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Internet of Things Business Models: The RAWFIE Case

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Abstract. Internet of Things (IoT) encompasses a wide range of devices and technologies which cumulatively shape a new environment with unprecedented business prospects. This paper aims to investigate the business potential of IoT, focusing on mobile IoT and IoT as a service. In this direction, it presents the case of RAWFIE, a H2020 project on a research and experimentation federated platform of mobile IoT testbeds and devices. The paper describes RAWFIE potential business models, analyzing them into their characteristics, based on the business model canvas, examining the possibilities as well as the challenges these entail, using a SWOT analysis, and testing them in a preliminary evaluation. The study offers research and practical insights as a starting point for business models of IoT as a service, focusing in the context of mobile IoT experimentation.

Keywords: Internet of Things, mobile IoT, business model, IoT as a service

1 Introduction

IoT is a very promising technology and is predicted to flourish within the next years. It is expected that 14.2 billion IoT devices will be in use in 2019 and they will reach 25 billion by 2021 [1]. Investments on IoT are predicted to reach $1.2 trillion in 2022 with a CAGR of 13.6% [2]. The IoT market is still in its infancy, with its potential yet to be revealed. IoT technologies offer vast opportunities for business models in almost every application domain. The introduction of mobile smart nodes further enhances the IoT potential for applications and business models. Mobile IoT involves moving devices equipped with processing and communication capabilities, which cover larger areas than 'typical' static IoT nodes. The movement of the devices intensively incorporates the spatial aspect in data gathering and processing. Mobile IoT applications are characterized by short and recurrent contact between IoT devices to perform assigned tasks [3]. Modern devices are equipped with wireless technologies facilitating the creation of a vast communication infrastructure, where mobile devices are connected, allowing for the creation of numerous applications. However, despite the extant literature on IoT business models, research on mobile IoT and related business models is scarce.

In this paper, we aim to explore the business potential of IoT, focusing on mobile IoT and its provision as a service. We examine mobile IoT business models based on the case of the RAWFIE (Road-, Air- and Water-based Future Internet

Experimentation) EU H2020 project that provides research and experimentation facilities with a federation of unmanned mobile IoT devices (UAVs, USVs, UGVs) and testbeds. RAWFIE is examined from a business model perspective covering different variations of IoT as a service. RAWFIE business model is described using the Business Model Canvas and is further analyzed with a SWOT analysis, followed by a preliminary qualitative evaluation. The paper provides initial insights on mobile IoT business models and IoT as a service that can be of use to both researchers and practitioners.

The structure of the paper is as follows. Section 2 reviews related work while Section 3 presents the case of RAWFIE project. Section 4 describes the proposed business models, along their dimensions and characteristics, which are further analysed with a SWOT analysis presented in section 5. Section 6 describes a preliminary evaluation of the proposed RAWFIE business models and Section 7 concludes the paper.

2 Background

A number of business models have been proposed in the IoT [4]. [5] build on top of the analysis of 55 IoT business model patterns in [6], focusing on the value creation steps that ensure the success of business models. The results indicate that business model patterns could be depicted by six components while defining two independent business model patterns, digitally charged products and sensors as a service. [7] present a business model framework for IoT applications. Based on the Business Model Canvas, they identify the building blocks that are relevant in an IoT business model, types of options that can be focused on within these building blocks and the relative importance of these building blocks and types. [8] has also proposed the use of Business Model Canvas for business models in the context of industrial IoT. The author presents the phases of the industrial Internet evolution and discusses the key elements in such a setting. [9] aim to develop a generic business model framework for IoT businesses through literature analysis and interviews. A set of case studies are adopted for testing purposes in IoT companies. The findings suggest that the capability for data analytics is an essential element for IoT service and open ecosystems help companies provide new integrated services and offer greater value for consumers. [10] study IoT business models discussing design challenges, i.e..diversity of objects, immaturity of innovation and unstructured ecosystems, and suggesting a design tool.

[11] propose a framework for designing business models for IoT in a structured and actionable way, based on 34 case studies. [12] propose a traditional value based business model applied for IoT applications, targeting how value is created and exchanged between actors. [13] propose an e3-value methodology applied to traditional business models for IoT applications, focusing on value proposition and target customers. [14] adopt a value net analysis for proposing a business model in IoT through a case study related to real-world traffic data generated by IoT services. [15] describe the use of a value based approach to business modeling of new solutions based on IoT and apply an e3-value methodology to demonstrate how a sustainable business model can be built for the IoT.

