Capturing Value in the Internet of Things

The Internet of Things (IoT) promises to deliver enormous business value. More specifically, IoT solutions disrupt existing business models by opening up novel service opportunities. In order to help companies understand the opportunities and challenges of this development, we shed light on different IoT revenue models. Based on an inductive case study approach, we identify nine direct and indirect revenue patterns. The different types of revenue patterns all use IoT-enabled services to create value for customers; the extent and the monetization of services, however, vary.

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In view of unexploited service opportunities, more and more companies recognize the Internet of Things (IoT) as a game changer within their industries. IoT represents the vision that every object and location in the physical world can become part of the Internet (Iansiti & Lakhani, 2014). More specifically, Porter, and Heppelmann (2015) argue that the key novelty of IoT solutions lies in "the changed nature of the things", including their connectivity and the digital services they ultimately facilitate. Hence, IoT is regarded as the next wave of digitalization and IoT solutions are supposed to disrupt existing business models.

In light of these developments, the present paper identifies different IoT revenue models. We also uncover the role of IoT-enabled services, i.e., whether these services are really monetized or just provided for free to fuel physical good sales. Based on 32 case studies, we identify nine distinct revenue patterns. The different patterns all use IoT-enabled services to create value for customers; however, value capturing varies.

Value Creation in the IoT

IoT offers combine the physical world with the digital world. Consequently, various layers determine value creation in the IoT, as summarized in figure 1 (Fleisch, Weinberger, & Wortmann, 2015). At a very abstract level, the value of an IoT solution can be reduced to a simple formula: thing + IT = thing-based functionality + IT-based service. The potential of such a hybrid value proposition and the growing number of connected objects cause more and more companies to recognize IoT as a potential game changer. For the upcoming years, exponential growth rates are forecasted for the number of smart devices and the IoT market size in total (Bain & Company, 2018).

When it comes to understanding IoT revenue patterns, value capturing, value creation and value delivery can be distinguished (Amit & Zott, 2012). Hence, each IoT revenue model can be characterized by the locus of value creation (physical vs. digital) and the type of value delivery (product vs. service). Thus, the revenue model framework displayed in figure 2 distinguishes four distinct revenue streams represented by physical product, digital product, physical service and digital service. Providers of IoT solutions have to actively design their revenue models to capture value, as there is an important difference between potential revenue streams ("might be monetized") and actual revenue streams ("are monetized"). The color scheme indicates whether a specific IoT solution element is monetized (green) or offered for free (white).

Data Collection and Analysis

We followed an inductive approach to identify different IoT revenue model patterns, applying the revenue model framework in figure 2. We selected the sample based on industry reports, IoT market landscapes, and our first-hand experience with several IoT companies. Since a single company can offer multiple IoT offerings with different revenue mechanics, we allowed for more than one case per company and analyzed a sample of 32 different cases. To make use of data triangulation, interviews were conducted in addition

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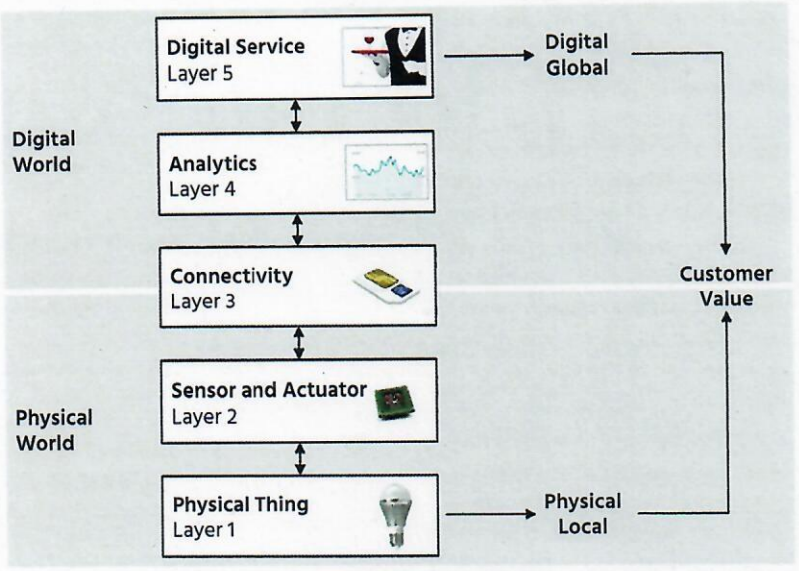
Fig. 1: Value Creation in the IoT



Source: Own Illustration.

to secondary data sources (e.g., websites, internal documents). All cases were analyzed with reference to the revenue model framework by means of a structured qualitative content analysis (Eisenhardt, 1989). To increase the validity of the results, the obtained revenue patterns were subsequently discussed with experts from the respective companies.

