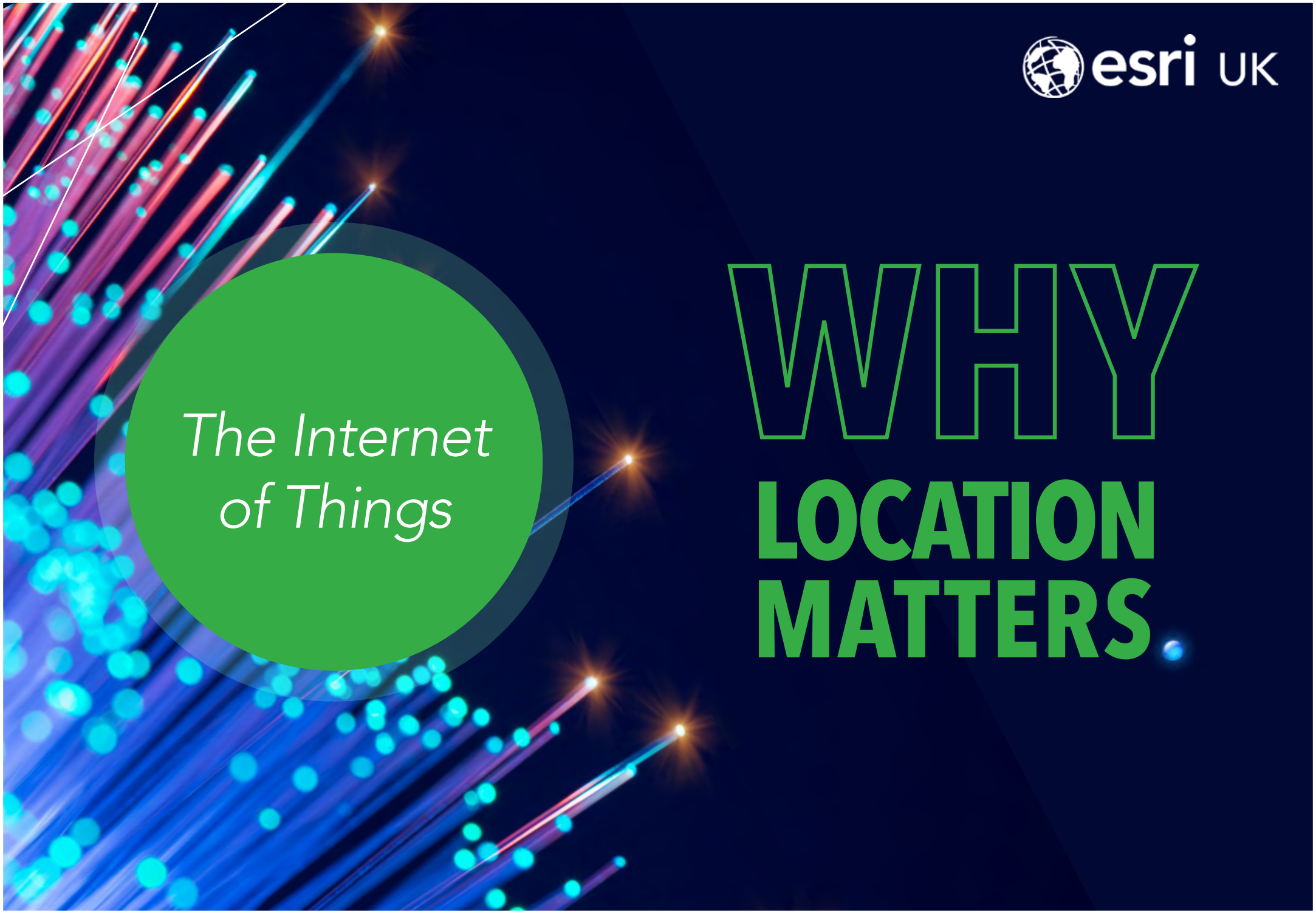
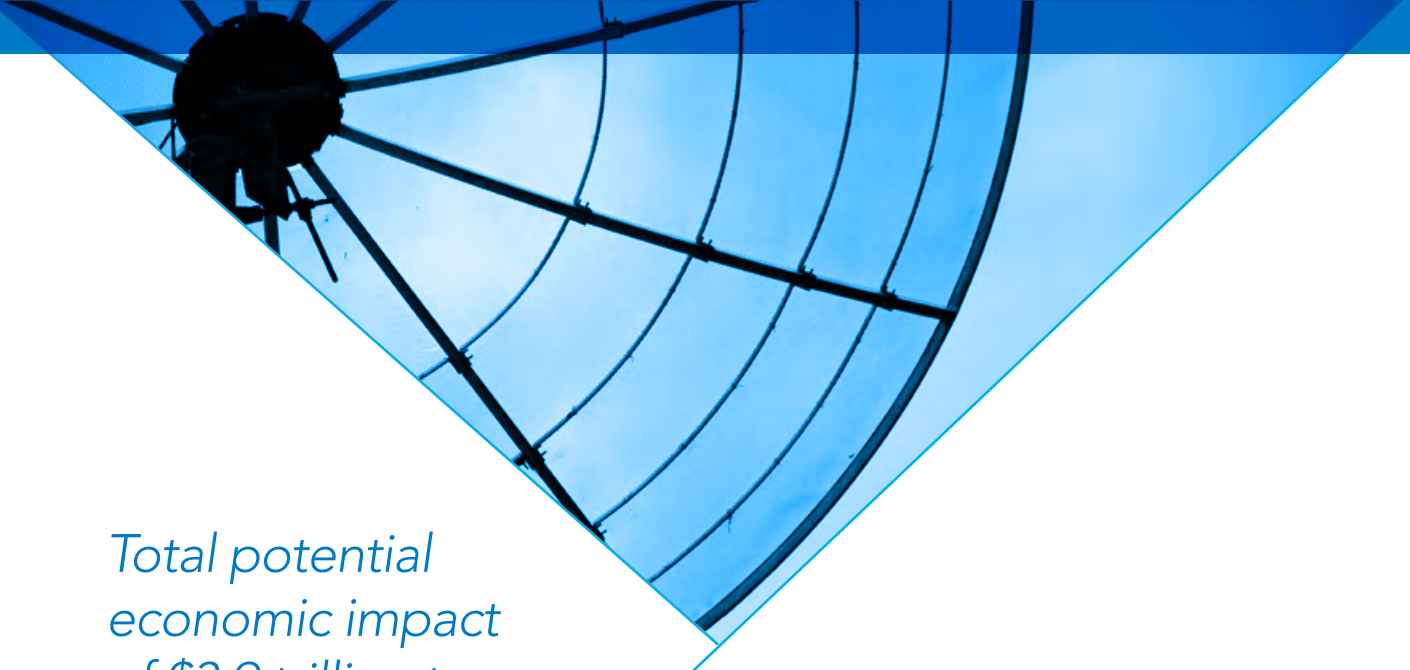

