



Advanced Communication Technologies (CCE534)

Lecture 1

Introduction to Internet-of-Things (IoT)

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Course Info

Title

Advanced Communication Technologies (CCE534)

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References

Multiple references and Online Courses will be used:

Assessment 100



Introduction to Internet-of-Things (IoT)

Billions of “Things” are being connected

How we get here?
What drives us into such vision?

- We want to receive more data
- We want to control stuff
- We want to automate
- We want to make things faster



How we get here?

“...hundreds of wireless computing devices per person per office, of all scales [...] This is different from PDA's, dynabooks, or information at your fingertips. It is invisible, everywhere computing that does not live on a personal device of any sort, but is in the woodwork everywhere. [...] its highest ideal is to make a computer so imbedded, so fitting, so natural, that we use it without even thinking about it.

Mark Weiss (Xerox PARC) – Ubiquitous Computing, 1988



“... it looks like the rapid growth of the World Wide Web may have been just the trigger charge that is now setting off the real explosion, as things start to use the Net.”

Neil Gershenfeld (MIT Media Lab), 1999

“...We need an internet for things, a standardized way for computers to understand the real world”

Kevin Ashton (Auto-ID @ MIT) – Internet of Things, 2002



How we get here?

- In the 2000s, we are heading into a new era of ubiquity, where the “users” of the Internet will be counted in billions and where humans may become the minority as generators and receivers of traffic.
- Instead, most of the traffic will flow between devices and all kinds of “**things**”, thereby creating a much wider and more complex **Internet of Thing**

(“The Internet of Things”, ITU Internet Report 2005)



network of interconnected objects, from books to cars, from electrical appliances to food [...]. These objects will sometimes have their own Internet Protocol addresses, be embedded in complex systems and use sensors to obtain information from their environment [...] and/or use actuators to interact with it

IoT — An action plan for Europe, 2009



The Internet of Everything (IoE) brings together people, processes, data, and things to make networked connections more relevant and valuable than ever before – turning information into actions that create new capabilities, richer experiences, and unprecedented economic opportunity for businesses, individuals, and countries

Cisco – coins Internet of Everything, 2013



- ✓ **The Internet of Things (IoT) is the network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment.**
- ✓ **Internet technology connecting devices, machines and tools to the internet by means of wireless/wired technologies**



IoT Ecosystem and Key Ingredients



Small form factor



Low power, low cost



Sensors and actuators



Wireless communication



Connected to the Internet



Programmable



Some level of autonomy



Image from <http://www.cchc.cl/informacion-a-la-comunidad/industria-de-la-construccion/personaje/>

Smart Waste Management

- Ultrasonic fill-level sensor
- Cellular IoT
- Solar powered
- Predictive pattern recognition



