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Characteristics and success factors of digital platforms

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Management Summary

As the digitalisation of business progresses, intermediaries who act as a central link, connecting several groups via digital platforms, are becoming increasingly important. A digital platform connects two or more player groups in the market while the groups benefit from the size of the other group(s) and would not be able to interact as efficiently without the platform. Especially when it comes to production where digital and connected business processes are only now starting to take hold, digital platforms are becoming a central interface for the change taking place in existing customer-supplier relationships and in the development of new business models. This topic is also related to current developments in almost all areas of business. Other examples of this include smart home and smart grid along with automated and connected driving. The developments that already began in B2C commerce around 10 to 15 years ago have now entered the world of B2B. What's important here is the network and the transparency that a platform provides to market players. A crucial factor for the success of a platform is that it must provide standardised handling of interaction between many different players so that transaction costs can be significantly reduced compared to traditional business relationships. The market dynamic in the field of digital platforms is subject to its own specific characteristics and laws which differ completely from non-digital market structures without platforms.

Despite the supposed dominance of foreign companies in relevant areas of the Internet economy, the market for digital platforms continues to be open with a view to future topics such as Industry 4.0 and data-based smart services, and companies in Germany are competing for shares in added value here. At the same time, there is also a risk that some companies may miss out on the trend towards a platform economy. From a company perspective, important strategic decisions need to be made now which will be particularly successful when there is a clear understanding for the characteristics and success factors of digital platforms. This is the starting point for this study. It offers an overview of the features of the platform economy and the key factors for establishing successful digital platforms. An inventory of digital platforms in Germany and the ideal types derived from this data aims to provide both young and established companies, which have had little or no dealings with the platform economy to date, with a first introduction that highlights the most important global key elements for developing digital platforms. Similarly, current R&D projects with a platform character can use the ideal types presented here as a starting point for designing how to later commercially exploit their R&D results.

Literature on industrial economics provides a basis for presenting the special features of two-sided digital markets which can be used to derive **six key factors** for establishing successful digital platforms. The digital platforms in this study are divided into two categories: **transaction-centric** and **data-centric** platforms. The line between these two types is not always clear in terms of their practical forms, however, they do differ considerably when it comes to decisive key factors. The focus with transaction-centric digital platforms is on their function as a facilitator, i.e. the platform brings supply and demand together and facilitates transactions (just like in a classical marketplace). Data-centric digital platforms focus on data-based networking, i.e. this kind of platform creates a data-based integrated system where complementary products (hardware, software, data and/or services) are linked to form an integrated system (digital ecosystem).

The inventory of digital platforms in this study is based on structured telephone interviews conducted with managers of 14 digital platforms in Germany. The interview selection focused primarily on industry and B2B commerce. The interview results have been prepared so that they provide a good impression of the design and strategic approaches of digital platforms in Germany. By analysing the telephone interviews, it was possible to identify clear-cut patterns of digital platform design. Two ideal types were then derived from these patterns; one for transaction-centric and one for data-centric digital platforms.

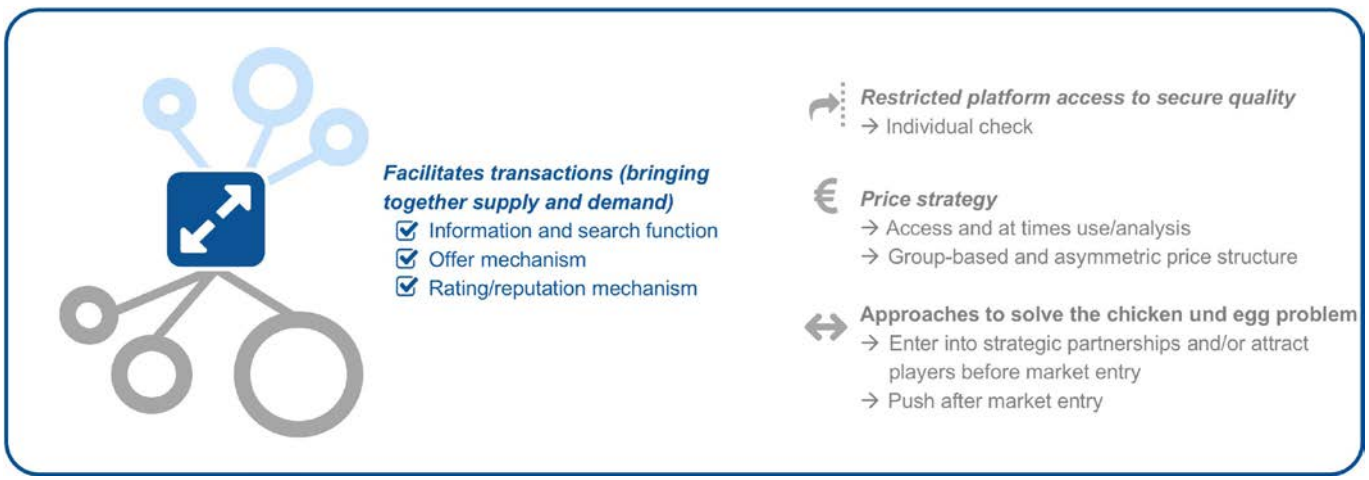
These ideal types offer practical pointers for designing and setting up a digital platform.

The features describe two antagonistic ideal types which, in practice, do not necessarily have to be applied or which can also overlap. It must be emphasised that these ideal types refer strongly but not exclusively to B2B commerce where markets are still very open. This is where companies in Germany have the biggest opportunities because market niches have not yet been occupied by major players from the US and Asia.

The ideal type of **transaction-centric digital platform** derived in this study provides a place for transactions, i.e. it brings supply and demand together and offers a suitable information and search function, an offer mechanism along with an appropriate rating and/or reputation mechanism. For reasons of quality, access to the platform is restricted and suppliers of products/services must undergo screening. The ideal type of transaction-centric digital platform sees itself as a neutral marketplace and is independent of other market players. It charges a fee for access and use (e.g. margin). An asymmetric and group-specific price structure is used. In order to generate a critical mass, the platform enters into strategic partnerships or already binds players to the platform in other ways before entering the market. Once it has entered the market, the platform assumes a pro-active approach in order to quickly build up a high number of users.

It is important for transaction-centric digital platforms to be credibly perceived as a neutral marketplace or as a platform that offers reliable, professional services. Strategic partnerships can sometimes have an adverse effect on how other players perceive the platform's independence. The right kind of price strategy is essential, especially when it comes to reaching a critical mass. This is where surveys and quick responses to customer feedback can be useful in addition to customary knowledge in the sector.

The second form derived in this study – the ideal type of **data-centric digital platform** – is an integrated data-centric system of complementary products and controls this system. It compiles and analyses data flows for the players involved and coordinates usability and customer-satisfaction management of the related ecosystem.



Ideal type of transaction-centric digital platform

Suppliers of system components can have their products accredited by the platform. Access is linked to technical or minimum requirements (access hurdles, e.g. to secure data interpretability or interoperability of the integrated components). Accreditation or quality standard certificates are also required for access. The platform charges a fee for access and use while certain data analyses are also subject to a separate fee. Once again, an asymmetric and group-specific price structure is applied here. In order to achieve a critical mass, this platform relies on approaches that already bind a sufficient quantity of system components or their suppliers to the platform and hence integrate them into the ecosystem before entering the market. That's why this platform is partially integrated (parent company or shareholder as a supplier of complementary products) and enters into strategic partnerships with other suppliers of complementary products.

One particular challenge that data-centric digital platforms face is how to create a system that is seen to be open and to provide easy access (e.g. thanks to open standards). Medium-sized businesses, for instance, fear the dependency that comes with technological locks-ins. It may not be possible to establish an ecosystem because some players see the system as one that is not open or as a strongly dependent system. This does not necessarily apply only to open access: Integrated platforms or platforms with strong strategic partners may also be perceived by different players as 'not open' or as dependent.

All in all, it is apparent that **transaction-centric** and **data-centric** digital platforms in B2B commerce are caught in the trade-off between quality and reliability, on the one hand, and growth, speed and agility, on the other. Excessively long development times and hesitant action must be avoided. That being said, growth and speed cannot be sacrificed for the sake of quality and reliability ('serious growth'). That's why in most cases it makes sense to initially enter the market with a simple, targeted (lead) yet reliable service offer and to then gradually adapt or expand the service in response to customer feedback.

For German companies, the development of digital platforms offers huge opportunities. What's important here is to make clever use of the industry expertise and business networks that already exist in order to develop new business models. Transaction-centric platforms offer huge opportunities for start-ups. Due to their independence, they

Ideal type of data-centric digital platform

can be established as a neutral facilitator between suppliers and customers. In this case, (sub-) markets, especially B2B markets, that have not yet been addressed must be identified and occupied with tailored service offerings (also taking into account the characteristics of the sector, exploitation of domain knowledge, etc.). Setting up a data-centric platform means establishing a broad-based ecosystem that is perceived to be open. Established companies have the advantage that they are already known in the respective market (key word: expectations), that they themselves can offer complementary products (including data) and they can use their business ties and contacts to attract relevant players to the ecosystem.

1 Introduction

Digitalisation is leading to an ever-faster convergence between industrial production and digital products and services. Intermediaries who act as a central link in multi-sided markets, connecting several groups of players via digital platforms, are becoming increasingly important. In a market dominated by one digital platform, market transactions are carried out via this very platform or this platform constitutes an integrated data-driven system. Digital platforms are a central interface for changing customer-supplier relationships and for the development of new business models, especially in production. This topic is related to current developments in almost all areas of business. Examples of this include smart home and smart grid along with automated and connected driving. The developments that already began in B2C commerce around 10 to 15 years ago have now entered the world of B2B.

In recent years, the innovations that took place in the platform economy were largely driven by US companies. Even current developments, especially in B2C, are being comprehensively shaped by companies from the US. According to figures by the Wall Street Journal and Dow Jones VentureSource, there are currently 90 start-ups in the US with a market potential of more than USD 1 billion (so-called 'unicorns'). A great many of these promising start-ups have digital business models or digital platforms. Momentum in Asia is also considerable with a total of 44 start-ups that are considered to have a market value of more than USD 1 billion. Europe by comparison has just 16 companies (Austin/Canipe/Slobin, 2017).

The importance of digital platforms is growing continuously and possible monopolisation trends in conjunction with digital platforms are dominating current debates – see, for instance, the debate triggered by BMWi regarding the matter of suitable competition rules (BMWi, 2016a, 2016c) and BMWi's resultant White Paper on Digital Platforms (BMWi, 2017a). The world's four biggest platform opertors (Alphabet, Amazon, Facebook und Alibaba) now have greater market capitalisation than all 30 DAX companies combined (Schmidt, 2017). This is considerable in light of the fact that digital platforms usually primarily enable market transactions and they themselves do not maintain any production systems to produce physical goods or services. Uber and Airbnb, who are competing with the taxi and hotel business, do not own their own hotels or vehicle fleets. What is important here is the network and the transparency that a platform provides to market players. A crucial factor is that the platform must provide standardised handling of interaction between many different players so that transaction costs can be significantly reduced compared to traditional business relationships.

Despite the supposed dominance of foreign companies in relevant areas of the Internet economy, the market for digital platforms continues to be open with a view to future topics such as Industry 4.0 and smart services, and companies in Germany are competing successfully for shares in added value here. At the same time, there is also the occasional risk that companies may miss out on the trend towards a platform economy. According to a recent survey conducted by Bitkom, only 36% of managers and board members of German companies have ever heard of the term 'digital platform' (including its synonyms) (Bitkom, 2017). 51% of these managers and board members consider platforms to be relevant for their company (in industry, however, only 35%). Of this figure, 82% themselves offer products and 71% purchase products on a platform. This means that even though close to 15% of all German companies surveyed already use a platform, there is still much catching up to be done considering the predicted importance of digital platforms. Companies need to face up to the challenge in order to help shape the trend towards the platform economy because, in the future, digital platforms will increasingly occupy the interface between internal and external company areas, and this will shift added value shares more towards platform operators.

As part of this process, ownership or business models will change dramatically. 'Pay per X' business models are

becoming increasingly important (VDI/VDE-GMA, 2016). Potential is emerging for new added value in the services sector and the opportunities arising here will be particularly relevant for small and medium-sized enterprises (SMEs). Digital platforms offer comprehensive opportunities for companies to tap the potential of digitalisation. One exemplary discussion about the potential of digital platforms in the automotive sector can be found in fortiss GmbH, 2017.

