IoT (Internet of Things) : is an advanced automation and analytics system which exploits networking, sensing, big data, and artificial intelligence technology to deliver complete systems for a product or service. These systems allow greater transparency, control, and performance when applied to any industry or system.

IoT systems have applications across industries through their unique flexibility and ability to be suitable in any environment. They enhance data collection, automation, operations, and much more through smart devices and powerful enabling technology.

This tutorial aims to provide you with a thorough introduction to IoT. It introduces the key concepts of IoT, necessary in using and deploying IoT systems.

IoT – Key Features

The most important features of IoT include artificial intelligence, connectivity, sensors, active engagement, and small device use. A brief review of these features is given below –

- **AI** – IoT essentially makes virtually anything "smart", meaning it enhances every aspect of life with the power of data collection, artificial intelligence algorithms, and networks. This can mean something as simple as enhancing your refrigerator and cabinets to detect when milk and your favorite cereal run low, and to then place an order with your preferred grocer.
- **Connectivity** – New enabling technologies for networking, and specifically IoT networking, mean networks are no longer exclusively tied to major providers. Networks can exist on a much smaller and cheaper scale while still being practical. IoT creates these small networks between its system devices.
- **Sensors** – IoT loses its distinction without sensors. They act as defining instruments which transform IoT from a standard passive network of devices into an active system capable of real-world integration.
- **Active Engagement** – Much of today's interaction with connected technology happens through passive engagement. IoT introduces a new paradigm for active content, product, or service engagement.
- **Small Devices** – Devices, as predicted, have become smaller, cheaper, and more powerful over time. IoT exploits purpose-built small devices to deliver its precision, scalability, and versatility.

IoT – Advantages

The advantages of IoT span across every area of lifestyle and business. Here is a list of some of the advantages that IoT has to offer –

- **Improved Customer Engagement** – Current analytics suffer from blind-spots and significant flaws in accuracy; and as noted, engagement remains passive. IoT completely transforms this to achieve richer and more effective engagement with audiences.
- **Technology Optimization** – The same technologies and data which improve the customer experience also improve device use, and aid in more potent improvements to technology. IoT unlocks a world of critical functional and field data.
- **Reduced Waste** – IoT makes areas of improvement clear. Current analytics give us superficial insight, but IoT provides real-world information leading to more effective management of resources.
- **Enhanced Data Collection** – Modern data collection suffers from its limitations and its design for passive use. IoT breaks it out of those spaces, and places it exactly where humans really want to go to analyze our world. It allows an accurate picture of everything.

IoT – Disadvantages

Though IoT delivers an impressive set of benefits, it also presents a significant set of challenges. Here is a list of some its major issues –

- **Security** – IoT creates an ecosystem of constantly connected devices communicating over networks. The system offers little control despite any security measures. This leaves users exposed to various kinds of attackers.
- **Privacy** – The sophistication of IoT provides substantial personal data in extreme detail without the

user’s active participation.

- **Complexity** – Some find IoT systems complicated in terms of design, deployment, and maintenance given their use of multiple technologies and a large set of new enabling technologies.
- **Flexibility** – Many are concerned about the flexibility of an IoT system to integrate easily with another. They worry about finding themselves with several conflicting or locked systems.
- **Compliance** – IoT, like any other technology in the realm of business, must comply with regulations

Low Interoperability for the IPv6:

Internet Protocol version 6 (IPv6) is the latest revision of the Internet Protocol (IP) and the first version of the protocol to be widely deployed. IPv6 was developed by the Internet Engineering Task Force (IETF) to deal with the long-anticipated problem of IPv4 address exhaustion.

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1 Introduction

The Internet of Things requires interoperability and low power consumption, but interoperability and low power con- sumption have thus far been mutually exclusive. This talk outlines the challenges in attaining low power operation for the IPv6-based Internet of Things, how this affects interop- erability, and what must be done to combine the two.

Research and standardization has come a long way to- wards providing efficient protocols and specifications for IPv6 for the Internet of Things.

