A Study on Internet of Things (IOT) and Sensor based Applications

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Abstract - The Internet of Things is a platform where every day devices become smarter, every day processing becomes intelligent, and every day communication becomes informative. While the Internet of Things is still seeking its own shape, its effects have already stared in making incredible strides as a universal solution media for the connected scenario. The potential benefits of Internet of things (IoT) are almost limitless and IoT applications are changing the way we work and live by saving time and recourses and opening new opportunities for growth, innovation and knowledge creation. The Internet of Things allows private and public-sector organizations to manage assets, optimize performance, and develop new business models. Sensor is a device that detects events or changes in the environment, and transform signals from different energy domains to the electrical domain then provides a corresponding output. IoT devices are vulnerable to sensor-based threats due to the lack of proper security measurements available to control use of sensors by apps. By exploiting the sensors (e.g., accelerometer, gyroscope, microphone, light sensor, etc.) on an IoT device, attackers can extract information from the device, transfer malware to a device, or trigger a malicious activity to compromise the device. In this survey, we explore various threats targeting IoT devices and discuss how their sensors can be abused for malicious purposes. Specifically, we present a detailed survey about existing sensor-based threats to IoT devices and countermeasures that are developed specifically to secure the sensors of IoT devices.

Keywords— *Sensory side-channel attacks, IoT threats, IoT device security* ,Internet of Things (IoT) Architecture.

1. Introduction

Internet of Things (IoT) is a concept that aims to enhance the forms of communication that we have today. Currently, the Internet is a network tool that humans access using devices. The main form of communication is human-human. IoT attempts to not only have humans communicating through the Internet but also have objects or devices. These things are to be able to exchange information by themselves over the Internet, and new forms of Internet communication would be formed: human-things and things-things. The number of things connected to the Internet will be much larger than the number of humans, and things become the major generators and receivers of traffic . The Internet of Things is a technology born out of a network. On the ends of the network are information sensing equipment and systems. These are devices that are able to obtain data or information from the physical world. Through a network, these objects can be connected to other such devices or other smart objects. Smart objects are able to analyze the data obtained from the information sensing equipment and make independent decisions. Imagine a shirt being able to tell the washer it is in what color it contains and any special care instructions it may have, and imagine the washer independently acting accordingly. The data can be stored in circuitry inside the shirt, or this shirt may refer the washer to an information database on the Internet. Thus, the communication over the Internet would include human-thing and thing-thing.The ability of things to communicate opens up a wide variety of applications. IoT can be used to provide trace ability to aid in green supply chain management. In healthcare, IoT can also provide easier measurement of patients conditions as well as communication between hospitals to patients for ambient assisted living where patients are living at home. IoT technology is also beneficial to the effective integration of infrastructure resources to have a successful electrical fire monitoring system. Among these applications, there are many others in many fields such as automation, transportation, smart grids, etc. These applications serve as a proof that IoT will bring big changes to the society

Fig.1. Definition of Internet of Things

For example, through RFID, laser scanners, global writing system, infrared sensors and other information sensing devices are connected to any object for communication services and data exchange. At last, to reach the smart devices to be tracked, located, and monitored and to handle the network functions, to make the IT infrastructure and physical infrastructure consolidation IoT is the most needed one.

2. Overview of Internet of Things

Before the investigation of the IoTs in depth, it is worthwhile to look at the evolution of the Internet. As shown in Fig. 1, in the late 1960s, communication between two computers was made possible through a computer network. In the early 1980s, the TCP/IP stack was introduced. Then, commercial use of the Internet started in the late 1980s. Later, the World Wide Web (WWW) became available in 1991 which made the Internet more popular and stimulate the rapid growth. Then, mobile devices connected to the Internet and formed the mobile- Internet. With the emergence of social networking, users started to become connected together over the Internet. The next step in the IoTs is where objects around us will be able to connect to each other (e.g. machine to machine) and communicate via the Internet.

2.1 IOT working procedure

The IoT can be viewed as a gigantic network consisting of networks of devices and computers connected through a series of intermediate technologies where numerous technologies like RFIDs, wireless connections may act as enablers of this connectivity.

- ***Tagging Things :*** Real-time item traceability and addressability by ***RFID***s.
- ***Feeling Things : Sensors*** act as primary devices to collect data from the environment.