esri UK
The Internet of Things
WHY
LOCATION MATTERS

Contents



Total potential economic impact of $3.9 trillion to $11 trillion per year in 2025[1]

Moving to an ever more connected world

The digital transformation of people's lives, both at work and outside of work, has become a relentless force. Network connectivity is both extending its geographic reach and multiplying as the number of networks available in any given place continues to grow. The computational power of devices continues to increase, cloud computing has become more cost effective and devices themselves get smaller and smaller. Advances in sensor technology are turning everyday objects into sources of data. The combination of these trends has led us to a new place. It is now possible for a network of physical objects (vehicles, buildings, infrastructure, equipment of all shapes and types) to collect and exchange data and to work together. This enables devices, sensors and systems to operate autonomously in pursuit of goals and objectives set by the human architects of the system.

*This has become known as **The Internet of Things (IoT)** & will drive radical change in the telecommunications industry.*

1. The Internet of Things: Mapping the value beyond the hype. Mckinsey Global Institute, June 2015.

NEW OPPORTUNITIES
for the telecommunications industry

As person-to-person (P2P) telecommunications has become a mature industry, Service Providers have been forced to look for growth from new types of revenue stream. The vision of Machine to Machine (M2M) communication services is highly attractive as there are many more machines in the world than people. IoT is the opportunity to deliver this vision and a resultant step change upwards in connection volumes. It is this huge growth opportunity that has driven so much excitement in the IoT market.