Example protocol

HTTP, CoAP
TCP, UDP
IPv6, RPL, 6lowpan
CSMA
X−MAC/ContikiMAC
IEEE 802.15.4

Low-Power Interoperability

To attain low-power interoperability for IPv6 for the Inter- net of Things, interoperable radio duty cycling is essential. We have demonstrated interoperability between Contiki and TinyOS [6], but with an always-on radio layer. Our experi- ments showed that interoperability is not a binary property: two implementations that have good performance on their own can have a suboptimal performance in a mixed network. This is due to subtle variations in implementation choices and low-level details. Our results suggest that implementa- tions of Internet of Things protocols need to be tested not just for correctness but also for performance. Given that interop- erability in the simpler case of an always-on radio provides such unexpected results, we have reason to believe that inter- operability with duty cycling will provide many unforeseen challenges.

A review of IOT working across:

The Internet of Things (IoT) is an emerging paradigm that enables the communication between electronic devices and sensors through the internet in order to facilitate our lives. IoT use smart devices and internet to provide innovative solutions to various challenges and issues related to various business, governmental and public/private industries across the world .

1. IoT is progressively becoming an important aspect of our life that can be sensed everywhere around us. In whole, IoT is an innovation that puts together extensive variety of smart systems, frameworks and intelligent devices and sensors. Moreover, it takes advantage of quantum and nanotechnology in terms of storage, sensing and processing speed which were not conceivable beforehand

2. Extensive research studies have been done and available in terms of scientific articles, press reports both on internet and in the form of printed materials to illustrate the potential effectiveness and applicability of IoT transformations. It could be utilized as a preparatory work before making novel innovative business plans while considering the security, assurance and interoperability.

3. another important achievement of IoT is Smart Health Sensing system (SHSS). SHSS incorporates small intelligent equipment and devices to support the health of the human being. These devices can be used both indoors and

outdoors to check and monitor the different health issues and fitness level or the amount of calories burned in the fitness center etc.

RFID Technology introduction and mapping and localization of RFID technology:

Radio frequency identification (RFID) is a general term that is used to describe a system that transmits the identity (in the form of a unique serial number) of an object wirelessly, using radio waves. RFID technologies are grouped under the more generic Automatic Identification(Auto ID) technologies.

RFID stands for Radio Frequency Identification. It uses radio waves to identify and track tags affixed on objects. RFID readers are installed at tracking points and can read information from tags when they come into range, which can be of several feet radius. They are used to check identities and track inventory, assets, and people.

WSN stands for Wireless Sensor Networks. It comprises a collection of spatially distributed sensor devices that monitor and record environmental conditions. The information from the sensors is collected by a central computer or gateway and processed. They have a wide range of applicability like earth sensing, pollution monitoring, forest fire detection, military tracking, health & home applications, and industrial & commercial applications.

The integration of RFID and WSN extends the application of RFID to larger areas of 100–200 meters. It comprises an RFID reader, a Radio-Frequency transceiver, and a micro-controller. Tags integrated with WSNs can communicate with other tags, thus forming a multi-hop network, spanning a wider area.

Mapping and localization with RFID technology

We analyze whether radio frequency identification (RFID) technology can be used to improve the localization of mobile robots and persons in their environment. In particular we study the problem of localizing RFID tags with a mobile platform that is equipped with a pair of RFID antennas. We present a probabilistic measurement model for RFID readers that allow us to accurately localize RFID tags in the environment.

RFID sensors have entered the field of mobile robotics

Low-cost passive tags with long range help in navigation, localization, mapping etc

Radio frequency identification (RFID) is poised for growth as businesses and governments explore applications implementing RFID. The RFID technology will continue to evolve to meet new demands for human and target location and tracking. In particular, there are increasing needs to locate and track multiple RFID-tagged items that are closely spaced. As a result, localization and tracking techniques with higher accuracy yet low implementation complexity are required. This paper examines the applicability of direction-of-arrival (DOA) estimation methods to the localization and tracking problems of passive RFID tags. Different scenarios of stationary and moving targets are considered. It is shown through performance analysis and simulation results that simple DOA estimation methods can be used to provide satisfactory localization performance.

