Platform Economy: Converging IoT Platforms and Ecosystems

Sven Jung, Felix Wortmann, Wolfgang Bronner, and Oliver Gassmann

1 The Power of Platforms

Over the last two decades, many platform businesses have outperformed traditional businesses. In fact, as of today eight out of the ten most valuable companies globally are platform companies (e.g., *Apple*, *Amazon*, *Alibaba*), and many more are on the rise to disrupt entire industries (Price Waterhouse Coopers 2020). Some of the most famous examples that have disrupted entire industries are *Facebook* and *Instagram* in social media, *Amazon* and *eBay* in retail, *booking.com* and *Airbnb* in travelling, as well as *Uber* and *Lyft* in transportation.

S. Jung (✉)
University of St. Gallen, St. Gallen, Switzerland
e-mail: sven.jung@unisg.ch

F. Wortmann • O. Gassmann
Institute of Technology Management, University of St. Gallen, St. Gallen, Switzerland
e-mail: felix.wortmann@unisg.ch; oliver.gassmann@unisg.ch

W. Bronner
Bosch IoT Lab, University of St. Gallen & ETH Zürich, St. Gallen, Switzerland
e-mail: wolfgang.bronner@bosch.com

O. Gassmann, F. Ferrandina (eds.), *Connected Business*,
https://doi.org/10.1007/978-3-030-76897-3_2

The success of these companies is heavily based on network effects, i.e., an increased number of users leading to a higher value of the platform (Rochet and Tirole 2003). Compared to traditional businesses, platforms can scale much faster and more easily. This is because platforms often do not build or own any assets (e.g., apartments in the case of *Airbnb*) but instead provide the infrastructure that enables value-creating interactions between users (interactions between apartment owners and travellers in the case of *Airbnb*) (Parker et al. 2016). The success of platforms makes it almost inevitable for a manager to engage in the platform economy or as an entrepreneur to think about building a platform venture from scratch. But how do their underlying mechanisms work? How do the concepts of ecosystem and platform relate? And are platforms only for digital players? What is the impact of platforms on the physical world and the Internet of Things (IoT)?

While the digitalization made many platforms possible, early traits of platform thinking have already existed before. For example, car manufacturers like *Volkswagen* or camera manufacturers like *Nikon* have utilized platform thinking in their product development. While each camera model consists of a few unique features, most components are based on an underlying technology platform that is shared among all models. This type of platform is referred to as an "internal platform" (Gawer and Cusumano 2014) with the primary goal to make production more efficient.

However, when we talk about today's leading platforms—the *Amazon*s, *Apple*s, or *Airbnb*s—we usually have a different platform concept in mind. Tech companies like *Microsoft* or *Intel* were one of the first to utilize platform thinking for their business model. But what was so different compared to a traditional, pipeline business model? With *Microsoft* Windows, *Microsoft* developed an operating system and a platform that was open for external software companies to build complementary applications on top of Windows (ibid.). In comparison to a pipeline business where companies seek to optimize their internal value chain, *Microsoft* optimized its offering so that other companies, i.e., third-party software companies, could complement its own offering. Shifting value creation from the inside to the outside gave *Microsoft* Windows a competitive advantage in the years to follow, as numerous complementary software solutions were developed. The Windows platform was able to scale faster because *Microsoft* did not have to create all the competitive assets, such as complementary applications, but instead drew value from external resources (van Alstyne et al. 2016). This, in turn, benefited the adoption of Windows in the early years, making it the leading operating system—in turn, *Apple*'s operating system was left behind in the beginning, as they only opened up to external developers much later (Zhu and Iansiti 2019).

Although there are different perspectives on platforms, there are three characteristics that are fundamental to a platform business (Parker et al. 2016):

1. Platforms are intermediaries that bring two or more sides of a market (customer groups) together.
2. Platforms provide infrastructure and rules that facilitate transactions between the sides (transaction platforms like *eBay*) and/or enable innovation (innovation platforms like *Microsoft* Windows).
3. Platforms are based on network effects.

The value-adding interactions between two or more sides of a market could be of almost any sort. *Airbnb* is bringing hosts and travellers together to facilitate stays, *Amazon* is connecting sellers and buyers together to exchange products, and *Kickstarter* is linking investors and entrepreneurs together to exchange money and bring ideas to live. *WhatsApp* is bringing people together to exchange messages and photos, and *Apple* is bringing app developers and smartphone users together through their App Store.

While platforms can take many forms, network effects are core to platforms. They refer to the dynamic that "the more users who adopt the platform, the more valuable the platform becomes to the owner and to the users because of growing access to the network of users and often to a growing set of complementary innovations" (Gawer and Cusumano 2014). Due to a lack of network effects, many online stores, such as simple fashion online stores, are often incorrectly portrayed as platform businesses. Similarly, *Amazon* started as an online merchandiser selling books via an online shop and not as a platform business. It was only by transforming the online store to an open marketplace with third-party vendors joining that *Amazon* became the thriving platform we know of today.

Network effects are not only a distinguishing feature of any platform business but one of the features that make platform companies so successful (Rochet and Tirole 2003). However, there can also be negative network effects that should not be neglected. In general, network effects can be divided into direct and indirect effects (see Fig. 1).