[16] studies existing business models and proposes a strategy for using business models in the development of IoT for China mobiles. The strategy includes four aspects, the improvement of high-quality network for IoT, the value proposition, the key partnerships and the key activities for launching the IoT product. [17] propose business models for the value and revenue creation in the IoT. Finally, [18] categorize business models for IoT in the manufacturing industries. The authors describe challenges like unprofitable environment, exploded market and need to extract more value in the existing business models for IoT and establish a framework for identifying different IoT business models.

3 RAWFIE project

3.1 RAWFIE aim and scope

RAWFIE (Road-, Air-, and Water- based Future Internet Experimentation) (http://www.rawfie.eu) is a project funded by the European Commission (Horizon H2020 programme) under the Future Internet Research Experimentation (FIRE+) initiative. RAWFIE provides a platform for interconnecting multiple testbeds aiming at providing research facilities for mobile IoT devices, specifically unmanned vehicles UxVs, e.g., Unmanned Aerial Vehicles (UAVs), Unmanned Surface Vehicles (USVs), Unmanned Ground Vehicles (UGVs), for research experimentation in vehicular, aerial and maritime environments. The platform supports experimenters with smart tools for conducting and monitoring experiments in various domains of IoT.

RAWFIE project aims at delivering a federated infrastructure synthesized of heterogeneous testbeds and unmanned vehicles, operating in air, sea and ground. RAWFIE offers experimentation facilities that can accommodate diverse and complex experiments of various scales for testing and fine tuning mobile IoT technologies. RAWFIE operates as an Experimentation-as-a-Service model, providing a platform of testbeds, devices and specialized software tools for conducting experiments in mobile IoT. It enables experiments across three main axes; testing of hardware components, testing of software implementation of algorithms and network communication, and testing of dynamic re-routing of unmanned devices. RAWFIE includes testbeds in Greece, Spain, Germany and France. It also offers several types of UAVs, USVs and UGVs, which are either part of its testbeds or standalone. In addition, RAWFIE platform includes its own experiment toolset for designing and managing experiments.

There have been several research initiatives in the Future Internet Research & Experimentation (FIRE) open research environment, focusing on heterogeneous testbeds federations, such as Fed4FIRE, OneLab or WISEBED. While RAWFIE shares many similarities with some of these projects, it differs in the integrated use of UxV nodes in the testbeds. Federated testbeds mainly provide common access to several testbeds in the federation, which reduces the effort to conduct a test in another testbed. RAWFIE transfers this benefit to UxVs testbeds. It allows multidisciplinary experiments with potentially unlimited types of technologies, and offers a common platform for the management of a federation of testbeds, by providing a single point of access and a common software infrastructure, for the management, execution and

analysis of experiments carried out using UxV resources which can be available at the different testbed facilities with minimal adaptations, as the platform can easily support the addition of new data formats for data exchange with UxV nodes.

3.2 RAWFIE architecture

RAWFIE adopts a multi-tier architecture where each tier contains various components for the support of the mobile IoT vision. RAWFIE enables the implementation of a highly and easily extensible remote experimentation platform. The functionalities for the presentation of information to the experimenters, the implementation of the core parts of the business logic and the software interfaces for the integration of the different modules along with the data persistence are separated in different tiers. More specifically, the Testbed Tier undertakes the responsibility of providing functionalities for the actual control of the testbed resources (e.g. mobile IoT nodes) and the communication with the upper layers. It includes the software and hardware components that are needed to run the testbeds and UxVs. Testbeds comprise various software components related to the communication with the upper layers (i.e. Middle and Front-End Tier), the management of the infrastructure and the control of the UxVs.

