



# EECE5155: Wireless Sensor Networks and the Internet of Things

Josep Miquel Jornet

Associate Professor, Department of Electrical and Computer Engineering

Director, Ultrabroadband Nanonetworking Laboratory

Member, Institute for the Wireless Internet of Things

Northeastern University

[jmjornet@northeastern.edu](mailto:jmjornet@northeastern.edu)

[www.unlab.tech](http://www.unlab.tech)

# Module T1: Introduction

---

Introduction: Module T1

# A Bit of History...

---

- **First Industrial Revolution:**
  - Great Britain, late 18<sup>th</sup> century
  - Steam power and water power transferred manual labor from homes to powered textile machines in factories
- **Second Industrial Revolution:**
  - Great Britain, Germany, USA, late 19<sup>th</sup> and early 20<sup>th</sup> centuries
  - Triggered by electrical power generation and the development of the internal combustion engine
- **Third Industrial Revolution:**
  - Worldwide, late 20<sup>th</sup> century
  - Enabled by electronics and information technology and their application in automated production systems

# A Bit of History...

---

- **ARPANET:**
  - **1961:** Leonard Kleinrock writes about the predecessor of ARPANET in a paper titled “Information Flow in Large Communication Nets”
  - **1969:** A communication link between a computer in UCLA and a computer in Stanford is established
- **Internet:**
  - **1973:** University College of London (England) and Royal Radar Establishment (Norway) connect to ARPANET: The Internet is born
  - **1974:** The first Internet Service Provider (ISP) is born with the introduction of a commercial version of ARPANET, known as Telenet
- **Web:**
  - **1989:** Tim Berners-Lee invents the World Wide Web
  - **1990:** Lee writes the first web browser computer program while employed at CERN in Switzerland
  - **1991:** The Web browser is released outside of CERN
- More details: <https://www.livescience.com/20727-internet-history.html>

# The First Website (Ever)

---

## World Wide Web

The WorldWideWeb (W3) is a wide-area [hypermedia](#) information retrieval initiative aiming to give universal access to a large universe of documents.

Everything there is online about W3 is linked directly or indirectly to this document, including an [executive summary](#) of the project, [Mailing lists](#) , [Policy](#) , November's [W3 news](#) , [Frequently Asked Questions](#) .

### What's out there?

Pointers to the world's online information, [subjects](#) , [W3 servers](#), etc.

### Help

on the browser you are using

### Software Products

A list of W3 project components and their current state. (e.g. [Line Mode](#) , [X11 Viola](#) , [NeXTStep](#) , [Servers](#) , [Tools](#) , [Mail robot](#) , [Library](#) )

### Technical

Details of protocols, formats, program internals etc

### Bibliography

Paper documentation on W3 and references.

### People

A list of some people involved in the project.

### History

A summary of the history of the project.

### How can I help ?

If you would like to support the web..

### Getting code

Getting the code by [anonymous FTP](#) , etc.

# Yahoo (1994)

The screenshot shows the classic 1994 Yahoo homepage. At the top, there's a banner with two circular icons: one for 'New' featuring a cartoon character, and one for 'Cool' featuring a stylized yellow circle. To the right of the banner is the large red 'YAHOO!' logo. Below the banner, there are two main promotional banners: one for 'Win a Jeep from ichat' and another for 'Kingston TECHNOLOGY'. To the right of these is a call-to-action button: 'Click here to enter contest.' Further right is another banner for 'Win Free Music for Life'. Below these are several links: 'Yellow Pages', 'People Search', 'Maps', 'Classifieds', 'Personals', 'Chat', 'Email', 'My Yahoo!', 'News', 'Sports', 'Weather', and 'Stock Quotes'. A search bar with a 'Search' button and a link to 'options' is located below these links. At the bottom of the page, there are three columns of category links:

- **Arts and Humanities**  
[Architecture](#), [Photography](#), [Literature](#)...
- **Business and Economy [Xtra!]**  
[Companies](#), [Investing](#), [Employment](#)...
- **Computers and Internet [Xtra!]**  
[Internet](#), [WWW](#), [Software](#), [Multimedia](#)...
- **News and Media [Xtra!]**  
[Current Events](#), [Magazines](#), [TV](#), [Newspapers](#)...
- **Recreation and Sports [Xtra!]**  
[Sports](#), [Games](#), [Travel](#), [Autos](#), [Outdoors](#)...
- **Reference**  
[Libraries](#), [Dictionaries](#), [Phone Numbers](#)...