Indirect network effects (1) refer to network effects between the different sides of the platform. The value for one side increases/decreases if an additional user from the other side joins the platform. For instance, in the case of *Amazon*, additional sellers lead to a larger product offering which attracts more buyers on the other side. Vice versa, more buyers lead to an increased demand which attracts additional sellers to join the platform. This re-enforcing dynamic is essential for all successful platform businesses. The example of

Fig. 1 Platform network effects, Parker et al. (2016)

Amazon also shows how positive network effects can turn into negative ones if the platform is not well managed. If too many sellers join the platform, at some point, buyers become overwhelmed by the unstructured offering leading to negative, indirect network effects.

In comparison, direct network effects (2) refer to the same side of the platform. The value for one user increases/decreases if an additional user from the same side joins the platform. For instance, in the case of *Amazon*, additional buyers lead to more reviews which, in turn, attract additional buyers onto the platform (positive, direct network effects). If you look at the other side of the platform, additional sellers intensify the competition in the long run, making it less attractive for new sellers to join the platform (negative, direct network effects).

Depending on the platform type as well as the competitive situation, network effects can generate so-called "winner-takes-it-all" platforms. Once the network has exceeded a certain threshold, it becomes enormously difficult for competitors to build a platform in the same segment. Due to the strength of the network, none of the sides would have an incentive to move from the existing to the new platform with the same offering but a weaker network. However, companies systematically overestimate their chances of creating a "winner-takes-it-all" platform. In fact, the platform economy can be characterized through a paradox: Everyone wants to create their own platform. However, network effects often do not unfold. This in turn is the reason why only a few platforms are highly successful and thousands of platform initiatives from corporates and start-ups fail.

2 Toward Platform Ecosystems

Platforms and ecosystems are closely related. But how do the concepts really relate to each other? Does a successful ecosystem need a platform or vice versa? While the term ecosystem has its origins in biology, the term was first coined in a business context by large corporations such as *Apple*, *Ford*, and *Walmart*, which began to build partnerships beyond industry boundaries. This ecosystem strategy gave them a competitive advantage in comparison to the "lone wolves" in the same market. *Apple* in its early days has been building an ecosystem with at least four industries: personal computers, consumer electronics, information, and communications. However, the early concept of the ecosystem was very broad and included various types of organizations, from suppliers to competitors to generic stakeholders (Iansiti and Levien 2004). The concept has since evolved, particularly in the context of digitization. An ecosystem can be characterized through the following three elements (Adner 2017):

1. **Common goal:** An ecosystem comprises multiple organizations working toward a common goal.
2. **Multi-lateral collaboration:** In an ecosystem, organizations collaborate and complement each other to achieve this common goal.
3. **Alignment:** The members of an ecosystem are independent but are being aligned by an orchestrator.
4. **Value proposition:** An ecosystem creates a superior or new value proposition for the customer through the aligned efforts.

An ecosystem distinguishes fundamentally from traditional business structures like hierarchical and market-based structures (Jacobides et al. 2018). In a hierarchical structure such as a traditional value network, the final product is determined by the central company. The central company can determine the suppliers and freely choose how their products are aggregated. This directly affects what and how the customer consumes. In comparison, an ecosystem allows suppliers to become complementors that equally face the end-customers. The consumer gets empowered and gets to choose what product(s) to combine and how to consume them. For instance, as an Android user, you can choose which complementary apps to install and combine on your smartphone—compared to the situation where *Google* would pre-define your smartphone with apps giving you no options. In a market-based structure, there is no alignment (complementarity) between the suppliers and customers can directly consume products from competing suppliers without any type of

intermediary (Jacobides et al. 2018). In comparison, in an ecosystem, an orchestrator aligns the different offerings through common standards or interfaces. Here the concepts "ecosystem" and "platform" are often used interchangeably. Platforms also offer means to establish a standard as a basis for complementary innovations.

1. ***Nespresso*'s ecosystem:** *Nespresso* was able to create an ecosystem including coffee, capsule producers, and coffee machine manufacturers. These products are naturally complementary and can only be consumed together (unique consumption). In addition, the manufacturers of the complementary products, for example, *Krups* coffee machine and *Dallmayr* coffee capsules, need to develop a special machine and comply with the *Nespresso* capsule standard. This alignment among the producers (unique production) makes *Nespresso* an ecosystem. In contrast, traditional coffee machine and coffee powder manufacturers do not constitute an ecosystem as they are so standardized that they can be produced without any coordination among producers. Other examples of ecosystems are the photovoltaic solar panel industry including panel producers, installation providers, racking producers, or the RunFlat technology for tires including car manufacturers, tire manufacturers, and garages.
2. ***Apple*'s platform ecosystem:** *Apple*'s smartphone operation system (iOS) and third-party applications is a platform ecosystem as it relies on network effects. The users' utility increases, the more applications are specifically developed for iOS (supermodular consumption). At the same time, it requires an alignment among the complementary producers (unique production). To align, *Apple* provides interfaces in form of software development kits (SDKs) upon which external developer can develop complementary applications. While *Apple* is in control, the app developers have some degree of autonomy. Another example is *Sony PlayStation* including third-party games.
3. ***Uber* and *eBay* are pure platforms:** Some platforms do not rely on an ecosystem and distinguish themselves from platform ecosystems. Although they rely on supermodular consumption and therefore gain network effects, production on platforms like *eBay* or *Uber* is very generic. This means there is almost no interdependency among the complementary products and the platform itself. Ultimately, for example, there is no need for coordination between different *eBay* sellers and the *eBay* platform itself. Sellers can just upload their products on *eBay* without the need to adjust specifically to the platform *eBay*. Furthermore, there is no need for sellers to coordinate with each other.