IoT Revenue Patterns

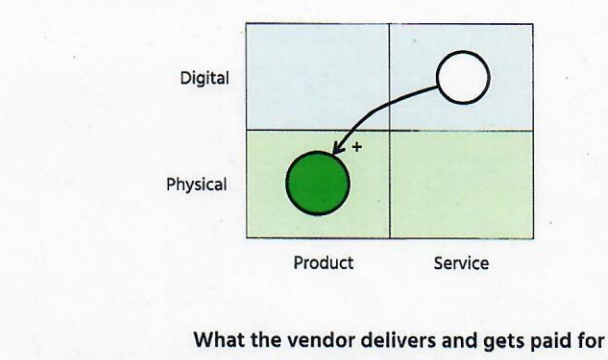
Revenue models are often grouped into direct revenue models (i.e., two parties involved) and indirect revenue models (i.e., ecosystems that involve more than two parties). Similarly, we identified direct and indirect IoT revenue patterns (see figures 3 and 4). In direct single stream patterns there is only one source of revenue, and thus only one potential revenue stream is monetized. However, some companies use more than one direct revenue stream to monetize their IoT offerings (direct dual stream patterns). Our sample also revealed monetization mechanisms that go beyond a pure user–provider relationship (indirect patterns). All identified patterns are described in detail in the following.

Direct Single Stream Patterns (SSP)

Physical product (SSP-1). The first IoT revenue model pattern utilizes the physical product for the single revenue stream. For example, the Dutch technology company Philips sells a smart light bulb for $160* and additionally provides digital services such as geofencing or alerts for free. According to this pattern, the vendor receives a one-time payment for its hardware while additionally offering digital services for free. The latter are not monetized but improve the selling proposition, thus enabling the company to realize significantly higher prices for the physical product. While a set of three traditional, dimmable LED lamps sold by Philips costs around $30*, a Philips Hue starter kit costs $160*. In comparison to standard Philips LED lamps, this equals an increase of 433%. This is the dominating IoT revenue model pattern observed in the present study.

Hardware as a Service (SSP-2). The second single stream pattern observed in our sample is hardware as a