The digital economy and society is one of the high-priority future tasks of the federal government's new high-tech strategy (Bundesregierung, 2017). In conjunction with this, the digitalisation of business through Industry 4.0 is just as important. This is epitomised by BMWi's special support programmes, such as Autonomics for Industry 4.0 (BMWi, 2011), Smart Service World (BMWi, 2016b) or PAiCE (BMWi, 2015). In these three projects alone, more than 30 collaborative projects with a strong platform character are being supported with close to €100 million (a random sample overview of the current projects in this context can be found in the appendix on p. 24). Digitalisation also has a key role to play in programmes that are not restricted to a particular field, such as ZIM (BMWi, 2017b). In order to tap into the economic potential aimed at through support, companies will need to convert the results of technology programmes into successful products and make these widely available. This will generate future added value to Germany as a centre of innovation. From a company perspective, important strategic decisions need to be made now in this context which will be particularly successful when there is a clear understanding for the characteristics and success factors of digital platforms.

This study will help to make this understandable and is broken down as follows. Section 2 presents the special features and characteristics of digital multi-sided markets as described in literature on industrial economics and uses this to identify the central key factors for establishing successful digital platforms. Using these key factors, section 3 contains a structured inventory of up and running German platforms. To achieve this, structured telephone interviews were conducted with managers from 14 digital platforms in Germany. The focus here is on platforms in B2B commerce which has the greatest market momentum and is where companies from Germany have the greatest opportunities to grow beyond sub-markets and have the prospect of addressing international markets. Section 4 describes two ideal types derived from the results of the interviews. These ideal types offer practical pointers for designing and setting up a digital platform. Moreover, general conclusions are derived for companies who are currently developing platform-based digital business models, setting up a platform or optimising an existing platform. Together with other central documents, such as the Green Paper Digital Platforms, this study should help to overcome the challenges of the digital transformation.

2 Characteristics of digital platforms and digital platform markets

The platformisation of business is a term frequently used in current debate on the growing digitalisation of business and society. The term platform has various meanings and, in an industrial context, often also refers to technologies and standards. In this study, however, the term platform refers exclusively to digital platforms that connect two or more groups of players in the market. This means that the terms digital platform markets and digital multi-sided markets are used as synonyms and are defined as follows:

> *A digital platform connects two or more player groups in the market while the groups benefit from the size of the other group(s) and would not be able to interact as efficiently without the platform. This kind of platform market is also referred to as a two-sided or multi-sided market.*

This section addresses the characteristics of digital platforms and digital platform markets. It compiles the central findings of literature on (digital) multi-sided markets. The market dynamic in the field of digital platforms is subject to its own specific characteristics and laws which differ completely from non-digital market structures without platforms. This section then presents the special features of digital multi-sided markets. Finally, based on this, the central key factors for establishing successful digital platforms are discussed.

2.1 Characteristics of digital multi-sided markets

2.1.1 High degree of scalability and range as well as data analysis

Multi-sided markets or markets with platforms are not in fact a new phenomenon. Trade fairs, supermarkets and travel agencies are platforms. What's special about digital platforms, however, is the fact that the effects that are relevant for multi-sided markets are particularly prominent in digital markets and sometimes mutually boost each other's impact. A high degree of scalability and range is characteristic of digital markets and hence also of digital platform markets. Since (additional) computing capacity is not a technical obstacle and can be adapted quickly and flexibly, this means that platform can respond extremely quickly and flexibly to additional demand. Moreover, there are practically no geographic boundaries for digital offerings even though there may of course be some cultural, linguistic and legal (different legal systems) hurdles and barriers.

Just like in all digital markets, data is a central factor for digital platforms. On the one hand, this means opportunities to internally develop and control the products and services offered through the platform. On the other hand, data analysis leads to even more exploitation possibilities or business models which are always caught in the trade-off between possible analysis findings and data protection issues. Whenever data is exchanged between players, issues related to (in-)compatibility and interoperability also become relevant.[1]

2.1.2 Low transaction costs

The importance of transaction costs can be explained using the example below. Car-sharing schemes have been around since the end of the 1980s and yet car-sharing only really made an impact in recent years. The reason for this was that for a long time car-sharing was too complicated. The monetary and non-monetary costs involved were also an obstacle: access to the car (key handover), agreement regarding where to park the car, logistics of making all the cars available, as well as organising and monitoring fuelling. The conditions needed to make car-sharing simple and affordable and hence accessible to a broad public did not come about until the technical possibilities emerged, especially those provided by smartphones (i.e. car-sharing apps). This made car-sharing, at least in big cities, a successful social innovation which has become extremely popular, especially in recent years. In

1 With a view to compatibility and indirect network effects, please see below. With a view to software systems, see Engelhardt (2006).

other words, technical changes have drastically reduced the transaction costs of car-sharing (Hildebrandt/Hanelt/Piccinini/Kolbe/Nierobisch, 2015).

Generally speaking, the lower (higher) the related transaction costs, the more (fewer) market transactions take place (North, 1987): Whether a transaction takes place depends on how difficult it is to find a suitable business partner (information costs), to conclude the contract (negotiation and contract costs), to make subsequent amendments to the contract (amendment costs) and to monitor or enforce performance of the contractual services (monitoring and enforcement costs) (Stavins, 1995). Transaction costs hence influence whether or not certain economic activities take place in the first place, like car-sharing example. From a company perspective, transaction costs have a central impact on the decision regarding whether a service is to be performed by the company itself or is to be purchased in the market (buzzwords: make-or-buy decision and outsourcing). High transaction costs tend to lead to companies internalising products and services (Coase, 1937).

Technical progress can change transaction costs. The successful new business model approaches of digital platforms have one thing in common, i.e. they make extensive use of the potential of digital technologies to reduce transaction costs and they enable new or additional market transactions; this also involves changes in existing market relationships. The very high market capitalisation of today's dominant digital platforms (such as Airbnb, Amazon, etc.) is a clear indication of the high level of trust placed in the central business model of digital platforms.

Fig. 1 shows a very simplified schematic of a traditional business transaction without a platform. A company has a direct business relationship with a supplier. Entering into another business relationship with the second supplier company is unlikely due to transaction costs. If the information, negotiation and contract costs as well as the amendment, monitoring and enforcement costs are too high, no second supply relationship will be entered into.

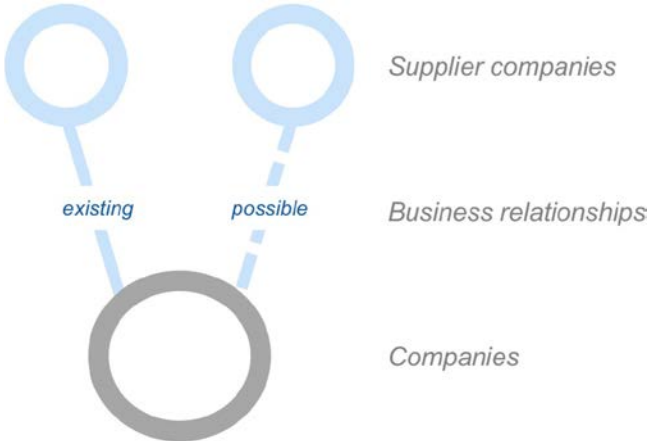


Fig. 1: Established and potential relationship in a market without a platform: The grey circle represents one company that has a business relationship with one supplier (blue circle on the left). No business relationship will be entered into with the second supplier company (broken line) if this is too expensive. High information, negotiation and contract costs, as well as amendment, monitoring and enforcement costs mean that is it not profitable to enter into this second market relationship.

But if a platform were to provide a service to that would reduce transaction costs significantly, the platform provider can act as an intermediary between the market players and in doing so fundamentally change market relationships. In this fictitious example, the grey company (together with another company) now has access to several suppliers via the platform (Fig. 2).

What's more, platforms can also create entirely new markets, e.g. if the platform has the preconditions for an integrated system, i.e. provides the basis for connecting several complementary services or products. Examples of these are operating systems that connect hardware and application software components, be it in the PC market or with mobile devices (smartphones and tablets). Platforms like these coordinate the integrated system, they ensure interoperability within the integrated system and in doing so reduce transaction costs (coordination costs) for the players connected to the ecosystem of the platform.

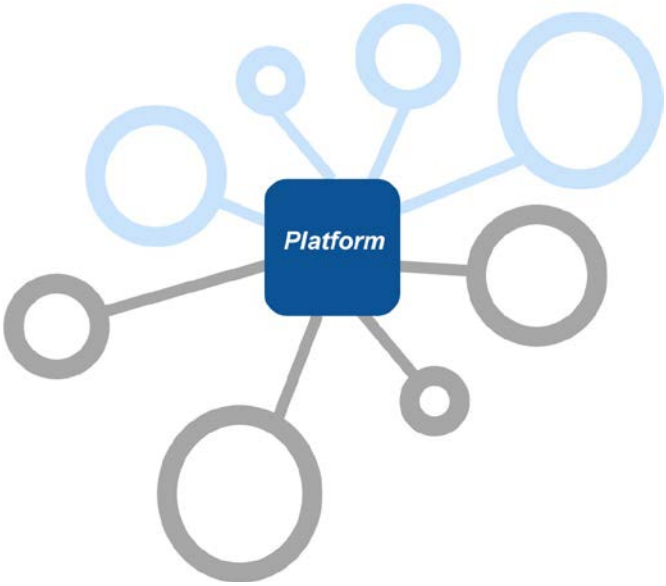


Fig. 2: Market with a (digital) platform. The platform provides the market players with simple access to several players on the other side (grey or blue, respectively). Thanks to the resultant reduction in transaction costs, more transactions can be carried out.

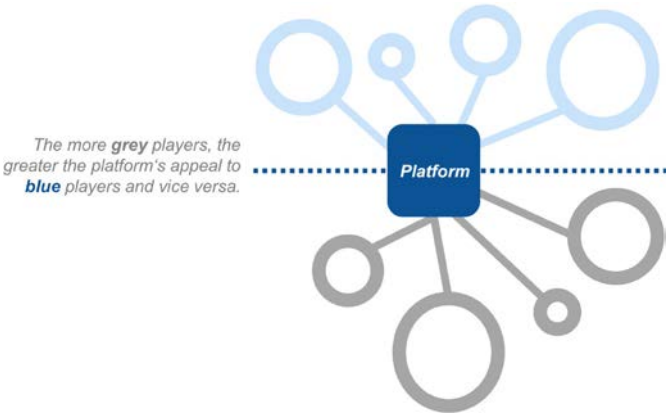


Fig. 3: The platform as the central player in a two-sided market with positive indirect network effects. The more grey players use the platform, the more the platform appeals to blue players – and vice versa. The platform needs to take this interaction (also known as the chicken and egg problem) into account in strategic decisions.

Current technological developments offer new ways to reduce platform transaction costs much further. Today the most well-known example of this is blockchain technology. Contrary to widespread reports, this technology does not have the potential to replace platforms, instead, it can strengthen the most decisive success feature of a platform, i.e. it's ability to reduce transaction costs (see the info box entitled 'Blockchain technology reduces transaction costs for digital platforms').

2.1.3 Strong network effects

Digital platforms connect many players from at least two or often more different groups in the market. Since these player groups want to interact with each other, the appeal of a platform depends not just on its measures to reduce transaction costs but also on how many potential transaction partners can be given access to the platform. The reason for this are the so-called positive, indirect network effects: Each group benefits from the network size of the group(s) (Peitz, 2006, p. 322 et seq.). This principle is shown in Fig. 3

The indirect network effects lead to mutually strengthening effects, both in a positive and negative sense. This means that platform providers who have yet to establish themselves in the market (newcomers) face one particular strategic challenge, the so-called chicken and egg problem: Their platform only appeals to one group when many players from the other group(s) use the platform and vice versa (Peitz, 2006, S. 323). In order to reach a critical mass, new platforms have to come up with creative solutions.