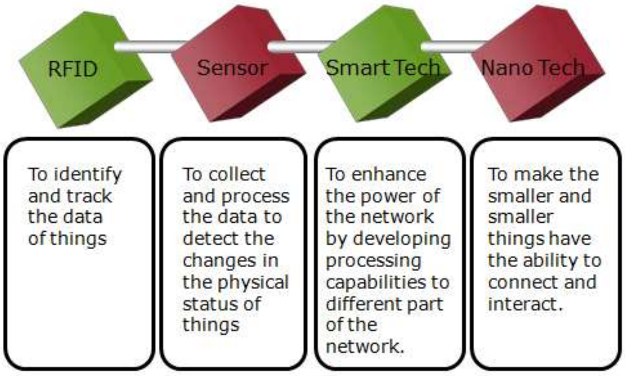


***Fig*.2. IOT working procedure**

- ***Shrinking Things : M***iniaturization and ***Nanotechnology*** has provoked the ability of smaller things to interact and connect within the "things" or "smart devices."
- ***Thinking Things : Embedded intelligence*** in devices through sensors has formed the network connection to the Internet. It can make the "things" realizing the intelligent control.

3. IOT Architecture

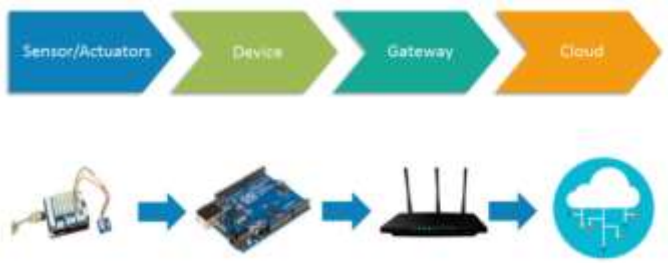


Fig.3 IOT Architecture

Stage 1:

- Sensors: Sensors collect data from the environment or object under measurement and turn it into useful data. For example: gyroscope in mobiles

- Actuators: Actuators can also intervene to change the physical conditions that generate the data. An actuator might, for example, shut off a power supply, adjust an air flow valve, or move a robotic gripper in an assembly process.
- Sensing/Actuating stage covers everything Example: Industrial devices to robotic camera systems, water-level detectors, air quality sensors, accelerometers, and heart rate monitors

Stage 2:

The stage 2 systems often sit in close proximity to the sensors and actuators.

For Example: a pump might contain a half-dozen sensors and actuators that feed data into a data aggregation device that also digitizes the data. This device might be physically attached to the pump. An adjacent gateway device or server would then process the data and forward it to the Stage 3 or Stage 4 systems

Stage 3:

- Once IoT data has been digitized and aggregated, it's ready to cross into the realm of IT
- However, the data may require further processing before it enters the data centre
- This is where edge IT systems, which perform more analysis, come into play
- Edge IT processing systems may be located in remote offices or other edge locations, but generally these sit in the facility or location where the sensors reside closer to the sensors, such as in a wiring closet

Stage 4:

- The data from Stage 3 is forwarded to physical data centre or cloud-based systems, where more powerful IT systems can analyse, manage, and securely store the data
- It takes longer to get results when you wait until data reaches Stage 4, but you can execute a more in-depth analysis, as well as combine your sensor data with data from other sources for deeper insights
- Stage 4 processing may take place on-premises, in the cloud, or in a hybrid cloud system, but the type of processing executed in this stage remains the same, regardless of the platform

4. Top Sensor Using in IOT

Sensors are often categorized based on their power sources: active versus passive. Active sensors emit energy of their own and then sense the response of the environment to that energy. Radio Detection and Ranging (RADAR) is an example of active sensing: A RADAR unit emits an electromagnetic signal that bounces off a physical object and is "sensed" by the RADAR system. Passive sensors simply receive energy (in whatever form) that is produced external to the sensing device. A standard camera is embedded with a passive sensor—it receives signals in the form of light and captures them on a storage device.

Passive sensors require less energy, but active sensors can be used in a wider range of environmental conditions. For example, RADAR provides day and night imaging capacity undeterred by clouds and vegetation, while cameras require light provided by an external source.

4.1 Types of sensors with representative examples

Sensor types	Sensor description	Examples
Position	A position sensor measures the position of an object; the position measurement can be either in absolute terms (absolute position sensor) or in relative terms (displacement sensor). Position sensors can be linear, angular, or multi-axis.	Potentiometer, inclinometer, proximity sensor
Occupancy and motion	Occupancy sensors detect the presence of people and animals in a surveillance area, while motion sensors detect movement of people and objects. The difference	Electric eye, RADAR