<http://ecubelabs.com/integrated-waste-management/>



Smart Street Lights

- Save energy
- Reduce light pollution
- Faster replacement

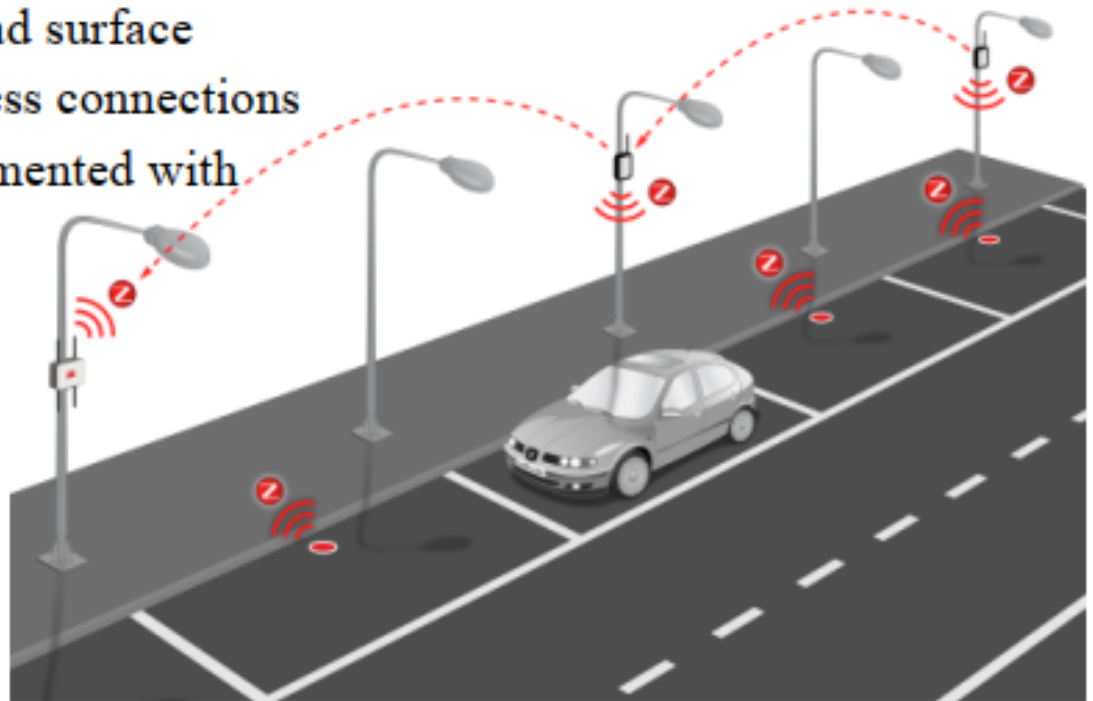


<http://www.tvilliam.com/>



Smart Street Parking

- Infrared- and magnetic-based vehicle detection sensor mounted on the road surface
- Zigbee, LoRaWAN wireless connections
- Mesh networks are implemented with in street lights.
- Apps to direct drivers to empty spaces
- Dynamic parking prices