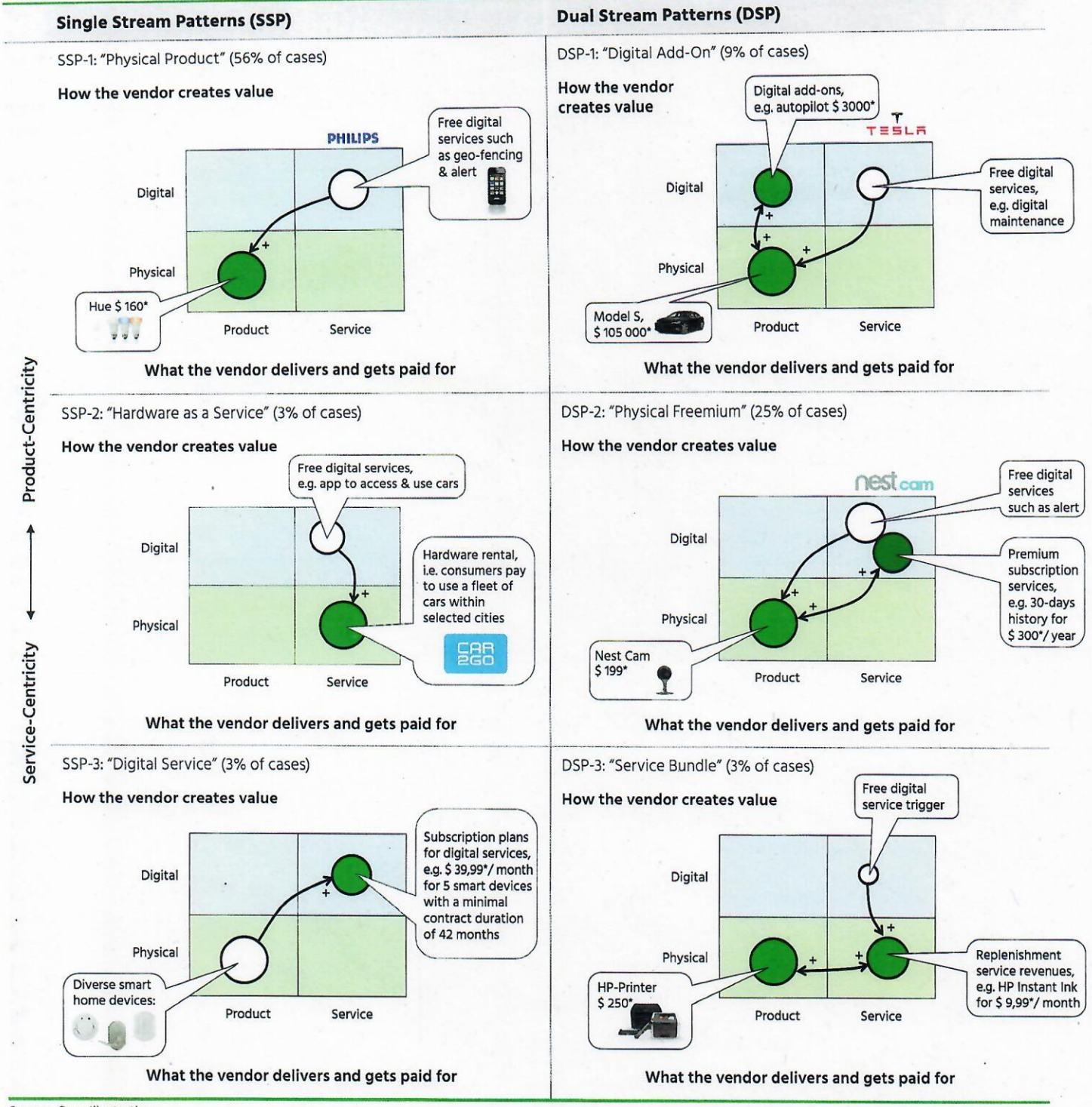
Fig. 2: IoT Revenue Model Framework



Source: Own Illustration.

* All prices are based on a study conducted in 2016

Fig. 3: Direct IoT Revenue Patterns



Source: Own Illustration.

service. A prominent example is the car-sharing service car2go. This program, which started as a collaboration of Daimler and Europcar and is now part of ShareNow, a joint venture of BMW and Daimler, offers customers the possibility to use a fleet of cars in selected cities leveraging their smartphones and an app provided for free to access and use the cars. In comparison to traditional car rental, this type of car sharing is not related to any fixed station and relies on digital services. Customers pay according to their usage time when they drive, resulting in recurring revenues for the vendors. In essence, applying the pattern hardware as a service, the vendor offers physical products for rent while offering corresponding digital services for free.

Digital Service (SSP-3). The third pattern focuses on digital service as the single revenue stream. The only example in our sample that applies this single stream pattern is Vivint, a U.S.-based smart home provider that received $100* million in funding from tech investor Peter Thiel. The smart home solution offered by Vivint consists of physical products (a variety of smart home hardware devices) accompanied by digital services (e.g. remote control or video recording). Vivint actively promotes its solution as a digital service offer with no hardware-related payments on the basis of slogans such as "free equipment". In order to cover the initial hardware costs, there is a minimum service contract duration with recurring service payments of 42 months. In essence, by applying the pattern digital service the vendor provides hardware for free, while financing both digital services and physical products through recurring service payments.

Direct Dual Stream Patterns (DSP)

Digital Add-On (DSP-1). The dual stream pattern digital add-on, depicted in figure 6 below, refers to a combination of the two revenue streams physical product and digital product. One of the most prominent examples of this revenue model pattern is Tesla with its Model S and the autopilot functionality. The US-based electronic car manufacturer sells electric cars (physical product) such as its Model S for over $100,000*, while additionally offering digital products, such as "autopilot convenience features" (digital product) for additional $3,000*. In this context it is not important whether the digital product is offered directly along with the physical product (i.e., the car and the autopilot in one package) or alternatively at a later stage in the after-sales phase. Any additional digital services that may be offered for free, such as digital remote monitoring and control, are not the decisive factor defining the core logic of this dual stream pattern.