The above examples clearly illustrate how the concept of platforms and ecosystem overlap in practice. Nevertheless, the strategic priorities differ: In an ecosystem, the individual partners and the quality of their relationships play an important role. Platforms that are based on an ecosystem need to keep this in mind. They must also invest in the quality of individual partnerships. Transitioning from a platform ecosystem toward a pure platform, the individual partners and its complementary products become less important. Individual complementary products become interchangeable as the number of complementors is growing. Focusing on quantity instead of quality, the objective for a platform owner is to "grow the relevant sides of the market in order to increase value through direct and indirect network externalities" (Adner 2017). Here, the focus is on managing network effects instead of partnerships.

3 Toward Industrial IoT Platforms

To date, most of the leading platforms are consumer platforms that focus on digital value exchange. However, the platform economy is becoming increasingly important for the B2B segment and companies with a manufacturing background. One of the key enablers of this development is the Internet of Things.

The IoT does not refer to a product or a solution but can be seen as a phenomenon that depicts how technology makes it possible to connect physical products to the Internet. In essence, the IoT aims to connect the physical and digital world. It starts at the product level, where physical devices are equipped with software, sensors, and communication technology that allow products to connect to the Internet. Such smart, connected products enable different capabilities, from controlling and monitoring to product optimization and autonomy (Porter and Heppelmann 2014). However, the added value of IoT does not result from connectivity alone but from the many business opportunities that result from smart, connected products. Typically, the value add for the consumer or business is digital and a result of the analysis of data generated by the connected products and/or additional digital services (Fleisch et al. 2014).

Smart, connected products also enable companies to shift their focus from internal to external value creation. For instance, manufacturers who connect their products to the Internet can give external companies access to their product data to enable third-party analysis or digital services. Ultimately, smart, connected products open up possibilities for companies from adjacent

industries to collaborate (Iansiti and Lakhani 2014). This is also where platform, ecosystem, and the IoT converge (see Fig. 2).

In the agricultural segment, for instance, physical products like tractors are being exceedingly connected with the Internet. These smart, connected products allow farmers to better manage and monitor their fleet. Typically, this often starts as a rather closed system (stage 1). There is no extensive platform thinking involved at this stage as this is typically a single initiative by the original equipment manufacturer (OEM) of the tractor. However, as soon as other devices, for example, connected harvesters or fields, are included in this system, an ecosystem is emerging (stage 2). For instance, a farm equipment system is bringing data of different systems together. As a user, you only benefit if you use the products together. At the same time, the manufacturers of the different machines have to align to enable standardized data exchange. Once external companies are allowed to be integrated into this system to provide value-adding services, such as yield optimization analytics, an IoT platform ecosystem is emerging (stage 3). For instance, a farm management platform brings machine manufacturers with external service providers and farmers together. The more value-added services are on the platform, the more attractive it is for farmers to join the platform and vice versa.

The ability to connect devices to the Internet has created many opportunities for businesses to participate in the platform economy. The example of smart agriculture has already briefly illustrated how platform, ecosystem, and IoT are converging. In fact, many different IoT-based platforms are currently emerging. To illustrate the diversity of IoT platforms in practice, it makes sense to distinguish them on the basis of their intended aim: transaction platform, innovation platform, and integration platform (Cusumano et al. 2019).

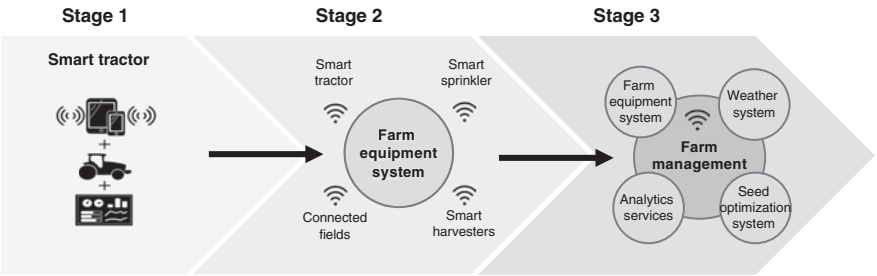

Fig. 2 The IoT shifting industry boundaries through platform thinking, Porter and Heppelmann (2014)

4 IoT Transaction Platforms like *Caruso*

Transaction platforms bring demand and supply sides together to exchange units of value. Many also refer to them as marketplaces (Cusumano et al. 2020). The unit of value can vary widely, ranging from physical to digital products and physical to digital services. One of the leading transaction platforms is Airbnb, where "stays" are exchanged as a core value unit. It brings apartment owners (supply side) together with people looking for temporary accommodation (demand side). By orchestrating external resources, i.e., empty apartments, *Airbnb* scaled very quickly. Although not owning any real estate, it has now become one of the leading companies in the travel industry with over seven million accommodations on its platform (Airbnb 2020). A common success factor for all transaction platforms—including *Airbnb*—is the ability to reduce transaction costs and offer consumers greater choice (Cusumano et al. 2020). But *Airbnb* also started small. Their strategy was to start in San Francisco and expand further once they had reached a critical mass in this local market. Other examples of leading transaction platforms are the *Amazon* marketplace, *eBay*, *Uber*, *WhatsApp*, and *Snapchat*.