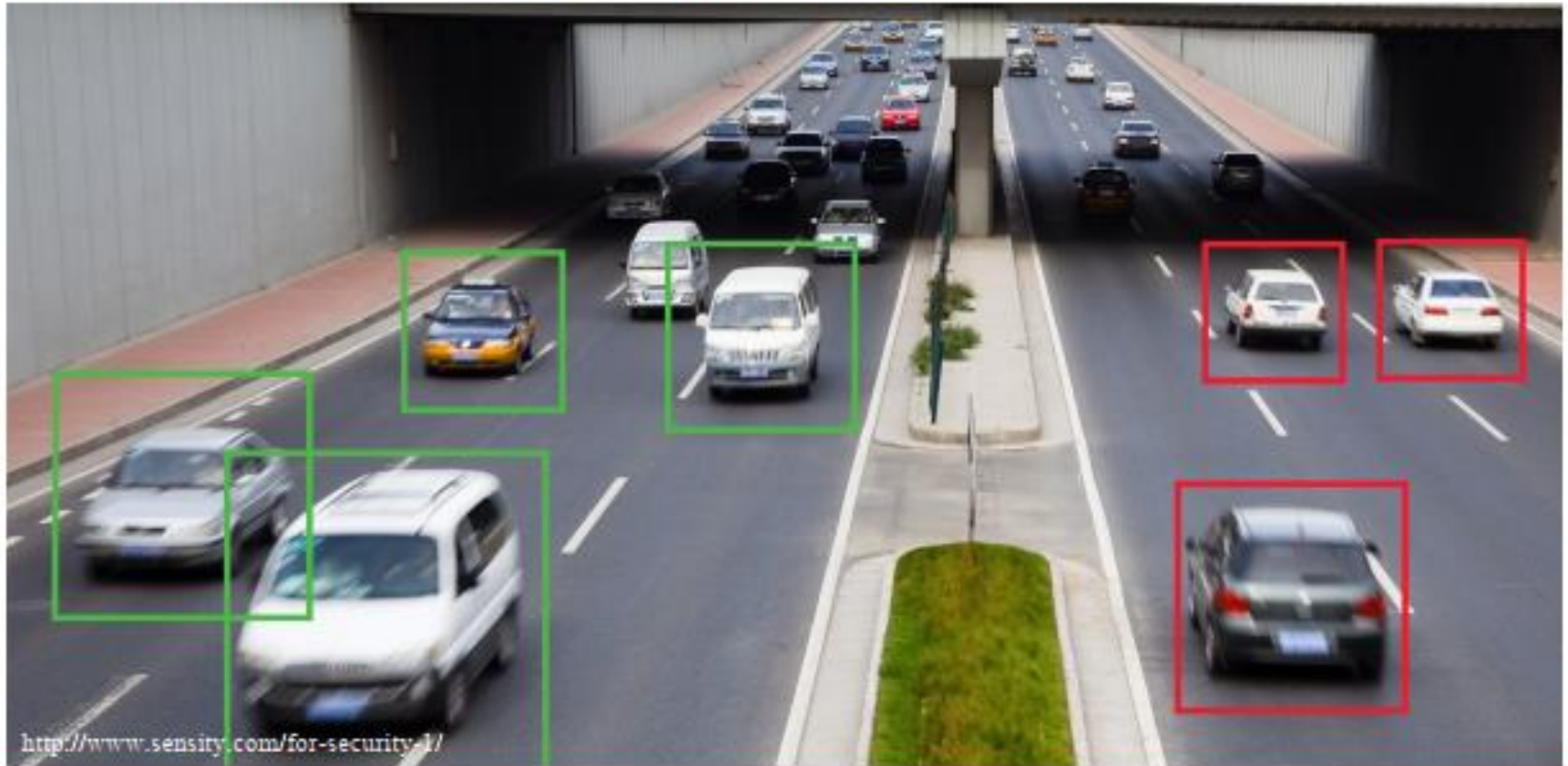


http://www.libelium.com/smart_parking/



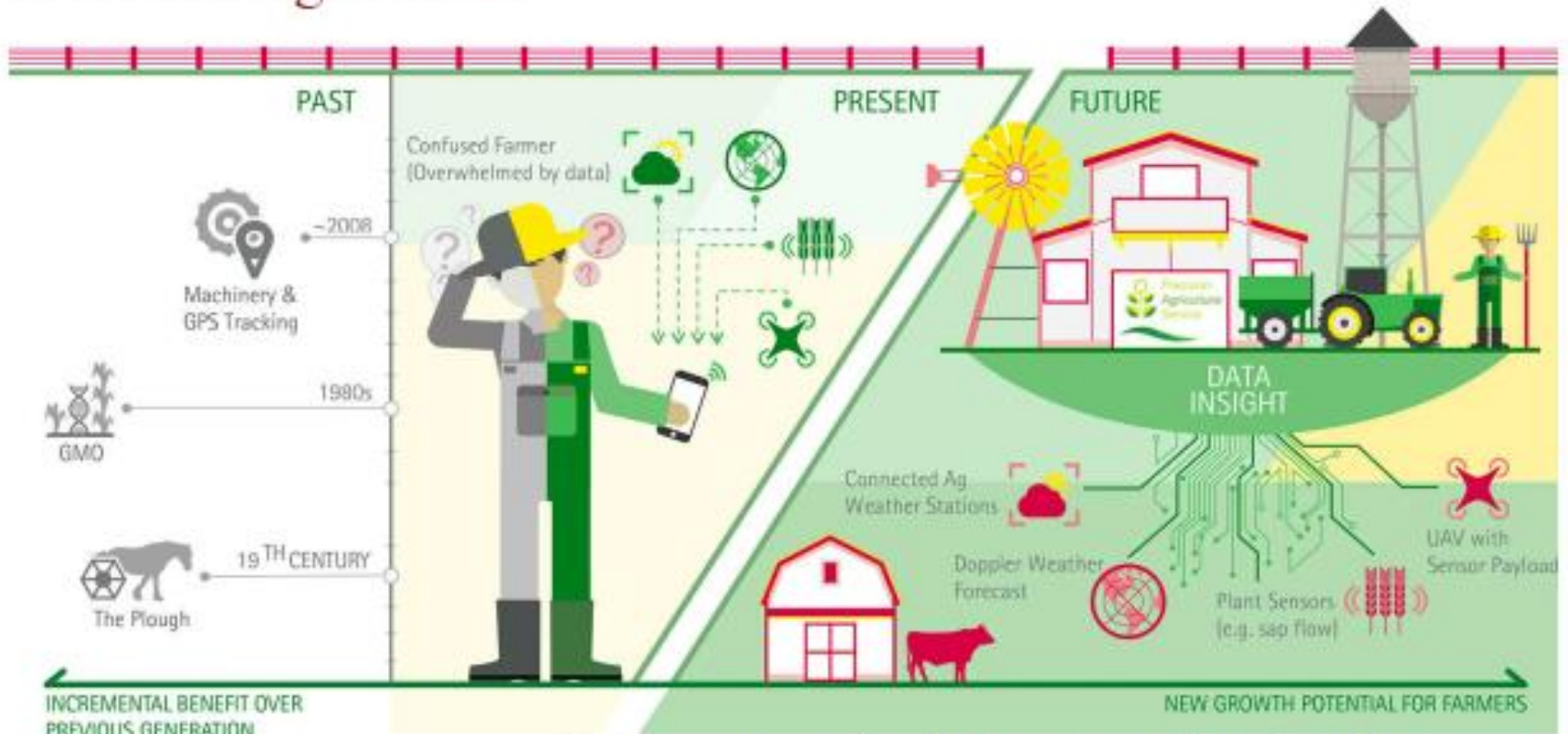
Samples of IoT applications

Security without Surveillance



Samples of IoT applications

Precision Agriculture



<https://www.accenture.com/cn-en/insight-accenture-digital-agriculture-solutions>