Physical Freemium (DSP-2). The dual stream pattern physical freemium combines the two revenue streams physical product and digital service. In the case of Nest Cam, for example, Nest sells a security camera (physical product) for $199*. In addition to the hardware, the company offers a free package of digital services such as alarm notification or live remote surveillance. However, two different premium subscription plans ($100* or $300* per year) for more advanced services are

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Management Summary

Product-oriented companies have traditionally relied on simple, direct monetization approaches that will be challenged in the realm of IoT. As of today, physical products are usually sold directly at a certain sales price or offered through leasing. IoT solutions comprise at least one physical and one digital component. This results in an additional complexity in monetization, since not every component has to be charged separately and bundling strategies might be applied. Hence, numerous monetization options are possible, and a revenue model must be actively developed. In light of these developments, this paper identifies different IoT revenue models. Based on 32 case studies, we identify nine distinct revenue patterns. The different patterns all use IoT-enabled services to create value for customers; however, value capturing varies between patterns.

also offered. For example, a video history of either 10 or 30 days is provided on the basis of a monthly or yearly subscription plan. 25 percent of all cases in our study applied this pattern, mostly in the two IoT market segments smart home and mobility.

Service Bundle (DSP-3). Finally, the two revenue streams physical product and physical service can be utilized in the context of the dual stream pattern service bundle. HP, for example, sells printers for a one-time payment and additionally offers a replenishment service for ink cartridges. The service called "HP Instant Ink", available with three different monthly subscription plans, includes free shipment and replenishment of ink cartridges for a predefined monthly fee. A free digital service trigger permanently monitors ink consumption and initiates the automatic replenishment. The digital service itself is free of charge. Instead, the replenishment service – with ink cartridge delivery at its core – is monetized.

Main Propositions

1. IoT solutions comprise at least one physical and one digital component and hence open up numerous monetization opportunities.
2. Each IoT revenue model can be characterized by the locus of value creation (physical vs. digital) and the type of value delivery (product vs. service).
3. Hence, four distinct revenue streams can be distinguished, i.e. physical product, digital product, physical service, and digital service.
4. Designing a revenue model is about identifying potential revenue streams that might be monetized and ultimately deciding which revenue streams are actually to be monetized.

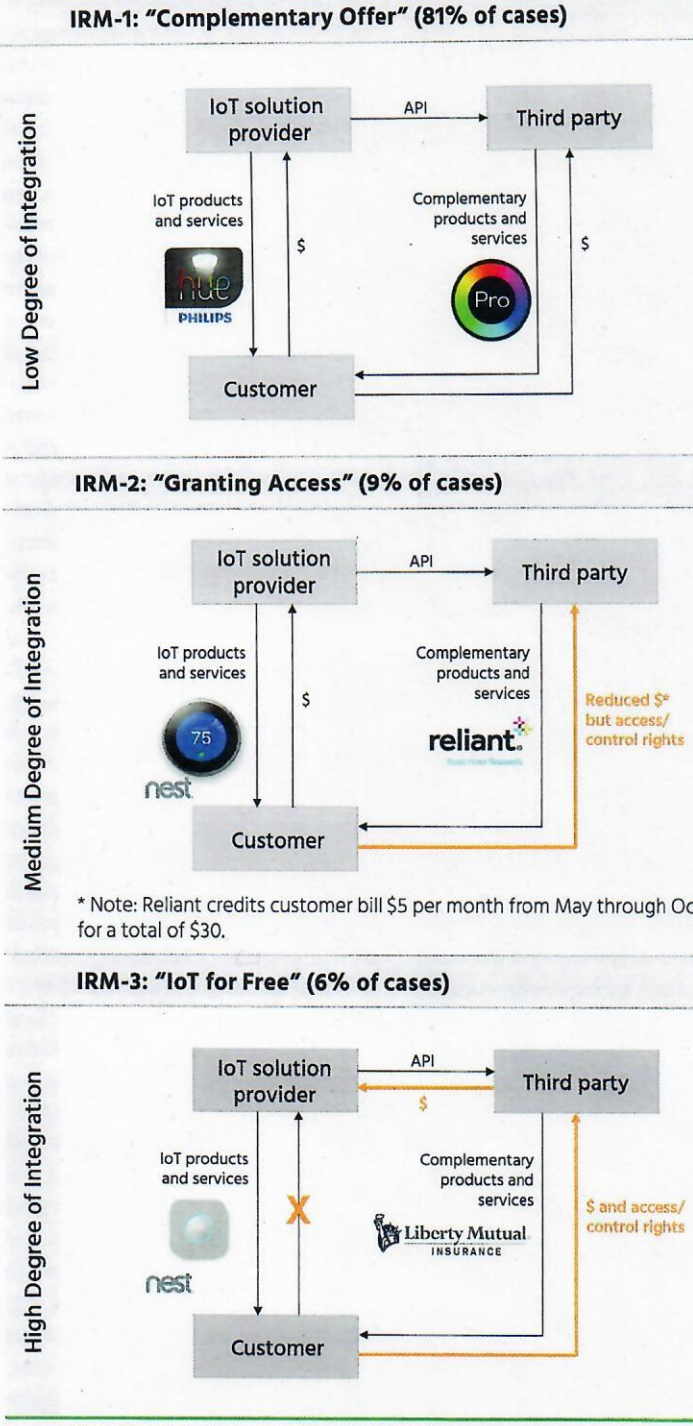
Indirect Revenue Models (IRM)