# Evolution

---

Internet of  
(only)  
Scientists

Internet of  
(all) People

Internet of  
Things

# The Internet of Things

---

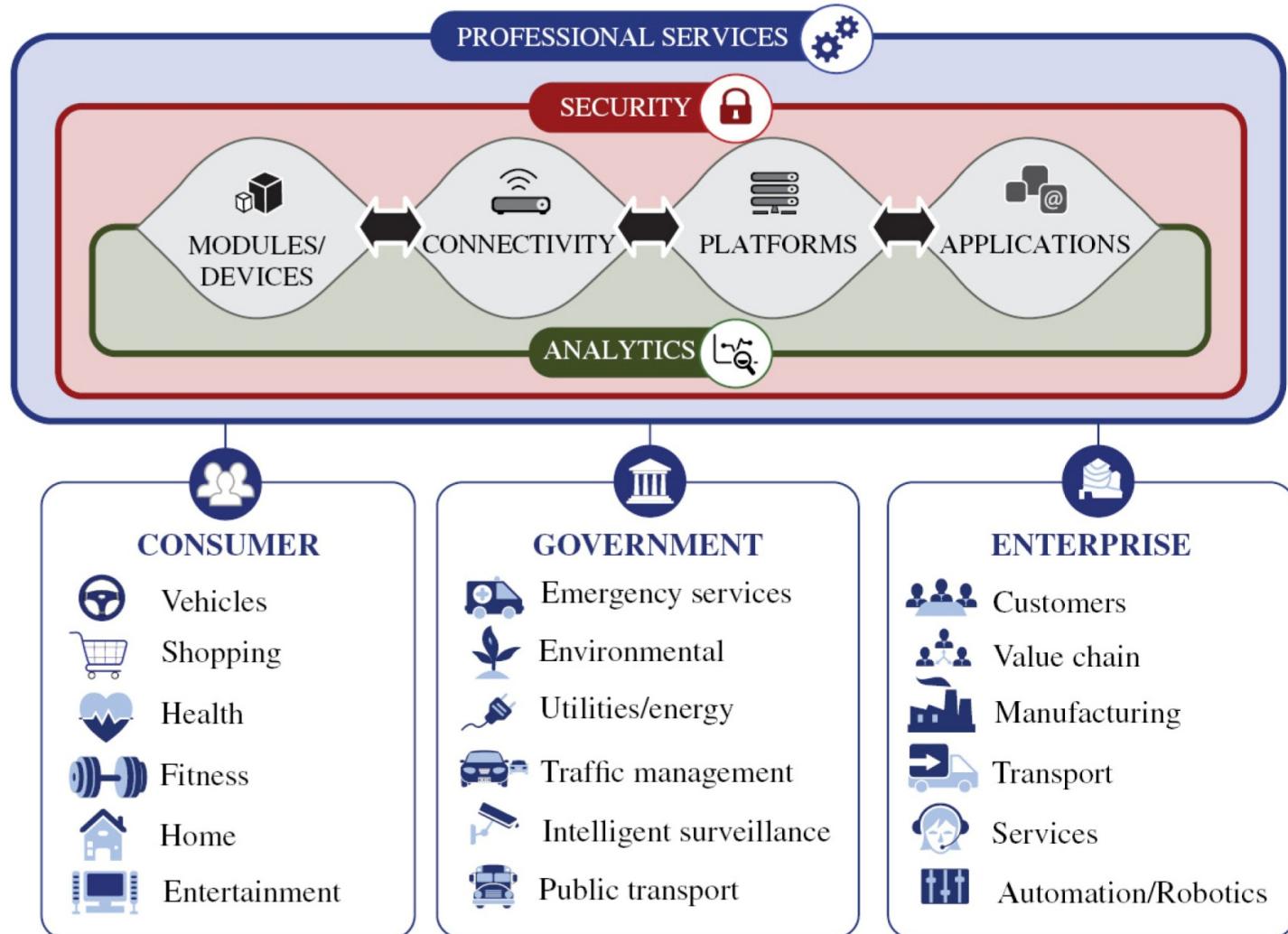
- **Definition:** Network of physical objects, embedded with sensors, electronics, software and network connectivity, which enables these objects to:
  - Collect and exchange data
  - Receive control commands and react accordingly
- **One concept, different names, different flavors**
  - Internet of Things
  - Internet of Everything
  - Wireless Sensor Networks
  - Machine to machine communication (M2M)
  - Device to device communication (D2D)

# History of IoT

- Kevin Ashton (British Entrepreneur) coined the term IoT in 1999:
  - He referred to a global network of radio-frequency identification (RFID) connected objects
  - First smart device network began with a modified vending machine at Carnegie Mellon University in 1982, which used the Internet to report inventory & product temperature readings



# Applications



# Consumer Applications

---

- **Smart home:** energy management, water management, home and chore automation, home robots, safety and security, air quality
- **Connected vehicles:** autonomous vehicle, navigation, logistics, routing, operations management, condition-based maintenance
- **Healthcare:** illness monitoring and management, personal fitness and wellness
- **Life and entertainment:** hobby, gardening and water, music, smart pet

