



UNIVERSITY
ACTION LAB

A grey map of Europe with Portugal highlighted in red. A white box with the word 'Portugal' in red text is placed over the red area. A red line and a blue line cross the map.

Portugal

Good Practice Case Study

Porto Living Lab

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PROJECT PARTNERS



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GENERAL INFORMATION

| | | | |
|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|----|
| Title of the case | Porto Living Lab | | |
| Sales pitch | The partnership between Porto Digital, the Municipality of Porto and the University of Porto turned the city of Porto into a smart city and an urban-scale living lab – the Porto Living Lab. The Living Lab comprises a network of wireless sensing and communication nodes that is interoperable with the city's optical fiber and Wi-Fi networks. | | |
| Organisations | <ul style="list-style-type: none">• Porto Digital• Municipality of Porto• University of Porto (Center of Competence for Future Cities) | | |
| Country | Portugal | | |
| Authors | <ul style="list-style-type: none">• Catarina Reis• Filipe Aranda de Sá | | |
| Nature of interaction | Urban-scale living lab | | |
| Level of mechanism | <input type="checkbox"/> Government policy (e.g. law, funding framework) <input type="checkbox"/> Organisational strategy (e.g. university/business/agency) <input type="checkbox"/> Structural element (e.g. centre, lab, office) <input checked="" type="checkbox"/> Operational level (e.g. activity or programme) | | |
| Length of programme | Not specified | Formality | NA |

Curricula-bound,
co or extra-
curricular?

| | | |
|----|---------------------|----|
| NA | Level of initiative | NA |
|----|---------------------|----|

Summary

The Porto Living Lab is the result of a long-term partnership between the Academia and the Municipality, led by the Center of Competence for Future Cities of the University of Porto. It is not a physical lab, but a network of institutions, supported by technologies, which look at the city as a test bed. In fact, it serves as an agile collaboration platform for a critical mass of scientists and engineers based at various schools of the University of Porto.

The Porto Living Lab aims to turn the city of Porto into a lab for urban sciences and technologies for smarter cities, by providing different test beds (infrastructures used to test technologies, such as software and hardware, normally in real or close to real scenarios) with a wide range of sensors and communication infrastructures. It is creating the conditions for present and future research and development using advanced technologies for data collection through mobile platforms, wireless communication and large-scale information processing.

The Porto Living Lab is a good example of university-city collaboration because it had tangible impacts on citizens' benefits (free access to wi-fi in the city of Porto and particularly on buses), on university students (widening the coverage of the EDUROAM wi-fi network), on the Municipality and on the University (for both, in several domains, particularly in terms of international projection). On the other hand, it created the conditions for a spin-off company of the Academia (Veniam) to test and demonstrate its technology on an urban scale, thus contributing to its growth and international affirmation.



CASE STUDY PROFILE

BACKGROUND

In October 2012, the University of Porto kicked-off the Future Cities project (a European-funded project). The goal was to expand the Center of Competence for Future Cities of the University of Porto, thereby unlocking the full potential of interdisciplinary research in urban technologies, while strengthening knowledge transfer activities in close cooperation with local and global industrial partners.

The main project's activities required the deployment of advanced sensing and communication technologies in the city, in order to be used as large-scale experimentation facilities (urban test beds) for research and development (R&D) purposes – the Porto Living Lab needed Porto Digital.

Porto Digital owns and manages a metropolitan optical fiber network and a public access Wi-Fi network in the city of Porto, which were key technological assets for the operation of the test beds, which also required the deployment of new infrastructure in the city, in particular, in the public space.

Accordingly, in 2013 Porto Digital, the Municipality of Porto and the University of Porto joined efforts towards the creation of the Porto Living Lab, which comprises a network of wireless sensing and communication nodes that is interoperable with the city's optical fiber and Wi-Fi networks.

