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UNDERSTANDING THE INTERNET OF THINGS: A CONCEPTUALISATION OF BUSINESS-TO-THING (B2T) INTERACTIONS

Complete Research

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Abstract

The Internet of Things is widely regarded as one of the most disruptive technologies as it integrates Internet-enabled physical objects into the networked society and makes these objects increasingly autonomous partners in digitised value chains. After transforming internal processes and enhancing efficiency, the Internet of Things yields the potential to transform traditional business-to-customer interactions in a way previously not thought of. Remote patient monitoring, predictive maintenance, and automatic car repair are only some innovative examples. This paper contributes to the conceptualisation of the emerging business relationships based on such empowered smart things by proposing a series of core and advanced business-to-thing (B2T) interaction patterns. The core patterns named C2T-Only, B2T-Only, Customer-Centred, Business-Centred, Thing-Centred, and All-In B2T classify alternative interactions between businesses, customers, and smart things, using the connected car as an ongoing case and Uber as an example to demonstrate how patters can be composed. The proposed patterns demonstrate the affordances of integrating smart things into the networked society and sensitise for the emergence of B2T interactions.

Keywords: Business-to-Thing, B2T, Internet of Things, Digitisation, Composition of Patterns, Speech Act Theory, Interaction Patterns

1 Introduction

The Internet of Things (IoT) describes the digitisation and Internet-enabled integration of physical objects into the networked society (Rosemann, 2014b). Empowering objects of all kinds via sensors and actuators allows sensing signals from such things, analysing incoming data streams, and in return controlling these things remotely. Examples are remote patient management in the health care sector, smart meters in the energy sector, and predictive maintenance in the manufacturing sector. According to Gartner (2014b), there will be 26 billion smart objects installed by 2020, creating new market opportunities in excess of 300 billion USD. Consequently, it is no surprise that the IoT is regarded as one of the most disruptive technologies with impact on most industries (McKinsey Global Institute, 2013).

The ability to address and control physical objects does not only add an exponentially growing number of objects to the networked society, in many cases it also changes established business relationships. In particular, the IoT facilitates direct business-to-thing (B2T) relationships where previously customers were the moderating intermediators. Examples are patient sensors sending healthcare providers a regular data stream instead of patients seeking medical advice, or cars sensing quality issues without relying on drivers noticing these problems first.

While the IoT has been comprehensively discussed in terms of engineering-related challenges (Atzori et al., 2010; Kortuem et al., 2010) as well as from a business-to-business (B2B) perspective (Geerts and O'Leary, 2014), the Information Systems (IS) community has been rather passive with regards to researching the customer-related business implications of the IoT. In this context, this paper aims to contribute to a better understanding of how smart things can be integrated into, extend, and revise existing business-to-customer (B2C) relationships. In particular, we propose the notion of B2T relationships as a new and potentially highly disruptive pattern of interaction. Against this backdrop, our research question is as follows: *What B2T interaction patterns can be differentiated?*

Using the connected car as a proxy for smart things and as an ongoing example, we are interested not only in the implications of ‘putting the Internet into the car’, but even more in its contribution as a smart thing integrated into the networked society, i.e., what does it mean ‘to put the car into the Internet’. As a theoretical lens for our analysis, we use speech act theory (Austin, 1962; Searle, 1979) and the concept of decomposing conversations into well-defined patterns. We therefore study the changing speech acts and workflow loops between businesses, customers, and things with a focus on B2T interactions. Furthermore, we develop a typology of core B2T interaction patterns in line with Nickerson et al.’s (2012) method for typology development, discuss selected advanced B2T interaction patterns taking multiple stakeholders into account, and use Uber to demonstrate how patterns can be composed.

The paper is structured as follows: In section 2, we briefly discuss related work. Section 3 introduces speech act theory as the theoretical lens of our study, and embeds the IoT into multichannel management and customer relationship management. Section 4 outlines the applied research method, before our main contribution with a proposed typology of six core B2T interaction patterns is introduced in section 5. Section 6 then outlines selected advanced B2T interaction patterns and demonstrates the composition of patterns. In section 7, we discuss findings, limitations, and future research opportunities.

2 Related Work

Although the underlying concept seems intuitive, the IoT is not consistently defined in academic literature (Boos et al., 2013). The reason is the close relatedness of the IoT to several almost identically evolving technologies such as Ubiquitous Communication, Pervasive Computing, and Ambient Intelligence (Li et al., 2012). Friedewald and Raabe (2011) state that this differentiation is of rather academic nature as all named technologies aim at assisting people and optimising processes through sensors and microprocessors integrated in the environment.

Having reviewed many different definitions (Boos et al., 2013; McKinsey Global Institute, 2013; Uckelmann et al., 2011b), we define the IoT as the connectivity of physical objects (things), equipped with sensors and actuators, to the Internet via data communication technology, enabling interaction with and/or among these objects. The IoT-enabled object, in the following also referred to as smart thing, is thus a physical object (e.g., car, refrigerator, or thermostat) that exists independent of IoT technology. This excludes PCs, tablet computers, and smart phones (Gartner, 2014b). Being uniquely identifiable, smart things are linked to their virtual representation in the Internet, providing additional information such as status, history, and location as well as programming and communication interfaces (Uckelmann et al., 2011a, p. 8). Based on bilateral communication, the IoT enables tracking, coordinating, and controlling smart things, whereas at the same time a smart thing might initiate actions or processes (Rosemann, 2014b).

