 1 is a very important factor for companies and private customers to remain competitive across industries in international competition.

Empirical studies to quantify the impact of the infrastructure mix in different regions and country clusters have yielded a number of elasticity estimates. For example, for a ten percent increase in broadband penetration, studies forecast a positive effect on GDP of between 0.25 and 1.4 percent. With regard to broadband speed, Arthur D. Little found, in a joint study with Ericsson and Chalmers University of Technology in 33 OECD countries, that doubling broadband speed increases the GDP of an economy by an average of 0.3 percent. Although such positive effects are also expected to decrease as the market becomes more mature, pandemics such as the current Covid-19 pandemic will in turn increase these effects, as the importance of digitalisation and connectivity as an enabler or a foundation increases.

In addition to the macroeconomic effects already mentioned, the infrastructure mix is having a particular impact on the growth of the digital industry in Germany, which in turn will have an increasing influence on all other industries. Within the framework of this study, we consider the future impact in the form of two scenarios. The scenarios each reflect a different degree of progress in the expansion of the infrastructure mix in Germany up to the year 2030.

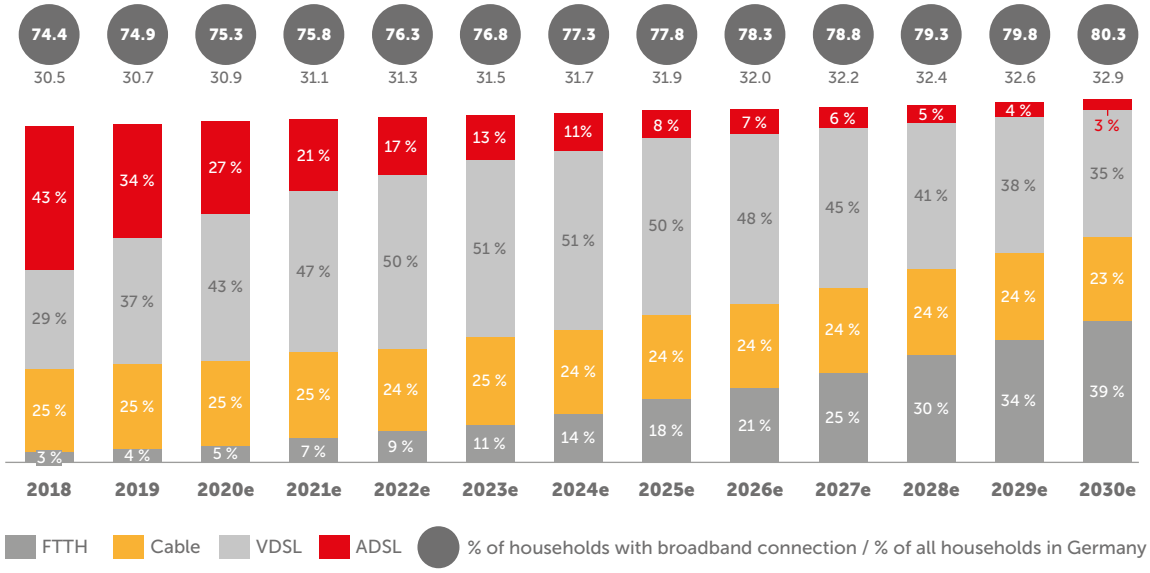
For the growth rates of the layers and segments of the Internet industry in Germany up to 2025 assumed in Chapters 1 to 3, the baseline scenario, a dynamic infrastructure mix, was assumed. In order to maintain this infrastructure mix until 2025 and beyond, substantial expansion investments (alone in the area of fibre optic networks in Germany, with a volume well into double-digit billions) are assumed, most of which have already been announced by the network operators. If these investments are not made sufficiently and systematically in the coming years, this will have a dampening effect on the growth and revenue development of the Internet industry in Germany up until 2030. A second scenario illustrates the effects of such stagnation in the expansion of the infrastructure mix until 2030.

To determine the two long-term scenarios, growth and diffusion curves of the technologies in the infrastructure mix in Germany were defined. In this way, an individual growth curve was determined for each technology such as ADSL, VDSL, cable, FTTH and FWA (Fixed Wireless Access). In defining the curves, regional differences in Germany (for example, population density) and individual growth stages of the respective technology were taken into account.

4.1 Baseline Scenario: Dynamic Infrastructure Mix

For the baseline scenario, optimal conditions for the comprehensive expansion of the infrastructure mix up to 2030 were assumed: The intensity of competition in the expansion of FTTH (fibre optic) is intensified by substantial investments by alternative network operators. In order to maintain their leading competitive position, the major network operators will fully meet their FTTH roll-out announcements within the corresponding timeframe. In addition, German mobile network operators complete the mobile expansion defined in the 2019 license conditions, including the roll-out of the 5G standard, on schedule. Investments in backbone connections, transit services, CDNs, public Internet Exchanges, and data centres accompany this development and will also be continued on an ongoing basis.