Complementary Offer (IRM-1). The IoT ecosystem pattern named complementary offer describes an IoT solution accompanied by complementary products or services offered by third parties. Referring back to the example of Philips Hue, Philips offers smart light bulbs in exchange for one-time payments together with a free app from Philips to control the system. Thus, Philips applies the IoT revenue model physical product. Simultaneously, as an IoT solution provider it also offers API access to third parties, enabling them to develop their own complementary apps around the Philips Hue product portfolio. One example of such a third party app is "Hue Pro". This very popular app shows significantly better ratings in the Google Play Store than the original Philips app, even though "Hue Pro" costs $1* and engenders in-app purchases of up to $18*. Overall, the complementary offer increases the value proposition of Philips' smart home system, creating a win-win-win situation for the IoT solution provider, third parties, and the customer.

Granting Access (IRM-2). In this IoT ecosystem pattern, named granting access, third parties are allowed to monitor and even control IoT devices in exchange for monetary incentives. From the launch of its offering, Nest has applied the revenue pattern physical product for its thermostat. More specifically, Nest has sold its thermostat for a one-time payment of $250* while providing free digital services such as remote temperature control. At the same time, Nest has allowed utility companies such as Reliant Energy to offer their customers special utility contracts based on the Nest Thermostat and its API. Utility companies are often challenged by high electricity consumption during specific peak hours, e.g. when many people use their air conditioning at the same time during hot summer months. These peaks usually cannot be covered by relatively cheap energy, if they can be covered at all. Thus, in exchange for control rights to increase individual household temperature during peak hours (maximum of three degrees), Reliant offered customers reduced monthly fees (i.e. a discount of $5* per month).

IoT for free (IRM-3). Finally, the IoT ecosystem pattern IoT for free is applied by Nest with its smart smoke detector "Nest Protect". Nest supplies its customers with smoke detectors, but instead of receiving money from the customer, an insurance company such as Liberty Mutual pays for the physical product. In addition, Liberty Mutual offers its customers special insurance contracts with reduced fees. All these benefits are offered by the insurance company in exchange for the right to continuously check whether the Nest smoke detector is turned on and running failure-free. In this way, the insurance company intends to minimize the risk of fire-related damage events and respective claims. This IoT ecosystem pattern shows a radical difference to the previously discussed patterns: Customers can use IoT solutions for free. With a single innovative market player applying the IoT for free strategy, it becomes very difficult for other providers

Fig. 4: Indirect IoT Revenue Models (IRM)



* Note: Reliant credits customer bill $5 per month from May through October, for a total of $30.