# Government Applications

---

- **Smart city:** power and lightning, adaptive traffic management, parking meter, surveillance, events control, natural or human-made disaster management, emergency response system, resource management
- **Smart transportation:** fleet management, connected car, roadway, rail, aviation, port
- **Smart grid:** demand response, power line efficiency
- **Smart water:** domestic waterworks and waste water management
- **Smart infrastructure:** structural health monitoring
- **Environment:** environmental monitoring, air quality, landfill and waste management

# Enterprise Applications

---

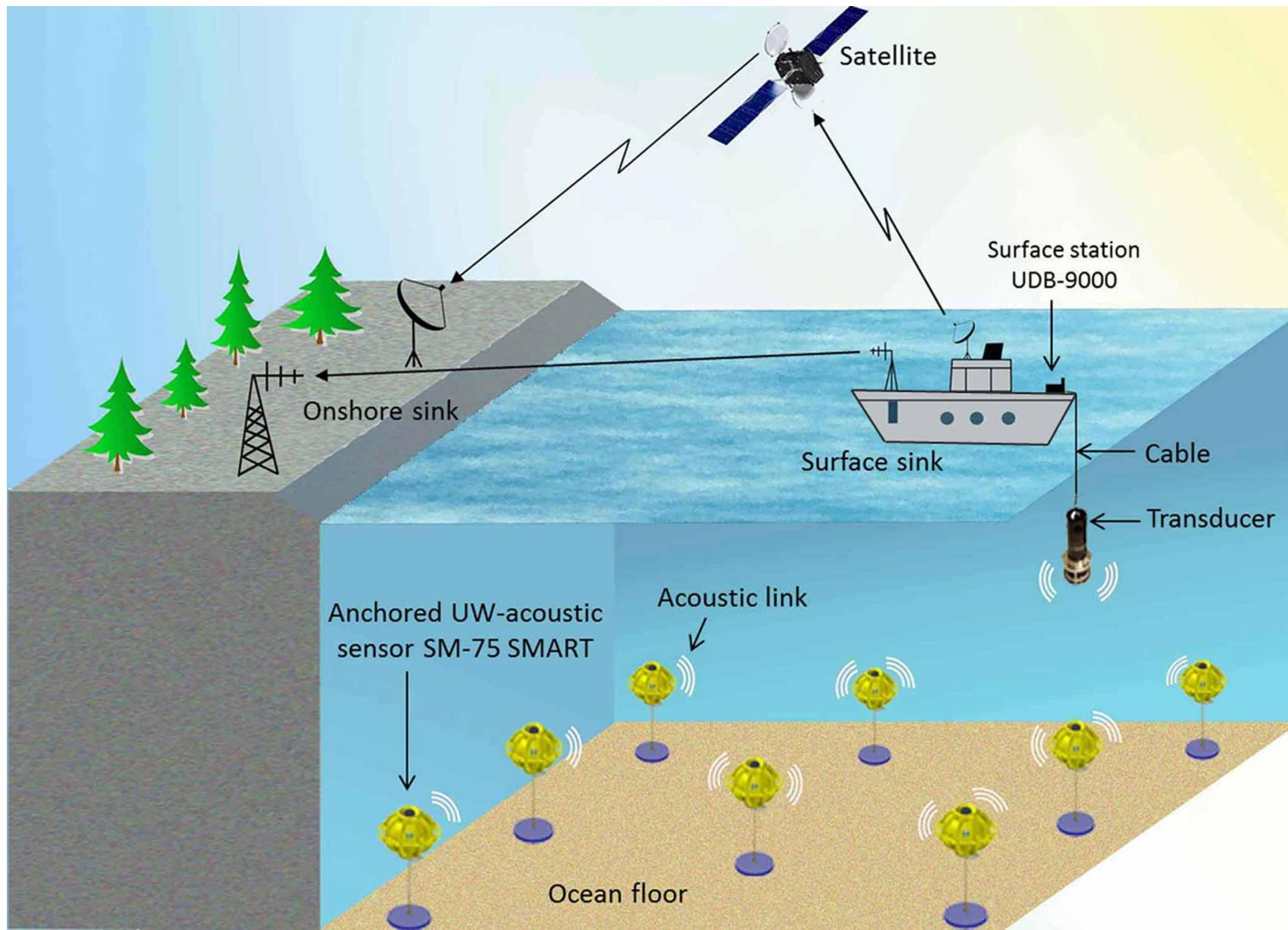
- **Energy (Oil/gas, solar, wind, etc.):** rigs and wells predictive maintenance, operating management, spill accident management
- **Smart healthcare:** hospital, emergency ambulance service, emergency room, clinic, lab diagnosis, surgery, research, home care, elder care, billing, industrial IoT, equipment efficiency, asset management
- **Smart retail:** digital signage, self-checkout, in-store offers, loss prevention, layout optimization, beacon routing, inventory control, customer relationship management
- **Smart agriculture**
- **Smart banking**
- **Smart building**
- **Smart construction**
- **Smart education**
- **Smart insurance**