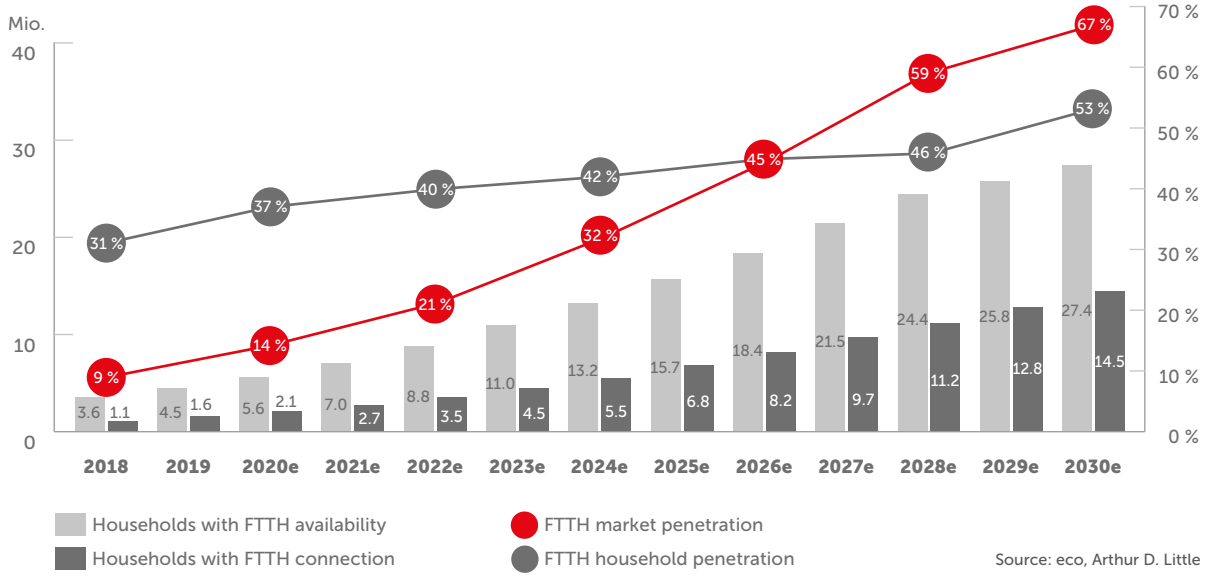
Fig. 19 **Baseline Scenario: Development of Broadband Technologies by 2030**



Source: eco, Arthur D. Little

Figure 19 shows the development of broadband technologies for fixed lines until 2030 in the baseline scenario. Between 2019 and 2030, the overall share of households with broadband access will increase from 74 to 80 percent. While ADSL had a technology market share of over 43 percent in 2018, this will shrink to three percent by 2030. VDSL technology, which is also based on a copper line, will only temporarily play a dominant role in the selection of technology for fixed-line connections. Their market share will nonetheless rise to 50 percent between 2020 and 2025, as slower ADSL connections continue to be replaced by the modernised variant. In the second half of the decade, however, VDSL will begin to lose ground to the more powerful FTTH technology. Due to its low susceptibility to interference and (almost) unlimited performance, FTTH will thus establish itself as the dominant broadband technology in Germany from 2030.

Fig. 20 **Baseline Scenario: FTTH Development up until 2030**



Source: eco, Arthur D. Little

Figure 20 shows the development of fibre-optic connections for German private households up until 2030 in the baseline scenario. The number of available FTTH connections in Germany will rise to 27.4 million in 2030. This means that the size of the FTTH network will increase fivefold compared to 2020, and 67 percent of the residential customer market will be covered by FTTH. Over the same period, the number of FTTH customers will increase almost sevenfold. This increases the penetration rate from 31 to 53 percent of the households served.

In addition to the increased expansion and adaptation of high-performance broadband technology, the baseline scenario also involves extensive investments in mobile network expansion. By opening up new mobile phone sites and expanding existing ones, the goals of the federal government's mobile phone strategy will be achieved by 2030 – coverage of at least 97.5 percent of the area and 99.95 percent of households. In parallel with this development, the nationwide expansion of the LTE network to include the new 5G technology and the demand-oriented expansion of Internet Exchanges and data centres also takes place.

With the investments described above, an optimal infrastructure mix in Germany can be maintained and expanded until 2030. This creates the framework conditions for the Internet industry in Germany to continue its growth path beyond 2025. In the baseline scenario, revenues from the layers and segments of the Internet industry can be further increased year on year between 2020 and 2030.

4.2 Scenario 2: Scattered Infrastructure Initiatives/Infrastructure Stagnation

For the stagnation scenario, framework conditions were assumed which slow down or prevent the expansion of the infrastructure mix until 2030: These include, in particular, delays or the partial non-fulfilment of roll-out announcements for FTTH. Landline network operators have tied up a lot of capital with major acquisitions and need to invest on various (technology) fronts. Due to this variety of investment needs, resources are not fully sufficient for landline network expansion. Accordingly, market leaders would continue to rely on existing VDSL and cable and delay large-scale investments in FTTH expansion.

External lenders and equity investors could also reduce investments due to general market conditions. This would also cause the expansion of alternative providers to falter, resulting in significantly lower volumes of new FTTH connections. The migration of copper technologies such as VDSL and ADSL to the future-proof fibre-optic technology shown in scenario 1 would decelerate considerably. By 2030, five million or more connections could thus remain on existing technologies and FTTH coverage would achieve a lower market penetration.

In addition, investments in the expansion of mobile communications could stagnate. Fulfilment of the coverage requirements from the 2019 frequency auction would not be fully monitored and followed through on by the federal government (for example, due to the Covid-19 pandemic). The development of new mobile phone sites and the expansion of existing sites by 2030 would be given lower priority by mobile network operators due to liquidity and investment bottlenecks. Accordingly, "grey" and "white spots" in mobile coverage would only be partially filled. The nationwide expansion of the LTE network to include the new 5G technology as well as an expansion of Internet Exchanges and data centres would experience major delays.

