How will IoT improve public sector services?

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What is the Internet of Things and what impact can it have on society? While many industries already capture the huge potential of IoT, it is also true that the public sector can benefit significantly from the variety of devices in the world of IoT. By leveraging the power of these devices, we are entering an era of "Smart Cities", where sensors and automations can enhance public services, and therefore the daily life of citizens.

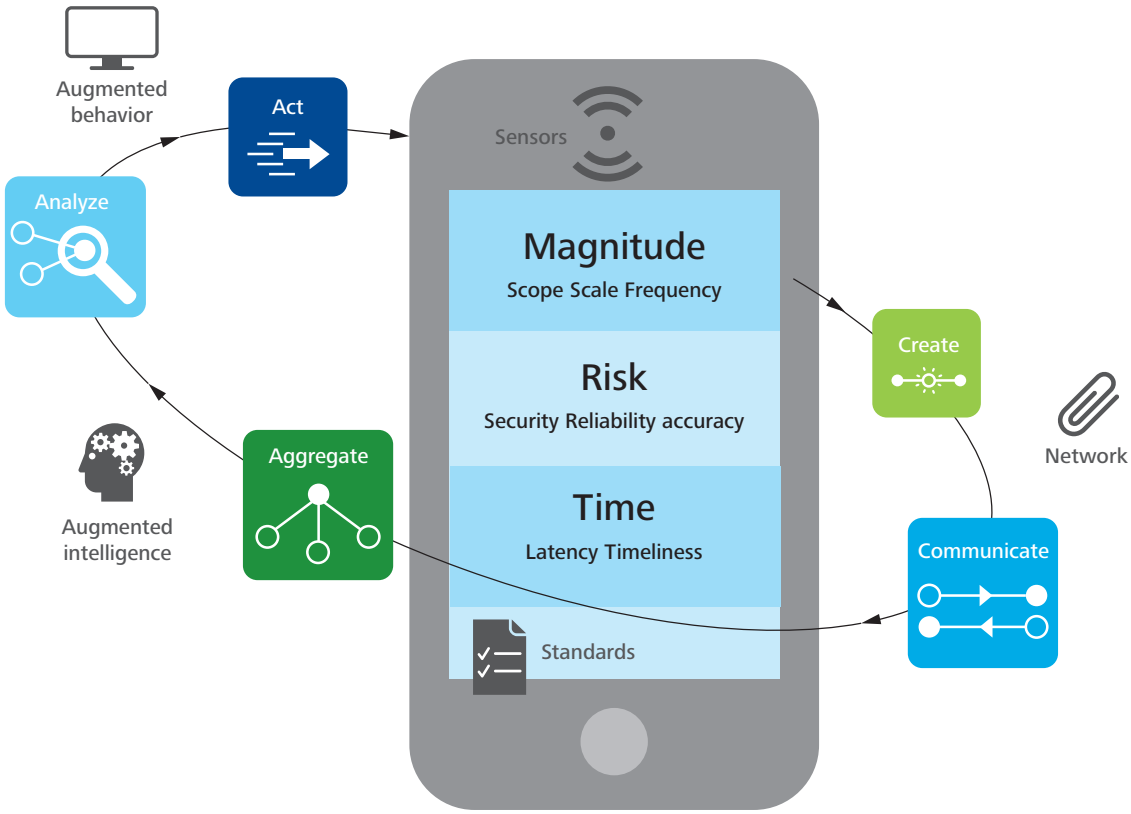
What is the meaning behind the term IoT?

If you've ever seen the "check engine" light come on in your car and had the necessary repairs done in a timely way, you've benefited from an early-stage manifestation of what is today known as the Internet of Things (IoT). Something about the way your car was operating—an action—triggered a sensor, which communicated that data to a monitoring device. The significance of this data was determined based on aggregated information and prior analysis. The light came on, which in turn triggered a trip to the garage and necessary repairs.

In 1991 at Xerox PARC, Mark Weiser saw beyond these simple applications. Extrapolating trends in technology, he described "ubiquitous computing"—a world in which objects of all kinds could sense, communicate, analyze, and act or react to people and other machines autonomously, in a manner no more intrusive or noteworthy than how we currently turn on a light or tap.