Since the term IoT was first introduced at the Massachusetts Institute of Technology (MIT) in 1999 when RFID technology was presented, many researchers dealt with the technical underpinnings of the IoT (Cvijikj and Michahelles, 2011). For instance, Laya et al. (2014) focus on the next generation of dense networks that meet the growing requirements for data transmission. Atzori et al. (2010) report on different visions of the IoT and related enabling technologies such as identification, communication, and sensing technologies. Kortuem et al. (2010) introduce an architectural model for the IoT as a decentralised system of smart things with increasing levels of real-world awareness and interactivity.

IoT-based product and process innovations have been explored with a business-centric focus on logistics and supply chain management, predominantly applied within single companies or in a B2B context. Uckelmann et al. (2011b) state that the IoT means greater visibility, faster handling, increased cost efficiency, and process agility. Qin (2011) investigated how the IoT helps Shanghai become one of the largest logistic hubs in the Asia-Pacific region. Research by Geerts and O'Leary (2014) found that the IoT enables more accurate forecasting of stock situations. Finally, Boos et al. (2013) present a theoretical framework for studying the relationship between control capabilities and accountabilities of human actors using IoT technologies in a supply chain context.

Beyond these techno- and B2B-centric contributions, few researchers focused on the customer-related business implications of the IoT. Porter and Heppelmann (2014) as well as Rosemann (2014b) provide high-level strategic insights on IoT-based challenges and opportunities, listing new business models and an economy of shared things as emerging opportunities. Li et al. (2012) develop a framework on how to choose an IoT strategy. Komarov and Nemova (2013) discuss synergies between the IoT and the Internet of Services taking on a rather technical perspective that sees the customer as a special type of a service user in a cloud architecture. New participation models based on the IoT have been introduced by Jara et al. (2014) in the sense of participative marketing. Bucherer and Uckelmann (2011) outline IoT-enabled information flows between consumers, things, and businesses. Acknowledging that there are only few applications utilising the full potential of these information flows, they develop four exemplary IoT-based business model scenarios without further investigating B2C relationships.

The preceding analysis reveals that the impact of the IoT on existing B2C relationships has been recognised, but not exhaustively investigated. To the best of our knowledge, what is missing is a structured and theoretically well-founded conceptualisation of B2T interaction patterns, i.e., how the IoT re-shapes the interaction between businesses, customers, and smart things.

3 Background

3.1 From Speech Act Theory to Workflow Loops

The core of the IoT is the ability to interact with physical objects. When identifying a theoretical lens for our attempt to conceptualise the newly afforded communication with such objects, we turned to speech act theory. The main message of speech act theory, which describes basic units of communication, is “to speak is to act” (Goldkuhl, 2005, p. 9). A speech act represents the essence of communication describing an utterance that has a performative function. The sub-acts, i.e., locutionary, illocutionary, and prelocutionary acts, reflect the act of performance, the content, and the underlying objective of an utterance. Speech acts require knowledge about the language and the use of the language in a certain culture (Austin, 1962; Hirschheim et al., 1995; Searle, 1979).

Speech act theory provides the basis for the so-called language/action perspective (LAP) (Weigand, 2003), which can be seen as the foundation of several communication-based approaches to business process design and IS development (Goldkuhl, 2005). The LAP has been extended by Winograd and Flores (1986), mainly contributing a conversation-for-action scheme, where two roles in interactions are differentiated: one who requests and one who executes a task. This concept of “request” and “execution” is the backbone of the workflow loop notation (Denning, 1992; Denning and Medina-Mora, 1995). Thereby, a basic workflow loop connects a customer and a performer in a 4-phase cycle, i.e., request, negotiation, performance, and acceptance. Each phase represents at least one speech act. In this paper, we base our understanding of interactions between businesses, customers, and smart things on the workflow loop notation considering the phases “request” and “execution” (Winograd and Flores, 1986). Figure 1 illustrates a basic workflow loop, indicating the applied phases “request”, which comprises “request” and “negotiation”, and “execution”, including “performance” and “acceptance”.

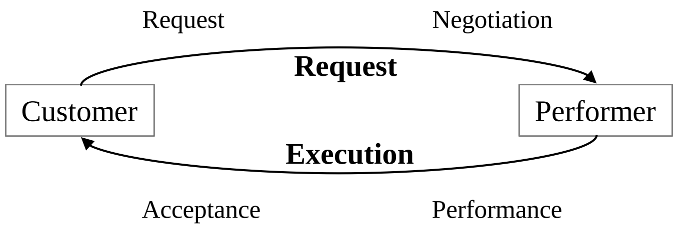


Figure 1. Workflow Loop

In the following, we not only aim at describing single speech acts or interactions with smart things. Rather, the objective is to derive so-called *interaction patterns* that conceptualise the newly afforded interactions between businesses, customers, and smart things enabled by the IoT (Barros et al., 2005). We illustrate these interaction patterns based on the approach of Froehle and Roth (2004) who provided visualisations of different contact forms between a customer and a service provider mediated by technology.