One of those test beds is the Vehicular Ad-hoc Networking (VANET), which is a network of vehicles that connect to each other and to the infrastructure. The VANET test bed consists of hundreds of networked vehicles, which use DSRC (Dedicated Short-Range Communications), Wi-Fi or cellular communications to connect to each other and to the infrastructure. The VANET test bed comprises communication systems which assure vehicle-to-vehicle (V2V), vehicle-to-roadside (V2R) and vehicle-to-infrastructure (V2I) communications, and was deployed by installing on-board units (OBUs) on vehicles, road side units (RSUs) at particular city spots and by connecting the RSUs to the access infrastructure (fiber network).

After successful initial tests made on city taxis, the VANET network was expanded to the public bus network, which is operated by Sociedade de Transportes Colectivos do Porto (STCP). By doing so, each bus was turned into a Wi-Fi hotspot, and thus, enabling the connection of the bus and the bus passengers to the VANET and to the Internet. At the time, this was the largest vehicular network in the world.

As a natural result, STCP launched a free Wi-Fi service to its bus users – the “STCP Free WiFi service” – which covered almost the entire fleet. The launch event took place on the 22nd of September 2014 (the World Car Free Day) and within the 2014 European Mobility Week. Although STCP's bus network covers six cities of the metropolitan area of Porto, the Wi-Fi

service was only available within the city of Porto, because this is the only city equipped with RSUs and with a metropolitan optical fiber network.

At the time, as a result of a previous technology transfer process from academia to business, the intellectual property related with the VANET's technology and owned by Instituto de Telecomunicações (IT), University of Aveiro (UA) and University of Porto (UP) was already being exploited by a local start-up company, which was a spin-off of these R&D partners.

Accordingly, this deployment and service was a proof-of-concept and the 'final' test of the developed VANET technologies, a demonstration of their feasibility on a city-scale level and a validation of the company's solutions on a real-life urban scenario. This demonstration was very important for the company in the process of capital raising from international venture capital firms and for its internationalization, and thus turning it into one of the most successful and worldwide known Portuguese technology-based scale-up companies.

As a conclusion, Porto Living Lab enabled urban-scale experimentation and testing by the R&D community, enabled a free Wi-Fi service to be provided to the public bus users in the city of Porto, engaged with end-users, and empowered a local start-up company to scale-up to global markets. It also strongly contributed to positioning the city of Porto as a smart city and to raise its awareness, nationally and internationally, in the smart cities' domains.

The living lab also enables the development of research in areas such as sustainability, mobility, urban planning and information and communication technology.

CONTEXT

To enable the University of Porto to become a key European player in the emerging scientific and technological field, the Center of Competence for Future Cities was built on the expertise of several research groups that have attained international recognition for their research programmes in topics relevant to Future Cities. Originating from different schools (Sciences, Engineering, Psychology and Education Sciences), these research groups use very diverse methodologies and scientific approaches.

The Center of Competence for Future Cities of the University of Porto creates the necessary conditions for these groups to work together in a multidisciplinary way, thus fostering present and future research collaboration, and increasing the innovation potential of the University of Porto and its industrial partners.

OBJECTIVES AND MOTIVATIONS

The Center of Competence for Future Cities of the University of Porto, the Municipality of Porto and Porto Digital wanted to create the Porto Living Lab. The Center of Competence for Future Cities of the University of Porto (together with other R&D partners) wanted to deploy city-scale test beds in order to perform urban experimentation and testing. The Municipality of Porto had the ambition and a strategy to become a smart city. Porto Digital wanted to expand its optical fiber and Wi-Fi networks. STCP wanted to provide free Internet access on the bus fleet, and thus

provide a valued service to its passengers and attract new public transportation users. A local start-up company (which was a spin-off company of the Universities of Porto and Aveiro) wanted to demonstrate their technologies and solutions at a city-wide level and real-life urban scenario. All wanted to raise international awareness.