One way of capturing the process implicit in Weiser's model is as an Information Value Loop with discrete but connected stages. An action in the world allows us to create information about that action, which is then communicated and aggregated across time and space, allowing us to analyze that data to modify future acts.

Figure 1: The information Value Loop



Create: The use of sensors to generate information about a physical event or state
Communicate: The transmission of information from one place to another
Aggregate: The gathering together of information created at different times or from different sources
Analyze: The discernment of patterns or relationships among phenomena that leads to descriptions, predictions, or prescriptions for action
Act: Initiating, maintaining, or changing a physical event or state

Despite the generic nature of this process, it is perhaps even more relevant, as the future Weiser imagined is increasingly upon us. It is not due to one particular advance in technology or even a breakthrough, but rather to the confluence of improvements to a suite of technologies that have collectively reached levels of the required performance.

As illustrated in figure 2 below, each stage of the value loop is connected to the subsequent stage by a specific set of technologies, defined below.

Figure 2: The technologies enabling the Internet of Things

Technology	Definition	Examples
Sensors	A device that generates an electronic signal from a physical condition or event	The cost of an accelerometer has fallen to 40 cents from $2 in 2006.2 Similar trends have made other types of sensors small, inexpensive, and robust enough to create information from everything from fetal heartbeats via conductive fabric in the mother's clothing to jet engines roaring at 35,000 feet.
Networks	A mechanism for communicating an electronic signal	Wireless networking technologies can deliver bandwidths of 300 megabits per second (Mbps) to 1 gigabit per second (Gbps) with near ubiquitous coverage.
Standards	Commonly accepted prohibitions or prescriptions for action	Technical standards enable processing of data and allow for interoperability of aggregated data sets. In the near future, we could see mandates from industry consortia and/or standards bodies related to technical and regulatory IoT standards.
Augmented intelligence	Analytical tools that improve the ability to describe, predict, and exploit relationships among phenomena	Petabyte-sized (10^{15} bytes, or 1,000 terabytes) databases can now be searched and analyzed, even when populated with unstructured (for example, text or video) data sets. Software that learns might substitute for human analysis and judgment in a few situations.
Augmented behavior	Technologies and techniques that improve compliance with prescribed action	Machine-to-machine interfaces are removing reliably fallible human intervention into otherwise optimized processes. Insights into human cognitive biases are making prescriptions for action based on augmented intelligence more effective and reliable.

What can IoT bring to the public sector?

Now that we have reviewed the meaning of IoT, we can start looking at what IoT can bring to improve public sector services. The table below (figure 3) gives an overview of potential applications within the public sector.

Figure 3

Category	Sub-Category	Example
Transportation	Public Transportation	• Using GPS tracking devices, we can enable real-time monitoring of buses and give better information on waiting times • Using swipe-card information, we can analyze peaks in use and provide a better supply of buses
	Traffic	• Using GPS tracking devices or presence detection sensors, we can enable real-time traffic analytics and have a smarter control of traffic lights to prevent traffic congestion
	Public bikes	• Using GPS tracking devices, we can analyze where public bikes are most needed and also balance the availability of bikes at different locations
Economy	Tourism	• Using beacons, we can push notifications on smartphones based on location and give people additional information about a place in a city or an art object in a museum
	Industry	• Smart infrastructures
Health	Assistance to people	• Using a single-push button, a person can send an emergency alert
	Automated medication	• Using medical devices, we can automate the supply of medicine for people with diabetes or high blood pressure and send alerts to their doctor when the device detects a problem
	Maintenance of medical devices and failure detection	• Using a sensor, a battery-powered medical device could send a notification when a battery needs to be replaced
Environment	Water supply	• Using sensors, leakage in water pipes can be detected
	Pollution	• Using sensors, we can monitor pollution levels and the amount a polluting particle emitted
Administration	Electronic identity device	• Using magic bands[1], people can have all their identity information and important information updated • Using biometrics, personal magic bands can be secured and prevent identity theft
Security	Drones	• Using computer vision, drones can identify security issues and report them
	Fire	• Using smoke detectors, automated notifications can be sent to intervention centers • Using sensors in gas pipes, we can identify potential sources of fire and deal with them before any damage is caused

1 An all-in-one wristband that holds a lot of information and enables services for the user (room key, electronic wallet, etc.). Some amusement parks are making use of this technology to enhance their clients' user experience.