There are four big areas where value for telecom service providers can be created

2. State of the Market: Internet of Things, Verizon, 2016.

1

New connectivity offerings based on dedicated IoT infrastructure

Current 3G and 4G wireless technologies are already being used to provide IoT services. But M2M communications have different characteristics to P2P communications, driving demand for brand new infrastructure. New technologies and standards are emerging which meet this need and provide the opportunity to create new connectivity services.

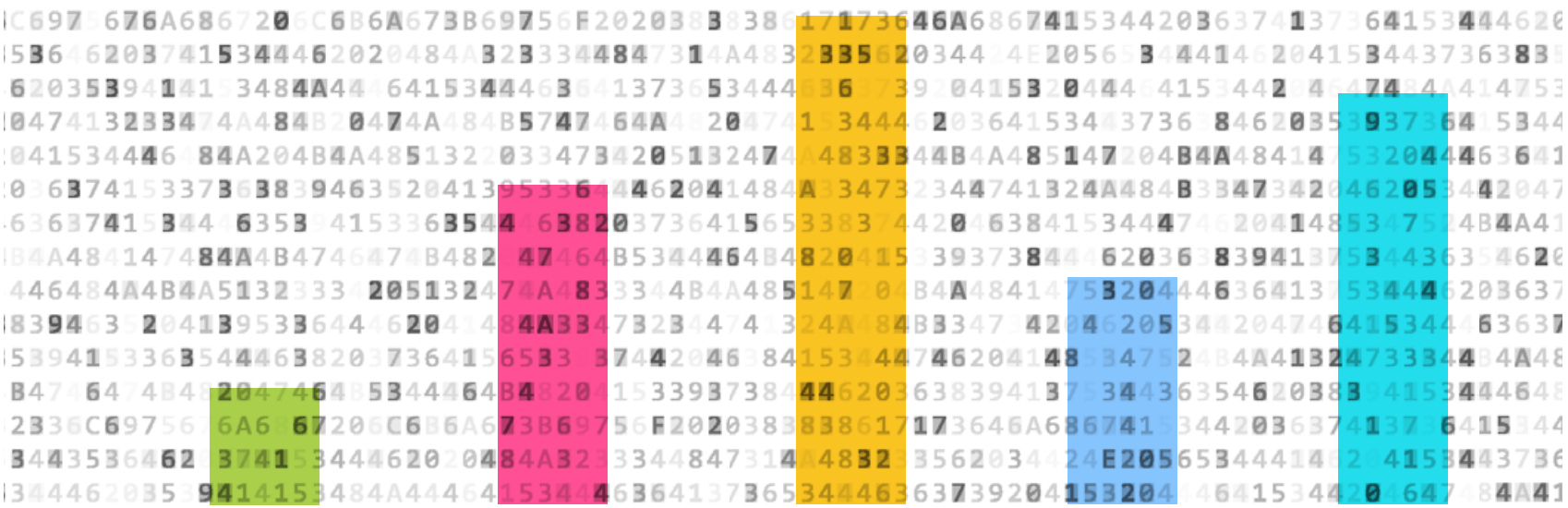
Narrow-Band IOT (NB-IOT) technology has been specially designed for the IoT. It features improved indoor coverage, lower costs, long battery life and the scope to operate with very large numbers of devices.

LoRaWAN™ is a Low Power Wide Area Network (LPWAN) specification intended for wireless battery operated Things which offers secure bi-directional communication, mobility and localisation services.

The next generation of wireless technology (5G) will provide another step change in data rates (multiple Gbps) and lower latency (milliseconds) making as-yet undreamt of high volume services possible.

2 Providing the platform

Developers and operators of IoT services face new challenges managing the vast array of connected devices and the huge volumes of data those endpoints generate. Service Providers can ease the process of market entry by offering IoT platforms that enable businesses to construct solutions and cost-effectively go to market. By providing a secure infrastructure and the toolset that developers require, new product launches can be de-risked and revenues can be accelerated.