As a result of the general conditions outlined above, the expansion and extension of the infrastructure mix would slow down considerably. The ongoing technological progress to 2030 and the associated data capacity requirements would not be able to be fully satisfied.

- In Layer 2, the growth of revenues from public cloud services and edge/fog computing would be significantly delayed. Due to low bandwidths and high latency times, industrial IoT solutions would only gradually achieve market penetration. Edge/fog computing would remain a niche technology due to a lack of demand. Criteria such as flexibility and scalability of data capacity would take a back seat for business decisions. The demand for public cloud services may not develop fully in all areas and fields of application.

- In Layer 3, the segments E-Commerce B2B and Online Advertising especially would be negatively affected. Technological advances such as video-based online advertising, Big Data analytics, IoT, artificial intelligence, augmented reality, voice assistance and gamification may drive growth in these segments less significantly due to infrastructure bottlenecks.

- In Layer 4, the segments of both groups, Paid Content and Smart Industries, would be restricted in their growth. Due to lack of bandwidth and high latency, gaming and streaming applications with high capacity requirements would only partially be able to penetrate the market. Similarly, IoT with applications in sectors such as Automotive & Mobility, Industry or Smart Buildings would be insufficiently utilised.

All in all, a stagnating infrastructure mix would reduce the growth potential of the Internet industry in Germany

by 1.5 to 2.0 percentage points. In view of the current positive market development and the pandemic resilience of infrastructure providers, which suggests that sufficient investment funds will continue to be available, we believe that this scenario as a whole is unlikely. However, all stakeholders must work towards the optimal infrastructure mix scenario. In particular, it is necessary that ...

... the network operators and other infrastructure providers fulfil their promises on time and offer high-quality and at the same time marketable services for private and business customers. This will enable them to realise the positive effects of demand, confirm their reliability, and thus ultimately meet the risk expectations of investors, which in turn will positively fuel further investments.

... the political actors ensure fair competition and sufficient investment incentives, which depend on long-term framework conditions. Market irregularities and monopolisation should be prevented – without, however, leading ultimately to inefficient parallel infrastructures.

5. 25 Years of eco in Germany

eco shapes the Internet

With more than 1,100 member companies from over 70 countries, eco is the largest association of the Internet industry in Europe. Since 1995, we have played a decisive role in shaping the development of the Internet: We promote new technologies, infrastructures and markets and shape framework conditions.

With numerous events we promote active exchange and networking: regionally, nationally and also internationally. This is how we try to attract as many members as possible to our common ecosystem and connect them with each other in such a way that added value is created for all.

For security & trust online

Together with our members, we are committed to a free, technology-neutral, network-neutral, and high-performance Internet. We thereby want to promote the security and reliability of the Internet as well as build trust in it. Our goal is to shape the digital transformation of society and the economy in the best possible way so that successful economic action can be brought to fruition on the basis of our democratic values. As the voice of the Internet industry, we assume social responsibility for ethically oriented digitalisation.

eco connects across industries

Digital transformation is penetrating more and more areas of our social life. This also expands the spectrum of our work as an association – not just in terms of content. It is important to shape progress and change together!

Companies in the information and telecommunications sector should engage in close cooperation with traditional industries in order to create a sustainably functioning digital ecosystem. eco serves as a neutral platform for discussing views, goals and concerns at eye level. In doing so, we bring our members and stakeholders from the business community into dialogue with science, society and politics.

eco creates standards

In our Competence Groups, you will find the ideal basis for exchanging information on current and future Internet topics and for developing them further. Work with us to develop industry standards, guidelines, statements and whitepapers, whose demands are propagated by eco as your mouthpiece in politics and business.

eco is part of the industry through its close connection to DE-CIX and an active shaper of digital transformation with strong technological core competencies in the areas of infrastructure and security.

Quality seals developed by eco set quality standards and make the market more transparent for suppliers and users. They sustainably strengthen the Internet and digital industry as a motor of the overall economy. eco's consulting services for members and services for Internet users provide support in questions concerning the legal situation, increase security and improve the protection of minors.

eco represents your interests

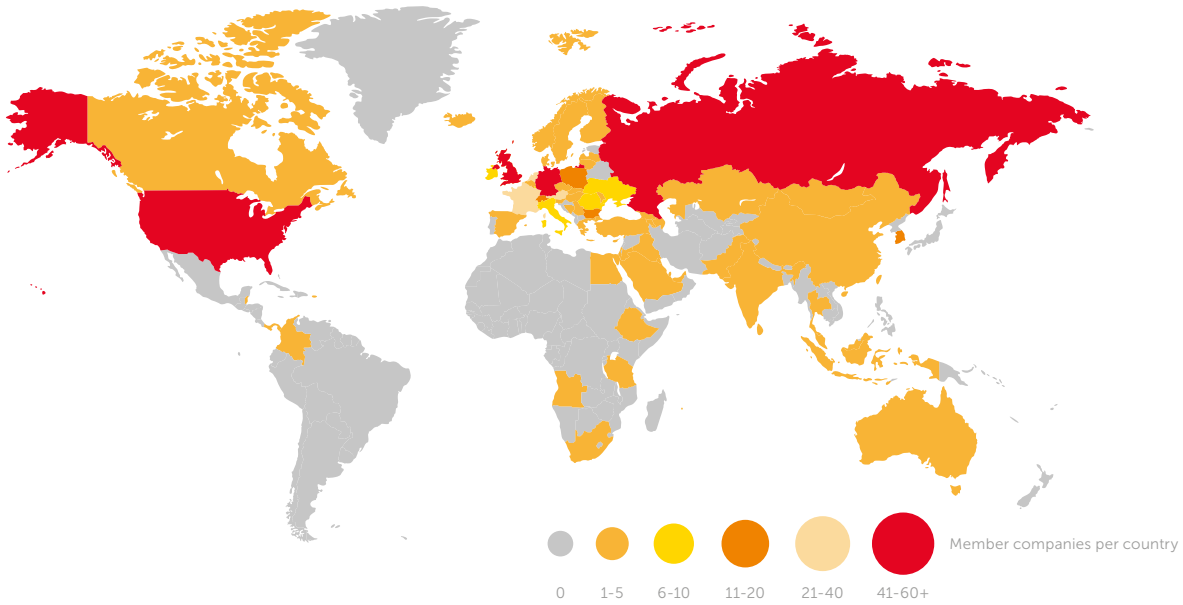
As an international pioneering competence alliance and a network partner for industry and politics, our goal is to sustainably strengthen providers of digital infrastructure and services. One of our most important tasks in this respect is to represent the interests of our members vis-à-vis politicians and in national and international committees. With our offices in Cologne, Berlin and Brussels we are on location for all of the relevant decision-making processes.