In many industries, data is becoming a core resource for value creation in the future (Chen et al. 2014). IoT also contributes to this development by increasing the number of connected products and, thereby, producing valuable data. The transaction platform *Caruso* takes advantage of this development. Founded in 2017 as an industry-wide initiative, *Caruso* has become a marketplace for IoT-based mobility data (Caruso 2020a). It primarily connects automotive OEMs such as *BMW* or *Mercedes* with companies that want to utilize mobility data. This data can range from basic car information, e.g., battery and engine status, user-based data, e.g., mileage and location, to very specific data, e.g., crash data (Caruso 2020b).

This type of IoT marketplace can enable many new business opportunities (see Fig. 3). Traditionally, to offer driving-based insurances, insurance companies had to make bilateral agreements with all car OEMs to access their mobility data. Alternatively, they could install a retrofit solution in the insuree's cars to collect the data themselves. Both options are very costly and inefficient making driving-based insurance in many cases unprofitable. A marketplace like *Caruso* can reduce these transaction costs significantly and enable use cases that rely on data from various sources. Instead of making bilateral agreements, the insurance providers can directly access mobility data of all major OEMs through the marketplace.

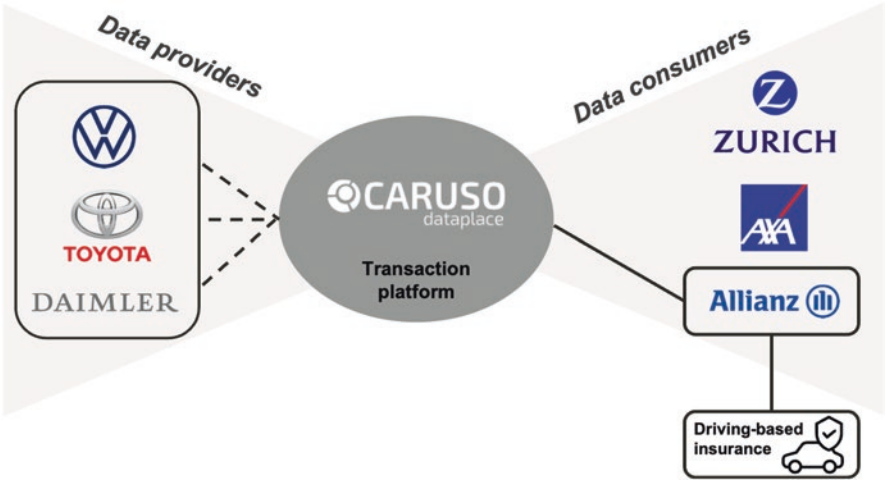

Fig. 3 Illustration of a potential use case for *Caruso*, a marketplace for IoT mobility data, author's own illustration

However, network effects are necessary for *Caruso*'s business model to work. Similar to *Airbnb*, the value for data consumers, e.g., insurance company, increases with the number of data providers, e.g., car OEMs. Hence, *Caruso* needs to provide strong incentives for OEMs to join its platform as data providers and to share their (sensitive) mobility data. On the other side of the platform, *Caruso* tries to attract companies that need data for providing value-adding analyses and services. To realize these positive, indirect network effects, *Caruso* relies heavily on standardization and scaling. *Caruso*'s strategy is to focus initially on flagship data providers, such as large OEMs, who, in turn, encourage data consumers to join the platform. Data consumers are additionally incentivized by free offers, e.g., free access for 3 months during the prototyping phase. Afterwards—borrowed from the consumer segment—*Caruso* tries to sell "data subscriptions" (Caruso 2020c).

Although *Caruso* is (so far) limited to mobility data, this type of marketplace for IoT data will play an increasingly important role in the future. In a world where data is becoming a key asset, such a marketplace can facilitate new business models. It can make this valuable and sensitive resource available to smaller actors and share it between producers, complementors, and end-consumers. Nevertheless, one must not forget how difficult it is to coordinate the various parties involved to exchange and use (each other's) data. This also illustrates the relevance of ecosystem thinking in the *Caruso* context, i.e., aligning and coordinating the producers of complementary products. It

is, therefore, no wonder that *Caruso* is not a stand-alone company, but a consortium that began as an industry-wide initiative. Moreover, *Caruso* is still in its infancy, and its future success cannot be taken for granted.

5 IoT Innovation Platforms like *Bosch* IoT Suite

Innovation platforms are "products, services, or technologies developed by one or more firms, and which serve as foundations upon which a larger number of firms can build further complementary innovations" (Gawer and Cusumano 2014). One of the leading innovation platforms is the *Apple* operating system for computers (macOS). The operating system forms the basis on which external companies can develop complementary applications. *Apple* tries to orchestrate this innovation by offering standardized interfaces such as SDKs that support external companies in developing these complementary applications such as *Microsoft* Office. The value and network effect on an innovation platform result from the complementary innovation. The more applications there are, the higher the quality and benefit for the users. This increases the willingness for new users to join the platform, i.e., to buy a notebook with the Macintosh operating system. Vice versa, if more consumers are joining the platform, more software developers are attracted to develop complementary software. Typically, most innovation platforms converge with ecosystems. It is no wonder that further examples of innovation platforms are *Apple* iOS, *Firefox*, *Microsoft* Windows, and *Sony PlayStation*.