Concept of wave: Let's talk now about waves! Take a look at the "IoT Waves" as predicted by Ericsson, where 3 waves are predicted for the development of connected devices. The first wave is Networked Consumer Electronics, the second is Networked Industries, and the third is Networked Society/Everything which is where we start talking about the "Internet of Everything".

The Internet of Things (IoT) is emerging as **the third wave in the development of the Internet.** The 1990s' Internet wave connected 1 billion users while the 2000s' mobile wave connected another 2 billion. **The IoT has the potential to connect 10X as many (28 billion) "things" to the Internet by 2020**, ranging from bracelets to cars. Breakthroughs in the cost of sensors, processing power and bandwidth to connect devices are enabling ubiquitous connections right now. **Smart products like smart watches and thermostats (Nest)** are already gaining traction as stated in Goldman Sachs Global Investment Research's report.

IoT has key attributes that distinguish it from the "regular" Internet, as captured by Goldman Sachs's S-E-N-S-E framework: ***Sensing, Efficient, Networked, Specialized, Everywhere***. These attributes may tilt the direction of technology development and adoption, with significant implications for Tech companies – much like the transition from the fixed to the mobile Internet shifted the center of gravity from Intel to Qualcomm or from Dell to Apple.

S-E-N-S-E	What the Internet of Things does	How it differs from the Internet
Sensing	Leverages sensors attached to things (e.g. temperature, pressure, acceleration)	More data is generated by things with sensors than by people
Efficient	Adds intelligence to manual processes (e.g. reduce power usage on hot days)	Extends the Internet's productivity gains to things, not just people
Networked	Connects objects to the network (e.g. thermostats, cars, watches)	Some of the intelligence shifts from the cloud to the network's edge ("fog" computing)
Specialized	Customizes technology and process to specific verticals (e.g. healthcare, retail, oil)	Unlike the broad horizontal reach of PCs and smartphones, the IoT is very fragmented
Everywhere	Deployed pervasively (e.g. on the human body, in cars, homes, cities, factories)	Ubiquitous presence, resulting in an order of magnitude more devices and even greater security concerns

Source: Goldman Sachs Global Investment Research.

A number of significant technology changes have come together to enable the rise of the IoT. These include the following.

- ***Cheap sensors*** – Sensor prices have dropped to an average 60 cents from $1.30 in the past 10 years.
- ***Cheap bandwidth*** – The cost of bandwidth has also declined precipitously, by a factor of nearly 40X over the past 10 years.
- ***Cheap processing*** – Similarly, processing costs have declined by nearly 60X over the past 10 years, enabling more devices to be not just connected, but smart enough to know what to do with all the new data they are generating or receiving.
- ***Smartphones*** – Smartphones are now becoming the personal gateway to the IoT, serving as a remote control or hub for the connected home, connected car, or the health and fitness devices consumers are

increasingly starting to wear.

- ***Ubiquitous wireless coverage*** – With Wi-Fi coverage now ubiquitous, wireless connectivity is available for free or at a very low cost, given Wi-Fi utilizes unlicensed spectrum and thus does not require monthly access fees to a carrier.
- ***Big data*** – As the IoT will by definition generate voluminous amounts of unstructured data, the availability of big data analytics is a key enabler.
- ***IPv6*** – Most networking equipment now supports IPv6, the newest version of the Internet Protocol (IP) standard that is intended to replace IPv4. IPv4 supports 32-bit addresses, which translates to about 4.3 billion addresses – a number that has become largely exhausted by all the connected devices globally. In contrast, IPv6 can support 128-bit addresses, translating to approximately 3.4 x 1038 addresses – an almost limitless number that can amply handle all conceivable IoT devices.