As an example for an interaction pattern, Figure 2 shows the traditional B2C interaction. For instance, a car as a proxy for a thing (T) is used by its owner, who is a customer (C) of one or more businesses (B), i.e., a car manufacturer or third-party car service provider. The car’s ability to communicate is very limited. At most, it might be able to indicate when it is time for a fuel-filling. Hence, traditionally the interaction is limited to the car owner and the manufacturer or car service provider, for instance with regard to car and maintenance services.

For the general conceptualisation of the interaction patterns derived in this paper, the workflow loops are not further specified. However, the resulting general patterns allow specifications for concrete examples via single-headed arrows as demonstrated in Figure 2a) and 2b). The direction of the single-headed arrow then indicates which party initiates a workflow loop, i.e., the arrow points to the party which is expected to perform a task. The double-headed arrow in Figure 2c) visualises that Denning’s workflow loop can be initiated by either the customer or the business, i.e., both parties can request or execute a task.

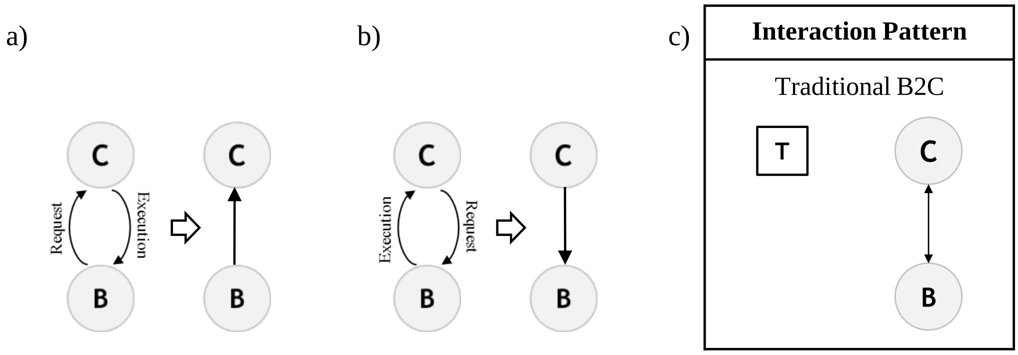


Figure 2. Traditional B2C Interaction Pattern

3.2 From B2C to B2T Interactions

In the context of multichannel and customer relationship management, routes of communication and B2C interaction between businesses and customers are called channels. Multichannel management can be defined as the "design, deployment, coordination, and evaluation of channels to enhance customer value through effective customer acquisition, retention, and development" (Neslin et al., 2006, p. 96). Customer relationship management is "a customer-focused business strategy that aims to increase customer satisfaction and customer loyalty by offering a more responsive and customised service to each customer" (Croteau and Li, 2003, p. 22). Channels are crucial for the conception, promotion, and delivery of positive customer experience (Gundlach et al., 2006). Hence, an integrated management of a company's communication and interactions with its customers across multiple channels is a critical driver of successful customer relationship management.

In times of an increasingly digitised media universe, companies are required to reflect on their traditional B2C interactions as established channels disappear, existing channels become digitised, and new as well as often customer-initiated channels are emerging (Hennig-Thurau et al., 2010). In the recent past, a growing number of social media channels and mobile devices facilitated interactions both between customers and businesses and among customers irrespective of location and time (Nguyen and Mutum, 2012). Following Gartner (2014a), the IoT will add further design alternatives to the already fast changing scope of multichannel and customer relationship management.

Companies have just begun to develop IoT-enabled products and services for customers such as the business models of Amazon Dash, Google's Nest, and Uber show. These cases underlie the meaning of the IoT in a B2C context: smart things being connected to the Internet enable direct workflow loops between businesses and smart things, where previously customers were moderating intermediators and the companies' communication counterparts. Hence, businesses will increasingly interact with smart things – instead or in addition. Automated B2T interactions, which seamlessly integrate into the customers' processes, will substitute parts of the mostly human-intensive B2C interaction, enabling efficient data collection and analysis. Following the familiar terminology of B2C and B2B, we suggest to refer to this new way of interaction as B2T. In particular, we propose the notion of B2T relationships as a new and potentially highly disruptive pattern of interaction.

4 Research Method

This paper is based on qualitative research, designed to facilitate the understanding of particular phenomena in a certain context. Qualitative research fits exploratory studies where "a phenomenon is not yet fully understood, not well researched, or still emerging" (Recker, 2013, p. 88). Especially classifications such as typologies help researchers and practitioners understand and analyse new phenomena. Typologies are conceptually derived multidimensional constructs that describe an exhaustive set of types, resulting dimensions, and the relationships among them (Nickerson et al., 2012, p. 339).

In this paper, we follow a method proposed by Nickerson et al. (2012) for developing a typology. This method allows for combining a conceptualisation/deduction and an empiricism/induction approach in an iterative way (Nickerson et al., 2012, p. 345). It comprises seven steps, whereas subsequently step 4 to 6 are specified for the conceptualisation/deduction approach only.