	between the two is that occupancy sensors will generate a signal even when a person is stationary, while a motion sensor will not.	
Velocity and acceleration	Velocity (speed of motion) sensors may be linear or angular, indicating how fast an object moves along a straight line or how fast it rotates. Acceleration sensors measure changes in velocity.	Accelerometer, gyroscope
Force	Force sensors detect whether a physical force is applied and whether the magnitude of force is beyond a threshold.	Force gauge, viscometer, tactile sensor (touch sensor)
Pressure	Pressure sensors are related to force sensors and measure the force applied by liquids or gases. Pressure is measured in terms of force per unit area.	Barometer, bourdon gauge, piezometer
Flow	Flow sensors detect the rate of fluid flow. They measure the volume (mass flow) or rate (flow velocity) of fluid that has passed through a system in a given period of time.	Anemometer, mass flow sensor, water meter
Acoustic	Acoustic sensors measure sound levels and convert that information into digital or analog data signals.	Microphone, geophone, hydrophone
Humidity	Humidity sensors detect humidity (amount of water vapor) in the air or a mass. Humidity levels can be measured in various ways: absolute humidity, relative humidity, mass ratio, and so	Hygrometer, humistor, soil moisture sensor

	on.	
Light	Light sensors detect the presence of light (visible or invisible).	Infrared sensor, photodetector, flame detector
Radiation	Radiation sensors detect radiations in the environment. Radiation can be sensed by scintillating or ionization detection.	Geiger–Müller counter, scintillator, neutron detector
Temperature	Temperature sensors measure the amount of heat or cold that is present in a system. They can be broadly of two types: contact and non-contact. Contact temperature sensors need to be in physical contact with the object being sensed. Non-contact sensors do not need physical contact, as they measure temperature through convection and radiation.	Thermometer, calorimeter, temperature gauge
Chemical	Chemical sensors measure the concentration of chemicals in a system. When subjected to a mix of chemicals, chemical sensors are typically selective for a target type of chemical (for example, a CO2 sensor senses only carbon dioxide).	Breathalyzer, olfactometer, smoke detector
Biosensors	Biosensors detect various biological elements such as organisms, tissues, cells, enzymes, antibodies, and nucleic acids.	Blood glucose biosensor, pulse oximetry, electrocardiograph

5. Applications of IOT

- **Smart home**

Smart Home clearly stands out, ranking as highest Internet of Things application on all measured channels. More than 60,000 people currently search for the term "Smart Home" each month. This is not a surprise. The IoT Analytics company database for Smart Home includes 256 companies and startups. More companies are active in smart home than any other application in the field of IoT. The total amount of funding for Smart Home startups currently exceeds $2.5bn. This list includes prominent startup names such as Nest or AlertMe as well as a number of multinational corporations like Philips, Haier, or Belkin.

- **Wearables**

Wearables remains a hot topic too. As consumers await the release of Apple's new smart watch in April 2015, there are plenty of other wearable innovations to be excited about: like the Sony Smart B Trainer, the Myo gesture control, or LookSee bracelet. Of all the IoT startups, wearables maker Jawbone is probably the one with the biggest funding to date. It stands at more than half a billion dollars!

- **Smart City**

Smart city spans a wide variety of use cases, from traffic management to water distribution, to waste management, urban security and environmental monitoring. Its popularity is fueled by the fact that many Smart City solutions promise to alleviate real pains of people living in cities these days. IoT solutions in the area of Smart City solve traffic congestion problems, reduce noise and pollution and help make cities safer.

- **Smart grids**

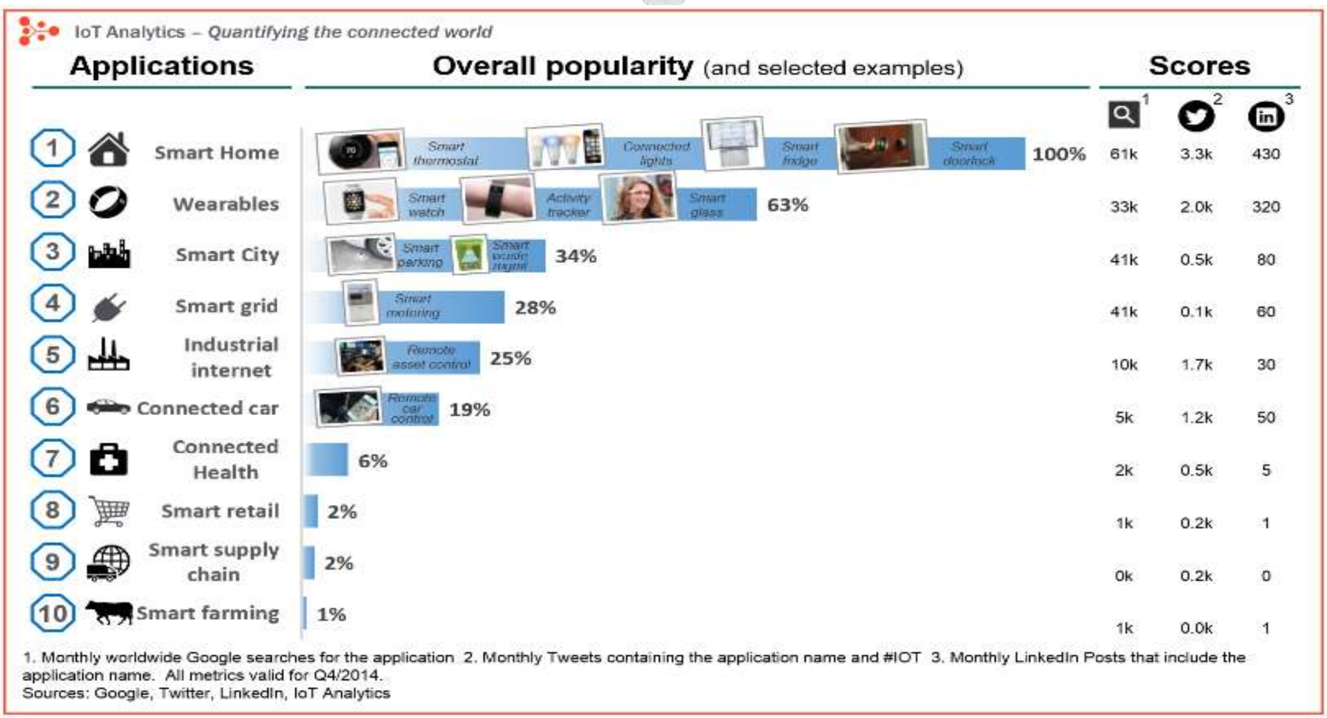
Smart grids is a special one. A future smart grid promises to use information about the behaviors of electricity suppliers and consumers in an automated fashion to improve the efficiency, reliability, and economics of electricity. 41,000 monthly Google searches highlights the concept's popularity. However, the lack of tweets (Just 100 per month) shows that people don't have much to say about it.