As we can see, there are many public sector services that could benefit from the various use cases that IoT has to offer. By automating processes, IoT can not only reduce costs but also increase reliability of services.

In the following sections, we focus on two specific areas. While other areas are just as relevant, we think transportation and security are topics that are clearer examples of the potential IoT has to offer the Public Sector.

Transportation is one of those areas that can be greatly improved thanks to the use of sensors from IoT. For example, many cities have started to leverage the power of GPS tracking devices to offer people more accurate bus waiting times. The data on waiting time can be correlated with peaks in usage and frequency can therefore be adapted accordingly. Monitoring usage of public transport can be as simple as counting the number of passengers using buses over the course of a day. Card-swiping devices, such as Navigo or MPass, are becoming common these days and can easily provide us with this information. On top of that, they are a convenient alternative to carrying many paper passes and, as a positive side-effect, they also prevent waste of paper and ink. Right now, many cities provide their own cards but it is foreseeable that standards will emerge and having the same pass nationwide could become a reality. Having a single pass whatever the destination makes procedures easier for people and so it is likely to foster growth in tourism as a consequence.

Besides public transportation, traffic management can equally benefit from IoT. The same GPS tracking devices as for buses or simply passage detection sensors at a lower scale can enable real-time monitoring of traffic and leverage analytics about road use. Then that data can be used to ensure smarter control of traffic lights and prevent traffic congestion.

Furthermore, the real strength of IoT is the possibility to aggregate data from various sources. Imagine that there are often traffic jams on a frequently used road. A correlation between traffic data and supply of public transportation can show that traffic could be more fluid if a new bus line were added for example. Or traffic signaling could proactively suggest alternate roads in order to maintain fluidity across the whole road network.

Another priority for the public sector is ensuring safety. IoT can be of great use to enable faster interventions when necessary. For example, reusing the traffic data we talked about previously, a fire engine could avoid traffic congestion and reach the incident location faster than simply taking the shortest route.

Increasing intervention speed is all well and good, but what if we could prevent issues from happening in the first place? IoT has the means to do so. Taking the previous example of a fire, this fire could actually have been triggered by a combination of various environmental elements. Smoke detectors are well-known, but sensors able to detect leakage in pipes also exist. For instance, thanks to such devices, we can identify potential risks of fire and notify a leakage in a gas pipe so that intervention can happen before the fire even has a chance to start, thus limiting or preventing damage. Similar sensors can be used for water pipes to prevent water damage, but also to identify infrastructure faults in the water delivery chain.

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Jumping in

The world of IoT provides us with a high diversity of devices and the data collected through these devices can even be aggregated, offering an incredible number of use cases. However, it is important to remain aware of the resources needed to deal with IoT data properly. Actually, projects leveraging IoT often deal with another well-known challenge, namely Big Data.

To operate projects like these, starting with a pilot is essential. Many points of concern first need to be addressed, especially in the domains of regulation and technology.

Under the category of regulation, we have to handle all issues related to data privacy as well as fulfilling security requirements for storing and transporting such data. The technology category is composed of many layers and its goal is to determine the technological stack need.

The following list shows the different layers to consider:

- Storage & Query (SQL, MongoDB, Hadoop, ElasticSearch, Graphs, etc.)
- Replication (depending on the storage)
- Security (user access, encryption, firewall, etc.)
- Availability (failure recovery, real-time, etc.)
- Scalability
- Aggregation
- Analytics

Entering the pilot phase, the first step is to identify what data needs to be collected. From there, a comparative analysis of different devices able to provide this data needs to be performed. Then, an initial proof-of-concept prototype can be created on a small scale to compare the best alternatives. Finally, based on the results of the prototypes, the project can be implemented and deployed starting at a reasonable scale, for a single city. Later on, adoption can be rolled out to more cities or even nationwide.

Conclusion

IoT is an ever growing ecosystem and its applications are many. Today, public sector services have to face the new needs of citizens who are becoming accustomed to having technologies facilitating their everyday lives. IoT can fulfill the new requirements of public services and shape a future with smarter cities and countries.