

# Researchers develop ways to make IoT truly ubiquitous

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Credit: Óscar Novo Díaz / Aalto University

In recent years, the Internet of Things (IoT) has become a reality. It has helped automatize our homes, healthcare and industrial manufacturing, to mention just a few application areas. In the home environment, this can mean that your energy supplier reads your energy meter automatically, or that you have a security system in your home that allows you to monitor and manage your property simply by using a mobile app.

Óscar Novo Díaz, Doctor of Science (in Technology) who recently graduated from Aalto University, says that IoT can be seen as an extension of the internet, and one of its most essential aspects resides in its ubiquitous nature. IoT devices are broadly available and fully connected to each other and the Internet.

However, one of IoT's main challenges, too, lies in its ubiquitous nature: Currently, technical challenges prevent making the most of IoT's potential. Óscar Novo recently defended his [doctoral dissertation](#) on this topic, and he focused on four specific categories: ubiquitous communication, access control, concurrency control and ubiquitous semantics.

"Right now, we have protocols for the Internet of Things, but we have to ensure that all those protocols—in terms of security, accessibility, and so on—are totally invisible and work very smoothly, without spending too many resources of the constrained IoT devices," he explains. By the term "constrained," he means that inexpensive devices, such as small sensors, run on batteries and have a relatively low computation power.

The decentralization of IoT, its heterogeneity in terms of protocols, technologies and standards, has created several interoperability questions from the perspective of connectivity, management and data processing. Many of those challenges are scattered across the various layers of the internet protocol stack, making it difficult to identify the crucial mechanisms contributing to the cause.

As an important part of his doctoral research work, Óscar Novo and his colleagues developed several solutions that address these problems. Specifically, the researchers implemented an IP-agnostic mechanism that enables the connectivity and communication of IoT devices behind network address translations. Moreover, they designed and implemented a resource concurrency framework to manage the concurrent access of shared resources in IoT environments.

To improve the current access control situation, they also designed a decentralized [access control](#) management system that relies on blockchain technology to control the authorization policy of the IoT devices. Finally, they addressed the problem of semantic interoperability, proposing and implementing a system designed to enable interoperability across heterogeneous semantic IoT domains.

Due to the COVID-19 pandemic, Óscar Novo's public defense took place online. He was physically together in the same lecture hall with the kustos, Professor Antti Ylä-Jääski, and the opponent,

Professor Sasu Tarkoma, but everyone else followed the conference over Zoom. Novo thinks that everything went well and having the conference online had its benefits. "Normally, public defenses are quite heavy and some people may be more interested in the presentation, while others want to hear the discussion with the opponent. Now, people could just join and leave the conference whenever they wanted."

Professor Ylä-Jääski kept track of the number of participants during the event and he told Novo that, at some point, around 20 to 30 people were following it online. "That felt really nice."

Óscar Novo has been working on the IoT field for years, for which reason it felt natural to select it as his dissertation topic, too. Currently, he is working as a researcher at a private company. "I would like to move toward another research topic, but still stay connected to IoT and use my IoT knowledge. For example, artificial intelligence is a very promising and interesting area of research."

Provided by Aalto University

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