- **Industrial internet**

The industrial internet is also one of the special Internet of Things applications. While many market researches such as Gartner or Cisco see the industrial internet as the IoT concept with the highest overall potential, its popularity currently doesn't reach the masses like smart home or wearables do. The industrial internet however has a lot going for it. The industrial internet gets the biggest push of people on Twitter (~1,700 tweets per month) compared to other non-consumer-oriented IoT concepts.

- **Connected car**

The connected car is coming up slowly. Owing to the fact that the development cycles in the automotive industry typically take 2-4 years, we haven't seen much buzz around the connected car yet. But it seems we are getting there. Most large auto makers as well as some brave startups are working on connected car solutions. And if the BMWs and Fords of this world don't present the next generation internet connected car soon, other well-known giants will: Google, Microsoft, and Apple have all announced connected car platforms.



- **Connected Health (Digital health/Telehealth/Telemedicine)**

Connected health remains the sleeping giant of the Internet of Things applications. The concept of a connected health care system and smart medical devices bears enormous potential (see our analysis of market segments), not just for companies also for the well-being of people in general. Yet, Connected Health has not reached the masses yet. Prominent use cases and large-scale startup successes are still to be seen.

- **Smart retail**

Proximity-based advertising as a subset of smart retail is starting to take off. But the popularity ranking shows that it is still a niche segment. One LinkedIn post per month is nothing compared to 430 for smart home.

- **Smart supply chain**

Supply chains have been getting smarter for some years already. Solutions for tracking goods while they are on the road, or getting suppliers to exchange inventory information have been on the market for years. So while it is perfectly logic that the topic will get a new push with the Internet of Things, it seems that so far its popularity remains limited.

- **Smart farming**

Smart farming is an often overlooked business-case for the internet of Things because it does not really fit into the well-known categories such as health, mobility, or industrial. However, due to the remoteness of farming operations and the large number of livestock that could be monitored the Internet of Things could revolutionize the way farmers work. But this idea has not yet reached large-scale attention. Nevertheless, one of the Internet of Things applications that should not be underestimated. Smart farming will become the important application field in the predominantly agricultural-product exporting countries.

5. **Conclusion**

This paper gives an overview on the Internet of Things concept as well as the various technologies used. The IoT requires devices to obtain technology from the physical world and turn them into data.The connections between people and communications of people will grow and between objects to objects at anytime, in any location. The efficiency of information management and communications will arise to a new high level. The dynamic environment of IoTs introduces unseen opportunities for communication, which are going to change the perception of computing and networking. The privacy and security implications of such an evolution should be carefully considered to the promising technology. The protection of data and privacy of users has been identified as one of the key challenges in the IoT. Internet of Things with architecture and design goals. We surveyed security and privacy concerns at different layers in IoTs. In addition, we identified several open issues related to the security and privacy that need to be addressed by research community to make a secure and trusted platform for the delivery of future Internet of Things. We also discussed applications of IoTs in real life. In future, research on the IoTs will remain a hot issue. Lot of knotty problems are waiting for researchers to deal with.

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