Each testbed available through the RAWFIE federation is comprised of nodes of the same `x' type (i.e. ground, air or water surface) that use the same communication protocols for the ease of their integration in a unified and fully controllable environment (i.e. testbed). A Web based Front-End Tier allows experimenters to have remote access to the platform, authorization and visualization of the information, and interaction with testbeds' resources. The front-end tier includes the services and tools that RAWFIE provides to the experimenters to define and perform the experimentation scenarios. The Middle Tier implements most of the business logic and, particularly, the communication between the Front-End and the Test-bed tiers. The Middle tier offers a set of components that 'transform' the 'commands' defined in the interface in the appropriate format to be consumed by the end devices and testbed components. It provides the software interfaces needed and includes useful software components related to security, trust, control and visualization aspects. This tier provides the infrastructure which enables the creation and integration of applications in the RAWFIE platform. RAWFIE middleware is a virtualized infrastructure, i.e., Infrastructure as a Service (IaaS), indicating the maturity and versatility of the developed RAWFIE layered architecture. The Data Tier is in charge of ensuring data persistence. It is a collection of repositories that store the different data types generated and collected by RAWFIE components. All the integrated testbeds and resources accessible from the federated facilities are listed in a central service. The Data tier manages information relevant to the testbeds and resources (i.e., location, facilities) as well information on the capabilities of a particular resource and its requirements for executing experiments e.g., in terms of interconnectivity or dependencies. The provided data repositories are accessed whenever an experimenter wants to retrieve information related to available testbeds and resources using the respective Front End tool. Data Tier provides a large, secure, cloud-based central repository in which collected data can be anonymized and made available to users.

RAWFIE follows the Service Oriented Architecture (SOA) paradigm: all components provide clearly defined interfaces, so that they can be easily accessed by other components or replaced by components with the same interface. The services are described in languages such as WSDL. Interaction with them is made possible by the use of remote service control protocols such as SOAP or the REST resource invocation style. Additionally, a message-based middleware (via a Message Bus) is used, providing a coherent communication model with distribution, replication, reliability, availability, redundancy, backup, consistency, and services across distributed heterogeneous systems. The message bus interconnects all components and all tiers. It is used for asynchronous notifications and method calls/response handling. As such, it can be used for transmitting measurements from producers (e.g., UxVs) to consumers pertaining to the Middle/Data tier (e.g., experiment monitoring or data repositories).

4 RAWFIE Business model

In this section we proceed to further examine RAWFIE from a business model perspective. The description has been based on the Business Model Canvas, introduced by [19], a business model design template which provides a visual chart for documenting business models. The business model canvas contains nine building blocks for conceptualizing and describing a business model, in terms of value proposition, infrastructure, customers, and finances. Infrastructure is analysed into three building blocks, key activities, key resources and key partners. Customers are defined by three building blocks, customer segments, channels, customer relationships. Finances comprise two building blocks, cost structure and revenue streams. These nine business model building blocks, including value proposition, have been used as a tool for presenting the RAWFIE business model conceptualization.

RAWFIE platform provides a set of smart software tools to enable experimenters to remotely conduct and monitor experiments in the domains of IoT, including networking and sensing. RAWFIE federation allows for multiple types of experimentation, including testing with and among multiple and different mobile IoT devices. Experiments can involve different UxVs (e.g. UAVs) or different UxV types (e.g. UAVs with UGVs). Devices used in experimentations can be from different manufacturers and can be tested among different testbeds. The stakeholders can be the testbed providers, the unmanned vehicles/devices (UxVs) manufacturers and suppliers and the experimenters.

Another type of business model can emanate from the RAWFIE platform serving as a consolidator of testbeds and UxVs, an intermediary business entity which testbed providers and UxVs suppliers can join under various payment schemes. Intended RAWFIE customers-members can participate by paying a subscription or a commission based on their own revenue resulting from their use through the platform by RAWFIE customers. In this approach, testbed and device providers, who were previous RAWFIE stakeholders, become customers, extending RAWFIE business partnerships by adding new collaborations and new revenue channels. In this way, RAWFIE can be a mediator between infrastructure (testbed) and equipment (UxVs) providers and end user entities

interested in using RAWFIE facilities. With such a business model, RAWFIE allows for a full implementation of Platform-as-a-Service, Infrastructure-as-a-Service and Experimentation-as-a-service.

4.1 Value proposition

RAWFIE business models can be created providing a range of offerings for IoT experimentation across various domains to interested parties. The offerings can extend along three axes of providing (a) testbeds, (b) IoT devices (i.e. UAVs, USVs and UGVs) and (c) software tools for experiments. These three RAWFIE assets can be offered either separately or in combination. For example, a device, or a set of devices, can be available for experimentation separately or jointly with the use of a particular testbed or with a set of specific testbeds. Therefore, RAWFIE has the potential to provide various value propositions to respective prospects. Regarding testbeds, RAWFIE can be an intermediary connecting testbed providers with research or other entities that seek to use such testbeds for experimentation purposes. The value proposition can be stronger by offering the option to find testbeds or additionally use the RAWFIE software platform for conducting experiments in the selected testbeds. In a similar vein, RAWFIE can serve as a mediator among device manufacturers and suppliers and entities that seek to use such devices for experimentation purposes. This business model can allow for the combination of different types of devices that can be requested or made available for rent or sale, for example, combining different UAVs, or combining UAVs and USVs. The value proposition can be strengthened by providing a marketplace in which participants have the possibility to buy and sell or rent unmanned vehicles or additionally use the RAWFIE software platform for conducting experiments with the selected devices. Furthermore, the value proposition can also include the matching of IoT devices with respective operators, such as UAV pilots, UGV drivers and USV captains. As an IoT device intermediary, RAWFIE can also offer its available UxVs in combination with providing the option for a selection of available testbeds to use for experimentation with these UxVs. Finally, in a full and more complex version, RAWFIE can operate as a hub for testbed providers, device manufacturers, device suppliers, unmanned vehicles operators and experimenters.