Indirect effects also need to be considered when it comes to pricing. This is explained once again using the grey-blue two-sided market. A price increase on the platform for the blue players leads to a more or less steep decline in the blue group, depending on price sensitivity. As long as the price increase more than compensates from the decline in use, sales will increase, and the net effect for the platform is positive. So much for the completely normal pricing effect. In two-sided markets, however, there are also indirect effects in addition to direct effects. Due to these indirect network effects, the platform becomes less appealing to the grey side as soon as the blue group becomes smaller. This would therefore lead to a decline in the grey group and hence to a reduction in total sales. On

Blockchain technology reduces transaction costs for digital platforms

Current debate on the platform economy also focuses extensively on the extent of the potential of so-called blockchain technology to put pressure on or even replace today's centrally organised digital platforms (Swan, 2015). The cryptocurrency Bitcoin is probably the most well-known application in blockchain technology. But it must be noted that platforms also play a central intermediary role here. Payments are, for instance, initiated via so-called Bitcoin wallets. The disruptive potential of cryptocurrency lies in the fact that market transactions can be managed without clearing houses and this reduces transaction costs significantly.

What distinguishes blockchain technology from other technologies is that it does not necessarily require user authentication. From a purely technical perspective, blockchain can also be coupled with user authentication. The technology also features high secure standards which is why it is regarded as an enabler for smart contracts. Loan agreements for cars are a common example. If the buyer is in arrears with payments, this can be identified electronically and access to the car disabled at the same time. The car remains disabled until the loan payments plus penalties have been settled. This means lower ex-ante monitoring costs (no user profile required) and leasing contracts can be signed without any proof of creditworthiness. It is now possible to bundle market transactions while customer-supplier relationships change along the value chain. As a result of this, those platforms may become more important that enable transactions linked to other transactions via smart contracts.

The amount of attention being paid today to blockchain technology results from the possibilities that are emerging beyond the borders of the financial sector. RWE, for instance, has teamed up with Slock.it (a start-up that developed a blockchain technology) in order to supply automated charging for electric cars. Looking ahead, a vast range of applications in different areas are conceivable, Industry 4.0, smart home, power supply or autonomous driving are but just a few of the areas where blockchain could be relevant in the future (Bergmann, 2016). The technology is, for instance, also relevant for exporting technologies to countries with weak institutions (e.g. with a view to enforcing property rights) because blockchain makes it possible to control the enforcement of the rights on the physical property (Wagenknecht, 2016).

At the same time, there are certain obstacles facing blockchain technology. The length of the register (blockchain) is probably the biggest obstacle. This is because each new transaction must be mathematically verified while all the transactions stored in the register must also be taken into account in the calculation. The more entries in the register, the longer it takes to verify a new entry. This means that in the case of a very high number of transactions, which may even be carried out at the same time, the blockchain technology will reach its practical limits. Work is already underway to develop new technologies, especially with a view to use in the Internet of Things, which are in fact based on blockchain technology but which solve current problems (e.g. IOTA[1]).

What remains to be noted is that technologies for decentralised, distributed handling of transactions, such as blockchain or IOTA, neither threaten nor will they oust platforms. Indeed, these technologies can be used to reduce transaction costs for platforms even further, so that as costs decline, the number and complexity of the transactions managed by the platform can be increased.

1 https://iotatoken.com

the other hand, a price reduction could be overcompensated by indirect network effects so that the net effect on the platform's sales and profit would be positive.

2.1.4 Special market dynamics

Generally speaking, digital markets are very dynamic. The rapid pace at which new technologies and data analysis methods are being developed and the arrival of new competitors with innovative business models mean that these markets are continuously changing. This momentum is boosted once again by the indirect network effects.

The positive indirect network effects that have a mutual strengthening effect can result in a platform becoming a dominant or even the only platform once it has exceeded a certain critical mass. Fig. 4 shows this market dynamic for a simplified case. The diagram starts with two identical platforms competing for shares in the market and entering the market at the same time. The platform that is able to serve both sides of the market better will end up as the sole supplier in this kind of market because the more successful or bigger platform will be chosen thanks to the positive network effects ('winner-takes-all' market').

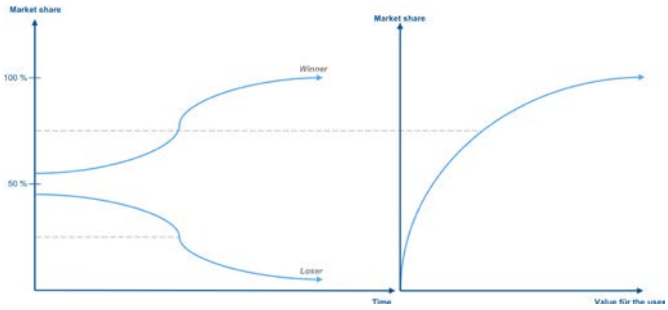


Fig. 4: Special market dynamic in the 'winner-takes-all' market. The left side shows an ideal type of development of the market shares of two competing platforms. The right side shows that the appeal of a platform increases the more users already use this platform (expressed in simple terms by the market share). This means that the platform with the bigger market share continuously increases its advantage which becomes unassailable once a critical mass has been reached, so that in the end only one platform remains with a 100% share of the market ('the winner takes it all'). Source: left side: (Shapiro/Varian, 1998), p. 177, right side: own diagram.

The market dynamic shown in Fig. 4 indicates that time is a critical factor when establishing the platform. In order to be the 'first' platform to reach the critical mass, an early and pro-active entrance in the market is essential in order to build up a high number of users. This phase is both resource-consuming and risky. Expectations have a huge role to play in this context: If a group expects that many players from the other group(s) will use the platform, they will sign up, making the platform appealing to the other players of the other group(s) (Roson, 2005).

The market dynamics induced by network effects can result in individual platforms becoming dominant and established as a quasi-natural monopoly in the market (Engelhardt/Freytag/Köllmann, 2013). That being said, there are aspects that counteract the monopolising tendencies caused by network effects (German Federal Cartel Office, 2015; Engelhardt/Freytag/Köllmann, 2013; Haucap/Wenzel, 2011).

1) Differentiation between platforms: Platforms can try to sufficiently distinguish their offering from that of competing platforms, for instance, by specialising in certain product or user groups as well as the range of services (additional services).
2) Multihoming: The aspect of multi-homing (compatibility) refers to the issue of whether players of a group (e.g. suppliers of certain services) can use several platforms parallel. Fig. 5 shows a market situation with multihoming. Two platforms compete in this market and there are users on both sides of the market (grey and blue players) who use both platforms. If multihoming is possible, there is a lesser tendency for one (dominant) platform to emerge.

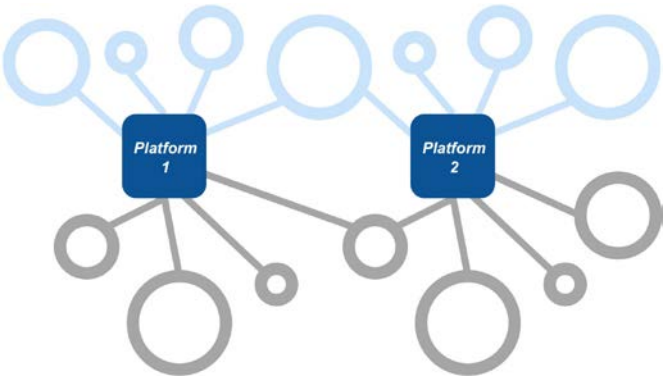


Fig. 5: Two-side market with multihoming. Multihoming refers to the parallel use of several platforms by individual users. Members of a group (e.g. customers) use several platforms. This gives the other group (e.g. suppliers) greater freedom in their choice of platform offerings. The competition that comes with multihoming reduces the market power of individual platforms.

2.2 Key factors of successful platforms

To be successful, digital platforms must consider the special market forces that prevail in digital two-sided markets. The properties of digital two-sided markets presented above and experience with the success and failure of (digital) platforms can be used to derive key factors for the successful establishment of digital platforms. These key factors address the following six dimensions: platform function, financing and revenue concept, platform openness, platform independence, contact to other market players and dynamic strategies.

2.2.1 Funktion der Plattform

The basic function of a digital platform in the market is determined by which services the platform offers for which group of players. These two aspects are closely related if not in fact identical. The heart of the matter is who is to be addressed by what services and brought onto the platform.

When it comes to the question which services the platform wants to offer, two different approaches can be outlined (Evans/Gawer, 2016)[2]:

The focus with **transaction-centric digital platforms** is on their function as a facilitator, i.e. the platform brings supply and demand together and facilitates transactions (just like in a classical marketplace). This kind of platform can offer several functions that reduce transaction costs.

1. A good search function simplifies the search for potential transaction partners and choosing the right partner (matching). The database can contain a vast amount of important information that makes it easier to find the right business partner. This cuts information costs dramatically.
2. The platform can reduce negotiation and contract costs with standardised contracts, contract templates or contract principles for the transactions handled via the platform (see, for instance, the rules at eBay).
3. By installing reputation mechanisms (ratings), arbitrators or settlement procedures as well as other protection and insurance mechanisms (similar to PayPal Purchase Protection), the platform can reduce amendment, monitoring and enforcement costs.

A platform can also operate as a one-stop supplier in the sense that a customer buying services enters into an agreement with the platform rather than the supplier – this is exactly what 'X as a service' models do.

The focus with data-centric digital platforms is on data-based networking, i.e. the platform creates a data-based integrated system. If in this case complementary products (hardware, software, data and/or services) are linked to form a growing integrated system, this is referred to as a digital ecosystem. One well-known example is the approach pursued by Google with Android (hardware manufacturer, app programmer and end user).

A data-centric digital platform ensures compatibility and interoperability between the system components (or data). This, in turn, reduces transaction costs and creates the precondition for the integrated system to work. Due to its central role in the integrated system, it goes without saying that the platform is also responsible for usability and satisfaction management of the integrated system. While platforms in transaction-centric marketplaces do not usually provide any installation support for hardware purchased via the platform, data-centric digital platforms frequently offer support if, for instance, certain system components do not (or no longer) work or cannot be installed. Usability and satisfaction management can be implemented here in different ways for the platform. The ideal types possible in this case are the decentralised 'on-site' solution (e.g. accredited and/or trained technicians on site) and the central approach (e.g. one-stop shop with plug&play).

2 Evans and Gawer distinguish between a total of four types of platforms: besides the transaction platform and the innovation platform (which is very similar to our data-centric platform), there is also the integrated platform (a combination of transaction and innovation platform) as well as the investment platform

Compilation and analysis of the data collected makes sense and is often the case, especially with data-central digital platforms, however, it is not mandatory (a platform could, for instance, link components or collect data in a cloud without actually compiling or analysing the data).

The two approaches, i.e. the transaction-centric and data-centric digital platform, differ in terms of their focus, however, they can certainly overlap at the periphery. Transaction-centric digital platforms can, for instance, generate data-based findings from marketplace activities (market data) and can make these findings available to players or third parties.

The question regarding which services the platform wants to offer or which basic approach is to be pursued (a transaction-centric or data-centric approach) is closely related to the question regarding which and how many different groups of players are to be brought together on the platform. It is, after all, conceivable for a platform to operate both in B2C and in B2B markets. But even in a B2B setting, the question still arises as to whether the platform should specialise in a certain niche or if certain niches are to be deliberately ignored. Selling market data to third parties may also mean integrating other groups of players.

2.2.2 Sales and revenue concept

There are different approaches to generating sales that depend on the market and business model. Essentially, the question is which services are to be sold and how are they to be priced. However, not all services offered by the platform have to come at a price.

As previously mentioned, a platform must also take interaction between groups into account in its price strategy. The trick is to set the relative prices in such a manner that increases the appeal of the integrated system. This means that in addition to observing how strongly certain groups respond to price changes (price sensitivity), the platform also needs to see how strongly a group responds to changes in the size of another group (relevance of indirect network effects). Asymmetric pricing is hence the rule rather than the exception in multi-sided markets (Rochet/Tirole, 2003) and prices amounting to zero as well as benefits (e.g. system components supplied below cost) for certain groups are not uncommon. In all cases, one group (or several groups) subsidise the other group through higher **prices**. In theory, two rules for optimum pricing can be derived here (Peitz, 2006; Rochet/Tirole, 2006; Roson, 2005) which can be presented in simplified form as follows:[3]

1. The group that is by comparison more interested in the size of the other group subsidises this other group and pays a price with a corresponding markup.
2. The group that is by comparison less responsive to price changes than the other group subsidises this other group and pays a price with a corresponding markup.

In practice, the information required here is often not available, not even through market analyses (or, if available, it is difficult to acquire or insufficient) and the optimum prices have to be identified through surveys and/or behaviour monitoring (trial and error). When it comes to the question of whether or not access or transactions and/or the data volumes used – or both – are to be priced, both the direct (peculiarities of the respective group) and indirect effects must be taken into account. It is therefore not unusual for different groups to see themselves faced with very different price structures.