# Variants

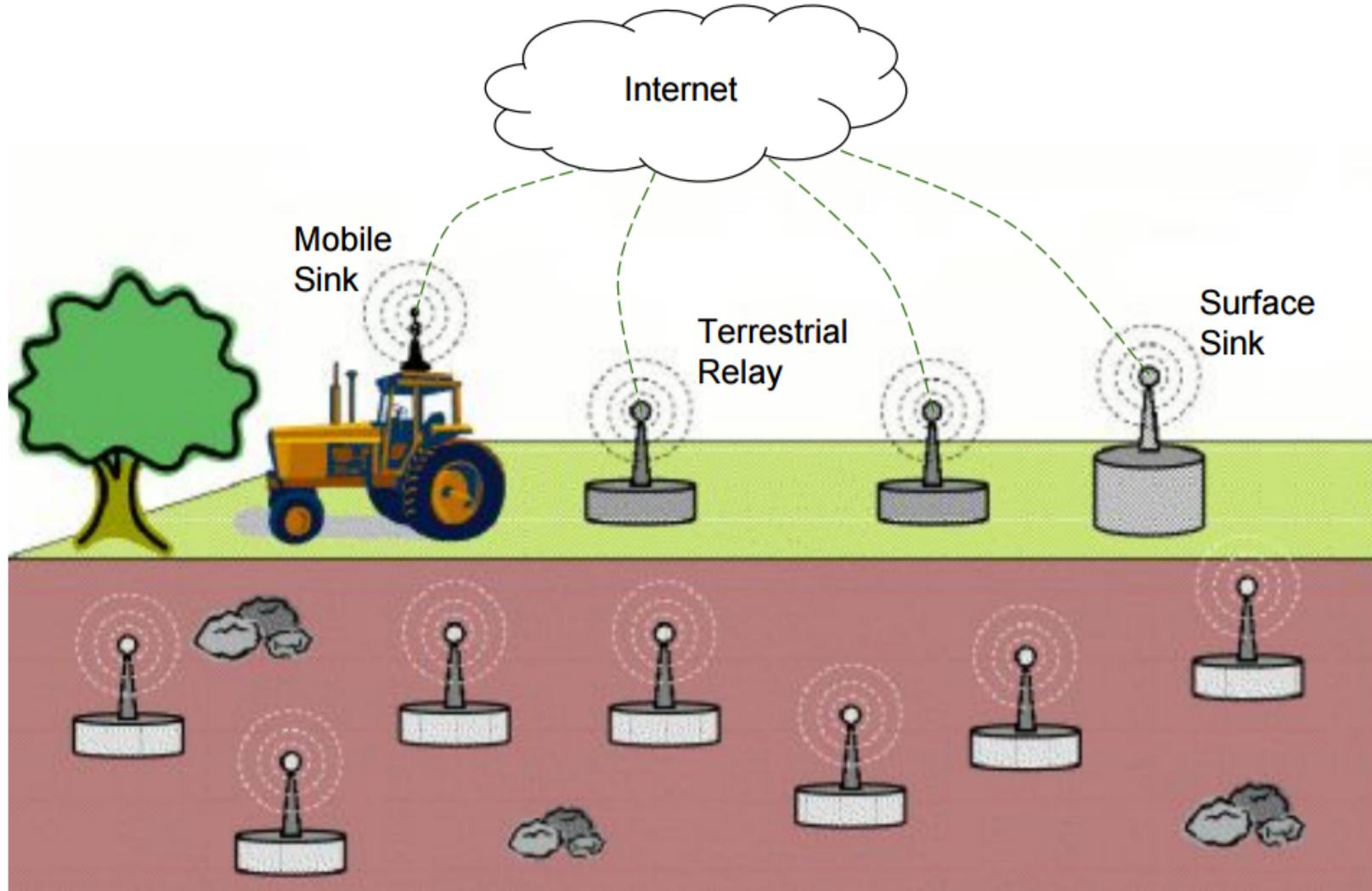
---

- Internet of Underwater Things
- Internet of Underground Things
- Internet of Battlefield Things
- Internet of Space Things
- ...
- Internet of *\*place keyword\** Things