1. *Determine meta-characteristic*: The meta-characteristic is based on the objective of the typology. This means that the users of the typology and their expectations must be taken into account.
2. *Determine ending conditions:* Objective and subjective conditions that end the iterative process of developing a typology need to be specified.
3. *Choose approach:* For each iteration, researchers must decide whether to follow either an empirical or a conceptual approach depending on the availability of data about the objects of interest and the researchers' knowledge about the domain under study.
4. *Conceptualise characteristics and dimensions*: Researchers derive the conceptualisation based on their notions about how objects are similar, a process where only little guidance is provided. For each dimension, mutually exclusive and exhaustive characteristics need to be determined, where these characteristics must be logical consequences of the meta-characteristic.
5. *Examine objects for these characteristics and dimensions:* Objects, i.e., examples, are mapped to the dimensions and characteristics to assure that they have characteristics in each dimension.
6. *Create (revise) typology:* The result of the previous steps is an initial or a revised typology, depending on the number of iterations conducted. The typology can be specified as $T_i = \{D_1 (C_{11,} \ldots, C_{1,n(1)}), \ldots, D_m(C_{m,1}, \ldots, C_{m,n(m)})\}$, where i equals the number of iterations, m the number of identified dimensions, and $n(m)$ the number of characteristics of a distinct dimension.
7. *Test of ending conditions:* If the ending conditions defined in step 2 are met, the typology development process terminates. Otherwise, steps 3 to 7 must be repeated.

When choosing an empiricism/induction instead of the conceptualisation/deduction approach in step 3, step 4 would include the *identification of subsets of objects,* step 5 the *identification of characteristics,* and step 6 would mean *deferring dimensions* accordingly to create the typology.

5 Core B2T Interaction Patterns

When applying the method for developing typologies introduced in section 4, we conducted 4 iterations before the following ending conditions were met: no new dimensions were added in the last iteration and at least one object is classified under each characteristic of each dimension. Moreover, after 4 iterations, all authors agreed that the typology is concise, robust, comprehensive, extendible, and explanatory. For all iterations, we chose the conceptualisation/deduction approach in step 3, as only few data were available and the researchers claimed to have a significant knowledge of the domain, as recommended by Nickerson et al. (2012, p. 345).

We refer to our results as a typology of B2T interaction patterns, an expression based on the work of Barros et al. (2005). Patterns have proven to be useful for generating problem-solving insights as they allow defining concrete objects, e.g., interactions, in an abstract form. Traditionally applied in software design, patterns have emerged in the IS and the business field, e.g., through the workflow patterns derived by van der Aalst et al. (2003). Below, we discuss the results of steps 1 and steps 4 to 6 from the 4th iteration, before refining the resulting typology to derive 6 core B2T interaction patterns.

Determine meta-characteristic: As we aim to provide researchers and organisations with a typology of B2T interaction patterns, the meta-characteristic comprises the *interaction between the three stakeholders: a business, a customer, and a smart thing*, where a business can be the original provider of a thing, a third-party service provider, or both. A smart thing is a physical object able to communicate via the Internet. The customer is specified as the user, not necessarily the owner of the thing.

Conceptualise characteristics and dimensions: Aiming to derive a typology of B2T interactions, the following dichotomous dimensions consider interaction aspects on a comparably high level of abstraction. (A) The *interaction dimension between the smart thing and the customer*, describing whether there is a workflow loop between the two parties in the sense of Denning's workflow loop. Hence, an interaction takes place when both parties are connected via a request-execution relationship. Merely providing, e.g., a platform mediating communication is not seen as an interaction. Correspondingly, (B) the *interaction dimension between the smart thing and the business* and (C) the *interaction dimension between the customer and the business.*

Figure 3 summarises the identified dimensions and characteristics in accordance with the introduced scheme from section 3.1. The Wi-Fi-symbol indicates that the thing is connected to the Internet. The double-headed arrow visualises that the workflow loop can be initiated by both parties involved in an interaction.

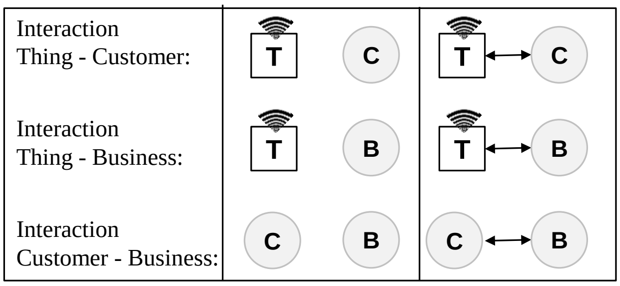


Figure 3. Overview of Dimensions and Characteristics

Examine objects for these characteristics and dimensions: We found a number of objects (examples) with the identified characteristics. However, we discuss relevant examples at the end of this section after reducing the final typology to 6 core B2T interaction patterns.

C*reate typology:* Following the notation provided by Nickerson et al. (2012, p. 349), the final typology is specified as T_4 = {Interaction between Thing and Customer (Interaction, No Interaction), Interaction between Thing and Business (Interaction, No Interaction), Interaction between Customer and Business (Interaction, No Interaction)}.