In the IoT, platforms cannot only serve as transaction intermediaries, as in the *Caruso* example. They can also offer manufacturers of devices the technology, in form of an innovation platform, to connect their devices to the Internet (see Fig. 4). With the connectivity of the devices, complementary applications, similar to the *Apple* operating system, can be developed. The *Bosch* IoT Suite is a good example for such a case. In its core, it provides software for manufacturers of devices to connect their physical devices with the Internet, collect data, and run analyses (Bosch.IO 2020a). This enables them to monitor and improve their products and services as well as build complementary innovation on top of the IoT platform.

The *Bosch* IoT Suite is based on open source software (Eclipse Foundation 2020) and provides, just like macOS, a basis for external developers to efficiently implement IoT applications. Similar to *Apple*, the more developers join the platform, the more applications are created. This, in turn, increases the benefits for the manufacturers of devices and their motivation to join the innovation platform, i.e., to purchase and integrate the IoT Suite. Vice versa,

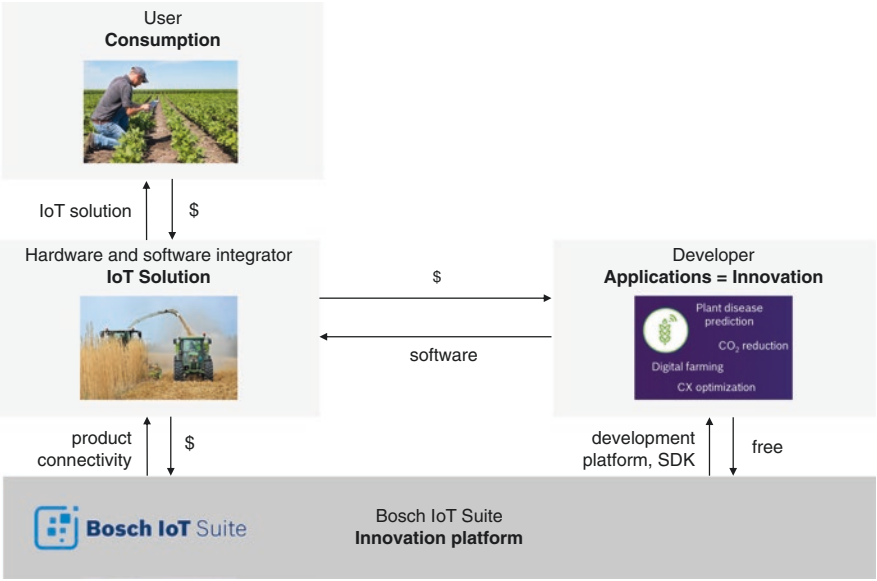

Fig. 4 Illustration of the *Bosch* IoT Suite, an IoT innovation platform, author's own illustration

the more IoT Suite users there are, the more developers are attracted. Also, data can be considered an additional driver of network effects in this cycle (Falk and Riemensperger 2019). The more data is generated via products connected through the *Bosch* IoT Suite, the more attractive it is for the developer to join this platform to develop complementary applications on the basis of existing data assets instead of joining a competitive IoT platform (see also chapter "Bosch IoT Suite: Exploiting the Potential of Smart Connected Products" for the *Bosch* IoT Suite).

Often, network effects known from consumer-based platforms like *Apple* iOS are not as strong in the case of B2B. Reasons are the heterogeneity of the user side, i.e., B2B companies, and the increased complexity for external developers to create complementary applications. Therefore, IoT innovation platforms like the *Bosch* IoT Suite try to provide an additional value with stand-alone applications. Instead of fully relying on complementary applications from the outside, *Bosch*, for instance, offers IoT solutions for different industries itself (Bosch.IO 2020b). This approach is also known in the consumer domain. *Apple*, for example, also providers its own macOS office suite with Keynote, Pages, and Numbers.

6 IoT Integration Platforms like *SAST*

Integration platforms combine a transaction and innovation platform. Thus, they are often referred to as a hybrid platform (Cusumano et al. 2020). *Apple* with its iPhone operating system (iOS) and the App Store can be regarded as one of the most successful integration platforms. On the one hand, *Apple* offers companies and individuals free SDKs to develop complementary applications (innovation platform). In fact, the iOS operating system has become the foundation for over four million complementary applications (Statista 2020). On the other hand, *Apple* brings app developers and users together via the App Store (transaction platform) to exchange apps. This has led to very strong indirect network effects between the two sides of developers and users. Other examples of successful integration platforms are *Salesforce*, *Google Play*, and *Facebook* with its SDKs.

While integration platforms have not yet become mainstream in IoT, there are promising ventures that bring innovation and transaction platform together. One example is *Security and Safety Things (SAST)*—a German-based start-up that has gone live at the beginning of 2020 (SAST 2020b). Its vision is—similar to *Google*—to create an app-store but for IoT-based security camera systems in the B2B segment. Based on the Android Open Source Project (AOSP), they have developed an operating system (see Fig. 5). Manufacturers of security cameras can integrate this OS into their smart, connected devices. *SAST* provides SDKs for its operating system so that external developers can create complementary applications for security systems (innovation platform). Furthermore, *SAST* provides a marketplace (transaction platform) for the developed security camera apps. Users or integrators of security cameras running *SAST* OS can easily download applications from this marketplace—in an *Apple* App Store kind of way—and add functionality to their surveillance camera. An exemplary B2B customer with a particularly high need for security is an airport. By purchasing hardware that runs on *SAST* OS, an airport could continuously improve the functionalities of its security cameras and adapt to changing legal requirements. A concrete application example could be AI-based baggage tracking of the owner in case of misplaced baggage on the airport premise or adding ad hoc functions like video-tracking of proper mask protection in the context of the Corona crisis (SAST 2020a).