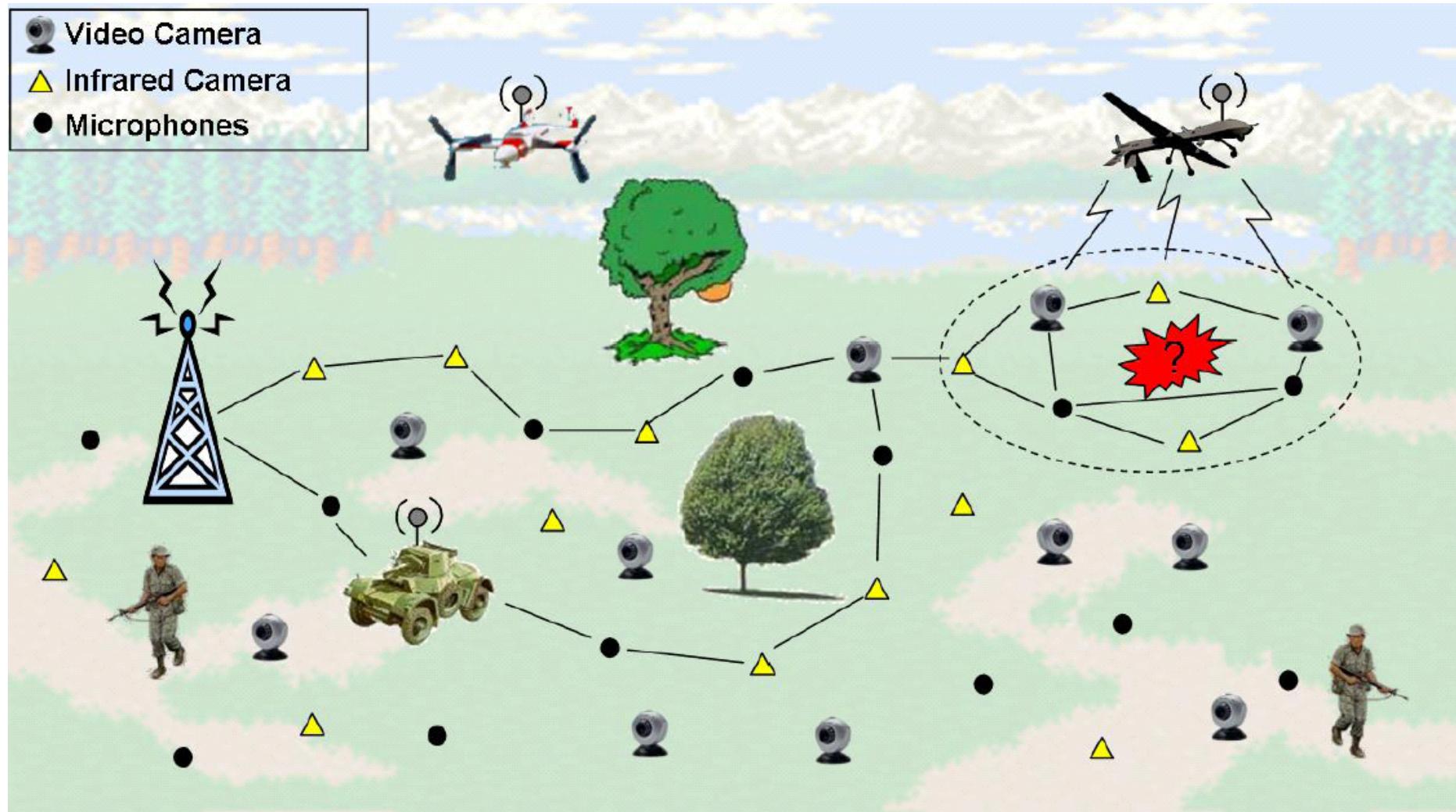
# Internet of Underwater Things



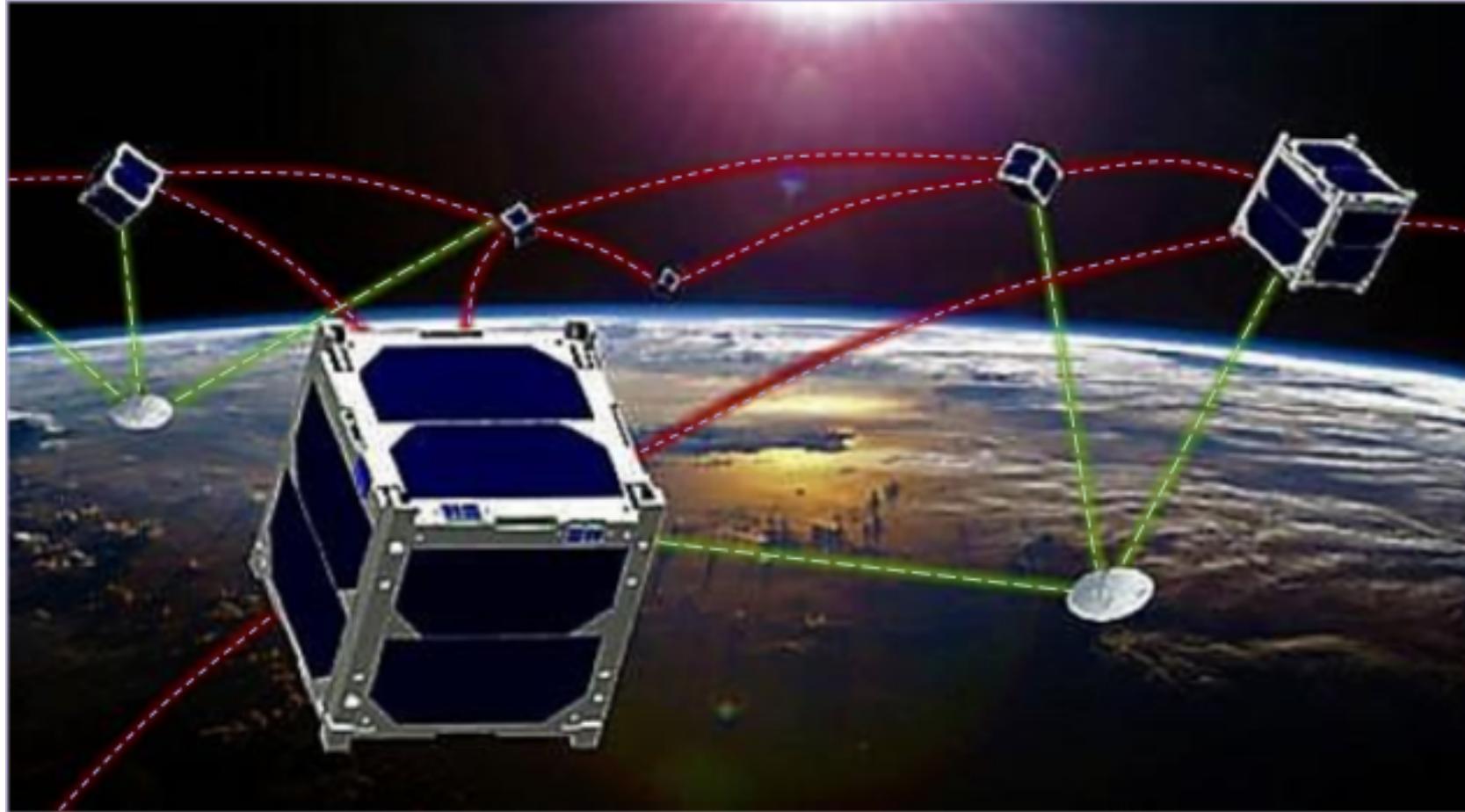
# Internet of Underground Things



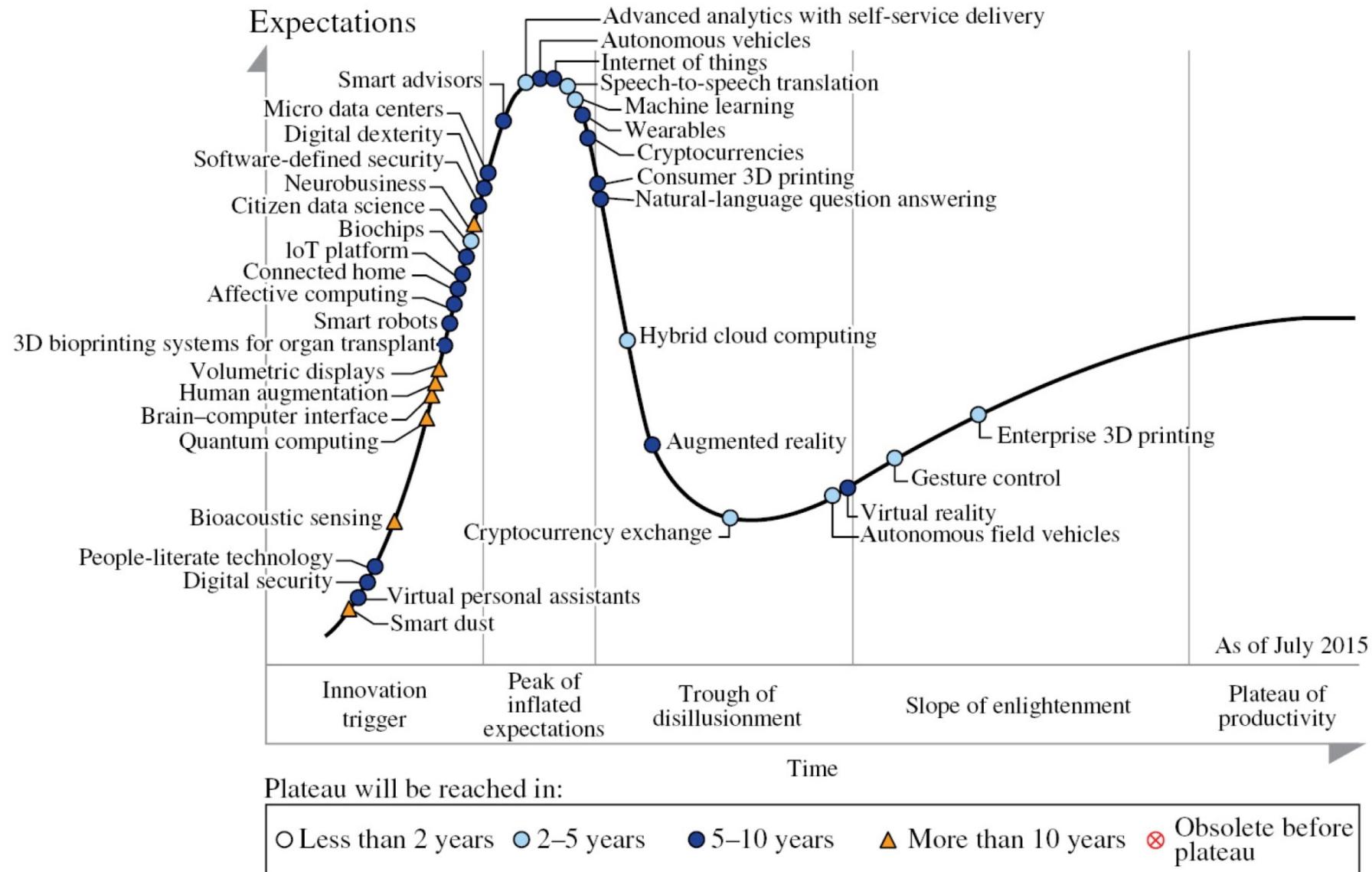
# Internet of Battlefield Things



# Internet of Space Things



# Hype Cycle

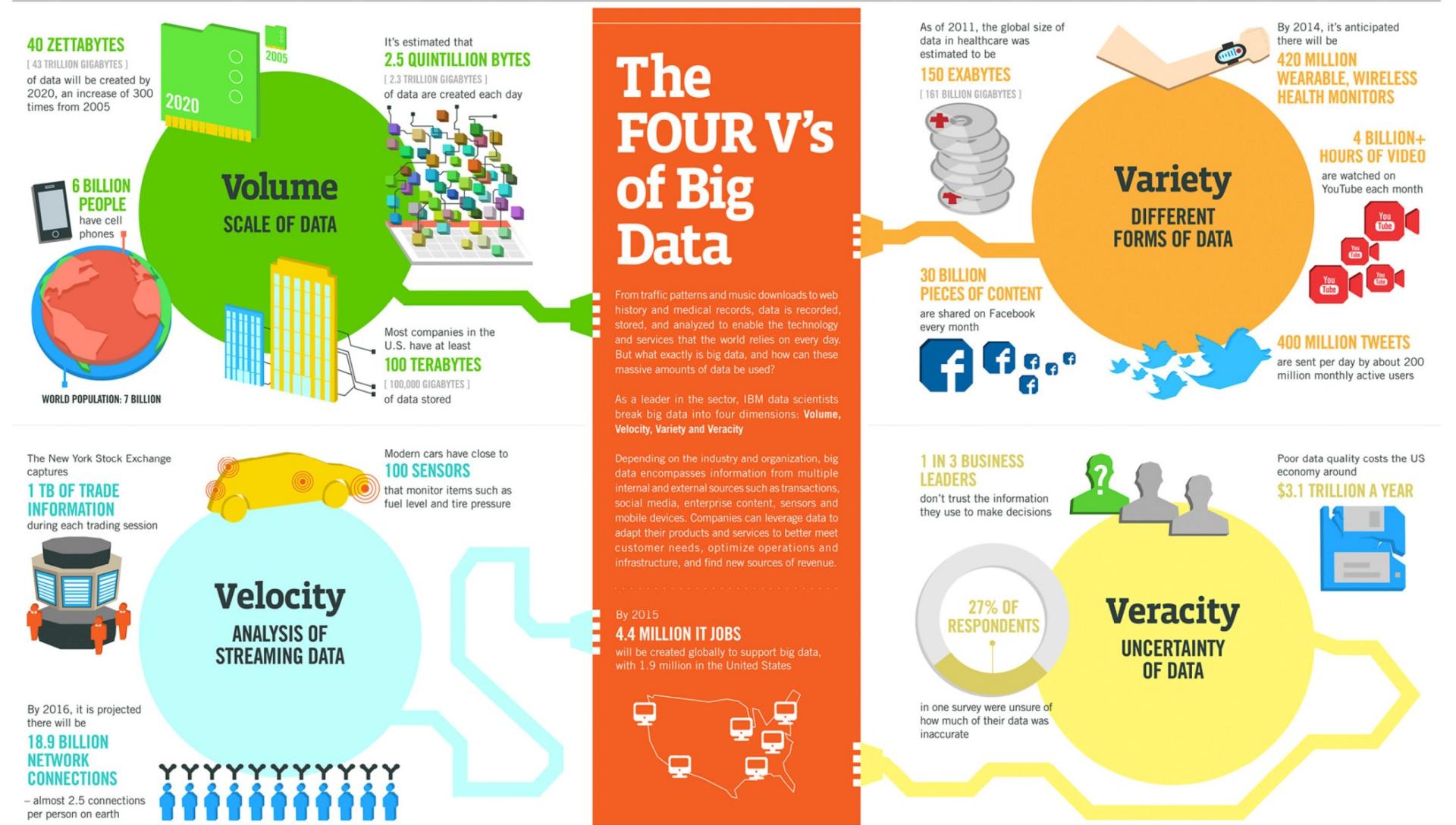