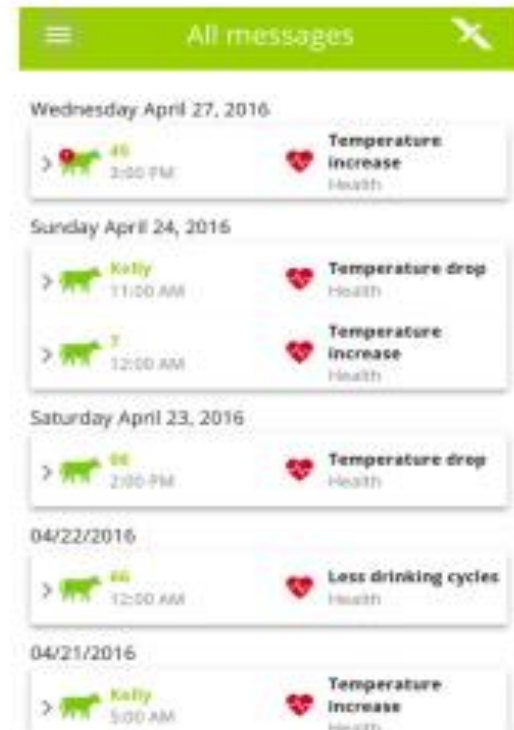


Samples of IoT applications

Connected Livestock

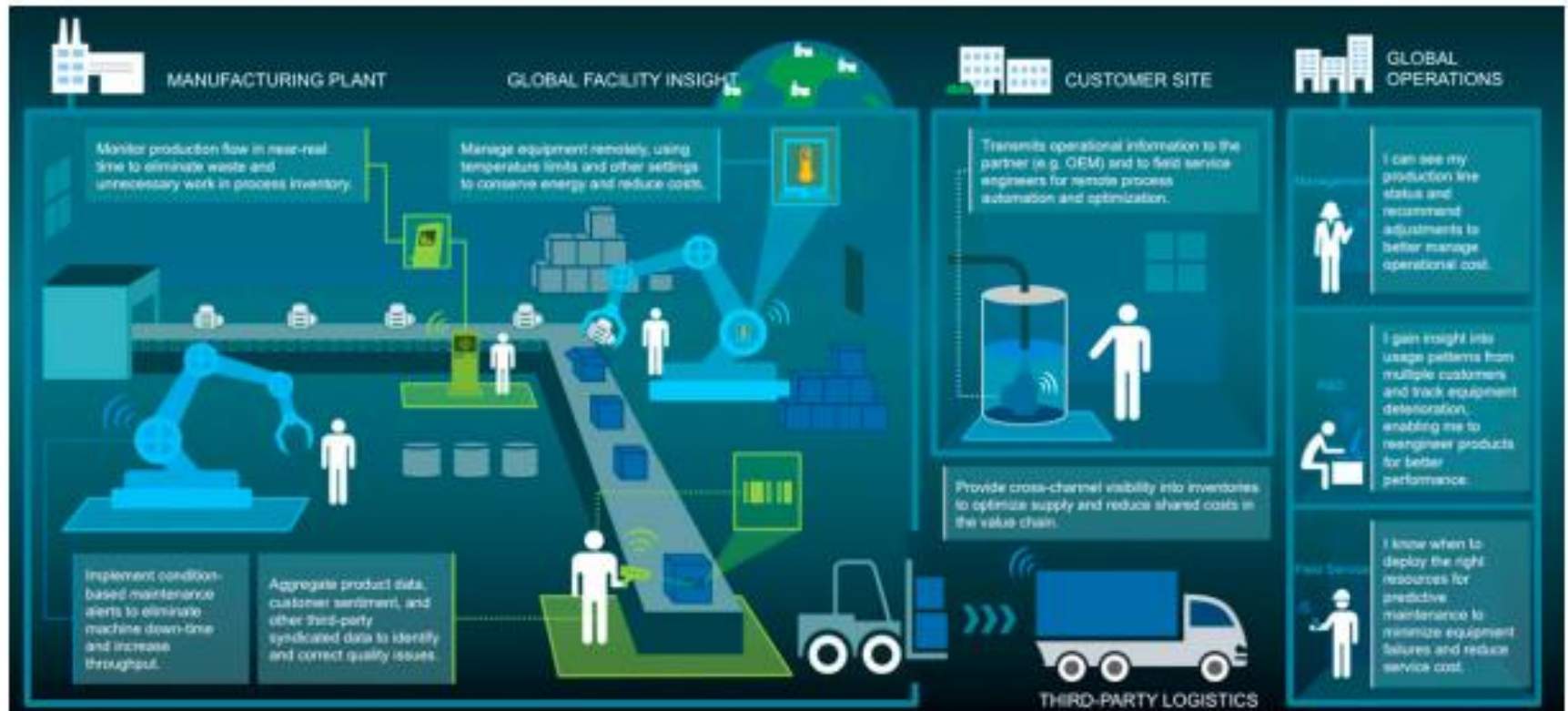


<http://uk.smaxtec.com/smaxtec-system/>



Samples of IoT applications

Smart Manufacturing



<https://www.slideshare.net/andrejt/ntk-2015-internet-of-things-track-iot-smart-home>