However, for its vision to work, *SAST* must convince three sides: (1) the hardware manufacturers to implement their OS, (2) the application developers to use their SDKs, and (3) the customers to purchase *SAST* supported hardware. The current strategy is to bring many key market players on board

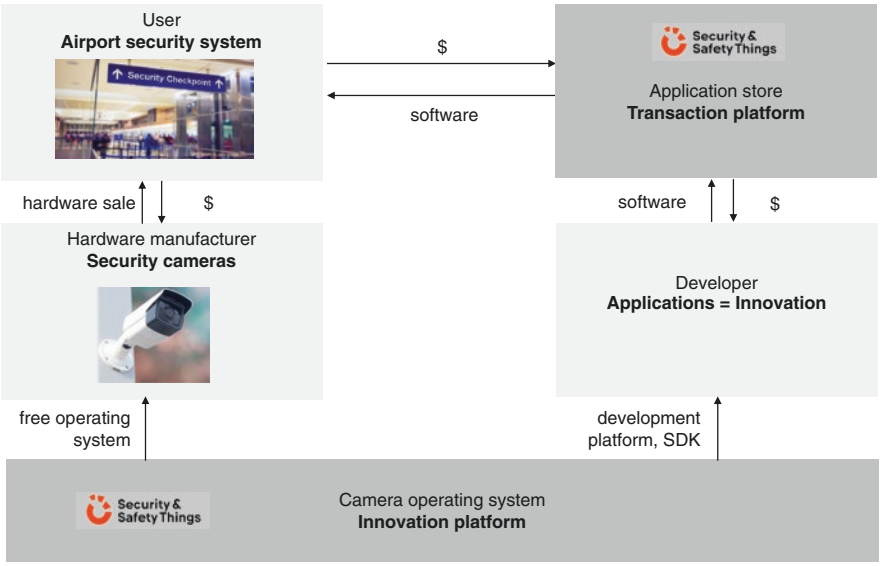

Fig. 5 Illustration of *SAST*, an IoT innovation platform and app store for security cameras, author's own illustration

to attract application developers to join as well. The offer of free SDKs and an initial demand will help to motivate application developers to participate. Recently—similar to the Android developer challenge in 2008—*SAST* launched a challenge with a 3× EUR 10,000 prize money for the best application (Bartlett 2020). To not inhibit the growth of network effects, *SAST* only charges a transaction fee for the purchase of applications—similar to the Apple App Store.

The indirect network effects of *SAST* can become quite strong as there are three sides. Essentially, if there are more manufactures (1) on the platform, more hardware runs on *SAST* OS which will attract more app developers and more users will potentially buy the hardware. If there are more developers (2), more complementary applications are built which, in turn, will attract more users and manufactures; if the user base is increasing (3), it becomes more attractive for additional manufacturers and app developers to join. However, having launched in 2020, the success of the platform has yet to be demonstrated. Nevertheless, the *SAST* application store already features—a couple of months after launching—72 applications for various use cases in different domains (SAST 2020a). The applications range from AI-based intrusion detection for commercial buildings, customer tracking for retail, privacy filters for airports, or livestock counting in agriculture.

7 Learnings from Building Platforms

The three examples illustrate that platforms in the IoT are particularly useful for making use of data and for enabling value-adding services. In fact, across the three platform types (transaction, innovation, and integration), IoT platforms (ecosystems) are becoming increasingly important. However, they also face unique challenges, in particular, compared to pure digital platforms in B2C, for instance.

Due to the nature of IoT, there is always hardware involved. Hence, platform owners have to understand the underlying physical products and their characteristics very well. For instance, *Caruso* has to deal with the "car" as the main source of shared mobility data. The *Bosch* IoT Suite has to deal with a variety of physical devices with different characteristics, from home appliances to special vehicle manufactures, and *SAST* has to understand security cameras and systems. Only in rare cases are platform owners also hardware manufacturers and can therefore already rely on their domain knowledge.

Due to the hardware component and heterogeneity of users, IoT platforms also do not scale as quickly, and network effects on IoT platforms tend to be weaker, especially compared to purely digital platforms like *Airbnb* or *WhatsApp*. On the other hand, data is given a very high priority. It is not just a unit of value exchanged over a platform, such as in the case of *Caruso*. It can also create opportunities for building new platforms, e.g., *Bosch* IoT Suite and *SAST*. In addition, data is becoming a major driver for network effects. In fact, network effects on IoT platforms depend not only on the growth of the two sides of the market but also on the data, as a result of the devices connected, to which the platform has access.