The dynamic aspects and signal effect of pricing are also relevant. It may make sense to initially enter the market with low prices in order to quickly reach the critical number of users. Certain services are often offered free of charge in order to boost the platform's appeal and to win

3 In technically correct terms, the two rules are: 1.) The group that generates the relatively strong indirect network effects is subsidised by the other group. 2.) The group that is more sensitive to pricing is subsidised by the other group.

a sufficient number of users, or in order to signal that the platform does not intend to exploit its (potential) market power in the short term but that it is pursuing the strategy of a long-term sustainable platform economy. Especially in the case of data-centric platforms, the focus is not on generating high prices for all services, but on creating room for growth so that a digital ecosystem can emerge with long-term profitability.

2.2.3 Openness of the digital platform

The aspect of openness is related to the issue of possible access control, multihoming (see section 2.1.4) and compatibility.

A platform can define its own conditions for participating in the platform in order to limit access in the interest of quality and for technical reasons. This means that it can influence the quality of the products, services and data offered or the technical requirements. If subsequent exclusion is possible, the platform has an instrument at its disposal to ensure that players on the platform act in a professional manner and adhere to the defined agreements.

When it comes to **multihoming**, the question is whether it makes sense for the platform to prevent parallel use of other platforms or whether this can be enforced at all. Restrictions like these are often viewed very critically, they can also be difficult with a view to competition and anti-trust law (see the EU's case against Google) and, in technical terms, it is not always possible to enforce or implement them.

The issue of compatibility and interoperability with other systems (and, if applicable, competing platforms) is related to multihoming but is not necessarily the same thing. The trend towards stronger horizontal compatibility/data portability or towards interoperability also generally meets with political support.

2.2.4 Platform independence

A platform can appear as an independent third party in the market, i.e. economically and legally independent of other players. However, it can also be integrated into one (or more) sides – be it because one of the players has set up a platform, be it because the platform offers services on one (or more) market side(s). It is also conceivable that the platform has entered into strategic partnerships with selected players or that platforms from several players, which may be made up of several groups, are jointly operated. Very open models are conceivable in cases like these. One extremely open example is the operating system Linux that is jointly developed by members of a community. Both private individuals and numerous companies participate in this community – either directly or indirectly, for instance, through the Linux Foundation. Linux acts as a platform that brings together hardware manufacturers, software suppliers, IT service providers and end users. What's special here, however, is that the open Linux platform itself does not charge anything for its service.

Important in this context is that when it comes to choosing the structure, consideration must be given to how the players in the individual groups perceive the constellation and the expectations that this will raise. Integration into one market side has the advantage that the platform itself, for instance, can offer complementary system components and hence counteract the chicken and egg problem. On the other hand, this may be viewed critically by other producers if they assume that an attempt is being made to establish market power in the connected markets through leverage effects on the market. In other words, integration may mean that other component suppliers may refuse to produce for the platform. However, suitable commitment strategies or deliberate openness can help to alleviate such fears. But it can also make sense to deliberately appear on the market as an independent, i.e. neutral platform.

2.2.5 Contact to (potential) platform users

This aspect refers to the issue of how contact to groups and marketing are to be organised. Digital platforms are, by their very definition, present on the net and can hence be found. The question, however, is how the platform wants to be found or how it wants to make itself known and how it wants to come into contact with users. Online marketing is not the only possible approach. Generally speaking, platforms can use traditional marketing channels, i.e. direct marketing, sales representatives and third parties (such as specialist retail/general retail). It is important that the channels selected overall match the other characteristics of the platform and that there are no contradictions. A platform does not necessarily have to directly approach all groups, instead it may be able to join the marketing channels of a group that operates in the multi-sided market. This is typical, for instance, in the case of operating systems where end users often purchase hardware with the operating system already pre-installed by the hardware manufacturer.

2.2.6 Dynamic strategy

Digital platform markets have dynamic properties that platforms must consider. That is why digital platforms should have a strategy on how to deal with dynamic challenges and to what extent the platform's business model approach, i.e. which groups are to be addressed, which services offered, which services are to be priced and how, etc., is to be changed or adapted over the course of time.

One key dynamic challenge is the chicken and egg problem referred to earlier. How can players from different groups be brought on to the platform at the beginning if the reason for the platform's appeal to players is to be found in the other group(s) already using the platform to a sufficient extent? Once the platform reaches a critical mass, then the other players will automatically get on board. This process, however, is extremely difficult at the beginning and platform operators must directly address potential users in order to build up the network. Solving the chicken and egg problem is referred to as one of the biggest challenges that determines success when setting up digital platforms.

There are various strategic approaches towards solving the chicken and egg problem (Evans/Hagiu/Schmalensee, 2005; Haucap/Wenzel, 2011; Müller/Schweinsberg, 2012; Parker/van Alstyne, 2005; Roson, 2005; Walter, 2016). They can be broken down into three basic approaches that can also be combined with each other.

a) The platform is directly or indirectly (shareholder, parent company) integrated into different sides of the market and hence can already offer complementary services from the beginning.
b) Before entering the market, players from one (or more) group(s) can be won either through strategic partnerships, subsidies, expectation management, etc. Once again, the aim is to achieve a significant (ideally a critical) mass, at least on one market side, at the time of market entry.
c) After entering the market, an attempt is made to get players from all groups on the platform as quickly as possible (through suitable price strategies, push marketing, niche approach, etc.).

The niche approach shows that even after successful market entry further adjustments and changes are important. The platform that pursues a niche approach focuses on one particular niche or a specific sub-market where the chicken and egg problem is relatively easy to solve. As soon as this platform has become established here, the circle of groups addressed and, if applicable, the service portfolio can be gradually expanded in order to serve a larger market in the long term. This can also mean initially restricting the platform to the domestic market in order to later develop an internationalisation strategy from a strong position.

As mentioned earlier, indirect network effects combined with technological developments (including new data analysis methods) lead to a special type of momentum.

This is where platforms need to remain flexible and respond quickly. The agile principles and methods approach comes from software development, but is meanwhile no longer restricted to this area. Agile project management and agility are widespread, especially in the B2C markets of digital platforms.

3 Inventory of digital platforms in Germany

In light of the characteristics of the digital multi-sided markets of successful platforms presented in section 2, structured interviews with managers from 14 digital platforms in Germany were conducted as part of this study. During the interviews, the key factors that were derived in section 2.2 from literature on industrial economics were extensively discussed with the experts. In case of the active platforms surveyed, this led to the concrete form of the key factors as summarised below.

The interview selection focused primarily on industry and B2B commerce. Half of the platforms surveyed were classified as data-centric and the other half as transaction-centric platforms.

The platforms surveyed:

Data-centric platforms	Transaction-centric platforms
DITG	3YOURMIND
fTRACE GmbH	Helpling
Guided AB	lieferanten.de
HERE	Mobilitäts Daten Marktplatz
Mindsphere	Partfactory
ProShape	Virtual Fort Knox
Qivicon	Werliefertwas

This selection does not claim to be statistically representative, however, it is relatively balanced and therefore relevant in terms of a case study. The interview results provide an impression of the design and strategic approaches of digital platforms in Germany.

3.1 Details of key factors

3.1.1 Platform function

The surveyed transaction-centric digital platforms typically link suppliers and customers in clearly definable areas or markets. This explains why the number of linked groups tends to be low here. The surveyed data-centric digital platforms typically bring together several different groups to form a data-centric integrated system. Smart home platforms, for instance, bring together suppliers of system components (hardware and software) from very different areas with other players, such as energy producers, telecommunications service providers, home owners and/or property management companies.

With a view to services by transaction-centric digital platforms, the results were as follows: A reduction in search and information costs is described as an important mechanism that accounts for the appeal of such platforms. That is why providing and processing information on potential transaction partners and differentiated functions are so essential for these platforms. Almost all transaction-centric digital platforms also use special offer mechanisms, such as auctions or parallel bidding. Standardised contracts, contract templates and/or principles for the transactions carried out on the platform between suppliers and customers are almost never used by the transaction-centric digital platforms surveyed in B2B commerce. Although specifications like those described in section 2 can reduce negotiation and contract costs, transactions and the related contracts in B2B commerce are usually so specific that standardised specifications are the exception to the rule. Generally speaking, it can be seen that direct customer-supplier-contact continues to be very important in B2B commerce. The performance of a platform in this area is primarily restricted to bringing the two parties together while the business partners themselves handle the actual transactions. This is why so few arbitrators and/or settlement procedures and protection or insurance mechanisms are offered in B2B commerce. It cannot be ruled out, however, that this may change over the course of time, for instance, because digitalisation can lead to a changed business culture and the importance of personal contact between the supplier and customer may decrease over time. An interesting aspect in this context are offers where groups no longer interact with each other but each with the platform only, as it is the case with ‘production as a service’ (i.e. the operating capacity is sold rather than the machine or plant). On the other hand, only a few transaction-centric digital platforms offer data analyses,

i.e. the processing of aggregated data and analyses as additional services for certain users.

The central service offered by many of the data-centric digital platforms surveyed is the definition of standards that warrant interoperability within the integrated system. Since the standards are binding for all of the players on the platform, this reduces transaction costs. With the exception of just one platform, the matter of usability and customer satisfaction with the ecosystem provided is so important for the data-centric digital platforms surveyed that they also take care of this matter themselves. The platforms surveyed hence focus on services that help to establish and orchestrate an integrated digital system (ecoystem). The facilitation of individual market transactions along with the related search and information mechanisms are rarely offered; the survey found that these are not the central functions of data-centric digital platforms.

It was found for both types of platforms that secondary analysis of data, for instance, for advertising purposes or to sell as market data or analyses to third parties, was not an important factor. It may be that data-based, individualised online advertising is generally not as widely accepted in B2B commerce as it is in B2C. On the other hand, what is surprising is that the secondary exploitation of market data is (still) not all that relevant. That being said, most experts agree that data analysis or data-based additional services have enormous potential which can and should be leveraged in the long term.

The subject of data protection and security is generally considered to be important. In most cases, the data protection regulations in force in Germany and the EU are seen to be expedient. In some cases, it is considered to be a competitive advantage if a platform is from Germany (with servers in Germany or in the EU), at least where the German market is concerned. Some of those polled stated that foreign customers also increasingly appreciated 'Quality from Germany' when it comes to data protection, which is why the topic of data security could become a success factor with a view to international markets. This positive evaluation is occasionally refuted and it is criticised that compared to the low standards abroad the current data protection regulations are an obstacle for competition.

Looking at the services offered by the platforms to secure quality, there are significant differences between the two groups: Data-centric digital platforms use certification tools and quality seals, i.e. suppliers of system components (complementary products) are audited and then accredited. Transaction-centric digital platforms mostly use reputation mechanisms in the form of rating systems as a quality assurance service.

3.1.2 Sales and revenue concept

With a view to sales and revenue concepts, no clear distinction can be found between data-centric and transaction-centric digital platforms. All the platforms offer different price structures for the different player groups.

The **asymmetric price structure** that is typical for platform markets was observed with both transaction-centric and data-centric digital platforms. All of the platforms surveyed in B2B commerce charge a monthly fee for access to the platform or to the service offered by the platform. Moreover, a fee is also often charged for "use volume", i.e. the platform charges a percentage-based surcharge per market value (price) of the transaction that is carried out on the platform, or a fee based on data use or analysis. Once again, the platforms sometimes distinguish between user groups, for instance, when only one group is charged the use-based fee. The reason most frequently given for this differentiated price strategy is that it is customary in the industry, followed by consideration of the differences in user groups and dynamic aspects.

Platforms often use price models that include a price scale, such as free access to the basic package, supplemented by additional offers for which a fee is charged

(so-called freemium models). This is possible especially when the platform not only offers pure transactions but also additional products and/or services (a software product or types of data analysis or special presentations by suppliers etc.). Free basic services as well as short notice periods for fee-based basic services (e.g. monthly) – a frequently stated calculation – make it easier for potential users to try the platform out. As soon as companies become aware of the added value of using the platform, they are willing to pay for premium access and additional services, such as market analyses. The business culture in the respective industry is a key factor for the selected payment model.

The survey showed that platforms often deliberately use dynamic elements in their pricing. Low prices are used, for instance, to attract certain user groups in order to quickly establish a critical mass, or low prices are generally charged during the introduction phase and increased later. Dynamic pricing is sometimes also combined with the freemium approach, i.e. a free (or very low-cost) core offer at the time of market entry which is later supplemented with other fee-based or higher-priced additional offers once the platform has become established.

