RESTful API Design: A Device Deployment Microservice
(Technical Project)

Automotive Industry's Closure on Software as a Service
(STS Project)

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

In today's society, ownership of contents has taken a different form from what it had been decades ago (Perzanowski & Schultz, 2016). For certain software programs, such as purchasing a game CD, once the user pays a one-time, upfront fee, they can access the functions as long as it resides on the computer. However, with the emergence of software as a service (SaaS), users can choose to obtain software capabilities as a service by paying a continuous fee for the duration that the service needed (Kaur et al., 2014). In this model, users will no longer take on the responsibility of managing the hardware and platform. This benefits the end users by reducing operational overhead, eliminating their need for maintaining hardware, and lowering idle resources wasted due to overcapacity. Furthermore, this model increases the availability, scalability, and security of the services provided by having specialized technology from a third party (Ajeh, 2014).

On the other hand, SaaS is also not an end-all-be-all model for software service delivery as various problems comes with using it. For instance, once fully embedded into SaaS, the user is subject to the price demands of the corporation provider due to the high switching costs the user would incur (Elfatatry & Layzell, 2002). Additionally, the user data is prone to malicious attacks due to the additional layer of transmission between the user and the service provider. In general, the size of the database also makes it a more lucrative target for attackers (Chouhan et al., 2015). Even with the various risks, individuals are more willing to trade physical ownership to corporations in hopes of better quality and variety of service. As such, SaaS has become an increasingly prominent choice of software delivery for both users and providers. (Daim et al., 2021).

Aside from software, this model of “X as a service”, where X is the functions and utilities provided to the user, can be seen adopted in many different industries. One such industry is the Internet of Things (IoT) industry (Cloud Iot Core, n.d.; *AWS IoT*, n.d.). Things as a service (TaaS) exposes the physical properties of things and the utility that it provides to the user as a service, such as the heat from a seat warmer (Mandal et al., 2019). This alleviates the duty of maintenance and installation of the thing for the user TaaS is different from SaaS, where in SaaS the utility of an intangible object is abstract, but in TaaS, the end user will be in proximity to a physical “thing”. For example, with smart devices that are interconnected to comprise the IoT, its physical presence may affect how people assume their ownership over such things (Schultz, 2016). A recent phenomenon in the automotive industry has especially challenged the traditional sense of ownership. For example, BMW has offered its heated seats and heated steering wheels as a subscription service (Charlton, 2020). In another example, Tesla has limited the range of its batteries for lower-end car models despite having the same battery model and capacity as its higher-end siblings (Fung, 2017). In my technical project, I will implement and design a device as a service API for better testing automation in the company where I interned. In my STS project, I will explore the relationship between different industries that offer their products as a service and how it affects consumers in their ownership of “things”. Furthermore, I will investigate the adoption of X as a service in the automotive industry.

Technical Topic

A Seattle-based cloud service company provides a deployment and development platform for IoT devices as a service. Customers will bring their own devices and download the platform, the customers will be charged on a per-use, per-device basis depending on how much data is used. This platform allows users to deploy code easily and without additional technical skills.

They would no longer have to worry about low-level embedded management and data transmission between the cloud and the device.

As part of its software development cycle, the company has adopted continuous integration, continuous deployment/delivery (CICD) as the norm for delivering agile products and maintaining software, and software testing is an important part of this CICD workflow (Arachchi & Perera, 2018). The company has its mechanism for administering automatic testing, but due to the product being relatively new and the addition of a physical device layer, the IoT platform team had to create its testing framework from scratch. However, the testing framework for their service is monolithic and is deployed per test case, resulting in inefficient allocation of resources and interference from test cases using the same devices. There is excessive overhead in obtaining a physical or virtual device to test and the team seeks to find a new way to provision devices for testing.

The proposed solution is to decouple the device provisioning process as a micro-service in the form of a RESTful API designed to follow industry standards and internal specifications for path, method, and payload. This abstracts the testing capabilities of the device and exposes it to the user, which is the orchestrator in this case. The device setup, such as operating system installation and dependency installation, is done for the user and a simple request to the API will return a device for testing. The user will not have physical access to the device, but the computational capabilities and characteristics will be accessible to them through the cloud. I designed the API using Swagger OpenAPI specification (Swagger, 2020), which is a common industry standard detailing contracts for path definition, methods, testing design, and documentation (Musyaffa et al., 2016). This API allows for a centralized way for devices to be provisioned, preventing the device contingency issue by having a delegator assigning devices to test orchestrators. Furthermore, this centralized agency allows for better scaling and utilization of resources by stopping unused devices and increasing devices on hot standby when the request count increases. My solution will be able to solve the issues with the current device provisioning process and provide additional features that will help with the test workflow.