STAKEHOLDERS

The stakeholders involved in the project include:

- Representatives from governmental organizations: Municipality of Porto
- Representatives from public organizations: STCP, Metro do Porto, APDL
- Students, professors and researchers from universities and polytechnics: University of Porto, University of Aveiro, Carnegie Mellon University, MIT, London's Global University, KTH Royal Institute of Technology, INESC TEC - Institute for Systems and Computer Engineering, Technology and Science, École supérieure d'électricité - Supélec
- Representatives from research centers: TICE.PT, UPTEC, CEIIA, CEDT
- Representatives from private companies: Instituto de Telecomunicações, Dell, Critical Software, Soares da Costa, Raditaxis, IBM, Microsoft, EDP, Porto Digital, Ubiwhere, Wipro, Devscope, Portico, Wavecom, 3Decide, Strong Step, Gisgeo, Cordmobili, Biodevices, Novabase, Nokia Siemens Networks, Efacec, ISA, SmartWatt, HP, Cisco, Witsoftware, Voice Interaction, Petrutex, Schneider Electric, PT, Nanium, Edigma, Multicert, Anubisnetworks, Geolink, Streambolico, CGI, InterHost, Creative System, Accenture, EDI Software, Shortcut, Microfil, Inovarix, Vmuse, Inovretail, Aream, Metrify
- Citizens (end-users)

PROCESS

INPUT

City-scale digital communication infrastructures (Porto Digital), knowledge and technologies on advanced sensing and communication technologies (UP and other R&D partners) and political will (Municipality of Porto).

ACTIVITIES

The activities performed within the project include the following:

1. Multidisciplinary research and development: Some of the R&D activities (e.g. telecommunications, electronics and computer engineering, psychology and health, architecture and design, computer science, and chemical and environmental engineering) involve stress and fatigue monitoring of bus drivers, policemen and first responders through cardiovascular assessment; citizens' happiness and mood assessment through crowdsensing and surveys; environmental monitoring with sensing technologies; relation between technology, art and design; vehicular DSRC communications; opportunistic communications; route optimization; and urban policies assessment.

2. Deployment of advanced sensing technologies in the city: Wireless (Wi-Fi) environmental sensing stations (which measure and monitor air quality, meteorological and noise parameters); pedestrian counters (which count the number of pedestrians in a given area); and crowdsensing technologies (which enable the citizens to use the sensors embedded on their smartphones to monitor several parameters, such as location and light conditions, and also to use external sensors, such as heart rate monitors).
3. Deployment of advanced communication technologies in the city: On-board units (OBUs) on vehicles (buses and taxis), which enable vehicle communications; roadside units (RSUs) at particular city spots; and connection of the RSUs to the city's access infrastructure (fiber network).
4. Technology and proof-of-concept testing and demonstration at a city-scale: Test and demonstration of a vehicular network (which, at the time, was the largest vehicular network of the world) operating at a city scale in real conditions (more than 400 vehicles), with real end-users, and with a fully deployed and operational service (STCP Free WiFi service).
5. Technology transfer from academia to business: The results of this project (in particular, the ones related with the vehicular network) were transferred to and exploited by a spin-off company of the Universities of Porto and Aveiro, after signing an IP agreement between the three parties.
6. New services exploitation: Free Wi-Fi service for the public bus users (STCP Free WiFi service).
7. End-user engagement: The solutions were co-developed and tested with end-users (such as, citizens who used crowdsensing tools, citizens who used the public buses, bus and taxi drivers, policemen, first responders, the Municipality of Porto, STCP).

More specifically:

The Vehicular Ad-hoc Networking testbed is being implemented in two ways. On the one hand, the FP7 initial project has instrumented with 802.11p technology harbor trucks that move regularly among containers packed as high as buildings, emulating a small-scale city. On the other hand, +600 buses in the City of Porto are currently operating a hybrid wireless ad-hoc network that seamlessly switch between 802.11p, Wi-Fi and 4G

SenseMyCity consists of an infrastructure for the simplified collection of geo-indexed data sensed using mobile devices, along with a pool of users willing to participate in experiments and the logistical support for city-wide experiments. The technical infrastructure consists of a mobile Framework to gather data from the device's available sensors; a server to store and process the data; and a webpage to consult information in a user-friendly way.

The Urbansense platform is a city-wide platform for pervasive environmental monitoring. It is composed of 20 monitoring units called Data Collection Units, or DCUs, that are deployed at relevant points of the city and contain a set of 10 sensors.