When combining the mutually exclusive and exhaustive characteristics of the final typology, eight interaction patterns can be derived. However, a combination with no interaction at all as well as the exclusive interaction between a customer and a business (B2C) is not in the focus of the paper and therefore excluded from the core patterns. This does not mean that traditional B2C interactions are trivial. They simply are not in the focus of this paper. For further insights into B2C, refer among others to the work by Nguyen and Mutum (2012). An interaction that takes place between a customer and a smart thing only (*C2T-Only*) does not include a direct interaction between a business and a smart thing. However, in case the business is the original provider of the smart thing but does not offer corresponding services, the business will still be interested in the interaction between the customer and the smart thing as it creates additional value to the customer. The value experienced by the customer affects a company's customer equity, which is a reasonable proxy of the company value (Gupta et al., 2004). Moreover, understanding this most elementary pattern and related affordances is crucial for being able to analyse and design more complex interactions that are based on such a simple *C2T-Only* interaction. As can be seen below a lot of examples from the IoT industry comprise *C2T-Only* interactions, which is considered adequately by including the *C2T-Only* interaction pattern into the six core B2T interaction patterns.

In Table 1, the resulting six core B2T interaction patterns as refined results of the typology are summarised. The column "Characteristics" comprises the dimensions of the typology, where respective characteristics are highlighted in grey. Moreover, examples from the connected car case, as a proxy for smart things, as well as from other industries are provided.

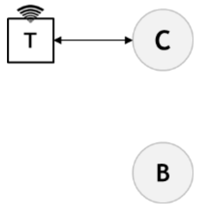
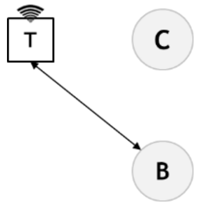
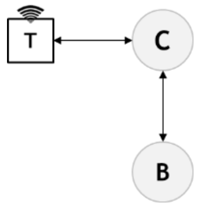
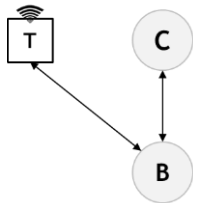
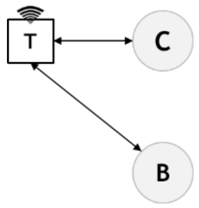
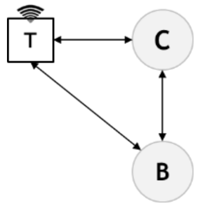
Interaction Pattern	Characteristics	Examples from the Connected Car Case	Examples from Other Industries
C2T-Only 	Execution Request: C, T, B C T B # Parties: 1, 1, 0	**Internet in the Car:** Remote car control **Car in the Internet:** Online journey analysis	**Fitness:** Up24 – fitness tracker
B2T-Only 	Execution Request: C, T, B C T B # Parties: 0, 1, 1	**Internet in the Car:** Automatic software update **Car in the Internet:** Online defect analysis	**Healthcare:** Biotronik – home health-monitoring system
Costumer-Centred B2T 	Execution Request: C, T, B C T B # Parties: 1, 1, 1	**Internet in the Car:** Car apps **Car in the Internet:** Vital-function control	**Smart Lighting:** Philips Hue – connected light bulbs
Business-Centred B2T 	Execution Request: C, T, B C T B # Parties: 1, 1, 1	**Internet in the Car:** Automatic call for maintenance **Car in the Internet:** Progressive insurance	**Smart Home:** Nest – self-learning digital thermostat
Thing-Centred B2T 	Execution Request: C, T, B C T B # Parties: 1, 1, 1	**Internet in the Car:** Online emergency call **Car in the Internet:** Automatic payment	**Healthcare:** Medtronic – digital blood glucose meter
All-In B2T 	Execution Request: C, T, B C T B # Parties: 1, 1, 1	**Internet in the Car:** Customised advertisement **Car in the Internet:** Parcel-to-car delivery service	**Fitness:** HAPIfork – smart fork

Table 1. Core B2T Interaction Patterns

With regard to the connected car case, two evolution steps of connectivity and communication abilities can be differentiated, namely the "Internet in the Car" (IC) and the "Car in the Internet" (CI) (Rosemann, 2014b). The first means that a car simply has a board computer and/or an own Wi-Fi connection, such as many cars already have. The latter refers to the actual definition of the IoT, namely that the car is virtually represented in the Internet via different sensors that provide information about the car's use and condition. In order to illustrate the evolution of the IoT and B2T respectively, we provide examples from the connected car case for both evolution steps acknowledging that the borders between them are fluent. As the core B2T interaction patterns consider three parties only, the following examples do not fully reflect the power of the "Car in the Internet" viewpoint since one-to-many relationships that might profit most from car-generated information are not discussed. However, interested into a connected car's contribution as a smart thing integrated into the networked society, we discuss implications, examples, and future directions in section 6.