As platforms, ecosystems, and the IoT are converging, one has to think about the implications for their own business. A deeper look at the topic also shows that platforms oftentimes fail. Instead of joining forces with an existing platform to accelerate its network effects and to become the dominating platform, many companies try to establish their own platform leading to a situation where no platform can become successful. We, therefore, want to highlight ten success factors for developing platforms:

1. **Understand the fundamentals of (your) platform business:** Is it really a platform business you are aiming for? What are the network effects and how can you manage them? Or is it an internal technology platform? Regardless of your decision, it is important to fully understand the dynamics and consequences of the transformation from a pipeline to a platform business—even if you are not a platform owner but "only" a complementor.

2. **Do not reinvent the wheel but learn from existing platforms:** Many successful platform businesses have evolved. Utilize existing business model patterns to imitate or adjust them for the sake of your own business model. In particular, brainstorm about what the "core value" and "core transaction" should look like and how each platform participant could benefit from the platform.
3. **Consider all strategic paths in the platform economy:** Start with an initial analysis of your industry: Are there platforms in your industry—or in adjacent industries—with the potential to disrupt your business? Are there chances to develop an own platform for your business? Depending on the industry and competitive situation, think about participating as a complementor or as a co-owner. Keep in mind that it does not necessarily always make sense for a company to build its own platform and to become the orchestrator.
4. **Strictly focus on the customer journey:** What are the gains and pains of the customer? What are the explicit and hidden requirements of customers and participating partners to join the platform? Users only lock in on a platform if they can expect a superior value proposition. If there is no such promise or if it is not fulfilled, the platform will become a zombie: not enough alive to grow and flower.
5. **Differentiate between the purpose of a platform:** Platforms are not just platforms. It is often oversimplified when success factors for platforms are summarized. Instead, it makes sense to distinguish according to the different platform function: Is it a transaction, innovation, or integration platform? Transaction platforms should be easy and convenient; innovation platforms should offer an attractive development environment and carefully design their openness, e.g., through APIs and SDKs.
6. **Think early about how you can address common challenges of platforms:** Although most challenges are well recognized in theory, history shows that platforms often fail for obvious reasons. It is important to early think about how to address common challenges. In particular, a strategy is needed on how to build network effects, i.e., how to overcome the chicken-and-egg problem, and how your platform can be successfully monetized in the long run.
7. **Monitor and manage your platform growth closely:** To establish a sustainable platform business, it is not enough to simply track traditional financial KPIs such as revenue. Especially at the beginning it is important to closely track network effects as a key growth driver, e.g., via interaction quality or number of users. The most successful platform companies go even further and carefully monitor and manage negative network effects. They should not be neglected, as they can potentially lead to a negative

vicious circle, e.g., if fraud or an information overload makes the platform increasingly unattractive.

8. **Think big but prove yourself in a micro-market:** Since all platforms depend on network effects, a platform idea must have the potential to generate strong network effects. At the same time, a business idea should prove itself already as a prototype or in a small market. Most successful platforms took advantage of this thinking and started in micro-markets, with a geographical and/or product focus, and continued to expand from there once a critical mass had been reached.
9. **Think both ecosystem and platform—especially for IoT:** At some point in time, to innovate, most of the successful platforms have expanded into adjacent industries, e.g., Apple moving into the health segment or Tencent moving into the payment segment. To achieve this mission, they are aiming to build strong ecosystems. Since IoT has become very diverse and complex, specific domain knowledge is often needed. It is therefore important to also align with other companies in order to realize one common value proposition in your IoT platform ecosystem.
10. **Know the underlying dynamics when dealing with IoT platforms:** Compared to digital platforms, IoT platforms always rely on devices. To create a successful platform in the IoT, one must, therefore, fully understand the underlying product(s)—especially if one is not a manufacturer of the same devices. They also do not rely as much on network effects. IoT platforms, therefore, bring more stand-alone value to the platform. In addition, the role of data in IoT platforms, as a resource and a driver for network effects, needs to be clearly understood. This comes with both challenges, such as privacy and security concerns, but also many opportunities for building novel platform business.

Success Factors for Developing Platforms

- Understand the fundamentals of (your) platform business.
- Do not reinvent the wheel but learn from existing platforms.
- Consider all strategic paths in the platform economy.
- Strictly focus on the customer journey.
- Differentiate between the purpose of a platform: transaction, innovation, and integration.
- Think early about how you can address common challenges of platforms.
- Monitor and manage your platform growth closely.
- Think big but prove yourself in a micro-market.
- Think both ecosystem and platform—especially for industrial IoT.
- Learn about the underlying dynamics when dealing with IoT platforms.