Political engagement at German and European level

The eco Politics, Law & Regulation division is committed to Internet-friendly regulations that open up optimal development opportunities for the dynamic and innovative Internet industry, thus offering the greatest possible scope for your entrepreneurial vision. In collaboration with our members, we participate in important national and international legislative processes on the strength of consultancy work and position papers. In so doing, we are able to influence all Internet-relevant issues such as platform regulation, data protection, copyright, youth protection, telecommunications regulations, artificial intelligence, and Internet governance.

Here we bring the weight of our full expertise to bear: our legal and technical know-how, as well as our long-standing experience in political work.

Head offices of eco member companies 2019



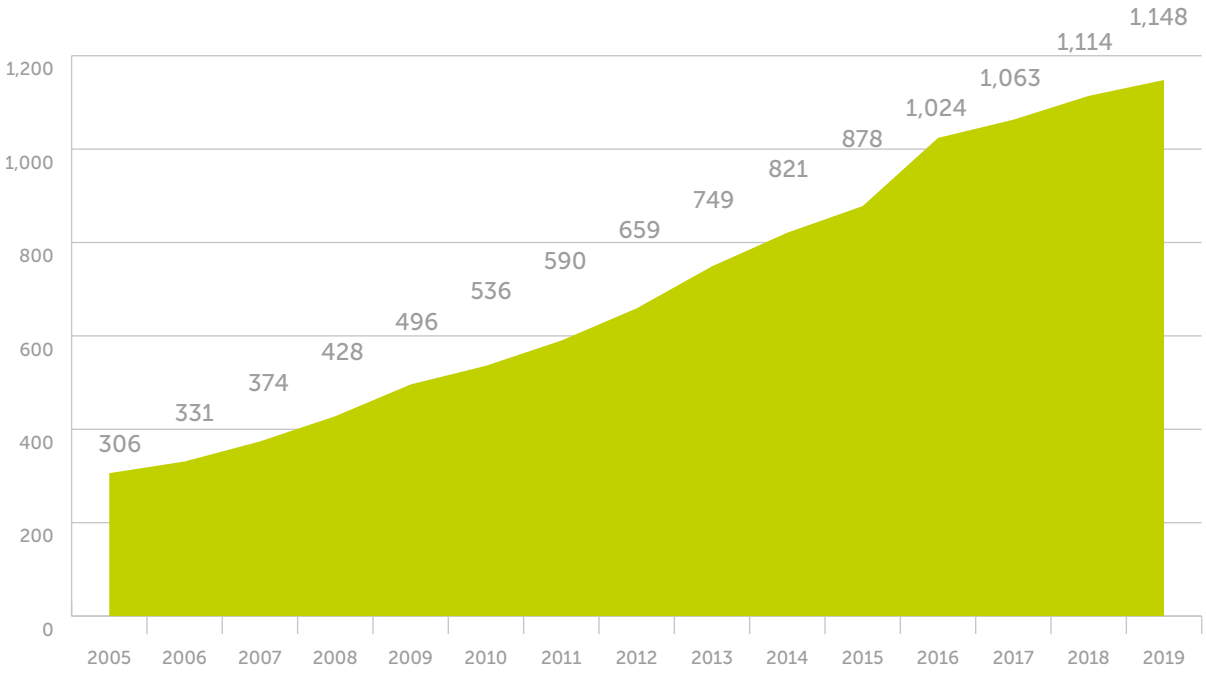
Active in important committees

eco is a founding member of EuroISPA, the European umbrella organisation of Internet service providers. We work closely together with EuroISPA in order to keep you informed at the earliest possible point about ongoing EU legal proceedings in Brussels and to influence decision-making processes at European level on your behalf.

eco is active in various international committees with a view to continuously advancing and shaping the topic of Internet governance as part of the multi-stakeholder approach. We are also a driving force of the Internet Governance Forum (IGF). At the IGF-D (Germany) and the European Dialogue on Internet Governance (EuroDIG), eco also engages in dialogue with state representatives, international organisations, the private sector, and civil society on topical problems of the Internet and possible global solutions.

eco also represents its members at ICANN, the "Internet Corporation for Assigned Names and Numbers", which coordinates the allocation of unique names and addresses on the Internet. In addition, together with other partners from politics and business, eco participates in various initiatives and alliances to combat illegal Internet content and to promote the youth media protection on the Internet.