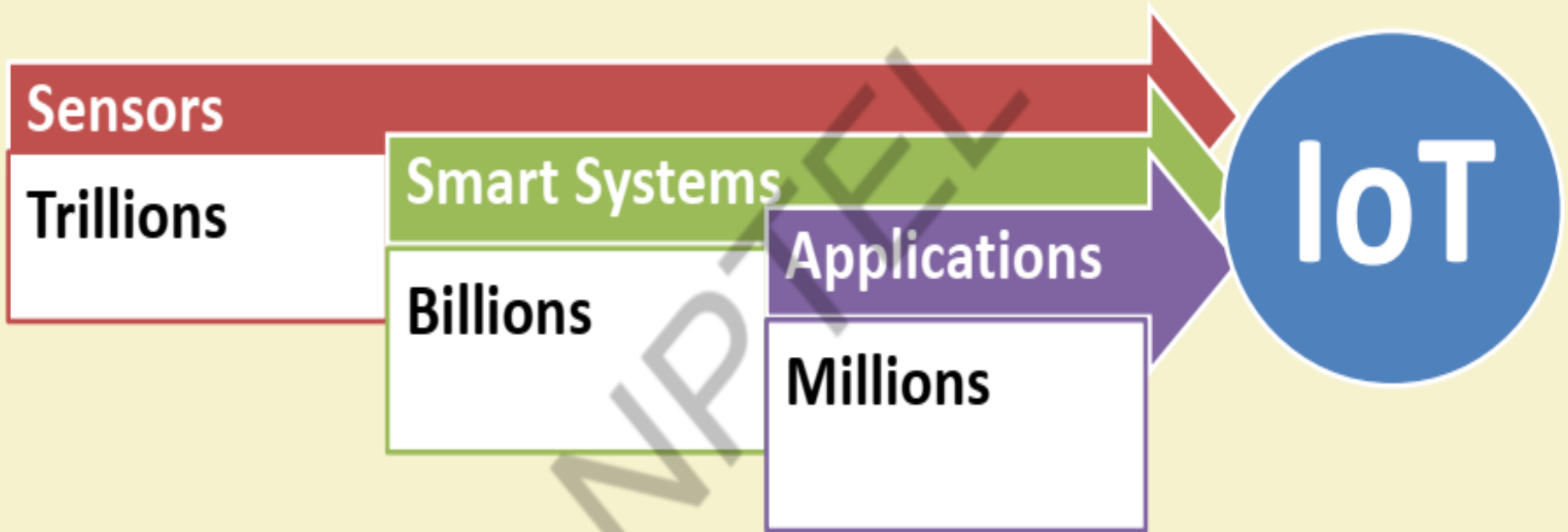
Samples of IoT applications

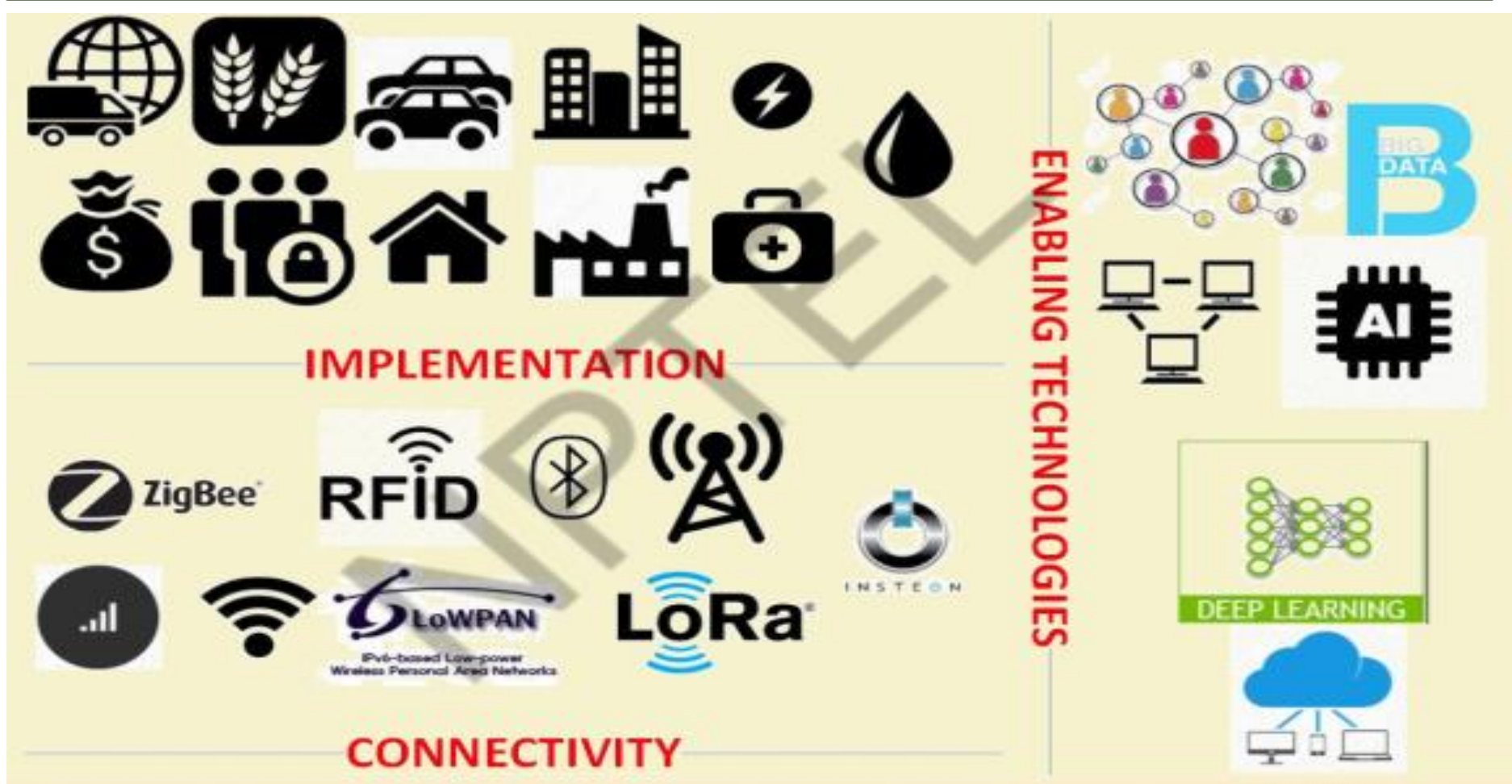
- **Traffic Congestion Detection**
- **Smart Roads**
- **Smart Grid**
- **Access Control**
- **River Floods Detections**
- **Stock Calculations**
- **Forest Fire Detection**
- **Air pollution**
- **Supply Chain Control**
- **NFC Payment**
- **Intelligent Shopping Applications**
- **Earthquake Early Detection**
- **Water leakage**
- **Radiation Level Monitoring**
- **Snow level Monitoring**