4.2 Customer segments

RAWFIE is addressed to any entity that is interested in conducting experimentations with mobile IoT. Potential customers of RAWFIE business models can be universities or research institutions that can use RAWFIE to conduct experiments for academic purposes. Public organizations such as the police, the army, the fire brigade, local authorities and border control can also benefit from RAWFIE by using its devices or testbeds in order to test possible solutions for creating new services or improving the services they already offer. RAWFIE platform could also be a valuable tool for ecological and environment bodies and organisations in the pursuit of testing the efficiency and effectiveness of their ecology and environment protection plans.

Industrial customers, such as UAV, UGV and USV manufacturers and sensor manufacturers are undoubtedly one of the most important RAWFIE customer segments.

RAWFIE would be of great value to them in several ways. On the one hand RAWFIE could be used for either testing their products as part of the design and manufacturing of new products or of the updating of existing ones. On the other hand, UxV and sensor manufacturers could be suppliers of RAWFIE infrastructure, by renting or selling their products for experimentation or for the platform itself.

Software developers specializing in IoT are also significant customers of RAWFIE, offering their products to the platform or using it for developing new software or upgrading existing one. Industrial customers also include electricity/water supply companies that would be interested in using RAWFIE for their planning and testing their mobile IoT-based operations, including energy saving processes.

4.3 Customer relationships

Relationships have already been established with testbed providers, software developers and UAV, USV and UGV manufacturers and experimenters as part of the project scope. There partners are third parties that have been selected for receiving financial support through three open calls. Additional customer relationships can be established with testbed providers, device manufacturers and vendors, software developers and experimenters that seek to use RAWFIE for their activities.

Customer relationships can vary depending on the type of the exchange taking place between customers and RAWFIE. They can range from transactional relationships, for a single use of the RAWFIE infrastructure, in case of one experiment. to long-term relationships, for use of the RAWFIE facilities on a regular, recurring basis for a series of experiments. Customer relationships can also involve relationships that can be established among RAWFIE customers. This is the case of RAWFIE serving as an intermediary connecting RAWFIE customers, enabling them to establish relationships with other RAWFIE customers. Such relationships can be either transactional or long-term in case of partnerships that are formed within the platform for joint service provision.

4.4 Key activities

RAWFIE key activities are largely horizontal across business model types. RAWFIE core activity can be considered to be the experimentation provision. This includes the activities of experiment planning, with the options of testbed booking, device booking and device operator booking if needed. Experiment design and execution services are also part of the core activity, including software testing. Platform management is also a RAWFIE key activity supporting its operation.

4.5 Key partners

RAWFIE includes all actors from technology to facility provision and management. RAWFIE key partners are software developers, testbed owners and operators, device manufacturers and device operators. Specialized personnel for device service and maintenance as well as device insurance agencies can also be deemed as key partners.

4.6 Key resources

RAWFIE key resources are needed for. Physical resources include the testbeds, the UAVs, USVs, UGVs available for experimentation, which can be part of the testbed infrastructure. Physical resources also comprise the software and hardware components needed to run the testbeds and the UxVs as well as for designing and executing the experiments. In addition, the facilities for the storage and maintenance of UxVs are part of the key resources required for RAWFIE being operational.

4.7 Channels

RAWFIE customers can be reached through online and offline channels. In the online setting, a main channel can be RAWFIE website and social media or presence in other relevant websites and social media. RAWFIE can seek communication and raise awareness through sharing mobile IoT expert interviews or publishing newsletters or other promotional material such as advertisements, articles and videos in related websites that are visited by potential customers in mobile IoT experimentation. Potential customers could also be attracted through organizing or participating in conferences, exhibitions and events on topics related to mobile IoT.