Membership development 2005 - 2019



eco anniversary campaign "25 Years of Internet with Responsibility"

Nothing has changed the economy and society in recent years as much as the digitalisation and networking of all things via the Internet. eco has accompanied this digital transformation for 25 years and has played a decisive role in shaping many developments. And yet we are only at the beginning and people have questions: How do we protect our data? Can the infrastructure withstand the increasing load? How can people of all ages discover these new possibilities and turn them into opportunities?

In the context of its 25th anniversary, eco is facing up to these challenges and would like to counter the negative debates with a constructive perspective. Together with its members and partners, the association is embarking on a digital journey through time in 2020, focusing on responsible use of the Internet. An important element in this context is also the study on the Internet industry presented here, which provides an outlook on future developments.

Further information is available at ***www.eco.de/25jahre***, ***https://international.eco.de/presse/happy-birthday-eco-celebrates-25-years-of-internet-with-responsibility/*** and ***https://international.eco.de/about-eco/***.

eco Services & Initiatives: 25 years in the service of the Internet industry

Alliance for the Strengthening of Digital Infrastructures in Germany

In order to draw attention to the importance of digital infrastructures in Germany and to enter into a constructive dialogue with politicians, leading companies have joined together under the umbrella of eco to form the Alliance for the Strengthening Digital Infrastructures in Germany.

Certified Senders Alliance

The CSA designs and establishes high legal and technical quality standards for commercial emailing and certifies companies that meet them.

Datacenter Star Audit

The eco Datacenter Star Audit is the quality standard for data centres. The eco Authorised Auditors objectively examine and evaluate the infrastructure and services of the data centre.

DE-CIX

With more than 20 locations on four continents, DE-CIX is the operator of the world's largest carrier and data centre neutral interconnection ecosystem, with DE-CIX Frankfurt as the largest Internet Exchange in the world.

eco Academy

The eco Academy offers the optimal mixture of impartial further education at the highest level and expertise from the daily business of the Internet industry.

eco Complaints Office

For more than 20 years, the eco Complaints Office has been successfully fighting against illegal content on the Internet and is committed to ensuring that such content is taken down and criminal charges are brought.

eco External Data Protection Officer

With the eco service External Data Protection Officer, we support our members individually and competently in all questions concerning data protection.

eco Youth Protection Officer

With the eco service Youth Protection Officer, we provide support for all questions concerning youth media protection.

eco Legal Consultations

With a strong team of lawyers, each with different areas of specialisation, we at eco have been focusing for many years on legal questions regarding all aspects of the Internet. We provide our collective know-how exclusively to our members.

Webinars

The eco Academy offers free webinars on relevant topics of the digital world. This enables users to better combine their further training with their professional and private interests.

EuroCloud Deutschland

EuroCloud Deutschland_eco is the association of the cloud computing industry in Germany and member of the European network EuroCloud.

Service-Meister

Under the leadership of eco, the Service-Meister consortium is developing an ecosystem based on artificial intelligence in the area of Industry 4.0. The cross-plant, cross-departmental, and cross-company service platform is tailored specifically to the challenges facing German SMEs.

SIWECOS

SIWECOS stands for "Secure Websites and Content Management Systems" and helps small and medium-sized companies to recognise and eliminate security gaps on their websites.

StarAudit

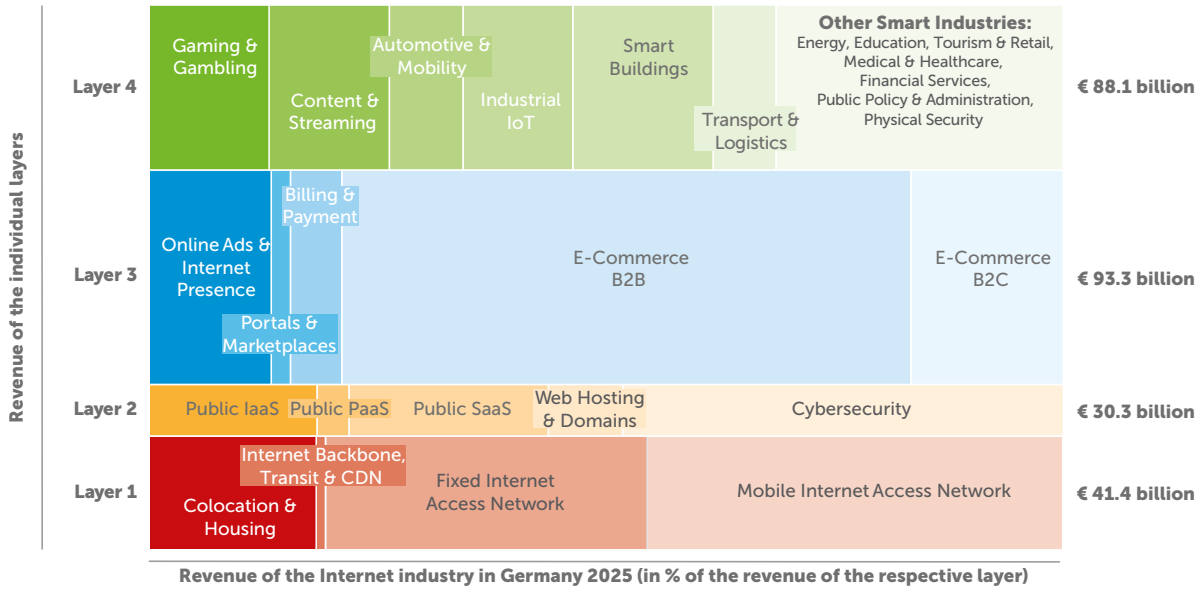
StarAudit provides a certification scheme to strengthen customer and user confidence in cloud services. The purpose of the StarAudit Scheme is to enable a transparent and reliable certification process for a traceable quality assessment of cloud services.