**IoT = Data**

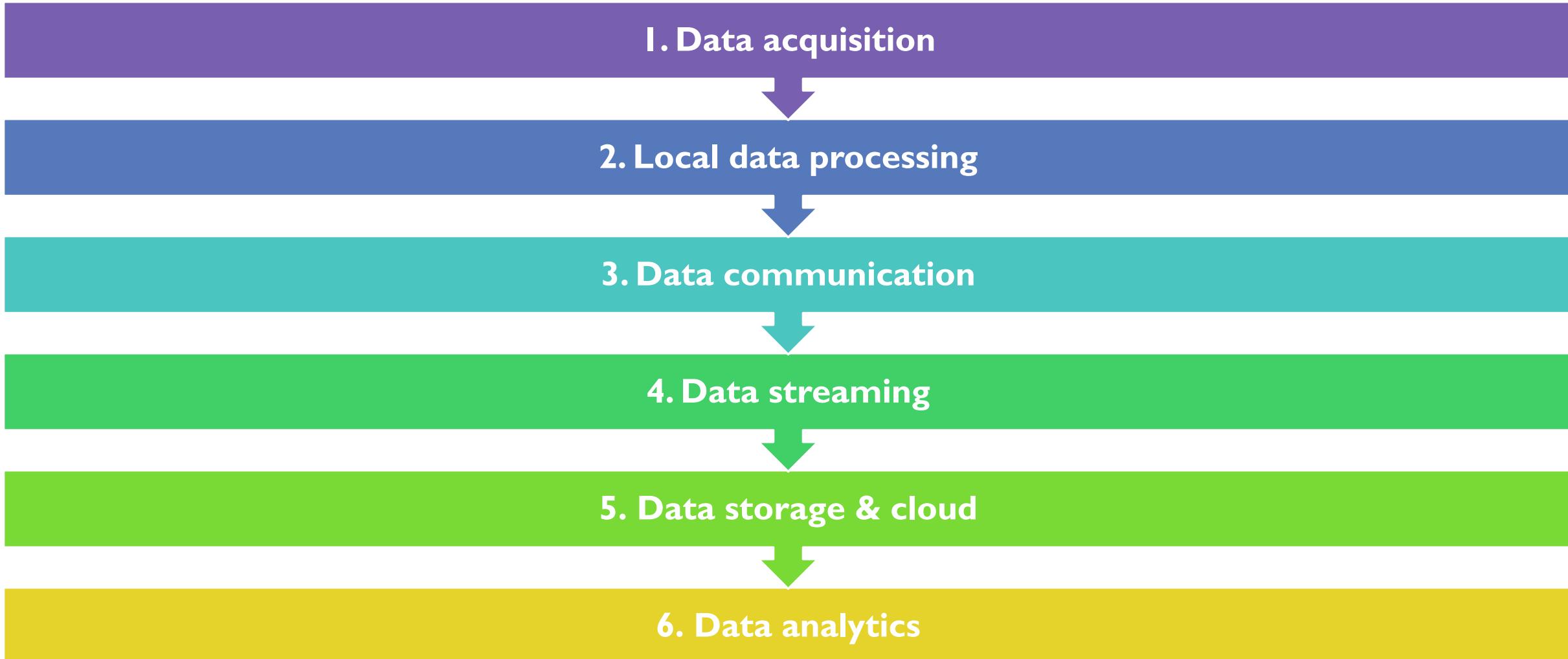
**Data = \$\$\$**

**IoT = \$\$\$**

# Big Data



# The Data Path



# Course Contents

---

- **Module T1:** Introduction to the Internet of Things ✓
- **Module T2:** Data Acquisition
- **Module T3:** Local Data Processing
- **Module T4:** Data Communication
- **Module T5:** Data Streaming
- **Module T6:** Data Storage & Cloud
- **Module T7:** Data Analytics

# Next Steps

---

- Make sure that you are properly registered
- Before Wednesday, make sure to indicate on the Student Hub whether you want to join the lectures in person or remotely
  - On Thursday, you can then know if you have been approved to come to class the following week
- Plan for the next week:
  - We will talk more about the final projects, team formation, etc.
  - We will introduce the computer laboratory modules and explain the software that we will be utilizing