C2T-Only describes a workflow loop and speech acts solely between a smart thing and a customer whereas both parties are able to initiate an interaction. The interaction might be mediated via communication infrastructure provided by a business, however the business is not actively involved. The IC, for instance, enables the customer to remotely control, open, or close a car and the car might also send regular status information to the customer (e.g., GM OnStar). The car having a virtual representation in the Internet means that information about the car such as fuel consumption, speed, temperature, or others can be requested online (CI). Such workflow loops between smart things and their users can already be found in other industries. For example, a number of fitness trackers count steps, calories, and sleeping hours, and make this information accessible online (e.g., Up24). Another example is the location device Tile, which allows the user to track items.

B2T-Only describes the interaction between a smart thing and a business bypassing the customer. For example, the car manufacturer Tesla uses the Internet connection of its cars (IC) to provide automatic software updates. The CI allows a car manufacturer to analyse online and remotely a car's functionality without bothering the customer, a workflow loop that might be initiated by the car. An example from other industries is Biotronik, a medical device company that offers a home health-monitoring system allowing physicians to remotely monitor their patients' health data.

Costumer-Centred B2T describes a B2T interaction pattern where the customer is the gatekeeper between the business and the smart thing, controlling two interrelated workflow loops. The IC enables, for example, a car to send a request in the form of a service reminder to its owner including information about the nearest repair shop, where in turn the customer requests the company for maintenance services. Moreover, scenarios become possible where businesses develop apps for the car which the user can purchase and download to the car enriching its functionality (e.g., navigation systems, fuel efficiency systems). The CI might provide information about a driver's vital functions, which he can request from the car and in case needed actively transfer to a doctor requesting advice. An example from another industry is Philips' light system Hue. Hue allows users to customise the lighting system in their homes. Among others, a mobile app is offered where the customer can ask the company for special colour creations and apply them to his home lighting system.

Business-Centred B2T eliminates the customer as a gatekeeping interface and facilitates direct B2T interactions, but still requires the customer as a confirming stakeholder. For example, a car might send a request to the business reminding that a service is due – planned or unforeseen. In turn, the business contacts the customer to offer the respective services (IC). The CI might lead to a new form of car insurance where the customer requests insurance services from an insurance provider. However, the insurance provider requests relevant insurance data directly from the car and bases the customer's insurance plan on his actual driving behaviour. An example from the smart home industry is Nest, a programmable, self-learning, and Wi-Fi-enabled thermostat that not only optimises heating and cooling of homes, but also transfers information on electricity consumption to energy companies, automatically leading to savings for the customer (e.g., rush hour rewards).

Thing-Centred B2T describes two interrelated interactions that are controlled by the smart thing as a gatekeeper. In this sense, the IC allows online emergency calls as Europe's eCall system demonstrates. In case of an accident, the car can automatically send a help request to an ambulance close by. At the same time, the car might advise the customer about the status of these requests (e.g., approaching ambulance). The CI might allow a more futuristic scenario: a digital representation of the car holds information about a customer's payment details such as credit card details. The customer would request the car to pay e.g., for fuel before the car automatically pays initiating a workflow loop with the fuel station. A real-world example on *Thing-Centred B2T* interaction is Medtronic offering digital blood-glucose meter that alerts patients as well as clinicians up to 30 minutes before a patient reaches a threshold blood-glucose level. In this case, both workflow loops are initiated by the smart thing.

All-in B2T describes an interaction pattern where all three parties communicate directly with each other. The IC allows a business to send customised advertisements to customers via the car based on previous interactions. The CI enables a new so-called parcel-to-car delivery service. The customer makes a purchase request to a shipping service provider. At the same time, the customer requests the car to provide the service provider access to its location as well as to its car boot. After a corresponding workflow loop between the service provider and the car, the customer's orders can be delivered in the car boot (e.g., Cardrop). A practical example for *All-in B2T* is HAPI-fork, a smart fork which measures the customer's speed of eating. The resulting information are provided to the customer as well as to HAPI offering nutritional consulting services.

6 B2T Interaction Patterns in the Networked Society

6.1 Advanced B2T Interaction Patterns

While the introduced core patterns only consider single stakeholders, e.g., one business, one customer, and one smart thing, the advanced B2T interaction patterns extend them by assembling different core patterns considering multiple stakeholders, i.e., multiple things, multiple customers, and/or multiple businesses. As such, advanced interaction patterns go beyond the private interactions of just three stakeholders and allow studying possible scenarios in a more open environment where various stakeholders of the connected society can contribute and benefit from smart things. As, in the future, smart things will lead to networks that allow for arbitrarily many new interactions, we do not claim completeness for the following patterns. Three selected advanced interaction patterns called *Multi-Thing*, *Multi-Customer*, and *Multi-Business B2T* are visualised in Table 2. Moreover, we provide examples from the connected car case highlighting the car's role in the connected society.

Multi-Thing B2T refers to a thing-to-thing communication, which is for instance required when realising the idea of driverless cars. Existing business models such as Nest already offer thing-to-thing connections. In cooperation with Up24 and Mercedes, the thermostat can adjust to a person's wake up rhythm communicated by the Up24 band or expected arrival time announced by a Mercedes car.