While data analysis as a source of revenue is only relevant in specific cases for transaction-centric digital platforms, this source of revenue is generally more important for data-centric digital platforms.

3.1.3 Openness of the digital platform

Both the surveyed data-centric and transaction-centric platforms use preconditions for access to restrict access to the platform. In addition to purely formal aspects (e.g. B2B marketplace for business people only), these access hurdles are used to secure quality and the minimum technical requirements, although the latter aspect is mostly relevant for data-centric platforms. The platforms differ in the way in which access requirements and securing quality are implemented. Some data-centric digital platforms, for instance, require that potential suppliers of system components furnish proof of accreditation or compliance with quality standards. On the other hand, transaction-centric digital platforms rely primarily on different extensive or complex, individualised pre-checks. Some data-centric platforms, however, perform their own checks; this is often linked to platform performance and the platform issues its own certificates (see section 2.2.1 and 3.1.1). Access requirements based on technical specifications are largely relevant for data-centric platforms. Securing technical standards is related in this case to compliance with data standards to secure interoperability as well as the matter of interpretability (buzzword: data semantics).

Interoperability can also go beyond the platform players or the individual ecosystem. Some of the platforms surveyed, for instance, deliberately use open interfaces or standards to secure **compatibility or interoperability** with other systems. In cases like these, the term openness is sometimes more than just a matter of free access. The subject of **multihoming** is hardly addressed, if at all, so that strategies to prevent or hinder it are not relevant.

3.1.4 Platform independence

The platforms analysed as part of this study cover the entire range of possibilities. From completely independent platforms to platforms with strategic partnerships or platforms that are directly or indirectly (via parent companies or shareholders) integrated platforms, all types are represented. Clear differences were found here between the platform types:

The surveyed **transaction-centric** digital platforms are independent, i.e. they are not integrated into one market side. The reason frequently cited for this was that the platform had to credibly demonstrate its independence to the different sides of the market. In other words, digital marketplaces or facilitators of supply and demand consider the neutrality of their platforms to be a central factor for success. Transaction-centric digital platforms enter into strategic partnerships in isolated cases only.

There are various reasons for this reluctance. On the one hand, some platforms believe that strategic partnerships threaten the (perceived) platform independence, on the other hand, this may be due to the fragmented structure of the market (many small suppliers) or the lack of suitable partners.

The result is less clear for **data-centric** digital platforms: Four of the seven platforms surveyed are not independent but are integrated into one or more sides of the market. This means that they offer products that are compatible with the system (hardware, software or services) – either directly or via the respective parent company or shareholders. The reason behind such an integration is usually the need to credibly show that the platform (as an ecosystem) can become successfully established in the market. A major player with a suitable offering can be advantageous in this case. Strategic partnerships, which are much more important for data-centric digital platforms, are interesting, especially when combined with integration. This can lead to strategic partnerships being entered into with competitors (i.e. with system component suppliers from the same category) – the key word here being: coopetition. Independence is extremely important for data-centric digital platforms when it comes to the openness of the standard used by the platform. This can mean that the market demands platform independence. In this case, consortiums can become a central factor for success – at least according to what was said in the interviews. A consortium also works when the partners need equal access to the data. There are some examples where consideration was given to cooperative models as a way to warrant independence. There are a few individual public platforms that operate in this way. The independence criterion is a strong argument when it comes to public participation.

3.1.5 Contact to (potential) platform users

There are very different, sector-specific ways in which (potential) platform users are addressed and contacted. Only two of the surveyed platforms limit their marketing and customer approach to the Internet; these are Internet marketplaces. All of the other platforms additionally use offline channels. Direct marketing is the dominant channel for data-centric digital platforms. Transaction-centric digital platforms also widely use broad channels to address customers, such as TV advertising. Generally speaking, however, direct contact to potential users is important for both types of platforms – this highlights a significant difference between B2B and B2C.

3.1.6 Dynamic strategy

Solving the chicken and egg problem is referred to as one of the biggest challenges that determine success when setting up digital platforms. Approaches from all of the three categories referred to in section 2.2.6 are used by the digital platforms surveyed in this study.

- Integration approaches are typically used by data-centric digital platforms. One interesting variant of this is when several players jointly establish one platform. This allows them to jointly build up a critical mass which makes the platform appealing to the other group or groups. Under certain circumstances, the platform may even attain a certain level of dominance that allows it to enforce binding standards for the other side of the market.
- In the case of approaches to win players from one or more groups for the platform before market entry, the surveyed data-centric platforms entered more strategic partnerships. Besides, both data-centric and transaction-centric platforms already tried to activate players before entering the market. At times, contacts that already exist in other contexts are used to activate customer networks for the platform.
- When it comes to approaches to attract players from all groups as quickly as possible after entry into the market, familiar strategies from B2C commerce are now used, such as 'aggressive marketing' or dynamic price strategies. Initially focusing on a niche or smaller sub-market is certainly also a successful strategy because it is often easier for the platform to win market players in a smaller playing field. Once the chicken and

egg problem has been successfully solved, the offer can be expanded to include additional products,services and hence groups. On the whole, it was found that platforms are very creative when it comes to developing suitable strategies. Indirect mechanisms are sometimes used, for instance, in order to link certain groups with the platform in order to help it to succeed. Besides freemium approaches, this can also take place on the level of connected services. One example: A software system enables visualisation of a prototype and is used for this purpose. This software can now be directly linked to the platform which, as a marketplace, establishes contact with service providers who produce the prototypes 'on-demand'. This helps to win one side of the market for the platform.

The survey shows that the platforms typically and repeatedly adapt or expand their business model approach, i.e. which groups are to be addressed, which services are offered and which services are fee-based etc. What is interesting is that all the surveyed platforms, which have been in the market for some time, reported that they had adapted their business model approach but only very few of them had planned to do this from the beginning. At the same time, the platforms stated that they had plans to adapt or expand their business model approach in the future.

In this context, it was very often reported that it was helpful to enter the market with a solid, i.e. reliable, core offer and to then gradually add additional services while taking user feedback into account. Therefore, most platforms did not believe that it made sense to enter the market with a portfolio of many, complex services. It was estimated, on the one hand, that this would mean a long development phase up to market entry, and on the other, it would not be possible to guarantee the reliability and quality of the services, especially in the early days, and potential users might be overwhelmed by complex services. This would also make fast customer feedback on the benefits of the platform impossible. Once successful, other services can then usually be connected to platforms with a simple business model. It is conceivable for transaction-centric digital platforms to add to their offering supplementary services (delivery, assembly, maintenance etc.), products, used goods, operating materials (oils, greases, screws etc.), a job exchange (job vacancies in the metalworking) and much more.

Both transaction-centric and data-centric platforms generally have an international focus. Apart from a few exceptions, all of the platforms have already considered internationalisation. At the same time, the strategy pursued by most of the platforms focuses for now on the domestic market. Different languages are one particular obstacle for internationalisation. Different legal and cultural environments were also referred to as barriers. Setting up an international platform is therefore a costly matter. Platform operators see opportunities in the English speaking territories while expansion into Asia is considered to be difficult. It was occasionally emphasised in this context that comprehensive competition can be expected in the future because players in Asia are also setting up successful platforms in B2B.

All of the platforms consider quality to be much more important than fast growth (both at a national and international level). All of the experts agree that growth in B2B commerce cannot be at the expense of reliability ('sound growth'). It was also mentioned that profit development in the different growth phases is not linear. This is the case if, for instance, a cost-intensive set-up phase (key word: chicken-egg) in a sub-market and the subsequent establishment is followed by expansion into new sub-markets so that another cost-intensive set-up phase follows, or another form of cost-intensive scaling or differentiation is pursued. In some of the interviews, the type of financing was referred to in this context. Some expressed the opinion that financing by a parent company or investor with a long-term interest was particularly beneficial when it comes to securing 'sound growth'. Others emphasised the need for flexible access to capital for new high-risk

business ideas and complained that there was still a limited supply of venture capital in Germany. Some of those surveyed would generally like to have more information or advice regarding financing and support possibilities.

4 Conclusion: Success factors of digital platforms

Important factors for the success of digital platforms can be derived from the platform survey. These include the right design as well as compliance with important rules and/or awareness of special challenges.

Even though the platforms surveyed differ, clear patterns can be seen in terms of their design. Two ideal types were then derived from these patterns; one for transaction-centric and one for data-centric digital platforms. These ideal types offer practical pointers for designing and setting up a digital platform. Fig. 6 and Fig. 7 describe the most important features of two antagonistic **ideal types** which, in practice, do not necessarily have to be applied or which can also overlap. It should be noted that these ideal types refer largely, but not exclusively, to B2B commerce where competition is currently much weaker than in the B2C commerce; that is because important market niches in the latter are occupied by dominant players from the US and Asia.

A **transaction-centric digital platform** facilitates transactions, i.e. brings together supply and demand. The ideal type of this platform offers users a suitable information and search function, an offer mechanism (e.g. auctions or parallel bidding) along with an appropriate rating mechanism to build up reputation. The latter can help to secure the quality of the services traded on the platform. The platform also uses pre-checks to ensure quality: Only those suppliers who have passed the platform's own check can offer products (goods and services) on the platform. The ideal type of a transaction-centric digital platform is not integrated, but is independent and sees itself as a neutral marketplace. It charges a fee for access to the platform and demands a share in the monetary transaction volume (use-dependent fee or margin). An asymmetric price structure is applied, i.e. the group that is more difficult to attract pays a lower price (or even nothing), and the volume-based fee is charged to just one group. In order to solve the chicken and egg problem, this platform

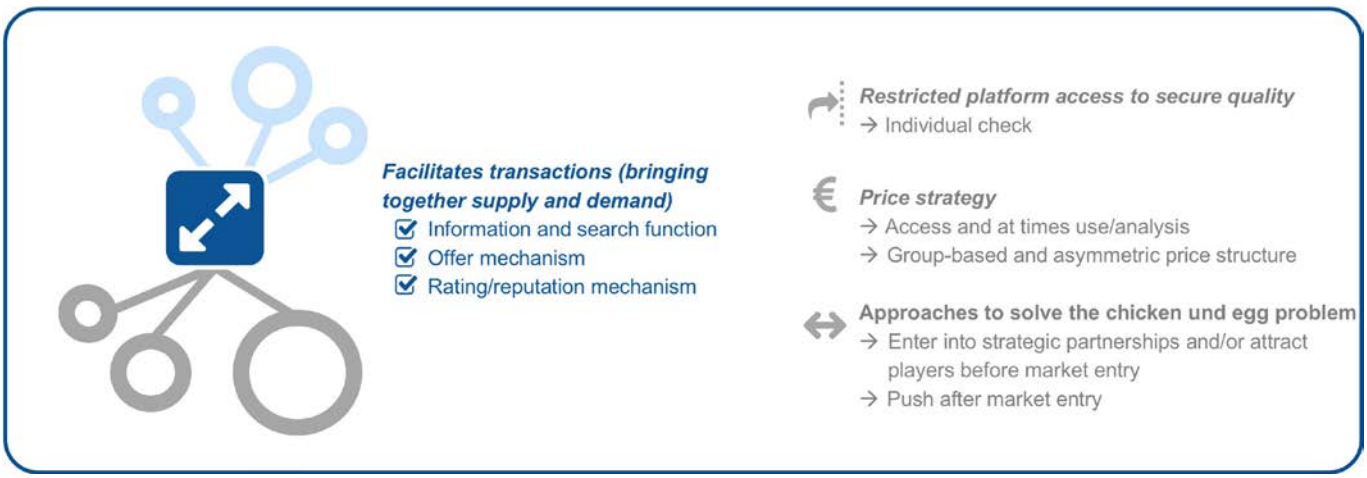


Fig. 6: Ideal type of transaction-centric digital platform

enters into strategic partnerships or already binds players to the platform in other ways before entering the market. Once it has entered the market, the platform assumes a pro-active approach in order to quickly build up a high number of users. Various instruments and approaches are combined to complement each other (low starting prices, push marketing, freemium approaches or an initial focus on one niche or a smaller sub-market). Platforms also develop additional offers (e.g. software tools) that allow one or more sides of the market easier access to the platform.

It is important for transaction-centric digital platforms to be credibly perceived as a neutral marketplace or as a platform that offers reliable, professional services. Strategic partnerships can sometimes have an adverse effect on how other players regard the platform's independence. The right kind of price strategy is essential, especially when it comes to achieving a critical mass. This is where surveys and quick responses to customer feedback can be useful, in addition to knowledge of what is customary in the sector.

