Internet of Things (IoT)

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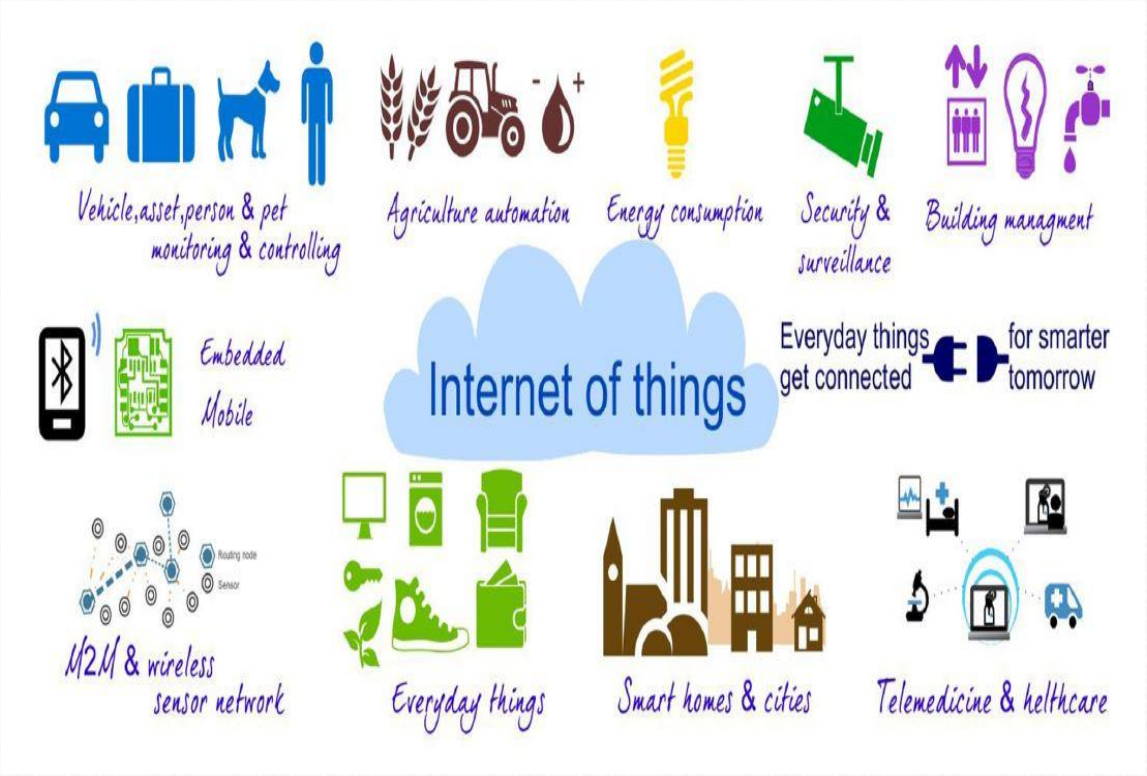
Overview

- What is Internet of Things (IoT)?
- What is all this buzz about?
- Utilized Technologies.
- Micro-location and geofencing.
  - Beacons
  - Example uses cases.
- IoT applications.
- Cloud and IoT
- Challenges.
- Conclusion.



What is Internet of Things?