3 Participating in the Data Market

Every data stream created in the IoT will be of value to a particular audience or audiences. For example, data captured from a smart chip on vehicles travelling along a motorway could be used to create a range of anonymised datasets: traffic volumes by time of day, origin/destination routes, shopping centre catchments… etc. These can be packaged and priced to meet the needs of specific audiences. But the data becomes more valuable if combined with other datasets such as weather feeds or foot traffic in retail centres, enabling (say) a retailer to forecast customer demand. We predict the emergence of IoT data consortiums – offering multiple data services using mix 'n' match aggregated data feeds.

This business model is widely used at present to provide syndicated services – such as online entertainment listings linked to ticket sales. It will enable non-competing IoT service vendors to leverage the value of their data and to spread the cost of collating data sets over a large number of consumers. A core source of value add for these organisations will be their ability to complement straightforward IT processing expertise with a platform that supports the geographical and time-based analysis of data as well as providing regulatory, legal and consumer advice alongside real-time pricing and billing services.

Service Providers are well positioned to provide and aggregate IoT datasets and create and take to market IoT services. Mobile Network Operators have a wealth of people movement data generated by the network which, when anonymised, aggregated and enriched with demographics, has value in transport, retail, city planning and environmental applications. This is an opportunity to create new revenue streams based on monetising existing assets.

The addressable market for 'telecom data as a service' will grow from $24.1 billion in 2015 to $79 billion in 2020[3]

3. 451 Research, 2015

4 Creation of new applications

Service Providers also have the opportunity to build the game-changing IoT applications that will transform our lives in the future. Applications in Smart Cities, healthcare, transport, agriculture, logistics, and the Smart Home are all in use today. Telecommunications infrastructure and operational data are a critical component of all of these services. The possibilities are limited only by our imagination and we give some examples later in this eBook.

However, an IoT SIM card is very different from a personal device SIM card. Whilst the volumes of devices and transactions are substantially higher, revenues per device are significantly lower. In order to achieve viable operating margins, Service Providers need to operate at much lower cost levels. They need to be much smarter, baking intelligence into these new, disruptive offerings from the outset.

Everything happens somewhere. All the Things in the IoT have a place.

How location transforms raw data into actionable intelligence

Knowing where something is located is a critical piece of contextual information that is integral to the successful function of the IoT. Take the example of road safety systems in a connected car. When the car senses slippery conditions its road traction systems respond within a fraction of a second to keep it on the road. It does that automatically, without needing to know where it is. However, that knowledge about a slippery road is immensely valuable to other road users if they too are likely to come across the adverse conditions. Location data can be used in three main ways:

01 DESCRIPTIVE ANALYTICS

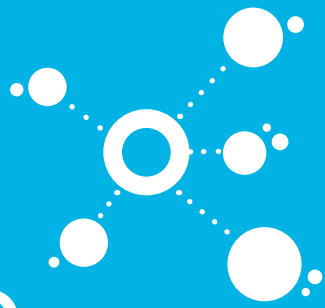
'What happened?'

Data mining and analysis gives us insight into past history. By transmitting the location of the hazard, the car can warn other cars in that area of the risk.

02 PREDICTIVE ANALYTICS

'What will happen?'

Use of modelling techniques to forecast the future. By collecting historical data from millions of vehicles over time and relating to weather data by location, the system can predict where and when slippery conditions will occur and warn cars before the risk is even encountered.



03 PRESCRIPTIVE ANALYTICS

'What should be done?'

Scenario modelling and simulation to evaluate the impact of remedies. By modelling the impact of alternative solutions on the locations of interest we can rank alternative solutions based on success criteria and choose the option that minimises or eradicates the hazard.

Sensor data collected in the IoT ecosystem requires context to make it meaningful and increase its value. Geolocation provides that context, by transforming the raw data into useful information and ultimately actionable intelligence. Later in this eBook we give examples showing how these principles can be put in to practice in the IoT.

