What's up with all these researchers using our open source software?

In this lightning talk we'll blitz through what makes the technology we developed at **reelyActive** attractive to researchers, and what part, if any, open source plays in this. Also, why did we as a for-profit startup choose to publish and not patent our own innovations? Finally, what have researchers achieved in hospitals, service stations, construction sites, experimental stores, preschools, and even buses—and what could these possibly all have in common?

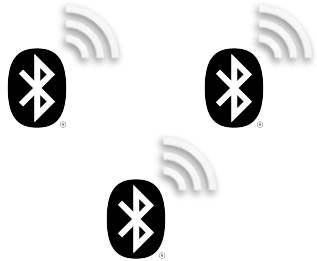
Jeffrey Dungen, Co-founder & CEO of reelyActive

What's our open source software?

Ambient data from *any* **radio-identifiable** devices captured by *any* infrastructure in any physical space

Middleware

Who/what is where/how?



Embedded software

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Scientific Data 7, Article number: 354 (2020) | Cite this article

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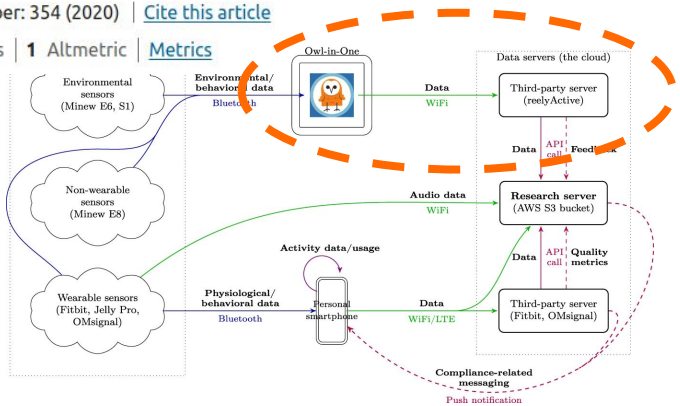
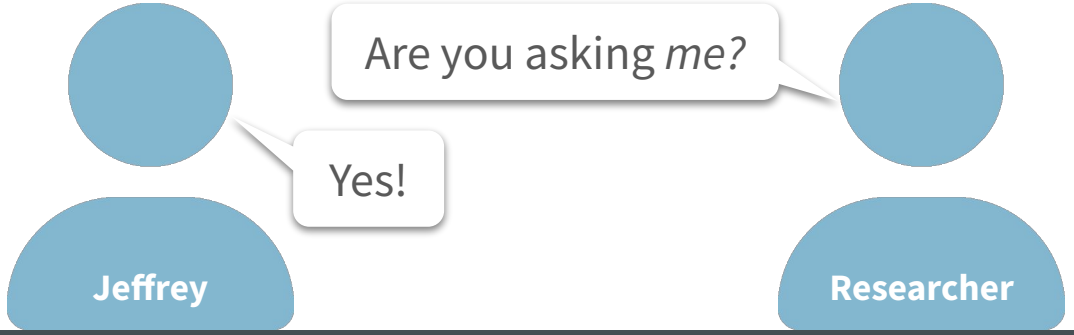