4.8 Revenue streams

RAWFIE business models can induce revenue through various streams. Revenue models can be subscriptions or license, paid for using RAWFIE infrastructure or parts of it for a predefined time period. Another revenue model would be a transactional, pay-per-use scheme, with several versions. Under this scheme, customers can be charged per different basis depending on their intended use. A set of charge options could be available to select from, such as charge per experiment or charge per testbed. A charge per device could also be available, based on the number and the type of devices used. Charge per device can be applied either separately or in combination with charge per experiment or charge per testbed, depending on the use scenario.

Revenue can also come from RAWFIE partners participating in the platform as suppliers of testbeds, devices, or software, renting or even selling their products to other intended customers. Such RAWFIE partnerships can be another stream of revenue for RAWFIE business model, by partners paying a commission based on their own revenue resulting from their use of the platform for transacting with RAWFIE customers. These RAWFIE customers could also possibly be a source of revenue if they are charged a service fee for using RAWFIE platform for their transaction with RAWFIE partners.

4.9 Cost structure

RAWFIE business models entail several costs. These can include the insurance cost for the devices and equipment, the license and training cost for the UxVs operators and the maintenance cost for the testbeds, the UxVs and the software platform. Customer acquisition costs should also be taken into account.

Table 1: RAWFIE Business Model Canvas

<table>
<tr>
<td rowspan="2">Key Partners
• Testbed providers
• unmanned vehicles/devices (UxVs) manufacturers/suppliers
• Software developers</td>
<td>Key Activities
• Planning for experiments
• Testbed booking
• Devices booking
• Platform management</td>
<td rowspan="2">Value Proposition
• Platform for experimentation
- Testbeds
- Devices
- Software
• Experiment design
• Consolidator of testbeds and UxVs</td>
<td>Customer Relationships
• Transactional relationships
• Long-term partnerships
• Collaborations among customers</td>
<td rowspan="2">Customer Segments
• Experimenters (universities, research institutions)
• public organizations (police, army, fire brigade, local authorities, ecological bodies)
• industries (UxV manufacturers, software developers, energy companies)</td>
</tr>
<tr>
<td>Key Resources
• Testbeds
• UAVs, USVs, UGVs
• Experimentation software tools
• UxVs storage facilities
• UxVs insurance
• Licenses</td>
<td>Channels
• Conferences
• Exhibitions
• Events
• Website
• Social media</td>
</tr>
<tr>
<td colspan="3">Cost Structure
• Insurance of devices
• Device operators license
• Testbed maintenance
• Device maintenance
• Software platform maintenance
• Customer acquisition</td>
<td colspan="2">Revenue Streams
• Subscriptions
• License
• pay-per-use:
- charge per experiment
- charge per testbed
- charge based on the number and the type of devices used</td>
</tr>
</table>

5 RAWFIE SWOT analysis

Our study continues to a deeper understanding and assessment of the RAWFIE business potential through conducting a SWOT analysis, examining the strengths, weaknesses, opportunities and threats of RAWFIE business model, towards a complete view of our case.

5.1 Strengths

RAWFIE's main strength is its pioneering characteristics, as it is an innovative, unique platform for experiments with mobile unmanned IoT vehicles. Its innovation can be discerned into three intertwined pillars; a federation of testbeds for conducting experiments, a set of mobile unmanned devices and an experiment toolset. These are combined into an integrated experimentation environment, offering a collection of testbeds and devices and enabling users to design and conduct their own custom experiments with this equipment through easy-to-use tools. It provides interoperability of testbeds and devices, comprised of UAVs, UGVs and USVs, allowing for scalability and security and at the same time offering flexibility in experiment and device management with EDL based tools. It enables testing in the field, in real world conditions, including the weather, and in conjunction with the space and weight limitations of UxVs for mounting equipment such as sensors, cameras or batteries.

5.2 Weaknesses

RAWFIE is a new federation, with lack of experience. It may have to be enhanced in terms of functionality and equipment to reach maturity. In addition, because of its specialized nature, customer or user awareness of RAWFIE is limited and hard to raise. It can mainly be of interest to a niche market of academic or industrial entities active in mobile IoT and interested in relevant research and experimentation. There is also a difficulty of adaptability of the available IoT devices to the specific requirements of experiments. Energy requirements of mobile devices, and, in particular, the idle time needed between experiments for device charging and maintenance are weaknesses that could also hinder the successful implementation of RAWFIE business models. Another point of weakness is limitations associated with the specific availability of testbeds and devices and their management.