Expectation

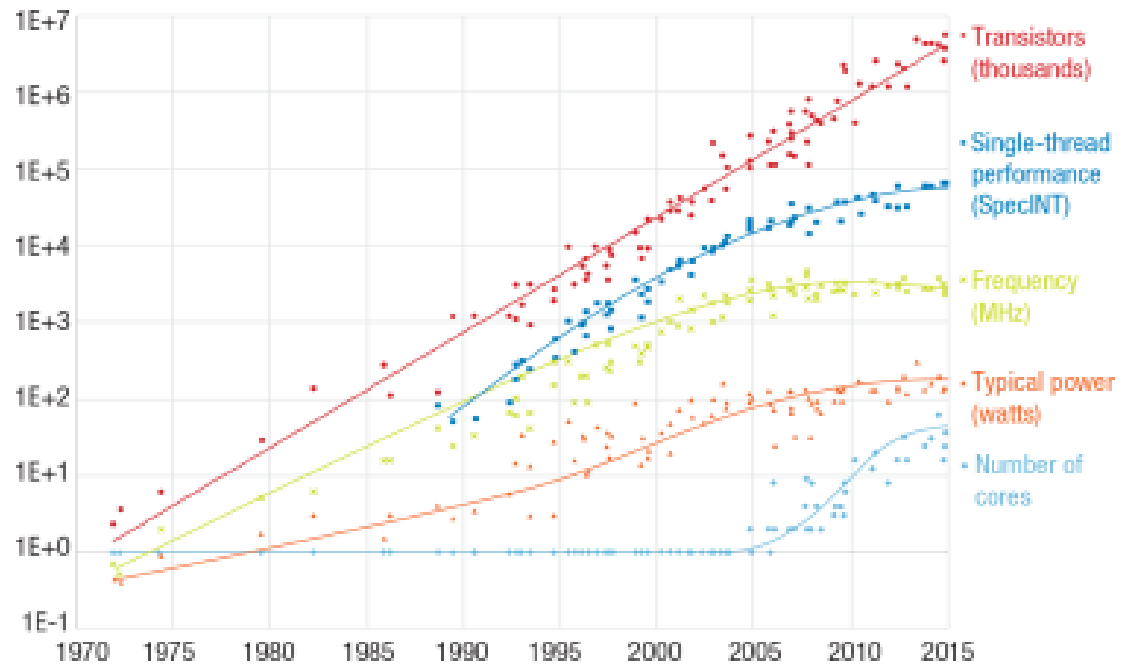
Expected!!





Several Technologies and advancement in both hardware and software make it possible

Enablers: 1. Computing power

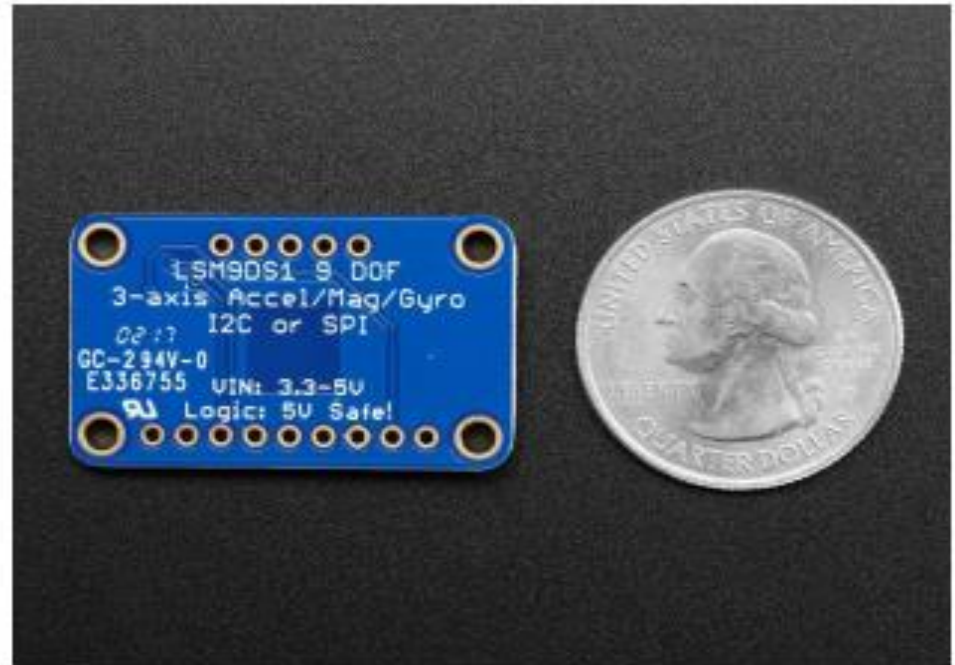


K. M. Bresnaker, S. Singhal, R. S. Williams, "Adapting to Thrive in a New Economy of Memory Abundance", Computer vol. 48 no. 12, p. 44-53, 2015