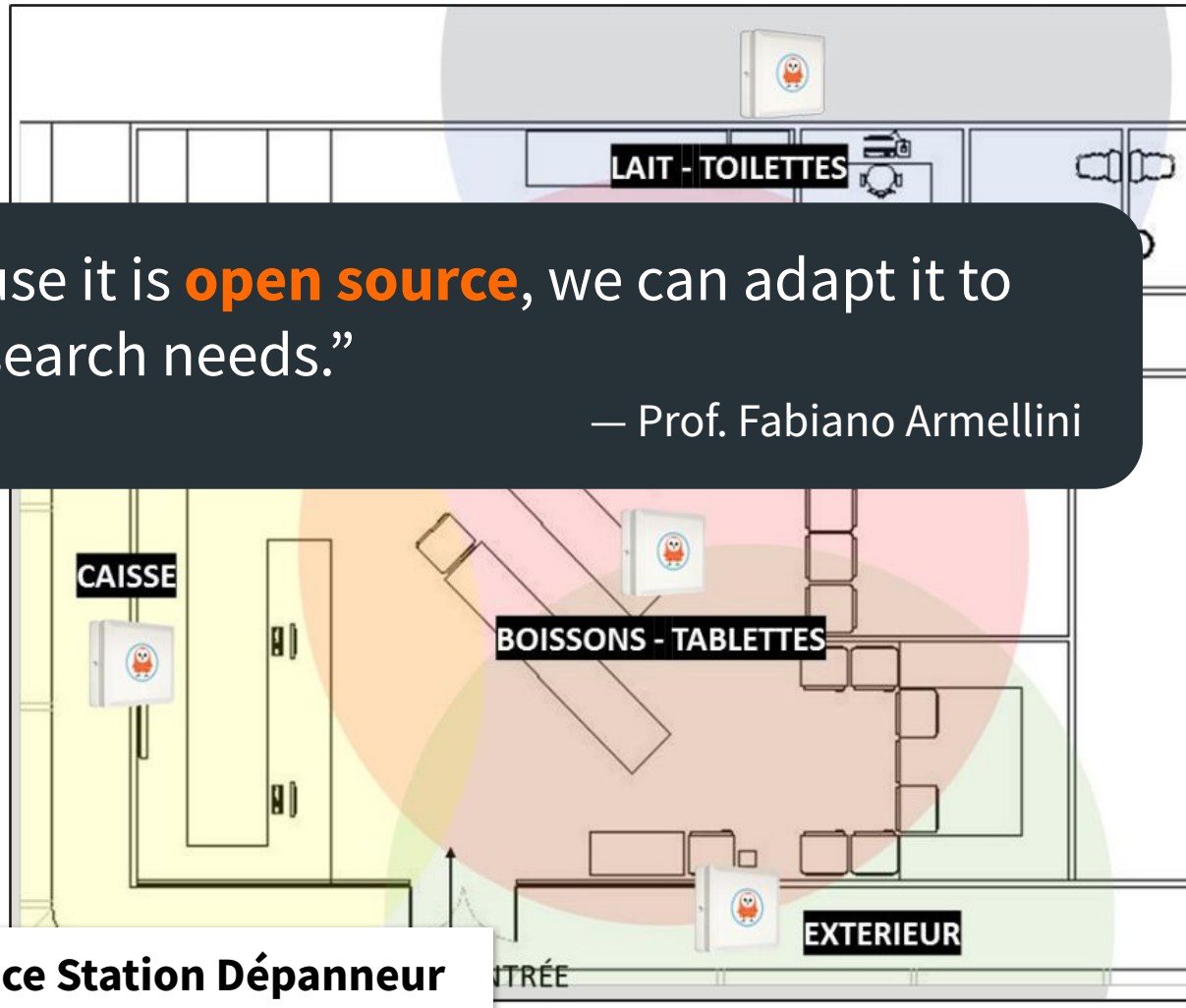
Published in Nature?

Pretty cool given that we never set out to develop research software!

What's the attraction for researchers?

And what part—*if any*—does open source play?





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"Because it is **open source**, we can adapt it to our research needs."

— Prof. Fabiano Armellini

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Exploring the application of IoT in the service station business

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Abstract: This study aims to research the application of the Internet of Things (IoT) using Bluetooth Low Energy (BLE) technology in convenience stores of gas stations to supporting decision-making and improve business operations. This study is developed in partnership with a gas station franchise of Canada's largest integrated oil and gas company operating in the province of Quebec. The data collected from the IoT-system are compared with the data from the enterprise management system and analyzed with data mining techniques. Results reveal that IoT can help improve customer experience and business operations in service stations toward the digital transformation.

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Keywords: Internet of things, Bluetooth, Product-Service Systems, Data mining, Industry 4.0, Information Communication Technologies, Design Science Research, Proof-of-concept.