6. Conclusion and Outlook

The Internet industry will remain one of the fastest growing economic sectors in Germany in the coming years, making a significant contribution to digitalisation and increasing value creation for all other industries and society. A comparison with other sectors of the economy shows that the Internet industry, with annual growth of over ten percent over the past five years from 2015 to 2019, has rapidly caught up and overtaken other sectors.

Reason enough for eco and Arthur D. Little to analyse this promising industry for the fourth time. The study "The Internet Industry in Germany 2020-2025" is based on a comprehensive analysis of the individual segments and forecasts sustained growth across all market segments: In 2020, the Internet industry in Germany will have a turnover of approximately 145 billion Euro. By 2025, sales are expected to increase by almost 75 percent to approximately 253 billion Euro, which corresponds to an average annual growth rate of twelve percent (2020-2025) and leads to the overall view as shown in Figure 21, using the model of the Internet industry in 2025 by eco and Arthur D. Little. The Internet industry will continue to create jobs in Germany over the next five years. By 2025, half a million people will be employed in the Internet industry.

Fig. 21 **Revenue of the Internet Industry in Germany in 2025**



Source: eco, Arthur D. Little

The restrictions introduced by the Covid-19 pandemic have impacted all sectors of the economy negatively. However, with a decline in sales of 1.2 percent in 2020, the Internet industry is coming through the pandemic robustly compared to other sectors. A detailed examination of the individual segments reveals opposing effects, which have both negative and positive impacts on business development. All in all, however, patterns are emerging which mean that many areas will quickly recover from the short-term negative "shock" and that declines in growth due to the initial nationwide lockdown in Germany can be fully compensated for by the end of 2022.

Already during the nationwide lockdown, societal awareness of the importance of digital transformation was raised in many sectors of the German economy. In the medium term, the Covid-19 pandemic will thus have a catalytic effect on the expansion of digital infrastructures and the implementation of digital business models. In the long-term perspective, the Internet industry will

receive an additional growth boost from the pandemic, which will increase the market potential until 2025. This results in particular in:

- Catalyst effects in the area of expanding digital infrastructures and implementing digital business models that lead to sustainable industry growth and

- An increase in overall economic significance, as the Internet industry will account for an ever-larger share of German GDP with average annual growth rates of 9.5 percent until 2025 – we expect this figure to rise from 4.2 percent in 2019 to seven percent in 2025.

In addition to digitalisation in all areas of private life and in everyday business life, the massive planned infrastructure investments will benefit the positive development of the Internet industry in the coming years.

7. Methods, Definitions and Market Description

In this study, the figures for revenue and employment in the Internet industry in Germany and the detailed segment profile were determined on the basis of data from eco and Arthur D. Little, as well as from a range of secondary sources from associations (BEVH, EITO, Bitkom, VATM, GAME, ZVEI, etc.), from publications by the German Federal Bureau of Statistics and other services (e.g. Statista and Destatis), and from numerous interviews with experts and industry insiders.

Modelling of revenue growth in Germany

The revenue of the German Internet industry is the sum of the revenues of all 23 segments of the Internet industry. The revenue corresponds to the domestic supply of all services consumed in Germany by the Internet industry. The revenues of each segment were determined using a bottom-up approach.

Employment

Employment was calculated on the basis of the average productivity of each segment. The average productivity is based on benchmarks from leading companies in the respective segment. Productivity is a key figure calculated based on revenue and number of employees.

Modelling of the effects of the Covid-19 pandemic

The effect of the Covid-19 pandemic on the revenue of the Internet industry in Germany corresponds to the sum of all relative changes in revenue growth compared to the previously identified industry trends in the 23 segments. The effect on revenue growth in each segment was determined using a bottom-up approach. In addition to specific segment-related surveys, company reports, press releases, and research analyses, the calculations are based above all on more than 30 expert and industry insider meetings held in April 2020. In macroeconomic terms, the modelling is based on the scenarios of the ifo Institute and the International Monetary Fund (IMF). Accordingly, the following assumptions were made: GDP slump of around minus five percent in 2020, easing of the lockdown from summer 2020, recovery of the overall economic situation in the course of 2021 and 2022.

Market Descriptions

Layer & Segment	Description
Network, Infrastructure & Operations	
Colocation & Housing	All services and applications that can be accessed over the Internet are stored on servers in data centres – which are known as "Internet Data Centres". As a result, only those data centres were examined that offered their services to both private and business customers; company internal data centres were not taken into account. Housing: The accommodation and network connection of one's own servers in an external data centre. Colocation: The provision of at least one complete rack for the company hardware and the infrastructure necessary for the operation of the server. Alongside the provision of space or racks for one or more servers, the service portfolio also includes the Internet connection, power supply and the cooling, and the provision of security systems and support services.

