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Ambient Intelligent IoT

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Abstract:

Internet of Things (IoT) is a new revolution of the Internet. IoT is the expansion of Internet services. It provides a platform for communication between objects where objects can organize and manage themselves. It makes objects themselves recognizable, intelligent, programmable and capable of interacting with humans. The Internet of things allows everyone to be connected anytime and anywhere. Objects can be communicated between each other by using radio frequency identification (RFID), wireless sensor network (WSN), Zigbee, etc. The Internet of Things will take us beyond connection to become part of a living, moving, global nervous system. This paper explains an innovative Internet of Things (IoT) architecture that allows real time interaction between mobile clients and smart/legacy things (sensors and actuators) via a wireless gateway. Smart cities, Smart cars, Public safety, Smart Industries and Environmental protection have been given the high intention for future protection by IoT Ecosystem. Making your life smarter through easy and quick access to your day-to-day workload is going to be the future through Internet of Things.

Keywords: Internet of Things (IoT), Sensors, Connectivity, Applications, Future IoT.

Introduction

Internet is a network of thousands of computer networks connecting millions of people all over the world. Internet of Things (IoT) is a new revolution of the Internet. IoT is the expansion of Internet services. IoT has become a household name these days because it relates to all "things" that could interconnect starting from a tiny toy to a giant turbine or a fighter plane. It covers all types of sensors, communication protocols, computational tools, techniques, devices, processors, embedded systems, data warehousing, big data, cloud computing, server farms, grid computing etc.

- The Internet of Things (IoT)—physical assets that connect and communicate via a networked system to help provide enhanced offerings—represents a revolutionary bridge between the virtual and the physical worlds. In the Internet of Things (IoT) paradigm, many of the objects that surround us will be on the network in one form or another.
- The Internet of Things (IoT) — refers to the ever-growing network of physical objects that feature an IP address for Internet connectivity, and the communication that occurs between these objects and other Internet-enabled devices and systems. The Internet of Things will take us beyond connection to become part of a living, moving, global nervous system. The term Internet of Things was first used by Kevin Asthon in 1999.

IoT Extends Internet Connectivity

The Internet of Things extends Internet connectivity beyond traditional devices like laptop and desktop computers, smart phones and tablets to a diverse range of devices and everyday things that utilize embedded technology to communicate and interact with the external environment, all via the Internet.

Significance of Internet of Things (IoT): The IoT is significant because an object that can represent itself digitally becomes something greater than the object

by itself. No longer does the object relates just to you, but is now connected to surrounding objects and database data. When many objects act in unison, they are known as having "ambient intelligence."

Importance of IoT

Before we can begin to see the importance of IoT, it is first necessary to understand the differences between the Internet and the World Wide Web (or web)—terms that are often used interchangeably. The Internet is the physical layer or network made up of switches, routers, and other equipment. Its primary function is to transport information from one point to another quickly, reliably, and securely. The web, on the other hand, is an application layer that operates on top of the Internet. Its primary role is to provide an interface that makes the information flowing across the Internet usable.

IoT Examples

Examples of objects that fall into the scope of Internet of Things include connected security systems, thermostats, cars, electronic appliances, lights in household and commercial environments, alarm clocks, speaker systems, vending machines and more. Businesses can leverage IoT applications to automate safety tasks (for example, notify authorities when a fire extinguisher in the building then it is blocked) to performing real-world A/B testing using networked cameras and sensors to detect how customers engage with products. [2]

How IoT works – An overview of the technology architecture:

The fundamental idea of Internet of Things (IoT) is that connectivity is rapidly growing -- via the Internet -- to a wide range of embedded sensors, devices and systems. IoT (Internet of Things) is a technology concept and/or an architecture which is an aggregation of already available technologies. Similar to the way in which Internet has changed the way we work & communicate by connecting us (humans) through World Wide Web, IoT aims to take this connectivity to next level by connecting various devices to the Internet – facilitating human-machine, machine-machine interactions also. The various devices of IoT are embedded with sensors, get interacted with the gateways and retrieve the data/signals from the cloud server to the devices.