References

Adner R (2017) Ecosystem as structure. J Manag 43(1):39–58
Airbnb (2020) About us. https://news.airbnb.com/about-us/. Accessed 1 Sept 2020
Bartlett, J (2020) Security and Safety things opens app challenge for developers. Security.World. https://security.world/security-and-safety-things-opens-app-challenge-for-developers/. Accessed 18 Apr 2020
Bosch.IO (2020a) Bosch IoT Suite service catalog. https://developer.bosch-iot-suite.com/service-catalog/. Accessed 1 Sept 2020
Bosch.IO (2020b) IoT use cases powered by AI. https://bosch.io/use-cases/. Accessed 1 Sept 2020
Caruso (2020a) Discover who we are and what we stand for. https://www.caruso-dataplace.com/about/#shareholder. Accessed 1 Sept 2020
Caruso (2020b) Success stories. https://www.caruso-dataplace.com/success-stories/. Accessed 1 Sept 2020
Caruso (2020c) Tailored pricing. https://www.caruso-dataplace.com/pricing/. Accessed 1 Sept 2020
Chen M, Mao S, Liu Y (2014) Big data: a survey. Mobile Netw Appl 19(2):171–209
Cusumano MA, Gawer A, Yoffie DB (2019) The business of platforms: strategy in the age of digital competition, innovation, and power. Harper Business
Cusumano MA, Yoffie DB, Gawer A (2020) The future of platforms. Sloan Manag Rev 61(3):46–54
Eclipse Foundation (2020) Eclipse Hono. https://projects.eclipse.org/projects/iot.hono. Accessed 1 Sept 2020
Falk S, Riemensperger F (2019) Three lessons from Germany's platform economy. MIT Sloan Manag Front. https://sloanreview.mit.edu/article/three-lessons-from-germanys-platform-economy/. Accessed 1 Sept 2020
Fleisch E, Weinberger M, Wortmann F (2014) Geschäftsmodelle im Internet der Dinge. HMD Praxis Der Wirtschaftsinformatik 51:812–826
Gawer A, Cusumano MA (2014) Industry platforms and ecosystem innovation. J Prod Innov Manag 31(3):417–433
Iansiti M, Lakhani KR (2014) Digital ubiquity How connections, sensors, and data are revolutionizing business. Harv Bus Rev 92(11)
Iansiti M, Levien R (2004) Strategy as ecology. Harv Bus Rev 82(3):68–72
Jacobides MG, Cennamo C, Gawer A (2018) Towards a theory of ecosystems. Strateg Manag J 39(8):2255–2276
Parker G, Van Alstyne M, Choudary SP (2016) Platform revolution. W.W. Norton, New York
Porter ME, Heppelmann JE (2014) Smart, connected products are transforming competition. Harv Bus Rev 92(11):64–88

Price Waterhouse Coopers (2020) Global top 100 companies by market capitalisation. https://www.pwc.com/gx/en/audit-services/publications/assets/global-top-100-companies-june-2020-update.pdf. Accessed 8 Sept 2020

Rochet JC, Tirole J (2003) Platform competition in two-sided markets. J Eur Econ Assoc 1(4):990–1029

SAST (2020a) Application store. https://store.securityandsafetythings.com/shop/catalog/c/main. Accessed 1 Sept 2020

SAST (2020b) Security and safety things brings growing IoT platform for security cameras to CES 2020. https://www.securityandsafetythings.com/news/press-release-january-2020. Accessed 7 Jan 2020

Statista (2020) Number of active apps from the Apple App Store 2008-2020. https://www.statista.com/statistics/268251/number-of-apps-in-the-itunes-app-store-since-2008/. Accessed 1 Sept 2020

van Alstyne MW, Parker G, Choudary SP (2016) Pipelines, platforms, and the new rules of strategy. Harv Bus Rev 94(4):54–62

Zhu F, Iansiti M (2019) Why some platforms thrive and others don't. Harv Bus Rev 97(1):118–125

Sven Jung is a PhD candidate at the Institute of Technology Management at the University of St. Gallen. He is part of the Bosch IoT Lab, a cooperation between the Bosch Group, University of St. Gallen and ETH Zurich, where he investigates (IoT) platform strategies and platform business models. Sven holds a Master's degree in Finance and Strategic Management from Copenhagen Business School and a Bachelor's degree in Business Administration from the University of St. Gallen. During his studies, he worked for a leading management consultancy, a biotech start-up and an investment bank advising technology start-ups.

Felix Wortmann, Prof. Dr., is Assistant Professor of Technology Management at the University of St. Gallen. He is also the Scientific Director of the Bosch IoT Lab, a cooperation between the Bosch Group, University of St. Gallen, and ETH Zurich. Felix Wortmann has published more than 100 publications and is among the top 5% of all scientists in business administration in the German-speaking countries (Wirtschaftswoche 2019). His research interests include the Internet of Things, machine learning, blockchain, and business model innovation in manufacturing, mobility, healthcare, and energy. From 2006 to 2009 he worked as an assistant to the executive board of SAP. After studying information systems, Felix Wortmann received his PhD in Management from the University of St. Gallen in 2006.

Wolfgang Bronner, Dr., is managing director of the Bosch IoT Lab, a cooperation between the Bosch Group, University of St. Gallen, and ETH Zurich. This lab is particularly dedicated on the Internet of Things, Data Science, and Business Model Innovation. Wolfgang Bronner had his first insight into the high-tech industry as a student at IBM in Silicon Valley. He has been working as an expert and manager in various industries and functions at Bosch in Germany and the USA since 2002. In his last position, he analyzed the impact of the most significant future technologies such as AI on Bosch, derived strategic recommendations, and discussed them with the executive management. He received his PhD in physics from the University of Stuttgart in 2003.

Oliver Gassmann, Prof. Dr., is Professor for Technology Management at the University of St. Gallen and Director of the Institute of Technology Management since 2002. His research focus lies on patterns and success factors of innovation. He has been visiting faculty at Berkeley (2007), Stanford (2012), and Harvard (2016). Prior to his academic career, Gassmann was the head of corporate research at Schindler. His more than 400 publications are highly cited; his book *The Business Model Navigator* became a global bestseller. He received the Scholarly Impact Award of the Journal of Management in 2014. He founded several spin-offs, is member of several boards of directors, like Zühlke, and is an internationally recognized keynote speaker.