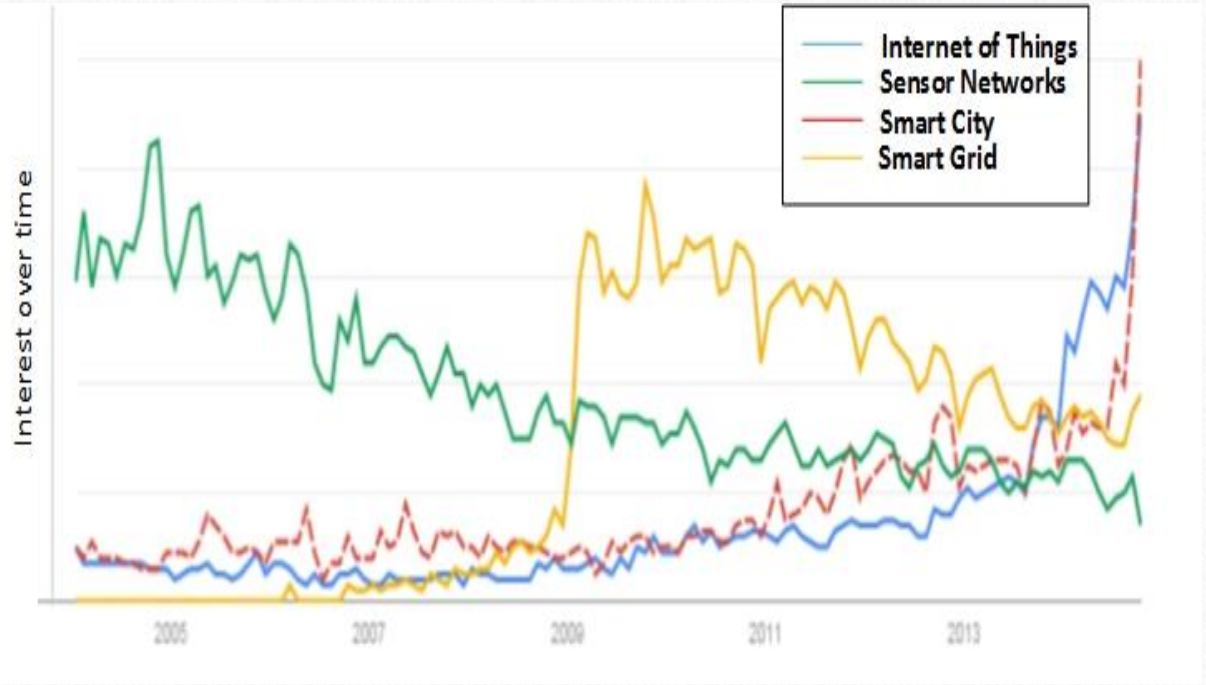
- Connecting every single ‘entity’ or ‘thing’ with each other.
- Those ‘things’ can be sensors, smart phones, actuators, and literally everything else.
- It is the next ‘big thing’.
- Gartner's Top 10 Strategic Technology Trends for 2015.
- According to Business Insider
  - Largest device market by 2019.
  - $1.7 trillion added into global economy by 2019.
  - $6.7 billion device shipment.

What is the Internet of Things? (cont.)

- The term was first coined in by Kevin Ashton in 1999, however it was in the field of Supply Chain Management.
- Over the years, various applications have been incorporated into the scope of IoT and now it has literally become a network of every single ‘thing’.
- The purpose is to provide better service and enhance user experience.

What is all this buzz about?

- Increase in Interest.
- Major companies have started to invest.
- A huge potential market.
- Incorporation of all technologies.
- In short, 'Welcome to the Future'



Utilized Technologies

- Both wired and wireless technologies can be used for the interconnection of the devices.
- Every device is provided with an IP address.
- Wireless technology is preferable over wired.
  - Flexibility.
  - Price.
- Heterogeneous networks.

Utilized Technologies (cont.)

KEY WIRELESS TECHNOLOGIES USED IN IOT

Technology	Maximum Range	Maximum Frequency	Maximum Throughput
Bluetooth IEEE 802.15.1 [12]	upto 100m for Class A	2.4 GHz	24.0 Mbps with version 4
ZigBee IEEE 802.15.4 [13]	upto 100m with certain tradeoffs	2.4 GHz	2-250.0 Kbps
IEEE 802.11a [14], [15]	5000m outdoor	5 GHz	54 Mbps
IEEE 802.11b	140m outdoor	2.4 GHz	11 Mbps
IEEE 802.11g	140m outdoor	2.4 GHz	54 Mbps
IEEE 802.11n	250m outdoor	2.5/5 GHz	600 Mbps
IEEE 802.11ac	35m indoor	5 GHz	1.3 Gbps with 3 antennas and 80 MHz
IEEE 802.11ad	couple of meters	60 GHz	4.6 Gbps
WiMAX [16]	depends on cell	2.3 GHz, 2.5 GHz and 3.5 GHz	365 Mbps downlink/376 Mbps uplink
Long Term Evolution [17]	depends on cell	2600 MHz	300 Mbps downlink/75 Mbps uplink
Long Term Evolution-Advanced [18]	depends on cell	4.44-4.99 GHz	1 Gbps downlink/500 Mbps uplink

Micro-location and Geofencing.