Layer & Segment	Description
Internet Exchanges	The Internet's public network hubs, which serve as exchange points for data and networks from various backbone providers. The costs for the operation of public Internet hubs are mainly covered by the payment of a flat sum to the operator of the exchange for a connection to the switch infrastructure of the exchange point by the participating providers.
Internet Backbone, Transit & CDN	Internet Backbone (basic infrastructure of the Internet): The leasing of fibre-optic infrastructure and related service offers and data transmission services. Transit/Peering: The exchange of data between Internet service providers. CDN: A content delivery network is a connected system of cache servers that use geographical proximity as a criterion for the provision of web content.
Fixed Internet Access Network	Includes all location-bound broadband Internet access via the fixed-line Internet.
Mobile Internet Access Network	Includes all location-bound broadband Internet access via the mobile Internet network.
Satellite Internet	Includes all location-independent broadband Internet access via a satellite broadband network.
Services & Applications	
Public IaaS (Infrastructure as a Service)	A standardised, highly automated cloud computing service in which computing resources, supplemented by storage and network capabilities, are owned by a service provider and offered to customers on demand. The customers are able to configure this infrastructure themselves with the help of a web-based graphic user interface, which serves as an IT operations management console for the complete environment.
Public PaaS (Platform as a Service)	A cloud computing service that provides hardware and software tools necessary for the development of applications on infrastructure owned by the provider. As a result, PaaS frees users from the necessity of owning their own hardware and software through which applications can be developed and used.
Public SaaS (Software as a Service)	A cloud computing service that makes available software that is owned and administered by one or several providers. The provider delivers software on the basis of a range of collective code and data definitions, which can be offered in a one-to-many model by all contract partners on a pay-as-you-go or subscription basis.

Layer & Segment	Description
Web Hosting & Domains	Web Hosting: The storage and, if necessary, the provision of applications and services on a server in a data centre. The server hardware is generally not owned by the company that makes use of this service. Domains: a logical subnet of an international network (the Internet) that is accessible via a particular domain name.
Cybersecurity	Cybersecurity is the sum of all digital products and services which are designed to protect networks, systems, hardware, software, service or data from theft, damage, interruption or abuse.
Edge/Fog Computing	Edge and Fog Computing enable the relocation of data processing from a data centre to the periphery of the IT network. Data generated by machines and sensors on site is collected, stored and immediately processed by a local server. This decentralised data architecture can reduce latency times and network load. Fog is an architectural pattern of edge computing in which the processing and storage of data is performed on multiple, hierarchically structured nodes; the fog nodes.
Aggregation & Transactions	
Online Advertising & Internet Presence	Online Advertising: Every form of influence of behavioural characteristics, distributed for a fee via the medium Internet. Online advertising revenue sources include keyword marketing, commission for intermediaries, and production costs for, for example, advertising and media agencies.
Portals & Classified Marketplaces	Subscription-based portals: Internet platforms with the primary objective of connecting users (jobs, partners, friends). At least one of the parties pays a non-performance-related fee, and the majority of revenue is generated through this business model. Classified marketplaces: Electronically supported advertising portals through which sellers and customers can be informed about goods and services that are available for sale or lease. The potential buyer/rental customer can contact the seller/leaser, if interested. Advertising income is not included in this segment, as this is already included in a separate segment.
Billing & Payment	This covers all forms of digital payment of goods and services purchased via the Internet (based on the total transaction volume). This includes all accrued service charges (percentage that is assigned to the provider).

Layer & Segment	Description
E-Commerce B2C	Websites or applications that sell goods and services to end customers via the Internet. The creation of value is based on the total value of the fulfilled transactions, minus the direct costs of goods and services sold. The deducted share is an estimation based on business reports by selected leading companies. Advertising income is not included in this segment, as this is already included in a separate segment.
E-Commerce B2B	Websites or applications that enable business-to-business purchases, sales and exchange of goods and services via the Internet. This includes e-commerce processes that are carried out via computer networks other than the Internet, such as electronic data interchange (EDI). The creation of value is based on the total value of the fulfilled transactions, minus the direct costs of goods and services sold. The deducted share is an estimation based on business reports by selected leading companies. Advertising income is not included in this segment, as this is already included in a separate segment.
Paid Content	
Gaming & Gambling	Provision for a fee of an interactive "gaming medium" or of (interactive) gambling on an Internet platform or as an app. Revenue generation through subscriptions, downloads or micro-transactions as well as wagers (win-lose), the purchase of digital lottery tickets, etc. Advertising income is not included in this segment, as this is already included in a separate segment.
Video & Music Streaming & E-Publishing	Temporary fee-based use of television or video content as well as music or podcasts via the Internet.This includes the purchase of fee-based digital written material such as articles, magazines and e-books via the Internet. Advertising income is not included in this segment, as this is already included in a separate segment.
Smart Industries	
Automotive & Mobility	These include IoT solutions for the automotive industry as well as value contributions of the Internet to fleet management and car sharing.