It's not about the map, in the IoT it's about the App

Geo-analytics within the system

Geo-analytics enables us to answer questions which have in the past been difficult to answer, either because of lack of data or because of lack of computational power. Questions like:

- What is happening in this area?
- What other things are close by?
- In what other places is a similar situation present?
- Where have we seen this before?
- Where might we see this in the future?

Traditional Geographic Information Systems (GIS) use maps to present geographic information in a way humans can understand. Geographic information is central to the IoT, but the map's primary role is to help people when visualising the data.

Within the system, sophisticated spatial queries and geo-processing algorithms built in to IoT platforms can connect data that was previously unconnected. This gives geospatial information a central role in the IoT data market described above. For real-time data feeds to deliver value they must be based on a consistent geographic base and be time synchronised in order to feed predictive analytics tools.

Presenting the information on a map makes it easy for people to use and to identify visual patterns which allow decision makers to increase sales or to control costs more effectively. The ability to handle large scale data sets in The Cloud, to present data geographically and to provide the tools for analysis are all ways in which value can be added to raw data.

Worldwide economic benefit of improved equipment maintenance $81–363bn annually in 2025[4]

Management of mobile industrial assets

Managing mobile heavy machinery is a major challenge for large construction sites and industrial campuses. The management problem begins with simply knowing what equipment is where, so that the right teams have the right equipment when and where they need it. But it goes much further than that. To maximise efficiency, Management need to be sure that the equipment is always operating at peak performance and that downtime is minimised.

By equipping plant and equipment with a GPS to monitor its location and sensors monitoring key vital signs, management have a real-time view of the safety, performance and security of plant machinery.

By continuously monitoring equipment it is possible to determine when maintenance will be needed, which reduces routine maintenance costs and critically, avoids failures. The plant owner can choose what parameters are monitored, for example alarms that highlight servicing requirements, remote diagnostics for fault-finding, and comparison of load levels against design specifications.

4. The Internet of Things: Mapping the value beyond the hype. McKinsey Global Institute, June 2015.

The UK is in breach of nitrogen dioxide limits in 38 out of its 43 areas[5]

Crowdsourcing air quality monitoring

Poor air quality is a major problem in modern cities. London, for example, has levels of pollution that are well above safe limits. In particular, levels of nitrogen dioxide, (which causes an estimated 23,000 deaths every year) and particulate matter such as dust, pollen, soot, smoke, and liquid droplets are a cause for concern.

Current urban air quality measurement systems rely on sensors that are often positioned well above street level, so they do not accurately capture the exposure of pedestrians. Furthermore, they are static, so interpolation is needed to build up an estimated pollution distribution.

The Internet of Things Academy (IOTA) has come up with an ingenious solution. BuggyAir is a system for air quality monitoring by attaching IoT devices to children's buggies in major cities across the UK. This has the advantages of measuring air right where it is actually breathed in by pedestrians and on the actual routes that they typically follow.

The system creates a dynamic air quality map by automatically uploading anonymised air quality data from pushchair sensors around the city and aggregating the data in a geo-analytics platform.

City authorities are able to make better informed planning decisions based on a more realistic picture of air pollution. Citizens are able to make informed choices about routes and avoid pollution hotspots.

5. House of Commons Environment, Food and Rural Affairs Committee, Air quality, 2016.

Global Out of Home advertising marketing set to reach $45 billion in 2019[6]

Targeted mobile advertising

Advertising on moving vehicles such as buses and taxis is a very effective form of marketing and has been around for a long time. But the marketing industry is evolving at a rapid pace. Advertising is increasingly being delivered over digital media in a highly targeted manner, to ever more finely segmented audiences.

Can traditional advertising compete?

Yes – by leveraging location information, the Internet of Things has transformed the traditional cab with a poster on the back into an attention-grabbing media delivery vehicle.

London taxis have been fitted with rooftop media screens, which display messages that are geo-targeted to the local area and dynamically change with constant updates of content. This allows advertisers to tailor messaging to specific geographic locations and to respond to events, news or social media in real time.

6. Global Entertainment and Media Outlook, pwc, 2015.

30%
FEWER BIN COLLECTIONS
Saving tax-payers money & reducing environmental damage

Smarter refuse collection

Public refuse collections are costly and damaging to the environment. Powerful diesel trucks emit high levels of nitrogen dioxide into Britain's towns and cities every day. Refuse collections are also inefficient, especially on commercial routes where waste disposal trucks frequently arrive at collection points to discover that the bin is almost empty and could have been left until next week.