A **data-centric digital platform** creates the basis for an integrated data-centric system of complementary components (hardware and software, data and/or services) and controls this system. The ideal type of such a platform offers compilation and analysis of data flows for the players on the platform. The quality of the integrated system (the ecosystem), including usability, is an important task of the platform and it achieves this by coordinating the ecosystem's usability and customer satisfaction management. Suppliers of system components can have their products accredited by the platform, i.e. these products are shown to match the integrated system and to meet with minimum requirements. In addition to this internal accreditation, the platform uses preconditions for access in the form of minimum requirements. Besides technical requirements, which ensure the data interpretability and interoperability of the integrated components, proof of accreditation or quality standards are preconditions for access. The platform charges fees for access, it may demand use-dependent fees and bill players for certain data analyses. The platform uses a differentiated price strategy which takes into account

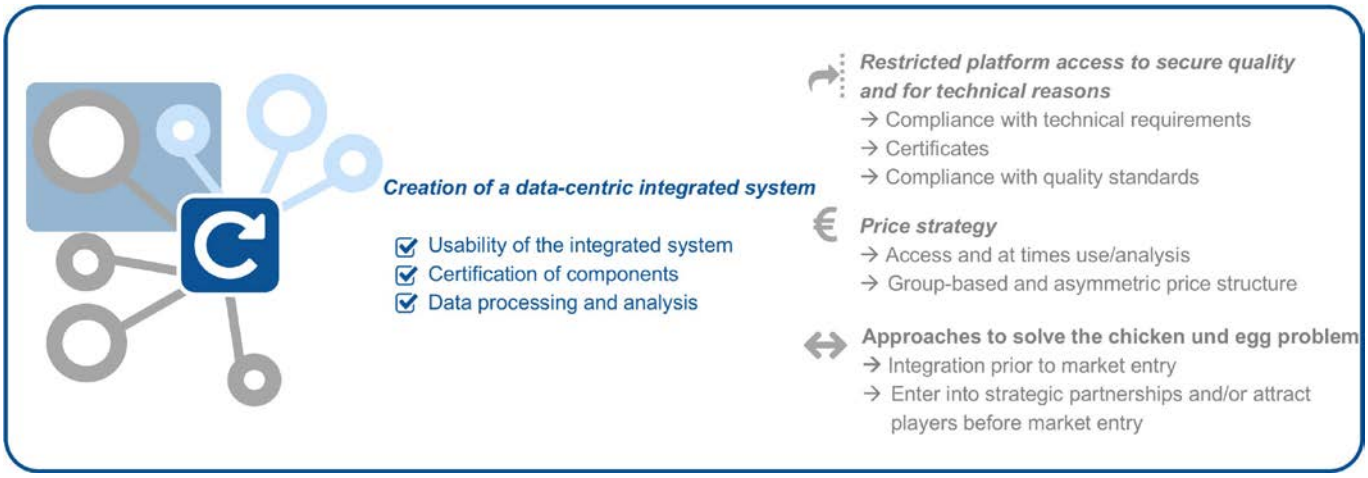


Fig. 7: Ideal type of data-centric digital platforms

the differences in the groups on the platform and features asymmetric price structures. In order to solve the chicken and egg problem, this platform relies heavily on approaches that already bind a sufficient quantity of system components (hardware and software, data and/or services) or their suppliers to the platform and/or integrate them into the ecosystem before entering the market. That is why the platform itself is partially integrated into the sides of the market, i.e. the parent company or the shareholders are suppliers of suitable components. Strategic partnerships are additionally formed with other suppliers.

One particular challenge that faces data-centric digital platforms is how to create a system that is seen to be open and to provide easy access (e.g. thanks to open standards). Projects can fail if stakeholders do not believe that the system in question is open. Medium-sized businesses, for instance, fear the dependency that comes with technological locks. All of the experts also consider the openness of their platform to be a central criterion for success. At the same time, however, it was found that openness is perceived in different ways: Integrated platforms or platforms with strong strategic partners are sometimes criticised by third parties for "not being open" even though the experts themselves describe their platforms as open. Industry experts see openness as being equal to platform independence (i.e. no side of the market is integrated into the platform).

All in all, it is apparent that both **transaction-centric** and **data-centric** digital platforms are caught in the trade-off between quality and reliability, on the one hand, and growth, speed and agility, on the other. The following statements can be derived from the results of the interviews: Excessively long development periods and hesitation must be avoided while securing the quality and/or reliability of the offering is essential. Unlike what may be possible in B2C markets, the services offered in B2B markets must be reliable from the very outset. That is why one approach involves entering the market as a platform with a simple, targeted (lean) but reliable offering and then gradually expanding the business model approach. In this context, agility in B2B markets means adopting a modular approach from the beginning, adapting and expanding the business model on the basis of customer feedback while warranting a high level of reliability at the same time. Growth is considered to be important, however, this should not take place at the expense of quality and reliability ('sound growth').

When setting up and designing the offering or the service of a digital platform, the starting point must be user needs or the 'solution to the problem' rather than the technology. Market analyses and surveys are instruments that are frequently used, for instance, in order to identify the right price strategy. Industry and domain knowledge are beneficial if it can be used to correctly identify user needs butthis should not hinder the creative search for new solutions. When it comes to analysing data, there is still potential waiting to be tapped – many platforms stated, for instance, that they were still only planning to develop or use corresponding (other) approaches.

Patience is essential in order to solve the chicken and egg problem and to establish a platform in the market. As a rule, only a few players can succeed with their platform idea in the (sub-)market and benefit from economies of scale. Extensive investments are needed to set up the platform, especially in the beginning. In the battle to reach a critical mass, platforms are particularly creative and/or they invest heavily, for instance, by cross-subsidising parts of the offering, searching for strategic partners or by offering complementary services or products.

For start-ups, access to venture capital is a success factor, however, the importance of other forms of financing was also emphasised. Generally speaking, the type of financing must take into account the special nature of setting up a digital platform in B2B commerce (winner-takes-all-risk and required investment, the need for sound growth, non-linear development of profits in the different growth phases etc.).

Compared to start-ups, established companies have the advantage that they have their own network and extensive options for financing. Both of these facts are central characteristics that can help to ensure the success of the platform idea. However, management must know and accept that setting up successful platforms is a very costly matter that poses a much greater risk of failure than conventional investments. At the same time, it may be challenging to signal that the platform is open and agile. As a rule, entirely new marketing concepts have to be developed.

It should be noted that developing digital platforms offers huge opportunities for German companies. What is important here is to make clever use of the industry expertise and business networks that already exist in order to develop new business models.

In the case of transaction-centric platforms, there are comprehensive opportunities especially for start-ups. Due to their independence, they can become established as a neutral facilitator between suppliers and customers. (Sub-)markets and niches that have not yet been occupied, especially in B2B commerce, need to be identified and the specific nature of the respective market niche must be addressed in detail. Setting up a data-centric platform means establishing a broad-based ecosystem that is perceived to be open. Established companies have the advantage that they are already known in the respective market (key word: expectations), that they can offer complementary products themselves (including data) and they can use their business ties and contacts to attract relevant players to the ecosystem.

5 Appendices: R&D projects with a platform character supported by BMWi

The table below provides an overview of R&D projects from three selected topic-specific support programmes by BMWi: Smart Service World (BMWi, 2016b), Autonomics for Industry 4.0 (BMWi, 2011) and PAiCE (BMWi, 2015). In these three programmes only, more than 30 collaborative projects with a strong platform character have been and will be supported with close to €100 million. It must be highlighted that this overview is simply a sample overview of the projects related to these programmes. In addition to a short description of the projects, as well as details on how to find more information, an attempt was made to assign these for the first time to the ideal platform types, i.e data-centric and transaction-centric, developed in this study. It must be emphasised, however, that these two types cannot always be strictly distinguished and it should be noted that the R&D projects are projects that were recently completed, are still underway or are just about to kick off. The economic exploitation of the results usually takes place some time after the project has been completed. It is only then that the possible business models are specified in detail so that reliable assignment to one type or both ideal types cannot be carried out before. Taking this into account, the projects described on the following pages can be assigned as follows:

Project	Type of platform	Project	Type of platform
AcRoSS	Data-centric	OPTIMOS	Data and transaction-centric
Add2Log	Data and transaction-centric	PASS	Data and transaction-centric
CAR-BITS.de	Data and transaction-centric	ProShape	Data-centric
DigiKAM	Data and transaction-centric	ReApp	Data and transaction-centric
ENTOURAGE	Transaction-centric	RoboPORT	Data and transaction-centric
GEISER	Data and transaction-centric	SAMPL	Data and transaction-centric
Glass@Service	Data-centric	SaSCh	Data-centric
GuidedAB	Data-centric	SePiA.PRO	Data-centric
Guided AL	Data-centric	SeRoNet	Data and transaction-centric
InnoCyFer	Data-centric	SERVICEFACTORY	Data-centric
INTEGRATE	Data-centric	Smart Farming Welt	Data and transaction-centric
IoT-T	Data-centric	Smart Orchestra	Data and transaction-centric
iSLT.NET	Data-centric	SMARTSITE	Data-centric
KOMMUNAL 4.0	Data-centric	STEP	Data-centric
MACSS	Data-centric	StreetProbe	Data and transaction-centric
MANUSERV	Data-centric	Symphony	Transaction-centric
OPAK	Data-centric	VariKa	Data-centric

Table 1: Examples of R&D projects with a platform character from the technology programmes of BMWi

AcRoSS

Making augmented reality usable for industry

www.across-ar.de

Type of platform: Data-centric

AcRoSS aims to provide companies of different sizes and from different industries access to augmented reality support. A platform is being developed for this purpose where all the necessary data will be exchanged and different AR services made available. The platform is open and extendable so that third parties can also participate in the development of new AR services.

Project partners: Fraunhofer-Einrichtung für Entwurfstechnik Mechatronik IEM (Konsortialführer); Atos IT Solutions and Services GmbH; DAI-Labor, Technische Universität Berlin; Krause-Biagosch GmbH; Ubimax GmbH

Contact: Dr.-Ing. Harald Anacker, Fraunhofer IEM
Technology programme: Smart Service Welt
Term: 1 March 2016 - 28 February 2019

Add2Log

The platform for decentralised production based on additive manufacturing and agile logistics

www.digitale-technologien.de/DT/Redaktion/DE/Standardartikel/PAICEProjekte/paice-projekt_add2log.html

Type of platform: Data and transaction-centric

The aim of the Add2log collaborative project is to develop and implement in prototype form an inter-company, software-based platform that will provide essential coordinating functions for new, emerging value creation networks. The enormous potential of decentralised additive manufacturing hubs is to be combined with agile logistics and made usable.

Project partners: Software AG (Konsortialführung); Forschungsinstitut für Rationalisierung (FIR) e. V. an der RWTH Aachen; Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V.; DMG MORI Spare Parts GmbH; TOP Mehrwert-Logistik GmbH & Co. KG; Materialise GmbH

Contact: Dirk Mayer, Software AG
Technology programme: PAiCE
Term: 1 March 2017 - 29 February 2020

CAR-BITS.de

Privacy compliant use of car data

www.car-bits.de

Type of platform: Data and transaction-centric

The project CAR-BITS.de is developing a service platform that will enable privacy compliant use of vehicle data for new services. Service prototypes are used to show how dynamic entries in digital maps can help to improve road safety, how cars can automatically report missing lane markings and how a network can be formed with different car manufacturers and suppliers in a manner that complies with the relevant legal requirements.

Project partners: Uniscon GmbH (Konsortialführer); Continental Automotive GmbH; Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V.; Hochschule Bonn-Rhein-Sieg

Contact: Dr. Hubert Jäger, Uniscon GmbH
Technology programme: Smart Service Welt
Term: 1 January 2016 - 31 December 2018

DigiKAM

Digital collaboration network to open up additive manufacturing

www.digitale-technologien.de/DT/Redaktion/DE/Standardartikel/PAICEProjekte/paice-projekt_digikam.html

Type of platform: Data and transaction-centric

The aim of this collaborative project is to set up a collaboration network to open up additive manufacturing. The network will especially address SMEs who, due to their limited resources, are not in a position to quickly build up the necessary AM know-how. With a scalable platform solution, very different AM users and AM service providers from different industries will be connected efficiently throughout the entire AM development process.