Layer & Segment	Description
Industrial IoT	This segment includes IoT solutions for Construction, Agriculture & Forestry, the Mechanical Engineering, Electrical & Electronics and Metal industries, and other manufacturing industries.
Smart Buildings	These include digital solutions to increase automation, energy efficiency, security, control and comfort in commercial buildings and private households.
Physical Security	This segment includes digital solutions for the development of intelligent safety systems in private and commercial contexts. Use cases include, for example, digital systems for access control, video security and intrusion detection.
Transport & Logistics	These include digital solutions that increase the automation, efficiency, security and control of public and commercial transport and logistics chains. Use cases include, for example, traffic control and traffic surveillance systems, passenger information and ticketing systems, and parking management systems.
Medical & Healthcare	This segment includes digital solutions for transmitting, receiving and processing information between the stakeholders of medicine & health care (hospitals, pharmacies, general practitioners, patients, etc.). Use cases include digital patient files, mobile health management, and telemedicine.
Education	This includes digital solutions for private and public educational institutions in Germany. Use cases include software (such as user interfaces and communication media), services (e.g. learning platforms) and content (e.g. audio and video learning tools).
Tourism & Retail	This segment is concerned with digital solutions for the tourism and retail sectors. Use cases include eGates & kiosks (Automated Border Control), digital signage, digital advertising spaces, location-based services and smart vending machines.
Energy	This includes digital solutions to improve automation, efficiency, safety and security and control along the value chains in the energy sector. Use cases include, for example, smart grids in the electricity and water supply systems, smart poles (street lighting) and smart filling stations.
Public Policy & Administration	This segment includes digital solutions to increase the automation, efficiency, security and control of processes in the public sector. Use cases include web portals, intelligent forms, servers and online applications.
Financial Services	These include digital solutions to increase the automation, efficiency, security and control of processes in the insurance and banking sector. Use cases include cashless payment methods and digital security systems for ATMs.

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About eco

With more than 1,100 member companies from over 70 countries, eco is the largest Internet industry association in Europe. Since 1995, eco has been instrumental in shaping the Internet, fostering new technologies, forming framework conditions, and representing the interests of members in politics and international committees.

Together with our members, we advocate for a free, technology-neutral, and high-performance Internet. Our focus is on promoting trust in the Internet as well as its security and reliability. The aim is to shape the digital transformation of society and the economy in the best possible way so that successful economic activity can be based on our democratic values. As the voice of the Internet industry, we assume social responsibility for ethically-oriented digitalisation.

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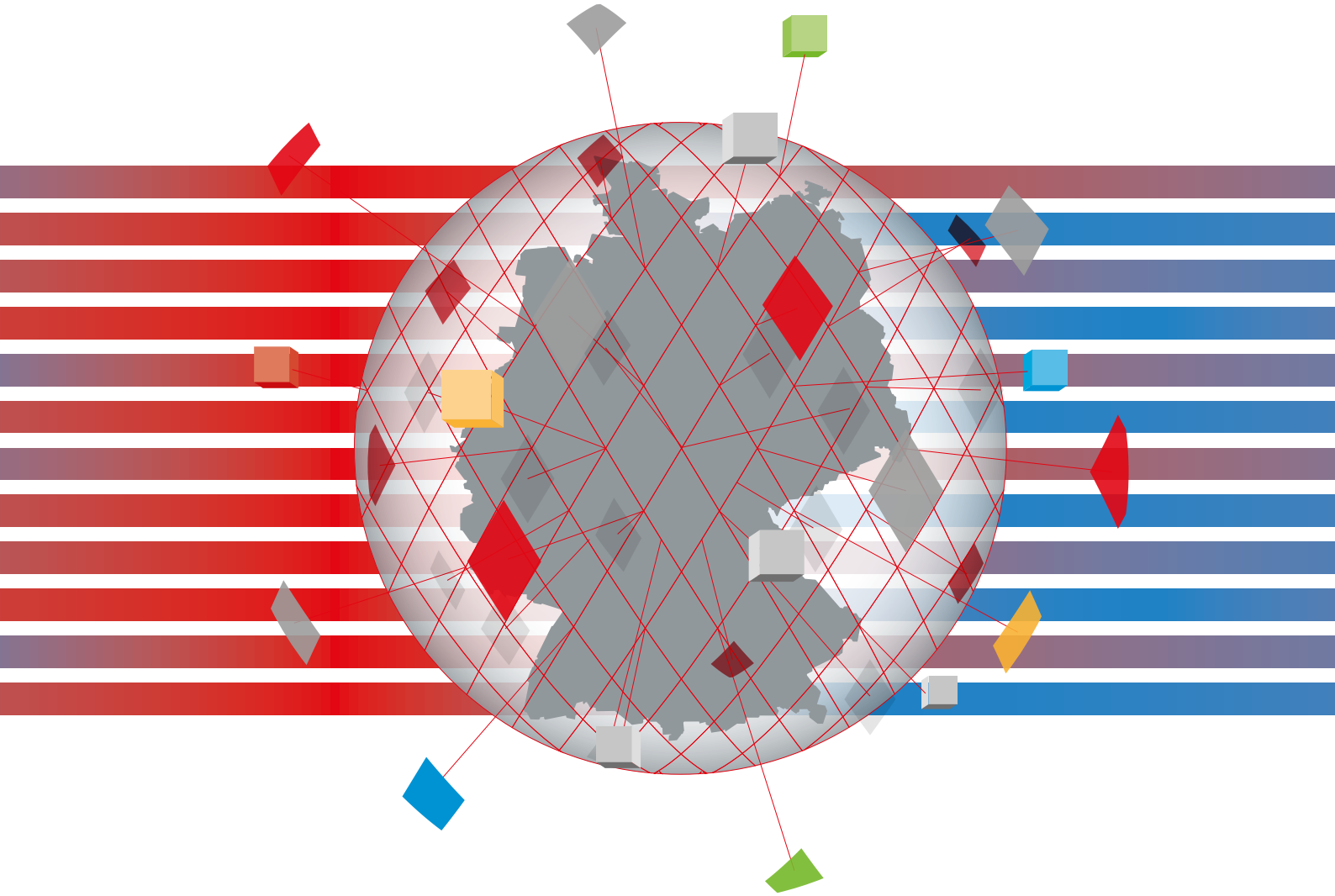

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