The IoT has a solution. Sensor-equipped bins have successfully completed trials in a number of UK cites. The sensor is fitted in the lid of the bin and uses an ultrasonic beam to measure the level of waste in the bin. It also contains a gas sensor which provides information about the age and type of the waste. GPS gives the location of the bin. This information is transmitted back to a central server via a wireless network, so the system can predict which bins will need emptying when. By combining bin locations with street maps and real-time traffic information it is able to plan the shortest possible routes for collection trucks in which only the sites where a collection is needed are visited. This results in around 30% fewer bin collections, saving tax-payers money and reducing environmental damage.

We generate about 177 million tonnes of waste every year in England alone[7]

7. DEFRA, UK government policy: waste and recycling, 2015

IoT Home monitoring connections grew 50% from 2014 to 2015[8]

The Smart Home

The Smart Home is a connected home in which many IoT devices and applications come together to make life for the occupants more convenient, comfortable and environmentally friendly. For example, a modern heating system might be controlled with a thermostat that monitors actual temperature and controls temperature against a target that varies by time of day. But if the owner decides to return home early one day, the heating system is not aware, so the temperature could be too cold or too hot for him or her when they get home.

But connect the heating controller to a smartphone and everything changes. The owner can use a geospatial App to erect a geofence around the workplace or the home. So if they leave or arrive early, the phone triggers the geofence and alerts the heating system to change the temperature. And it doesn't stop there. If a thousand people changed their plans the energy suppliers could be given advanced warning of an expected surge in usage. Power generation supplies can be adjusted to meet changing demand. As UK's energy contingency allowance gets smaller such system-wide intelligence will become vital to keeping the lights on.

8. State of the Market: Internet of Things, Verizon 2016.

Enabling the connected lifestyle

"…a connected world platform that will optimise the moments of your life"[9]

The trend towards increasingly connected devices brings opportunities but also creates risks. This proliferation of Apps, user interfaces, logins and controls could make a person's world more complex and harder to manage. However, technology can also be deployed to simplify the complexity and create new ways to manage the connected lifestyle.

Earlier, we predicted that data feeds will come together on data platforms which aggregate, filter and manage data products and services. In the same way we expect applications to come together as a seamlessly connected service bundle, all supported with industry wide standards and APIs.

A proof of concept called Smart Life illustrates how collaboration in the eco-system can be successful. This cloud-based smart energy platform demonstrates how location-based automation can control IoT connected devices, such as lights, alarm systems, and thermostats, based on a person's location. For customers this could improve safety, reduce energy consumption, and save them money without having to manually activate or manage multiple individual applications.

The platform was created by a consortium of Orange, Esri, BaseN, NTS and Infonova/ BearingPoint, who received 2016 Tele Management Forum (TMF) award for the Catalyst research project with the greatest adoption of TM Forum assets.

9. Christian Maitre, Deputy CIO, Orange Group.

Realising the opportunity

We have shown how location information is a critical component of the IoT. By providing context, location adds value, elevating raw data to actionable intelligence. Service Providers looking to leverage the opportunity presented by the IoT, whether through connectivity, platforms, data propositions or new applications, will be able to multiply the value of the opportunity by placing location at the heart of their proposition.

ESRI UK support IoT projects utilising our capabilities in the following:

- Mapping data
- Geo-processing
- Data visualisation
- Spatial analytics
- Data content services
- Big data aggregation

To discover more about how the power of location can be integrated into your IoT business plans contact Esri UK.

About Esri UK

Esri is the world's leading provider of Geographic Information Systems (GIS), providing solutions, technology and services. With the single, largest pool of GIS expertise, Esri UK is the technical authority on GIS in Great Britain. More than 10,000 UK customers across various industries and sectors use our solutions to gain enhanced insight and knowledge about their customers, assets and operations. Our customers are part of the largest GIS user community in the world, with more than one million users in nearly 350,000 organisations.

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