OUTCOMES AND IMPACT

OUTPUTS

Outputs of this collaboration include:

- Porto Living Lab [University of Porto, Municipality of Porto, Porto Digital, Veniam and end-users]
- Expansion of the optical fiber network [Porto Digital]
- Expansion of the Wi-Fi network [Porto Digital]
- STCP Free WiFi service [STCP, end-users]
- Demonstration/validation of a commercial solution [Veniam]
- Increase of national and international awareness in the smart cities domains/markets [University of Porto, Municipality of Porto, Porto Digital, Veniam and the city of Porto]

IMPACTS

The Porto Living Lab was instrumental in placing not only the University of Porto, but also the city of Porto on the map of smart cities in Europe and worldwide. The project has proven the viability of a city-scale mesh network of connected vehicles that become part of the city infrastructure to expand wireless coverage for a wide range of smart city applications. In addition, the Porto Living Lab led to the creation and growth of a university spin-off company, which is successfully translating the results of the basic and applied research into products, services, qualified jobs and export opportunities.

SUPPORTING ENVIRONMENT & SYSTEM

SUPPORTING MECHANISMS

Future Cities project (www.futurecities.up.pt), funded by the European Union under the FP7 - 7th Framework Programme for Research and Technological Development (<https://cordis.europa.eu/project/rcn/105134>).

BARRIERS AND DRIVERS

Barriers to the smooth implementation of the project include high bureaucracy of public procurement procedures (which brought complexity and delays in the equipment purchase by the University); and slow decision taking by some stakeholders (which made the deployment of the equipment dependent on the decisions of a small number of persons, in particular, in vehicles and in the city). The complex and expensive deployment of the city infrastructure is

another barrier due to the high number of required equipment, the need to perform installations in public facilities, and to make road works.

Drivers of the successful implementation of the project include common/ convergent goals, and high motivation and determination from the main stakeholders.



LESSONS LEARNED

CHALLENGES

Sustainable and longer-term funding would be needed for follow-up activities and sustainability of the solutions proposed by the students within PKP projects in general. However, as PKP projects are being funded regularly since 2014, there is opportunity for development of follow-up or upgraded projects, focusing on the same city area, or sustaining and deepening the partnerships established between the participating University and non-academic partners.

KEY SUCCESS FACTORS

Availability of significant financial resources by the University of Porto (provided by the European Union within the scope of the Future Cities project); availability of digital communication infrastructures in the city of Porto, in particular, the optical fiber Metropolitan Area Network (MAN); leadership of the Center of Competence for Future Cities of the University of Porto; political will and support from the Municipality of Porto.



FURTHER INFORMATION

AWARDS AND RECOGNITION

The STCP Free WiFi service was considered a “Good practice” on the [Smart City Index Portugal 2016](#) (where the city of Porto was ranked first).

TRANSFERABILITY

Technology transfer process of intellectual property from Instituto de Telecomunicações (IT), University of Aveiro (UA) and University of Porto (UP) to the spin-off company Veniam.

PUBLICATIONS

- Eric Jaffe, "Meet the Start-Up That Wants to Turn Your City Into One Big WiFi Hotspot", [CityLab](#), 02/12/2014
- Federico Guerrini, "Free wi-fi? Mesh networking? Bins that talk? Porto project shows it's a load of garbage", [ZDNet](#), 17/01/2015
- Matt Burgess, "Internet for all: The plan to turn one billion vehicles into free WiFi hotspots", [Factor](#), 17/02/2015
- Lauren Frayer, "Free Wi-Fi On Buses Offers A Link To Future Of 'Smart Cities'", [NPR](#), 02/03/2015
- Pedro M. Santos et. al., "PortoLivingLab: an IoT-based Sensing Platform for Smart Cities", IEEE Internet of Things Journal, Vol. 5 Nr. 2, pp. Pages: 523-532 (2018), [DOI: 10.1109/jiot.2018.2791522](#)

LINKS

- Center of Competence for Future Cities of the University of Porto: www.futurecities.up.pt
- Municipality of Porto: www.cm-porto.pt
- Porto Digital: www.portodigital.pt
- STCP: www.stcp.pt
- University of Porto: www.up.pt
- Veniam: www.veniam.com

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