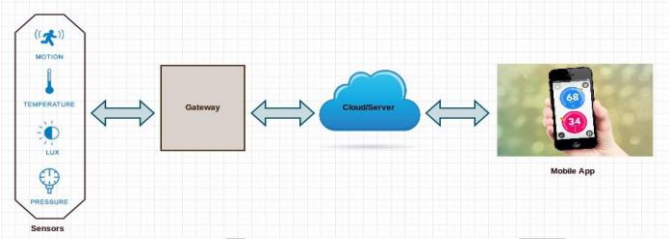

Figure 1: Diagram shows the building blocks of IoT

1) Sensors & Sensor technology – They will sniff a wide variety of information ranging from Location, Weather/Environment conditions, Grid parameters, Movement on assembly lines, Jet engine maintenance data to Health essentials of a patient.
2) IoT Gateways – IoT Gateways, as the name rightly suggests, are the gateways to Internet for all the things/devices that we want to interact with. Gateways help to bridge the internal network of sensor nodes with the external Internet or World Wide Web. They do this by collecting the data from sensor nodes & transmitting it to the Internet infrastructure.
3) Cloud/server infrastructure & Big Data – The data transmitted through gateway is stored & processed securely within the cloud infrastructure using Big Data analytics engine. This processed data is then used to perform intelligent actions that make all our devices 'Smart Devices'!
4) End-user Mobile apps – The intuitive mobile apps will help end users to control & monitor their devices (ranging from room thermostat to jet engines & assembly lines) from remote locations. These apps push the important information on your hand-held devices & help to send commands to your Smart Devices.

Sensors:
A sensor is a transducer that converts a physical stimulus from one form to a more useful form to measure the stimulus. More objects are becoming

embedded with sensors and gaining the ability to communicate. These sensors are part of a device category called a Micro Electro Mechanical System (MEMS) and are manufactured in much the same way microprocessors are manufactured, through a lithography process. These sensors can be paired with an application-specific integrated circuit or an ASIC. This is a circuit with a limited degree of programming capability and is hardwired to do something specific. It can also be paired with microprocessor and will likely be attached to a wireless radio for communications.

All IoT devices are embedded with sensors and wireless radios that enable connection, which offers the chance to remotely access products from around the globe as well as improve energy efficiency and save money and time for consumers and businesses. Many IoT devices have sensors that can register changes in temperature, light, pressure, sound and motion.

- **Pressure Sensor:** This type of sensor detects pressure around the earth which is very much useful to develop altimeter as well as barometer.
- **Accelerometer and gyroscope**: They are used to detect vibration, tilt and linear acceleration. They are used for implementation of pedometer, leveling, vibration alert, anti-theft and more.
- **Gyroscope**: It is used to measure angular velocity. Gyroscope is mainly used in 3D mouse, games and athlete training.
- **Temperature sensor**: It is used to control performance of the IoT device at varied temperatures.
- **Humidity sensor:** Similar to temperature sensor it is also used to control performance of the device.
- **Touch sensor:** Silicon Labs has 8bit and 32bit Microcontrollers which are used as capacitive touch sense applications. Viz. sliders, wheels, touch buttons, liquid level sensing and capacitive proximity sensing.

IoT devices communication

An IoT device will have a radio that can send and receive wireless communications. IoT wireless protocols are designed to accomplish some basic services: Operate on low power, use low bandwidth and work on a mesh network. Some work on the 2.4 GHz band, which is also used by Wi-Fi and Bluetooth, and the sub-GHz range. The sub-GHz frequencies, including 868 and 915 MHz bands, may have the advantage of less interference. The communication between devices and the Internet or to a gateway includes many different models: [11] • Direct Ethernet or Wi-Fi connectivity using TCP or UDP • Bluetooth Low Energy • Near Field Communication (NFC) • Zigbee or other meshes radio networks • SRF and point-to-point radio links • UART or serial lines

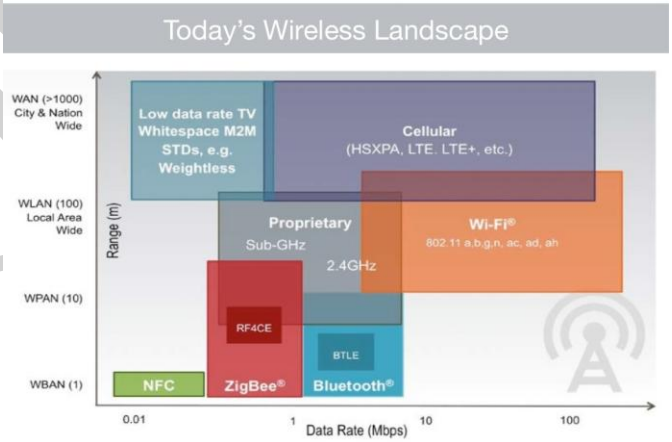

Figure 2**:** Diagram shows the Today's Wireless Landscape

To be able to communicate via Internet requires an IP (Internet Protocol) address to identify each thing. The world is running out of IP addresses within the current IPv4 system primarily due to increased use of personal "smart" electronics. IPv6 – IP addresses are the backbone to the entire IoT ecosystem. Internet is concerned about IP addresses only & not if you are a human or a toaster. With IPv4 we were running out of IP addresses, but with IPv6 (launched in 2012) we now have 3.4*10^38 IP addresses!