Project partners: Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V. (Konsortialführung); Friedrich Remmert GmbH; Miele & Cie. KG; Atos IT Solutions and Services GmbH; Krause DiMaTec GmbH

Contact: Prof. Dr.-Ing. Roman Dumitrescu, Fraunhofer IEM
Technology programme: PAiCE
Term: 1 January 2017 - 31 December 2019

ENTOURAGE

An open ecosystem for smart, secure and trusted assistance systems in the Internet of Things

www.entourage-projekt.de
Type of platform: Transaction-centric

ENTOURAGE is developing a unique open ecosystem where very different devices, platforms and services work together as equals. A technical and organisational architecture is being used to create a marketplace for privacy compliant assistance systems where small and medium-sized enterprises can also offer their services.

Project partners: ENX Association (Konsortialführer); CONWEAVER GmbH; Fraunhofer-Institut für Arbeitswirtschaft und Organisation (IAO); HaCon Ingenieurgesellschaft mbH; Robert Bosch GmbH; Technische Universität Darmstadt; Universität Kassel

Contact: Florian von Kurnatowski, ENX Association
Technology programme: Smart Service Welt
Term: 1 April 2016 - 31 March 2019

GEISER

Smart combination of sensors and geodata

www.projekt-geiser.de
Type of platform: Data and transaction-centric

The GEISER project is developing a cloud-based platform that combines sensor data with geo-positioning data, so-called geodata, and converts them into a standardised format so that they can be used to provide innovative smart services and products. The project looks at three specific use cases: smart navigation to the next free parking space, geoservices for improved deployment of service technicians and marketing based on geodata.

Project partners: USU Software AG (Konsortialführer); Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V.; metaphacts GmbH; TomTom Development Germany GmbH; Universität Leipzig; YellowMap AG

Contact: Roman Korf, USU Software AG
Technology programme: Smart Service Welt
Term: 1 March 2016 - 28 February 2019

Glass@Service

Smart glasses in production

www.glass-at-service.de
Type of platform: Data-centric

The aim of this project is to combine smart glasses in production with innovative means of interaction (e.g. eye and gesture control) and innovative IT services so that the glasses can be used as personalised information systems. This can boost the worker's freedom of movement and their efficiency.

Project partners: Siemens Aktiengesellschaft (Konsortialführer); Bundesanstalt für Arbeitsschutz und Arbeitsmedizin (BAuA); DIOPTIC GmbH; Fraunhofer-Institut für Organische Elektronik, Elektronenstrahl- und

Plasmatechnik (FEP); Ubimax GmbH; UVEX Arbeitsschutz GmbH

Contact: Dr. Frank-Peter Schiefelbein, Siemens AG
Technology programme: Smart Service Welt
Term: 1 January 2016 - 31 December 2018

GuidedAB

Energy efficiency, comfort and safety thanks to connected, self-learning building and home systems

www.guided-ab.de
Type of platform: Data-centric

The aim of GUIDED AB is to develop a new control system for building automation and home networking that adapts itself autonomously to the needs of users and residents. As a result, building and home networking components will be controlled efficiently and in line with residents' needs.

Project partners: Hager Electro GmbH & Co KG (Konsortialführer); Deutsches Forschungszentrum für Künstliche Intelligenz GmbH; FH Dortmund - Institut für Kommunikationstechnik (IKT); INTERACTIVE Software Solutions GmbH; IS Predict GmbH; QBUS eNET GmbH & Co. KG; Scheer Management GmbH

Contact: Johannes Hauck, Hager Electro GmbH & Co. KG
Technology programme: : Autonomics for Industry 4.0
Term: 1 October 2013 - 30 September 2016

Guided AL

Building data combined with mobile data to optimise various areas of life

www.guided-al.de
Type of platform: Data-centric

The Guided Autonomous Locations project aims to establish a web-based, system-independent service platform so that smart services can be implemented in the context of building automation. This involves assessing the technical requirements that must be met if existing and new automation solutions and smart devices are to be used so that cross-building smart services can be offered in various areas of life.

Project partners: Scheer GmbH (Konsortialführer); Banbutsu GmbH; Deutsches Forschungszentrum für Künstliche Intelligenz GmbH; Fachhochschule Dortmund; Hager Electro GmbH & Co. KG

Contact: Janina Hoppstädter, Scheer GmbH
Technology programme: Smart Service Welt
Term: 1 March 2016 - 28 February 2019

InnoCyFer

Bionically controlled production systems for manufacturing customised products

www.innocyfer.de
Type of platform: Data-centric

The InnoCyFer project is developing a web-based, open-innovation platform which provides customers with a toolkit that allows them to design technically viable products individually and according to their own ideas without the need for specific skills.

Project partners: TU München (Konsortialführer); Bosch und Siemens Hausgeräte GmbH; Festo Didactic GmbH & Co. KG; Fraunhofer IWU; HYVE Innovation Community GmbH

Contact: Michael Niehues, TU München
Technology programme: : Autonomics for Industry 4.0
Term: 1 November 2013 - 31 October 2016

INTEGRATE

Open service platform for integrated engineering and 3D technologies

www.digitale-technologien.de/DT/Redaktion/DE/Standard-artikel/PAICEProjekte/paice-projekt_integrate.html

Type of platform: Data-centric

The aim of this project is to develop a platform that allows a combination of design tools, which are not synchronised on a common database system, to communicate with each other using planning objects. A platform will be developed based on the AutomationML exchange format that enables cooperative engineering between different companies.

Project partners: INPRO Innovationsgesellschaft für fortgeschrittene Produktionssysteme in der Fahrzeugindustrie mbH (Konsortialführung); FZI Forschungszentrum Informatik am Karlsruher Institut für Technologie; Otto-von-Guericke-Universität Magdeburg; ABB AG; logi.cals automation solutions & services GmbH

Contact: Daniel Wolff, INPRO GmbH
Technology programme: PAiCE
Term: 1 February 2017 - 31 January 2020

IoT-T

Innovative testing of devices and software for the Internet of Things

www.iot-t.de

Type of platform: Data-centric

The purpose of the IoT-T project is to develop a test platform that will allow developers and users to comprehensively test software and devices for the IoT in order to help them reduce development times.

Project partners: Fraunhofer-Institut für offene Kommunikationssysteme FOKUS (Konsortialführer); Audi AG; DEKRA; Fraunhofer-Institut für Produktionsanlagen und Konstruktionstechnik (IPK); relayr GmbH

Contact: Dipl.-Inf. Michael Wagner, Fraunhofer FOKUS
Technology programme: Smart Service Welt
Term: 1 September 2016 - 31 August 2018

iSLT.NET

A network for intelligent, modular special load containers

www.digitale-technologien.de/DT/Redaktion/DE/Standard-artikel/PAICEProjekte/paice-projekt_isltnet.html

Type of platform: Data-centric

The aim of the project iSLT.NET is to design, implement as a prototype and test a network for intelligent modular special load containers. The purpose is to leverage the opportunities offered by a modular load container design and by the use of basic technologies in the Internet of Things (IoT) for data-based services in a network involving many different companies.

Project partners: Gebhardt Logistic Solutions GmbH (Konsortialführung); Bayerische Motoren Werke Aktiengesellschaft; DIS Dräxlmaier Industrial Solutions GmbH; Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V.; Technische Universität München; Hochschule für angewandte Wissenschaften Landshut

Contact: Dr. Andreas Sachs, Gebhardt Logistic Solutions GmbH
Technology programme: PAiCE
Term: 1 February 2017 - 31 January 2020

KOMMUNAL 4.0

Pooling information in municipal water management

www.hst.de/themenwelt/kommunal4null.html

Type of platform: Data-centric

The aim of KOMMUNAL 4.0 is to develop a data and

service platform for municipal infrastructures based on the example of water management. Business models are being developed to enable effective planning and efficient operation of municipal infrastructure systems.

Project partners: HST Systemtechnik GmbH & Co. KG (Konsortialführer); PEGASYS Ges. f. Automation u. Datensysteme mbH; SüdWasser GmbH; Institut für Automation und Kommunikation e. V.; Technische Hochschule Köln; IEEM gGmbH

Contact: Günter Müller-Czygan, HST Systemtechnik GmbH & Co. KG
Technology programme: Smart Service Welt
Term: 1 April 2016 - 31 March 2019

MACSS

Digital communication between doctors and patients
www.macss-projekt.de
Type of platform: Data-centric

The project MACSS aims to give patients with chronic illnesses greater safety and a better quality of life. This can be achieved through a more efficient communication between the doctor and the patient and between all of the doctors involved in treating the patient.

Project partners: Charité – Universitätsmedizin Berlin (Konsortialführer); Beuth Hochschule für Technik Berlin Deutsches Forschungszentrum für Künstliche Intelligenz GmbH; Dosing GmbH; SAP SE; SmartPatient GmbH

Contact: Prof. Dr. med. Klemens Budde, Charité Berlin
Technology programme: Smart Service Welt
Term: 1 January 2016 - 31 December 2018

MANUSERV

Planning and decision-making support system for selecting industrial service robots
www.manuserv.de
Type of platform: Data-centric

The MANUSERV project aims to develop a planning and decision-making support system that uses service robots in order to automate processes that have been carried out manually until now. The solution is provided as a service for users via an Internet platform where suppliers offer their service robot solutions in a technology catalogue.

Project partners: RIF e. V. – Institut für Forschung und Transfer (Konsortialführer); KHS Corpoplast GmbH; Albrecht Jung GmbH & Co. KG; GEA Farm Technologies GmbH; Icarus Consulting GmbH

Contact: Frank Heinze, RIF Institut für Forschung und Transfer e. V.
Technology programme: : Autonomics for Industry 4.0
Term: 1 January 2014 - 31 December 2016

OPAK

3D-supported engineering platform for intuitive development and efficient commissioning of production plants
www.opak-projekt.de
Type of platform: Data-centric

The OPAK project focuses on the development of a 3D-supported engineering platform for intuitive planning, development and commissioning of production plants. The plant can be initially planned, independent of the manufacturer, based on purely functional descriptions of the standard components of the automation system. The final components with the specific performance characteristics of the respective supplier are not added until later.

Project partners: Festo AG & Co. KG (Konsortialführer); ASYS Automatisierungssysteme GmbH; elrest Automationssysteme GmbH; Festo Didactic GmbH & Co. KG; fortiss GmbH; Hochschule Ostwestfalen-Lippe (inIT); 3S-Smart Software Solutions GmbH

Contact: Johannes Hoos, Festo AG & Co. KG
Technology programme: Autonomics for Industry 4.0
Term: 1 October 2013 - 30 September 2016

OPTIMOS

Secure identities for mobile services
www.optimos.org
Type of platform: Data and transaction-centric

The OPTIMOS project aims to create a platform that will bring together identification solutions with other applications for mobile services. The platform will be implemented on the basis of the national eTicketing system for public transport. The findings from the project will then be used in international standardisation work.

Project partners: VDV eTicket Service GmbH & Co. KG (Konsortialführer); Bundesdruckerei GmbH; Giesecke & Devrient GmbH; KAPRION GmbH; NXP Semiconductors Germany GmbH; Technische Universität Dresden; T Systems International GmbH

Contact: Cord Bartels, VDV eTicket Service
Technology programme: Smart Service Welt
Term: 1 July 2016 - 28 February 2018

PASS

Secure apps for cars
www.pass-projekt.de
Type of platform: Data and transaction-centric

The aim of the project PASS is to develop an open software platform for the uniform development, simple deployment and secure execution of apps in vehicles. The system will be open to third-party applications and will provide a basis for a wide range of services and business models.

Project partners: TWT GmbH Science & Innovation (Konsortialführer); atsec information security GmbH; Continental Automotive GmbH; Elektrobit Automotive GmbH; fortiss GmbH; SYSGO AG

Contact: Dr. Markus Pfeil, TWT GmbH
Technology programme: Smart Service Welt
Term: 1 January 2016 - 31 May 2019

ProShape

Hardware and software solutions for flexible energy supply and minimised costs
www.borderstep.de/projekte/proshapeconnected-energy
Type of platform: Data-centric

In a distributed energy management system, ProSHAPE uses household-based data on current and forecast energy consumption in order to co-ordinate energy generation in the building through distributed cogeneration and/or the sale or purchase of energy. Using dynamic, price-based weighing, the entire energy system in the smart home network can be optimised with a view to heat and electricity use.