1. INTRODUCTION

The Internet of Things (IoT) is a primary technology to enable Industry 4.0 and companies' digital transformation (Ferreira et al., 2020; de Paula Ferreira et al., 2022a,b; de Souza Dutra et al., 2020). It is defined as a "pervasive presence around us of a variety of things or objects [...] which are able to interact with each other and cooperate with their neighbors to reach common goals" (Atzori et al., 2010, p. 2787). A global survey across different retail segments reveals that most retail decision-makers are ready to adopt IoT to offer customers a personalized in-store experience, and they consider managing big data as critical to improve their operations (Zebra, 2017).

IoT-systems can be used to predict consumer needs by observing their habits through data coming from consumers' smart devices (e.g., smartphones, smartwatches), and to enhance existing Product-Service Systems (PSS) through new functionalities, i.e., customization and data transparency (de Souza Zanetti et al., 2016). For example, a customer who walks into the store can be identified by her or his phone and then notified to an in-store promotion, which is only directed towards her or him based on the browsing history (Manzyuk, 2015). Another identified IoT application is the optimization of the store layout based on consumers' location, where high margin products can be placed with high traffic (Gregory, 2015).

The Canadian industry of gas stations with convenience stores is expected to grow over the next years (IBISWorld, 2020). Nevertheless, according to Rubera et al. (2019), fuel retailers will need to (1) move from a vehicle-centric business model to a customer-centric, (2) transform the network of service stations and assets, and (3) develop new digital capabilities to capture new value opportunities, embracing innovation and new technologies, such as artificial intelligence and IoT. There are several studies on IoT in retail segments (Hwang and Jung, 2017; Hagberg et al., 2017; Jeon et al., 2018). However, to the best of the authors' knowledge, this is the first study analyzing the use of IoT in service stations' convenience store business.

Bluetooth low energy (BLE) technology allows dynamic data transmission between devices wirelessly using minimal energy (Jeon et al., 2018). It was designed to empower IoT applications, considered a primary solution for several IoT use cases, e.g., localization, proximity detection, and activity sensing (Jeon et al., 2018). This study investigates IoT technology's application in the service station's convenience store sector to support decision-making and improve business operations. A pilot project using BLE technology is developed in partnership with a gas station franchise of Canada's largest integrated oil and gas company, which owns a chain of 12 service stations with convenience stores located in the province of Quebec, Canada.

The remainder of this paper is organized as follows. Section 2 presents a literature review of IoT and data mining applied to retail and convenience store. Section 3 and 4 describes the methodology and IoT architecture, respectively. Section 5 introduces the results. Section 6 presents the discussion. Finally, Section 6 presents the conclusions and recommendations for future research.

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10.1016/j.ifacol.2021.08.383

Service Station Dépanneur

“Our research project combines blockchain and IoT for traceability, and **open source** technologies like Pareto Anywhere provide the freedom and flexibility to experiment with such novel integrations.”

— Prof. Luis Antonio de Santa Eulalia

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Lobster Supply Chain

Photo by Artem Zhukov on Unsplash

OSU researchers ‘kid-proofed’ their badges by adapting DirAct’s **open source** code.

Pre-K Classrooms

The Ohio State University

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GINA CODY SCHOOL OF ENGINEERING AND COMPUTER SCIENCE

"The **open-source** platform allowed us to develop a solution [that extended well beyond our original mandate.]"

— Prof. Mazdak Nik-Bakht

COMPLECCITY

Construction Sites

« Avec mes étudiants je fais de la recherche. Nous sommes intéressés par les applications, mais aussi par ce qui se trouve derrière l'application. Comment elle fonctionne? Quelle est la logique de programmation? Comment miser sur le code existant pour développer autres chose, etc. …et pour ça, **il faut avoir accès au code** 😊 »

— Prof. Ygal Ben-David

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What can we conclude?

Research is about **curiosity**, and **open source *eliminates* all artificial barriers** to **curiosity**.

Researchers were as delighted to have **access to the developers of the code**, as access to the code itself.

www.reelyactive.com
github.com/reelyactive