Importance of low power and low bandwidth in IoT: Some IoT devices will get power from electrical

systems, but many, such as door locks and standalone sensors, will use batteries. These devices send and receive small amounts of information intermittently or periodically. Consequently, the battery life of an IoT device can range from 1.5 years to a decade, if the battery lasts that long. One IoT maker, Insteon, uses both radio and power line communication, which can send data over existing electrical wiring as well as via a radio, which it says, will offer an increased measure of reliability.

Applications of an IoT

The interactions between the objects (entities) are creating new types of smart applications and services. The Internet of Things provides diversified applications, they are:

I. Smart Cities

a. Smart Parking: Monitoring of parking spaces availability in the city.
b. Structural health: Monitoring of vibrations and material conditions in buildings, bridges and historical monuments.
c. Noise Urban Maps: Sound monitoring in bar areas and centric zones in real time.
d. Smartphone Detection: Detect iPhone and Android devices and in general any device which works with Wi-Fi or Bluetooth interfaces.
e. Electromagnetic Field Levels: Measurement of the energy radiated by cell stations and Wi-Fi routers.
f. Traffic Congestion: Monitoring of vehicles and pedestrian levels to optimize driving and walking routes.
g. Smart Lighting: Intelligent and weather adaptive lighting in street lights.
h. Waste Management: Detection of rubbish levels in containers to optimize the trash collection routes.
i. Smart Roads: Intelligent Highways with warning messages and diversions according to climate conditions and unexpected events like accidents or traffic jams.

II. Smart Environment

a. Forest Fire Detection: Monitoring of combustion gases and preemptive fire conditions to define alert zones.
b. Air Pollution: Control of CO2 emissions of factories, pollution emitted by cars and toxic gases generated in farms.
c. Snow Level Monitoring: Snow level measurement to know in real time the quality of ski tracks and allow security corps avalanche prevention.
d. Landslide and Avalanche Prevention: Monitoring of soil moisture, vibrations and earth density to detect dangerous patterns in land conditions.
e. Earthquake Early Detection: Distributed control in specific places of tremors.

III. Smart Agriculture

a. Wine Quality Enhancing: Monitoring soil moisture and trunk diameter in vineyards to control the amount of sugar in grapes and grapevine health.
b. Green Houses: Control micro-climate conditions to maximize the production of fruits and vegetables and its quality.
c. Golf Courses: Selective irrigation in dry zones to reduce the water resources required in the green [1].
d. Meteorological Station Network: Study of weather conditions in fields to forecast ice formation, rain, drought, snow or wind changes.
e. Compost: Control of humidity and temperature levels in alfalfa, hay, straw, etc. to prevent fungus and other microbial contaminants.

IV. eHealth

a. Fall Detection: Assistance for elderly or disabled people living independent.
b. Medical Fridges: Control of conditions inside freezers storing vaccines, medicines and organic elements.
c. Sportsmen Care: Vital signs monitoring in high performance centers and fields.

d. Patients Surveillance: Monitoring of conditions of patients inside hospitals and in old people's home.
e. Ultraviolet Radiation: Measurement of UV sun rays to warn people not to be exposed in certain hours.

The Future IoT: As far as the reach of the Internet of Things, there are more than 12 billion devices that can currently connect to the Internet, and researchers estimate that by 2020 there will be 26 times more connected things than people.

Future applications

World sensor networks, Home automation and domestic, Daily life (Traffic monitoring, shopping etc), Tracking and shipping goods, Health and Unpredictable developments etc.

Conclusion

IoT will make data easily shared among peer groups for faster problem identification and resolution. The Internet of Things promises to deliver a step change in individuals' quality of life and enterprises' productivity. Through a widely distributed, locally intelligent network of smart devices, the IoT has the potential to enable extensions and enhancements to fundamental services in transportation, logistics, security, utilities, education, healthcare and other areas, while providing a new ecosystem for application development.

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