Enablers:
2. Miniaturisation,
more sensors,
decreasing cost

LSM9DS1:
accelerometer + gyroscope + magnetometer

Cost: ~£10



Source: adafruit.com

Enablers:
3. Batteries

Fitbit Flex



Li-Polymer, Single Cell, 5-day supply



Source: ifixit.com

Enablers:
4. Communications



Short range:
Bluetooth, Zigbee,
ANT, RFID



Medium range:
Wi-Fi, cellular



Long-range:
LoRa, NB-IoT, SigFox

Enablers: 5. Development Resources



Simple programming languages
Arduino C, (Micro)Python



Cloud communication protocols
(HTTP, MQTT, CoAP)



A range of powerful APIs/frameworks
(REST, IFTTT)



Language independent data formats
(JSON, YAML)



Cloud platforms
(AWS, GCP, Microsoft Azure, Arm Pelion)

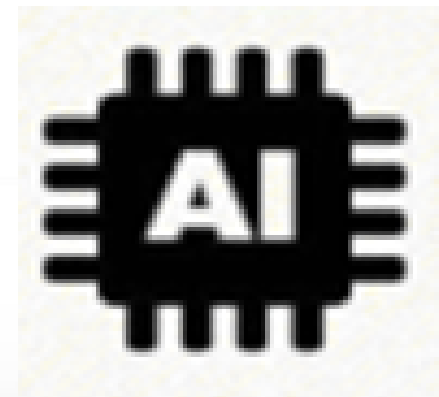


Visualisation tools
(Chart.JS, dygraphs, Kibana)

6. Big data Revolution



7. Machine Learning Algorithms



- **The following technologies are very closely related to IoT**

1. **Machine-to-Machine (M2M) communications:**

- ✓ M2M emphasis on machines interactions via one or more communication networks (e.g., 3G, 4G, 5G, satellite, public networks).
- ✓ **M2M is part of the IoT**
- ✓ IoT has a broader scope than M2M, since it comprises a broader range of interactions, including interactions between devices/things, things and people, things with applications and people with applications.
- ✓ It also enables the composition of workflows comprising all of the above interactions.



- **The following technologies are very closely related to IoT**

2. **Web-of-Things (WoT):**

- ✓ From a developer's perspective, the WoT enables access and control over IoT resources and applications using mainstream web technologies (such as HTML 5.0, JavaScript, Ajax, PHP, etc.)
- ✓ While IoT is about creating a network of objects, things, people, systems and applications, WoT tries to integrate them to the Web.
- ✓ Technically speaking, WoT can be thought as a flavour/option of an application layer added over the IoT's network layer.
- ✓ The scope of IoT applications is broader and includes systems that are not accessible through the web (e.g., conventional WSN and RFID systems).



- **The following technologies are very closely related to IoT**

- ✓ **Cyber-Physical-Systems (CPS):**

- ✓ **CPS** are physical and engineered systems whose operations are monitored, coordinated, controlled and integrated by computing core.
- ✓ CPS are not necessarily connected with internet. Ex. Smart electricity meters, Atomic reactors, and cars.
- ✓ CPSs that are connected to each other via internet are part of the IoT



- **The following technologies are very closely related to IoT**

- ✓ **Wireless Sensor network (WSN):**

- ✓ WSN is composed of several sensing nodes that collect data via wireless connection to a sink
- ✓ In a WSN, there is no direct connection to the internet. Instead, the various sensors connect to some kind of router or central node.
- ✓ WSN itself is a building block of IoT



References

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 - Introduction to Internet of Things, Prof. Sudip Misra, IIT Kharagpur, India
 - Internet of Things Services and Architectures, Summer School, innovation Lab, Romania
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- Perry lea, “Internet of Things for Architects”, Packt Publishing Ltd, 2018
 - Mohammad Ali Jabraeil Jamali, etal, “Towards the Internet of Things: Architectures, Security, and Applications”, Springer, 2020

Thank You