Multi-Customer B2T describes the connection of multiple customers to a thing and potentially a business. This enables new forms of car rental and sharing where users are directly connected to one or multiple cars accessing information about its current location and condition. The business might provide the underlying online platform, as zipcar's business model demonstrates. Another interesting example of current business models applying *Multi-Customer B2T* is Adhere Tech, a healthcare business that offers smart wireless pill bottles, which not only remind the patient to take his medicine, but also ask online for the reason in case the patient forgot taking it. Collected adherence data from many patients is provided anonymously to researchers who analyse and connect adherence information in order to improve clinical trials and research.

Multi-Business B2T refers to models where several businesses are connected with a smart thing. This comprises, for instance, so-called data markets, where a car manufacturer is connected to a customer and its car, but does not use the collected data for own services. Instead, the manufacturer can transfer the data (or grant access to selected parts of the data in line with the customers' privacy policy) to other companies such as insurance providers that, in turn, pay for the information. Sense-T, for instance, is a Tasmanian governmental project creating an economy-wide sensor network, connecting for instance cows, oysters, and grass. Sense-T aims to combine collected real-time data with spatial and historical data providing them to all kinds of businesses in agriculture.

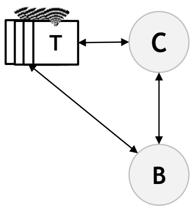
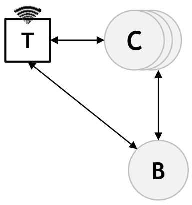
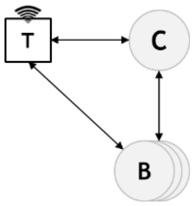
Interaction Pattern	Characteristics	Examples from the Connected Car Case	Examples from Other Industries
Multi-Thing B2T  	Execution Request: C, T, B C T B # Parties: 0-n, n, 0-n	**Car in the Networked Society:** Car-to-car communication	**Smart Home:** Nest – self-learning digital thermostat
Multi-Customer B2T  	Execution Request: C, T, B C T B # Parties: n, 1-n, 0-n	**Car in the Networked Society:** Car rental and sharing	**Healthcare:** Adhere Tech – smart wireless pill bottle
Multi-Business B2T  	Execution Request: C, T, B C T B # Parties: 0-n, 1-n, n	**Car in the Networked Society:** Data markets	**Connected Society:** Sense-T – intelligent sensor network

Table 2. Advanced B2T Interaction Patterns

6.2 Composition of B2T Interaction Patterns

Concluding the advanced B2T interaction patterns as interaction patterns of a networked society, we aim at demonstrating how patterns can be composed using the example of Uber, a ridesharing service, which puts into effect the idea of connected cars in a unique way. Uber's customers are looking for a ride from one location to the other and traditionally would have called a taxi. However, by connecting their personal cars to the Internet via a smartphone application, Uber enables individuals to offer their cars to give others a ride for lower rates than traditional taxis do. Figure 4 part a) illustrates Uber's interactions where two *Thing-Centred B2T* interactions and one B2B interaction can be identified. Figure 4 applies single-headed arrows to further specify the workflow loops involved. Here, the direction of the arrows indicates which party initiates an interaction.

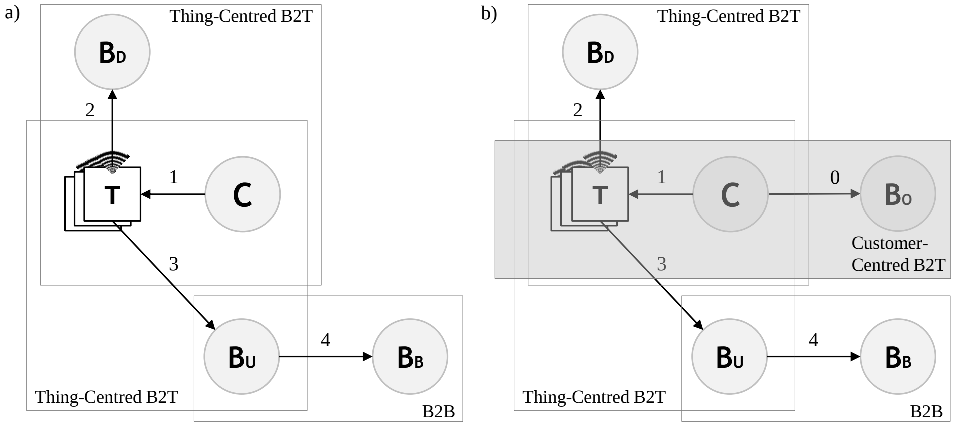


Figure 4. Two Evolution Phases of Uber's B2T Interactions towards a Connected Society

In the following, we describe the workflow loops (1) to (4):

(1) A customer (C), who has pre-registered on Uber's website with his personal data including his bank account, requests an Uber car (T) via the Uber app, sending this request including the destination to multiple Uber cars (T…T) nearby. The assigned Uber car informs the customer about the details of his transfer (e.g., brand and arrival time of the Uber car, name and photo of the driver), and gives ongoing updates of the approaching Uber car as well as of the route taken by the driver during the ride.

(2) The Uber driver (B_D) who first accepts the customer's request is assigned the order. Performing the request, the driver approaches the customer's destination that is communicated via the car.

(3) The driver starts and stops the taximeter manually. These data are then automatically transmitted to Uber (B_U) via the Internet.