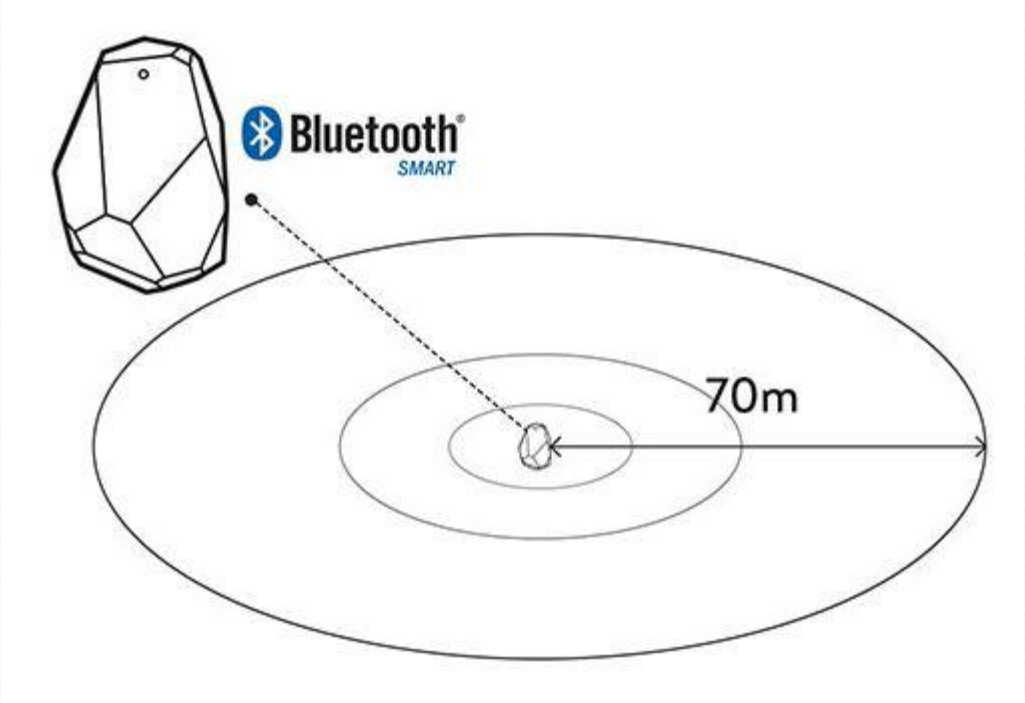
- Micro-location
  - Pin-pointing the location.
  - High accuracy required.
  - Usually indoors.
- Geofencing
  - A virtual fence created around some entity.
  - Alerts about the entrance and exit of an entity of interest.
- Both geofencing and micro-location have great potential.

Micro-location and Geofencing (cont.)

- Different technologies can be used.
- Beacons
  - Bluetooth Low Energy (BLE) devices that can be installed anywhere.
  - Used for micro-location purposes.
  - Apple introduced its iBeacon.
  - There are numerous other companies in the market that have started beacon based services.
  - Context aware location based platform.
  - Different power options
    - USB, External 5V DC and battery.
    - Can run for 2+ years using the coin battery.

Micro-location and Geofencing (cont.)

- Phones and other smart devices pick up the Bluetooth signal.
- Estimate their distance using the Received Signal Strength Indicator (RSSI).
- Probing of device can of different frequency.
  - Higher the frequency, better the performance.
- Every beacon has a Unique Universal ID (UUID) for identification.



Micro-location and Geofencing (cont.)

- Different companies have started offering Beacon based services.