This service is presented as a device as a service model, where the physical connection to the device is abstracted and its functionalities are exposed to the user. The user will then have access to a variety of device types and capabilities. However, the user ultimately does not own the device, and must be returned after a certain time. This service, and IoT in general, challenges the way that we traditionally think about devices. Physical proximity to the device does not equal virtual ownership, and in the case of the I designed API, virtual control of the device does not equate to ownership of the device (Raina & Palaniswami, 2021). As technology progresses, and as software are embedded in physical "things", the contingency between physical and virtual ownership becomes more apparent. This Device Provisioning API is one concrete evidence of a such trend, and my STS topic seeks to find the boundary, or the lack thereof, between such contingency by exploring the case in automotive industries.

STS Topic

The paradigm shift from physical tangible objects to virtual intangible content has challenged and shaped our view of ownership. In the book *The End of Ownership*, Perzanowski and Schultz provided a helpful example of book ownership (Perzanowski & Schultz, 2016). When you buy a physical book, you would expect to own the physical book and have access to it. You can decide to lend it to friends, re-sell the book, keep the book, or keep it in your possession decades from now. However, this is not the case when it comes to eBooks. In the end-user agreement that precedes the purchase of an eBook, many publishers state that the content of the book is licensed to the end-user and place restrictions on how the contents may be accessed or shared. While E-books provide an opportunity for readers to consume media on one device, this change has posed many challenges to existing readers as they need to spend the time to read and understand the terms of the agreement (Guthrie, 2012). Similarly, this shift from ownership to licensing can also be seen in entertainment content, with the rise of subscription services in the likes of Spotify and Netflix. The user trades ownership of individual entertainment content for access to a wide array of content. In his paper, Belk suggested that "traditional models of sales and ownership" need to be challenged and vendors should "consider forms of possession and uses that do not involve ownership" (Belk, 2014). However, the examples within the paper were largely internet related, like the car-sharing service ZipCar, and does not touch on individual ownership of physical properties, such as recent incidents of features that are offered in the car. How far can the extent of offering products as a service or subscription go and should it be adopted by every industry?

I seek to borrow from the theory of Social Construction of Technology (SCOT) as a method to analyze the application of X as a service. As Pinch and Bijker explained, in SCOT "the developmental process of a technological artefact is described as an alteration of variation and selection" (Pinch & Bijker, 1984, p. 411). In SCOT relevant social groups are not simply grouped into users and providers, they are bound by the value that they perceive from the technology. In the case of heated seats, the users can be further categorized into those who want heated seats and those who do not desire to have heated seats. There are two stages to the methodology of SCOT. The first is to show the interpretative flexibility of technology, not only in the perception of it but also flexibility in its design. X as a service demonstrates this flexibility as it has been adapted by many industries. The second stage of SCOT is closure, particularly closure by redefinition of the problem, where the meaning of the technological solution has been translated to another problem. As seen with the case in the automotive industry the subscription plan does not seem to satisfy, or at least the vendors do not demonstrate how it satisfies the user problem. This STS field and method is fit for analytical usage in investigating the difference between industries on the topic of X as a service.

In addition, I will also analyze the relationship between this technology and humans. Particularly, how X as a service influenced user expectation of technology in addition to how presumptions about its user have influenced the design and adaptation of the technology. I wish to use this to understand how such presumptions about the user gas led certain industries to design X as a service.

Research Question and Methods

The central question to my research is: “How have auto manufacturers enacted closure by redefinition of the problem around software as a service model.” Particularly, I would like to understand how auto manufacturers projected the SaaS model onto their industry. How has our perception of ownership shifted from the emergence of SaaS model and how are the auto manufacturers trying to pursue this? Do the different relevant social groups have closure? These questions are central to analyzing the necessity of the adaption of X as a service model in different industries.

I will investigate the research question with two methods: literature analysis and synthesis, and discourse analysis. Numerous works of literature have been published regarding the influence of digital content on psychological ownership and identity, a paper by Belk being such an example (Belk, 2013). I wish to read such articles in the cross-section of X as a service and perception of ownership, X as a service and IoT, IoT and perception of ownership, and automotive industry and X as a service. A synthesis of such reading will be constructed comparing and contrasting the adaptation of X as a service in the software industry and how auto manufacturers have redefined the problem to fit into this service model. Furthermore, a discourse analysis will be done on the topic of the auto industry adopting a subscription service. Due to the relatively new adaptation of X as a service in the auto industry, I will mainly be relying on marketing material, PR material, op-eds, and news articles.

Conclusion

Overall, I seek to analyze the relationship between X as a service and our perception of ownership. Both in how our acceptance of it in certain industries has accelerated the adoption of this model in other industries and how the option of a subscription service has influenced our preference in ownership and content consumption methods. In doing this analysis, it will help answer how our technological citizenship duties and rights have shifted by such developments and would hopefully help suggest a policy when dealing with such services going forward (Andrews, 2006). I expect that both relevant social groups, those that want heated seats and those that do not, did not find closure in this solution. Furthermore, I do not expect convincing support for the adaptation of X as a service in the auto industry besides the constant stream of revenue that will be generated.

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