Project partners: Borderstep Institut gemeinnützige GmbH (Konsortialführer); Berliner Energieagentur GmbH; DAI-Labor (TU Berlin); Dr. Riedel Automatisierungstechnik GmbH; Orga Systems GmbH; Wohnungsbaugenossenschaft Zentrum eG

Contact: Dr. Severin Beucker, Borderstep Institut gGmbH
Technology programme: Autonomics for Industry 4.0
Term: 1 January 2014 - 30 June 2016

ReApp

Plug-and-play integration of robots into industrial automation

www.reapp-projekt.de

Type of platform: Data and transaction-centric

ReApp defines standardised interfaces for integrating hardware and software from different manufacturers for robot systems. Together with a catalogue of reusable smart services (robot apps) and a model-driven development environment, robot systems can be adapted faster and at lower costs to the specific requirements of small and medium-sized enterprises (SMEs).

Project partners: Fraunhofer IPA (Konsortialführer); BMW AG; Dresden Elektronik Ingenieurtechnik GmbH; Fischer IMF GmbH & Co. KG; Fluid Operations AG; fortiss GmbH; FZI Forschungszentrum Informatik; InSystems Automation GmbH; ISG Industrielle Steuerungstechnik GmbH; Karlsruher Institut für Technologie (KIT) – Institut für Prozessrechentechnik, Automation und Robotik; Ruhrbotics GmbH; SICK AG

Contact: Dr. Ulrich Reiser, Fraunhofer IPA
Technology programme: Autonomics for Industry 4.0
Term: 1 January 2014 - 31 December 2016

RoboPORT

Robotic platform and open repository for toolkits

www.digitale-technologien.de/DT/Redaktion/DE/Standardartikel/PAICEProjekte/paice-projekt_roboport.html

Type of platform: Data and transaction-centric

The aim of RoboPORT is to establish an interdisciplinary community using a web-based platform where ideas and products can be developed through co-creation in service robotics. The platform will be specially designed to generate innovations and to convert these innovations more effectively into products. RoboPORT will hence strengthen small and medium-sized enterprises in Germany and will make it easier for prosumers to participate in service robotics.

Project partners: Local Motors GmbH (Konsortialführung); innosabi GmbH; General Interfaces GmbH; BSH Hausgeräte GmbH; Universität Stuttgart; Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung

Contact: Doris Lohrmann, Local Motors GmbH
Technology programme: PAiCE
Term: 1 April 2017 - 31 March 2020

SAMPL

Secure Additive Manufacturing Platform

www.tuhh.de/fks/010_research/projects/sampl/de/index.html

Type of platform: Data and transaction-centric

The objective of the collaborative project SAMPL is to develop an end-to-end security solution (chain of trust). This process begins with the generation of digital 3D print data and the exchange of data with trusted 3D printers and continues on to the printed products by means of an RFID chip. In addition to the 3D-CAD data encrypted in this manner, digital license management will be implemented based on blockchain technology that will allow secure and verifiable transactions.

Project partners: PROSTEP AG (Konsortialführung); NXP Semiconductors Germany GmbH; consider it GmbH; 3D MicroPrint GmbH; Universität Hamburg; Technische Universität Hamburg-Harburg; Universität Ulm; Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V.

Contact: Dr. Martin Holland, PROSTEP AG
Technology programme: PAiCE
Term: 1 November 2016 - 31 October 2019

SaSCh

Digital services for shaping agile supply chains

www.digitale-technologien.de/DT/Redaktion/DE/Standard-artikel/PAICEProjekte/paice-projekt_sasch.html

Type of platform: Data-centric

This project aims to achieve complete end-to-end monitoring of the quality of parts, components and products throughout their lifecycle. The relevant data is stored at the participating companies so that each company's data sovereignty is warranted. Data is exchanged between the companies on an event basis in the EPCIS network. Data analysis allows very different services to be offered in order to ensure product quality and to therefore expand the limits for JIT as well as JIS deliveries and hence avoid special deliveries, rework, production downtimes or even recalls.

Project partners: queo GmbH (Konsortialführung); BIBA - Bremer Institut für Produktion und Logistik GmbH; BLG Industrielogistik GmbH & Co. KG; Robert Bosch GmbH; GS1 Germany GmbH

Contact: Matthes Winkler, queo GmbH
Technology programme: PAiCE
Term: 1 November 2016 - 31 October 2019

SePiA.PRO

Optimising communication between machine tools

www.projekt-sepiapro.de

Type of platform: Data-centric

The SePiA.Pro project is developing a service platform for smart use of sensor and job data in state-of-the-art production plants. This development is based on smart services that enable detailed control, optimisation and behaviour prediction for individual components as well as entire production systems.

Project partners: TWT GmbH Science & Innovation (Konsortialführer); Blue Yonder GmbH; Deutsches Forschungszentrum für Künstliche Intelligenz GmbH; Daimler AG; TRUMPF Werkzeugmaschinen GmbH + Co. KG; Universität Stuttgart – Institut für Architektur von Anwendungssystemen

Contact: Dr. Ulrich Odefey, TWT GmbH Science & Innovation
Technology programme: Smart Service Welt
Term: 1 March 2016 - 28 February 2019

SeRoNet

A platform for collaborative development of service robot solutions

www.digitale-technologien.de/DT/Redaktion/DE/Standard-artikel/PAICEProjekte/paice-projekt_seronet.html

Type of platform: Data and transaction-centric

The aim of this project is to develop a platform geared to growth that supports dynamic value chain networks for efficient development of bespoke solutions throughout the main emergence phases of a service robot system (SR). The platform is designed to bring suppliers and operators/users of an SR solution together and to secure the SR development process beginning with one system in terms of economic efficiency and 'first-time-right' quality. The platform will host these networks by providing access to ontology-based domain knowledge by providing a repository service for standardised (OPC UA) services and by bringing together individual players to form collaborative sub-networks based on knowledge. In the final phase of development, the platform will operate independently.

Project partners: Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V. (Konsortialführung); FZI Forschungszentrum Informatik am Karlsruher Institut für Technologie; Hochschule Ulm; Universität Stuttgart; KUKA Roboter GmbH; Universität Paderborn; Klinikum Mannheim GmbH Universitätsklinikum Medizinische Fakultät

Mannheim der Universität Heidelberg; MLR System GmbH für Materialfluss- und Logistiksysteme; Ruhrbotics GmbH; Daimler TSS GmbH; Transpharm Logistik GmbH

Contact: Martin Hägele, Fraunhofer IPA
Technology programme: PAiCE
Term: 1 March 2017 - 29 February 2021

SERVICEFACTORY

Individually tailored services
Type of platform: Data-centric

The aim of this project is to create a prototype and to validate an online platform for the recording, transmission and analysis of personal data gathered by devices used in everyday life (wearables, trainers, smart watches etc.). Once aggregated, this data will be used to develop smart health and sports services tailored to each individual customer.

Project partners: adidas AG (Konsortialführer); Deutsches Forschungszentrum für Künstliche Intelligenz GmbH; Deutsche Telekom AG; Dresden Elektronik Ingenieurtechnik GmbH; Humotion GmbH; Rheinisch-Westfälische Technische Hochschule Aachen; Verein Deutscher Ingenieure

Contact: Chris Robertson, adidas AG
Technology programme: Smart Service Welt
Term: 1 January 2016 - 30 June 2018

Smart Farming Welt

Smart connection of agricultural processes
www.smart-farming-welt.de
Type of platform: Data and transaction-centric

The project Smart Farming World is developing a technical basis that will allow agricultural processes to be connected in a smart way and involving different producers and organisations. As a result, it will be possible to offer services to achieve optimal machine settings, optimised fertilising and harvesting strategies as well as process automation.

Project partners: Logic Way GmbH (Konsortialführer); CLAAS E-Systems KGaA mbH & Co KG; Deutsches Forschungszentrum für Künstliche Intelligenz GmbH; Deutsche Telekom AG; Forschungsinstitut für Rationalisierung (FIR) e. V. an der RWTH Aachen; Grimme Landmaschinenfabrik GmbH & Co. KG

Contact: Arndt Kritzner, Logic Way GmbH
Technology programme: Smart Service Welt
Term: 1 March 2016 - 28 February 2019

Smart Orchestra

Bringing smart-service 'soloists' together to form one large orchestra
www.smartorchestra.de
Type of platform: Data and transaction-centric

The cloud-based service platform created as part of the project Smart Orchestra will enable smart, connected products and services to be combined with each other, to be used 'in concert' and to be marketed. The platform will be used to establish an open and secure market place for smart services where they can be sold, used and combined in a flexible manner.

Konsortialpartner: StoneOne AG (Konsortialführer); Cleopa GmbH; Datenfreunde GmbH; Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V.; regio iT gesellschaft für informationstechnologie mbH; Universität Stuttgart

Contact: Andreas Liebing, StoneOne AG
Technology programme: Smart Service Welt
Term: 1 January 2016 - 31 December 2018

SMARTSITE

Connected machines in road construction

www.smartsite-project.de

Type of platform: Data-centric

The project SMARTSITE was used to develop software platforms for digital construction site networks, construction process control, semi-autonomous construction machines and systems. Based on uniform standards, they lead to complete or partial automation of collaboration between different individual systems and their connection to the construction site environment.

Project partners: Ammann Verdichtung GmbH; ceapoint aec technologies GmbH; Ed. Züblin AG; Universität Hohenheim; Topcon Deutschland Positioning GmbH

Contact: Dr. Burkhard Seize, Drees & Sommer Infra Consult und Entwicklungsmanagement GmbH
Technology programme: Autonomics for Industry 4.0
Term: November 2013 - 31 October 2016

STEP

Smart technician mission planning for industrial machine maintenance

www.projekt-step.de

Type of platform: Data-centric

The goal of the project STEP is to predict the maintenance needs of machinery and to use these projections to deploy technicians in an automated and efficient way, so that they can be where they are needed. All of this information can be pooled centrally on a cloud platform and in line with data privacy rules.

Project partners: USU Software AG (Konsortialführer); FLS GmbH; Heidelberger Druckmaschinen AG; Karlsruher Institut für Technologie (KIT); TRUMPF Werkzeugmaschinen GmbH + Co. KG

Contact: Henrik Oppermann, USU Software AG
Technology programme: Smart Service Welt
Term: 1 March 2016 - 28 February 2019

StreetProbe

Automatic data capture by vehicle sensors to monitor road conditions

www.streetprobe.de

Type of platform: Data and transaction-centric

The project StreetProbe is developing a cloud-based system to capture and assess the condition of roads. Based on the data gathered, smart services will be made available, such as automatic shock absorbers or precise roadmaps for highly automated car systems.

Project partners: Robert Bosch GmbH (Konsortialführer); Technische Universität Berlin; Bundesanstalt für Straßenwesen (BASt); Durth Roos Consulting GmbH; 3D Mapping Solutions GmbH

Contact: Martin Rous, Robert Bosch GmbH
Technology programme: Smart Service Welt
Term: 1 March 2016 - 28 February 2019

Symphony

Platform for ICT services

www.IKT-symphony.de

Type of platform: Transaction-centric

The platform Symphony will become a digital marketplace for ICT services specifically geared to small and medium-sized companies. This will allow SMEs to compare, select, combine, purchase and manage ICT services. This means that the related transactions will no longer have to be carried out with each supplier separately (one face to the customer).

Project partners: paluno – The Ruhr Institute for Software-Technology, Universität Duisburg-Essen (Konsortialführer); adesso AG; IN-telegence GmbH; Deutsches Institut für Normung e.V. (DIN); Verband der Anbieter von Telekommunikations- und Mehrwertdiensten (VATM e.V.)

Contact: Marc Hesenius, paluno
Technology programme: Smart Service Welt
Term: 1 September 2014 - 31 August 2018

VariKa

Connected product and production engineering based on the example of ultra-light metallic car bodies with their many different variants

www.digitale-technologien.de/DT/Redaktion/DE/Standardartikel/PAICEProjekte/paice-projekt_varika.html
Type of platform: Data-centric

The project VariKa focuses on the development of a connected product and production engineering system for ultra-light, bionically optimised, multi-functional car body components as well as a matching innovative manufacturing concept with laser-additive manufacturing and jigless joining.

Project partners: EDAG Engineering GmbH (Konsortialführung); Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V.; Adam Opel AG; FFT Produktionssysteme GmbH & Co. KG; FKM Sintertechnik GmbH

Contact: Dr.-Ing. Martin Hillebrecht, EDAG Engineering GmbH
Technology programme: PAiCE
Term: 1 April 2017 - 31 March 2020

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