5.3 Opportunities

RAWFIE federation comes in a fruitful environment characterized by an increasing use of IoT in various domains. Mobile IoT, in particular, is still in its infancy, and receives a growing interest globally, creating a favorable setting for RAWFIE platform and services. The need for research and experimentation for IoT, especially mobile IoT, is strong, in both academia and industry. At the same time, there is a scarcity of IoT platforms offering similar functionality, combining testbeds, devices and tools for custom experiment design, execution and analysis. Mobile IoT as a service can facilitate experiments by supporting experimentation as a service, platform as a service, infrastructure as a service and software as a service. In this context, RAWFIE can be a powerful enabler of such service provision.

5.4 Threats

There are several threats that can potentially hinder RAWFIE business model success. First of all, the development of other competitive mobile IoT nodes platforms can shape a difficult setting for strategic differentiation. RAWFIE can also be threatened by the inadequacy of data storage and processing on autonomous IoT devices. Devices cannot yet accommodate powerful processing units, particularly in the case of UAVs that due to their nature have additional weight limitations. Similarly, storage capabilities are also limited,

imposing the need for data transfer to cloud which is not always feasible in real time. The heterogeneity of devices as well as the technological immaturity of data exchange protocols can also be a problem in the expansion of the platform. Another setback can be the lack of an appropriate legal or regulatory framework that can prescribe the efficient use of unmanned mobile IoT nodes, particularly UAVs. This could also involve issues related to security and ethics, with respect to experiment and data management.

6 Evaluation

A preliminary study was carried out as a starting point for evaluating the proposed business models. We interviewed representatives of four testbeds that participated in RAWFIE as third parties receiving financial support from Open Call 1. The participants were asked if they would be interested in participating in the following business models: (1) a testbed agent, an intermediary for finding testbeds for conducting experiments; (2) an intermediary for finding testbeds for conducting experiments, (same as #1), with the additional option to also use the RAWFIE software tools for the experiments in the selected testbeds; (3) an intermediary for finding testbeds for conducting experiments, (same as #1), with the additional option to also find UxVs to use for the experiments in the selected testbeds; (4) as an intermediary for finding testbeds for conducting experiments, (same as #1), with the additional options (a) to use the RAWFIE software tools for the experiments in the selected testbeds and (b) to find UxVs to use for the experiments in the selected testbeds (combination of #2 and #3) and (5) a hub for testbed providers, UxV suppliers, UxV operators and experimenters, that could be used by anyone for finding testbeds, UxVs, UxV operators or experimenters, either separately or in any combination, for conducting experiments. Apart from experimenters finding testbeds and UxVs, this can include any participant collaboration, for example testbeds finding UxV suppliers.

The interviewees expressed a strong interest in participating in all proposed business models, with the first option being the most preferred one followed by the third and then options 2, 4 and 5. Although responses were all in favor of RAWFIE as a business model, they also included concerns about issues that should be taken into account. These referred to RAWFIE tools and the need to improve reliability in order to be able to deploy any experiment in a more stable and easy way. The need for full documentation and maintenance programs jointly with UxV manufacturers was also pointed out as a necessary part of an agreement. The concerns expressed against participating in a RAWFIE business model also involve the cost to hire personnel to run these tasks, the testbed organization position in the industry and facing possible legal barriers.

7 Conclusion

This paper approaches IoT from a business viewpoint through the case of RAWFIE project, analysing its business prospect through the business model canvas, describing the dimensions and characteristics of potential business models. The latter are further analyzed with a SWOT analysis and preliminarily evaluated through a limited scale qualitative study. RAWFIE comes in a promising setting with vast business possibilities thanks to the growth in IoT technologies and applications and the increasing interest in mobile IoT in diverse domains. Our preliminary findings are by no means complete or generalizable, yet they can be deemed as indicative of the potential of IoT business models and IoT as a service, with an emphasis in mobile IoT and experimentation. In that sense, our paper can serve as a starting point for studying IoT business models and mobile IoT as a service, for either academic or industrial purposes. Further research with more and refined IoT business models and empirical testing with input from all involved actors, such as IoT device manufacturers, is necessary to provide more insights towards this direction. In addition,

future studies should include an in-depth analysis of mobile IoT as a service paradigm and the enabling of experimentation as a service based on providing IoT software, IoT infrastructure and IoT platform as a service.

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