Note: Not all the examined cases offer an API and make use of indirect IoT revenue models.
Source: Own Illustration.

to sell competing IoT solutions at a profitable price point.

It should be noted that these three IoT ecosystem patterns show different degrees of stakeholder integration and complexity. The first pattern involves only a loose coupling of the involved stakeholders. The IoT solution provider offers APIs to enable third parties to build services and products around the core IoT solution. Consequently, such an ecosystem is easy to implement and currently the most popular one. A large majority of the cases in our sample offer some sort of API and thus could establish a developer community or make use of network effects. The more complex the IoT ecosystem patterns become, the greater the degree of integration of the involved stakeholders, and the more difficult for companies to implement them. Accordingly, the other patterns are less popular so far.

Implications

The present paper sheds light on IoT revenue models by identifying revenue patterns in the IoT consumer market. We were able to identify nine IoT revenue patterns, encompassing direct and indirect revenue models. Two patterns (SSP-1 and DSP-2) account for over 80% of the direct revenue models. Almost 60% of the cases follow the physical product pattern. The companies using this pattern generate their revenues on the basis of product-based upfront payments. Services are not monetized and provided free of charge, so that all potential service revenue opportunities remain unrealized. Approx. 20% of the cases have implemented the physical freemium pattern. Here, physical goods are subject to upfront payments, a set of fundamental services is offered for free and recurring payments are charged for premium services.

Lessons Learned

1. The IoT opens up numerous monetization approaches. Hence, a revenue model must be actively developed, e.g. on the basis of the identified revenue model patterns.
2. Companies have to understand that IoT revenue models that apply established "cost plus x%" pricing schemes can become complex and rather unattractive for customers.
3. Companies have to think beyond simple, direct revenue models and also consider more advanced (e.g., indirect) models.
4. Ultimately, companies have to differentiate the cash flow implications of their revenue models by distinguishing between product-based, service-based and hybrid revenue models.

In all, our findings confirm the growing importance of ecosystems in an IoT context. Our data sample revealed indirect monetization mechanisms that go beyond pure customer–vendor monetization and include more than two stakeholders. More than 80% of the investigated IoT offerings provide APIs. Hence, third parties are able to build services and products around the core solution. Many products are only functional or desirable when there is a set of complementary goods available for them. Thus, the amount and availability of complementary offerings can become decisive factors that influence purchasing decisions.

Product-oriented companies have traditionally relied on simple, direct monetization approaches that will be challenged in the realm of the IoT. As of today, physical products are usually sold directly at a sales price or offered through leasing. IoT solutions comprise at least one physical and one digital component. This results in an additional complexity in monetization since not every component has to be charged separately and bundling strategies may be applied. Hence, numerous monetization options are possible, and a revenue model must be actively developed, e.g., on the basis of the identified revenue model patterns.

In this context, product-based, service-based and hybrid revenue models must be distinguished to assess the viability of the revenue model. For example, a heating appliance with 10 years of remote maintenance can be offered for a one-off sales price, including the remote maintenance service (product-based revenue model), e.g., to keep up with competition. On the other hand, an annual rent can be agreed upon for 10 years which includes a heating appliance and remote maintenance (service-based revenue model). The separate billing of heating appliance and service (hybrid revenue model) is therefore by no means mandatory.

Ultimately, companies have to reflect on the cash flow implications of their revenue models. In the case of product-based revenue models, recurring service costs (e.g., remote maintenance service costs) must be compensated by the initial product margin (e.g., heating appliance hardware margin). As a consequence, the net cash flow decreases over time. With service-oriented revenue models, the cumulated cash flow increases over time thanks to recurring service revenue. However, in the latter case there is an initial financing challenge, as the hardware has to be manufactured upfront but (service) revenues are only coming in later. In the case of hybrid revenue models, the cumulated cash flow is positive from the beginning (hardware margin) and increases over time (service revenues). Thus, from the provider's point of view, the hybrid revenue model appears to be advantageous. However, this monetization approach is becoming increasingly difficult to enforce in business practice (Porter & Heppelmann, 2015) since more and more customers are asking for simple compensation schemes that either take away their burden of initial investment and convert capital expenditures (Capex) to operating expenses (Opex) (service-oriented revenue models) or avoid recurring costs on their side (product-based revenue models).

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