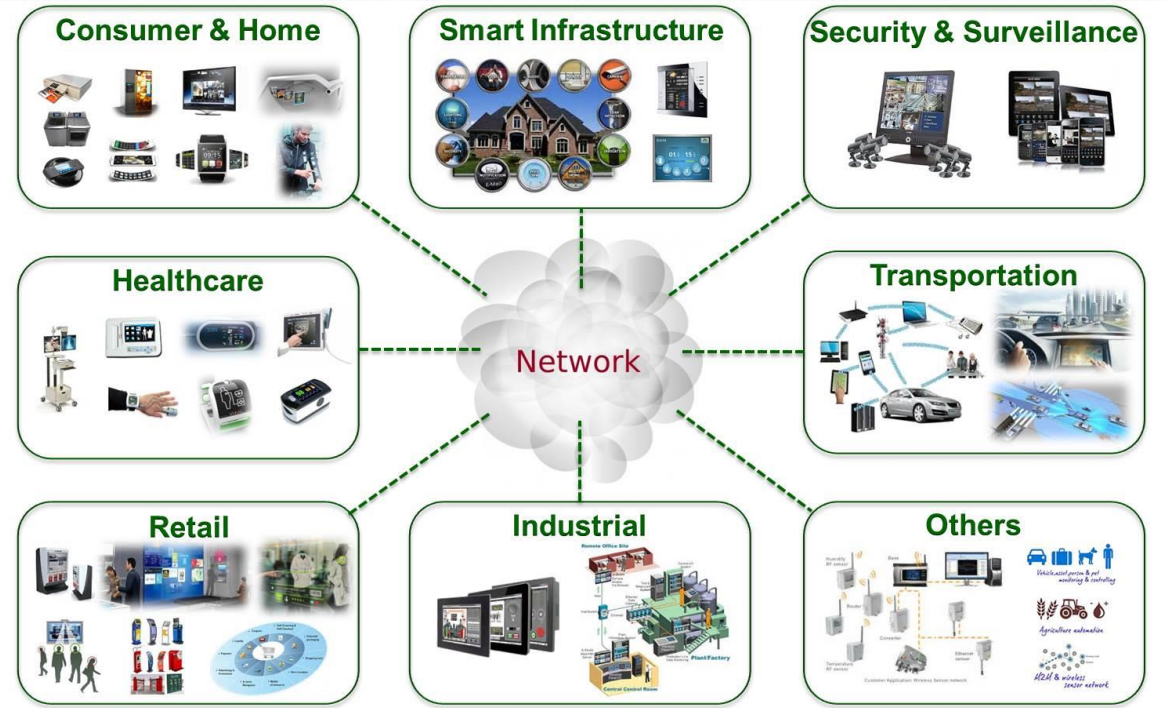
Company	Service Description
Apple Inc.[29]	The iBeacons are used for micro-location purposes. They are Bluetooth Low Energy devices that enable LBS.
Gimbal [28]	Gimbal's beacons provides a context-aware advertising platform. The beacon's communicate through bluetooth smart and they are as per the specifications of Apple's i-beacon.
Onxy Beacon [41]	Onxy Beacon also provides beacon based services that can help in better marketing and LBS. Onxy beacon also offers a beacon management system that is cloud based and helps in building micro location enabled applications for the beacons.
Swirl using iBeacon [42]	Swirl uses iBeacons and provides end-to-end mobile marketing platform within a store. It is an enterprise grade platform that helps to create, manage and optimize the LBS based mobile marketing.
Sonic Notify [43]	Sonic Notify uses beacons to provide enterprise proximity solutions.
Estimote [30]	Estimote utilizes beacons for creating new and contextually rich mobile services.

Example Use Cases

- Targeted E-Marketing
  - Coupons.
  - Enhancing game time experience.
  - Event Notifications.
    - Museum
- Tenant Assistance
  - Finding a location.
  - Enhancing office experience.
  - Enhancing residential experience.
  - Increasing the comfort level

IoT applications

- Smart Architectures
- Energy Efficiency
- Disaster Management
- Micro-location and Geofencing based services
- Health Care
  - Sensors inside the pills
- Security
- Literally ‘Everywhere’



Cloud and IoT

- Huge amount of Data
  - Storage
  - Analysis
- Cloud computing is an enabler of IoT domination in the near future.
- Changes in Cloud:
    - Busier hence better capacity management requirement.
    - Better security, higher storage and better networks.

Challenges

- Interoperability
- Adaptability and Flexibility
- Management and Energy Efficiency
- Security and Privacy
- Artificial Intelligence Enabled Devices.

Conclusion

- IoT is ‘The Future’ technology.
- There is a huge potential market.
- Various companies have realized the potential and started investment.
- Loads of applications.
- Challenges lie ahead that should be addressed.
- Sky is the Limit

Questions?

Thank you!

References

- http://www.forbes.com/sites/gartnergroup/2014/10/21/gartners-top-10-strategic-technology-trends-for-2015/
- http://www.businessinsider.com/how-the-internet-of-things-market-will-grow-2014-10
- F. Zafari, I. Papapanagiotou, K. Christidis, "Internet of Things in Smart Buildings: Challenges and Proposed Solutions" Submitted to IEEE Internet of Things Journal.
- http://beekn.net/2014/07/ibeacon-for-android/