(4) Based on the data transmitted, Uber determines the fare and issues a payment order to the customer's bank account (B_B).

As indicated in part a) of Figure 4, Uber's business model includes two *Thing-Centred B2T* interaction patterns where a customer is connected to one selected car, after the initial search phase. The connected car performs as the gatekeeper for interactions to Uber and the Uber driver. Direct interactions to both are possible, but not necessary for Uber's value proposition. In addition, the customer's bank is part of the extended network. In contrast to traditional taxi rides, the customer is not bothered with the handling of payments, he is updated about the position of the approaching car, and has ongoing access to the route the Uber driver takes. Where traditionally customers interacted with taxi-drivers, the Uber car handles the majority of interactions for the customer.

However, Uber has gone the next step towards offering its cars to the connected society by opening its application programming interface to third-party developers. This enables other businesses to integrate access to Uber extending their services. For instance, after requesting an online restaurant reservation via the mobile app of the service OpenTable (B_O), OpenTable offers a ride with Uber to the respective restaurant. The customer, as the gatekeeper, only needs to press a button integrated in the OpenTable app. Information about the location of the restaurant and reservation time are directly transferred to the Uber car. As reflected in part b) of Figure 4 this adds another *Customer-Centred B2T* interaction pattern where the customer interacts with a business before requesting a Uber car based on this previous interaction. This equals the newly integrated workflow loop (0).

More and more businesses such as United Airlines, Starbucks, and Spotify already offer similar interactions with Uber (Bloomberg, 2014). This exemplifies how service providers, not familiar with producing things, can make use of the IoT and B2T interactions contributing via smart things towards a connected society. In the future, it can be expected that even other things such as smart thermostats might be connected to Uber, too. The above derived interaction patterns help analyse emerging business models, and they can be used when conceiving innovative business models by combining different core and/or advanced interaction patterns. The more businesses, customers, and smarts things can approach the car of the future, the more the underlying core interaction patterns will converge towards *Multi-Thing, Multi-Customer,* and *Multi-Business B2T.*

7 Contribution, Discussion, and Topics to Further Research

Addressing the implications of one of the currently most disruptive technologies, our main contribution is a theoretically well-founded typology of core B2T interaction patterns. These interaction patterns analyse how smart things might be integrated into, extend, and revise existing B2C relationships. Moreover, we presented a selection of advanced B2T interaction patterns taking multiple stakeholders into account and used Uber to demonstrate how to compose these patterns. All proposed patterns form an initial foundation for analysing und designing IoT-enabled interactions between businesses, customers, and smart things, yielding the potential to fundamentally change an organisation's view of multichannel and customer relationship management.

The theoretical lens of our investigation was the speech act theory where, in our case, we studied the changing speech acts and workflow loops between businesses, customers, and things on a high level of abstraction. Especially the advanced B2T interaction patterns demonstrate that the changing nature of communication reveals affordances previously not thought of. The IoT will not only change B2C interactions as a whole, but all individual speech acts that, enabled by the IoT, can be initiated or answered by smart things. For instance, smart things might take over negotiations from customers directly communicating with different businesses, e.g., a car negotiating in real-time with a number of nearby fuel stations for the best price or insurance providers for the best rates. Moreover, interacting with smart things instead of customers offers organisations much cheaper interactions, much higher communication frequency if desired, and interactions independent of location and time. Hence, continuous data and information transfer means not only new interactions, but might also inspire entirely new business models, as the example of Uber has demonstrated. IoT-enabled interactions allow businesses to start thinking about how to seamlessly and continuously integrate themselves, their products, and services into their customers' processes (Rosemann, 2014a).

As in any research endeavour, our work is beset with limitations pointing to opportunities for further research. First, we provided only a selection of advanced B2T interaction patterns. Thus, a further analysis of patterns affecting multiple stakeholders is required. Second, only few empirical data points were analysed to validate the proposed patterns. An in-depth empirical analysis examining a structured range of real-life cases of IoT-enabled services should be conducted as soon as B2T interactions are more established in practice. Third, as discussed, we reside on a comparably high level of abstraction when analysing speech acts and workflow loops, which can be further elaborated in future research. Fourth, more detailed guidance on how to apply the proposed interaction patterns for analysis and design purposes could be elaborated and evaluating their application in collaboration with business representatives might yield additional insights. In a next step, also more IoT-enabled service ecosystems such as Uber should be analysed with the help of B2T interaction patterns.

The introduced patterns represent an initial conceptualisation of B2T interactions raising more questions for further research. For example, a business providing services needs to decide how to choose a particular thing to be connected and a set of appropriate corresponding interaction patterns. A business producing things would need guidance on how to build and secure the required IT infrastructure and how to capitalize on the vast amounts of data generated by smart things. Furthermore, it remains unclear which factors drive a customer's acceptance and usage of smart things, and how privacy and data security demands regarding his digital footprint can be met. Finally, it seems of crucial importance to determine who owns thing-generated data: the customer, the business, or even the connected society?

We hope that, by enhancing the understanding of how smart things might be integrated into, extend, and revise existing B2C relationships, this piece of research provides fellow researchers with a sensible foundation for continuing research in the domain of the IoT and B2T interactions.

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