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City-scale Internet of Things (IoT) infrastructure:

Applying a collaborative, people-centric approach

Background

The London Living Labs is a city-scale environment that is instrumented to enable experiments to be carried out in situ. It has been established by Intel, the Future Cities Catapult, researchers at ICRI Cities and a collective of local stakeholders in the city.

The environments include schools, parks and city neighbourhoods, which are instrumented using an Intel Galileo-based end-to-end Internet of Things (IoT) infrastructure and informed through an ethnographic research process. The multi-layered, people-centric approach helps us to better understand and design for a range of scenarios and use cases with communities, city officials and stakeholders to help design for the connectedness and sustainability of future cities. This collaboration is imperative to the London Living Labs project.

The current installation base is 120 Intel gateways servicing about 600 Intel sensor end points. Locations include Hyde Park, Enfield, Brixton, Elephant and Castle and Tower Bridge. Further deployments are in progress in Manchester, Peterborough, Dublin and San Jose.

Motivation:

The common sensor type, requested by all of the city stakeholders collaborating on the project, has been for air pollution.

To put this in context, from a health perspective, the World Health Organisation has reported that over 7 million deaths around the world could be attributed to poor air quality in 2012. From a financial perspective, the costs of particulate matter (PM2.5) levels to the UK, is in the range of £8-17 billion per year according to the Policy Exchange report "Something in the Air," and PM2.5 is only one of the many pollutants found in the air.

Smart city sensor system

Addressing the air quality issue is not simply an urban "problem", it's a question of how to address urban innovation in a way that is grounded but forward thinking as well as sustainable: environmentally, economically and socially.

One of the aims of the London Living Labs is to turn air quality from an invisible problem into a more tangible and thereby actionable one, by sensing air quality, increasing literacy and finally, both sharing and designing tools with people so that they can use them to contribute to the solutions. Part of the project is to find new ways to trial and prototype innovations in a real city environment, in order to build evidence of their performance-in-use which can help tools to become commercialised at scale.

Over the long term, insights from data will provide a foundation for evidence-based solutions which can help the project to support SMEs developing business cases for new products and services looking to scale existing solutions in this area.

Built Environment

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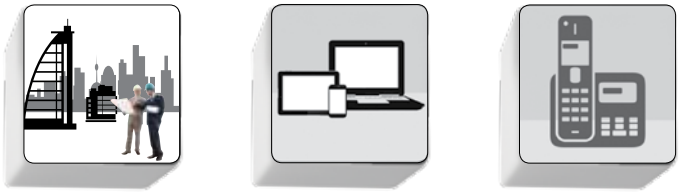

Development

In Enfield, the project team are working with the Council to explore how sensor data can empower councils and citizens to address air pollution. The approach has three phases: acquire, analyse and action.

- In the first phase, gateways monitor data from air quality sensors (CO, NO, NO2, SO2, VOC) and weather sensors (humidity, temperature, rain, wind) then transmit that data via either GSM, Wifi or Zigbee to our cloud data store.
- In the second phase, gateway level and cloud-based analytics are combined with sensor data and traffic flow data from third party sensor streams.
- In the third phase, those analytics are used to explore the relationship between interventions such as "walk to school campaigns" and their impact on reducing localised pollution associated with the school run.

Other deployments in the city use the same sensor units with the addition of acoustic, people counting, light, agricultural and water sensors, for example the project team are:

- Investigating how to build scalable sensing systems in Hyde Park to provide reliable coverage with lower costs by minimising the fixed infrastructure required.
- Exploring the impact of vehicular idling when Tower Bridge is raised and the opportunities for nudging driver behaviour through road-side signage and other interventions.
- Working with developers at Elephant and Castle to measure the impact of innovative NOx reduction technologies.

Results

The low-cost gateways developed to connect to a broad array of sensors, are providing a steady stream of data which is contributing to a quantified community.

Building an end-to-end solution that supports the addition of heterogenous sensors and the hooks to allow developers to build tools and services via the Mashery-based API, allows the project team to quickly prototype applications and support interventions in the community.

Ned Johnson, Principal Environmental Health Officer at Enfield Council, Greater London noted on the project, "*We've really focused on, at the moment, just point sources with traffic. What the sensors give us an opportunity to do is to look at the whole picture. So we move beyond just looking at the traffic issue, and start to get a broader picture of what's going on, and explore other areas of air pollution that today haven't really been thought about. They provide a very, very easy way of doing a lot of really good and important public health research.*"

Next Steps

This investment in London benefits from a collaborative mix of technology, social scientists and designers. The approach of the project team to envisioning a future sustainable city depends on taking a human-centred approach, engaging with the different mix of collaborators necessary to meaningfully represent a diverse cross spectrum of people.

Future smart city infrastructure will scale through the ability of multiple platforms to co-exist and work together for city officials who commission them and citizens who use their services. London Living Labs have started to explore the notion of plug and play sensor systems and are testing the commercial models required to support the free flow of urban data.

Acknowledgement

Dr Duncan Wilson, is Director of the Intel Collaborative Research Institute on Sustainable Connected Cities (ICRI). ICRI delivers research that explores how technology can enhance quality of life, create new economic opportunities and improve the environmental well-being of cities.

Its mission is to build global collaborations with academic pioneers who will discover and drive the ways in which computing will enrich the human experience for generations to come, and to be leaders, leveraging the resulting insights to influence Intel. ICRI is interested in the role technology plays in creating resilient urban environments, economies and communities. Its goal is to deploy technology in a way that ensures citizens can trust decision-making systems and participate in the creation of the value networks that are required for the development and acceptance of future cities infrastructure.

Each ICRI research community is Intel-funded, jointly-led, and focused on a specific technology area or discipline, bringing together top researchers from across academia working with Intel to explore and uncover not only new answers, but new questions.