MAI4CAREU

Master programmes in Artificial Intelligence 4 Careers in Europe

University of Cyprus

MAI650 Internet of Things

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Co-financed by the European Union
Connecting Europe Facility

This Master is run under the context of Action No 2020-EU-IA-0087, co-financed by the EU CEF Telecom under GA nr. INEA/CEF/ICT/A2020/2267423

CS6xx Internet of Things (8 ECTS)

Course purpose and objectives: The purpose of the course is to provide an overview on IoT tools and applications and to introduce to students hands-on IoT communication concepts through lab exercises.

Learning outcomes: Upon completion of this course, students will be able to explain the definition and usage of the term “Internet of Things” in different contexts. More specifically, the students will know how to apply the knowledge and skills acquired during the course to build and test a complete, working IoT system involving prototyping, programming and data analysis

Teaching methodology: interactive face-to-face lectures, group activities and discussions, in class/lab activities, student presentations and guest lectures or significant recorded public lectures

Assessment: Final exam (50%), midterm exam (20%) and assignments/project (30%).

Main text:

Rajkumar Buyya, Amir Vahid Dastjerdi, Internet of Things Principles and Paradigms, Morgan Kaufmann; 1st edition, 2016

J. Biron and J. Follett, "Foundational Elements of an IoT Solution", O'Reilly Media, 2016.

Other reading:

Jamil Y. Khan and Mehmet R. Yuce, Internet of Things (IoT) Systems and Applications, 2019, ISBN 9789814800297

David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, and Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, 2016, Cisco Press.

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INTRODUCTION

IoT Communication Technology - Introduction

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INTENDED LEARNING OUTCOMES

Upon completion of this introductory unit, students will be:

1. familiar with the IoT communication protocols and technologies
2. familiar with technologies and standards

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Introduction

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Introduction

- Enable the communication between the IoT objects
- The distance the data can be communicated affects the communication technology to be used.
- IoT communication standards and technology can be grouped based on the size of the network

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Introduction

- IoT applications have specific requirements such as:
  - Low data rate
  - Long range
  - Low energy consumption
  - Low cost

- Success of IoT applications assume the satisfaction of the above requirements

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IoT Communication Protocols and Technologies

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IoT Communication Protocols and Technologies

- Bluetooth
- BLE
- ZigBee
- Z-Wave
- 6LoWPAN
- Thread
- WiFi-ah (HaLow)
- 2G (GSM)
- LoRaWAN
- WirelessHART
- 3G & 4G
- LTE Cat 0, 1, & 3
- LTE-M1
- NB-IoT
- 5G
- NFC
- RFID
- SigFox
- Ingenu
- EnOcean

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LWPaN

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What is LPWAN?

- LPWAN (Low Power Wide Area Network) is one of the basic wireless data transport protocols for the implementation of IoT.

- Three technologies (LoRa, SigFox, LTE-M, NB_IoT) will concentrate 90% LPWAN technologies in the market by 2023.

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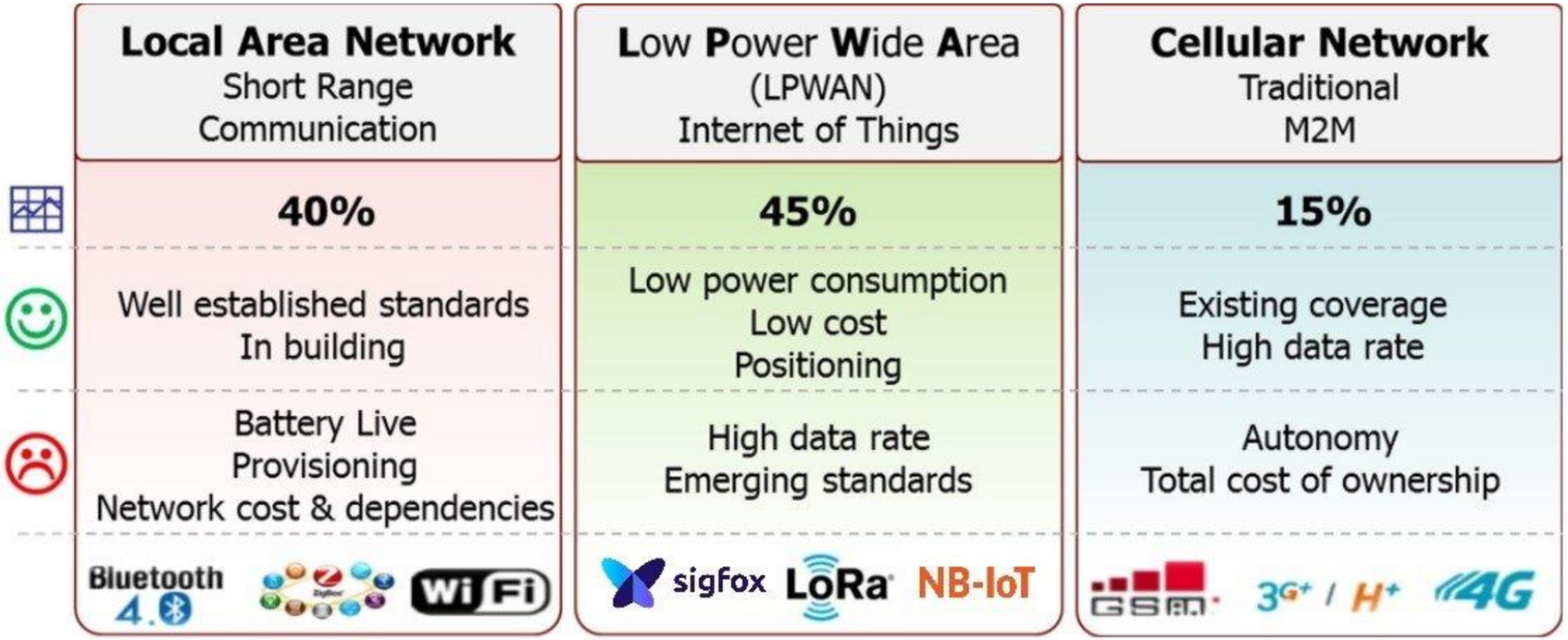
Importance of LPWAN



Credits to LoRa Alliance

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LPWAN Market

- LPWAN market is growing pervasively
- Will reach approximately 75 BN USD in 2023
- Major factors:
  - increasing numbers of IoT applications
  - rising need of long-range connectivity

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Technologies and Standards

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LoRa/LoRaWAN

- LoRaWAN defines the communication protocol and system architecture for the network, while the LoRa physical layer enables the long-range communication link.

- Basically, LoRa is the physical layer: the chip. LoRaWAN is the MAC layer: the software that's put on the chip to enable networking.

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LoRaWAN

- LoRaWAN is the most adopted type of LPWAN, and promises ubiquitous connectivity in outdoor IoT applications

- LoRaWAN network architecture is deployed in a star-of-stars topology

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Features of LoRa

10 to 15 km

Up to 27 kbps

10 -20 years

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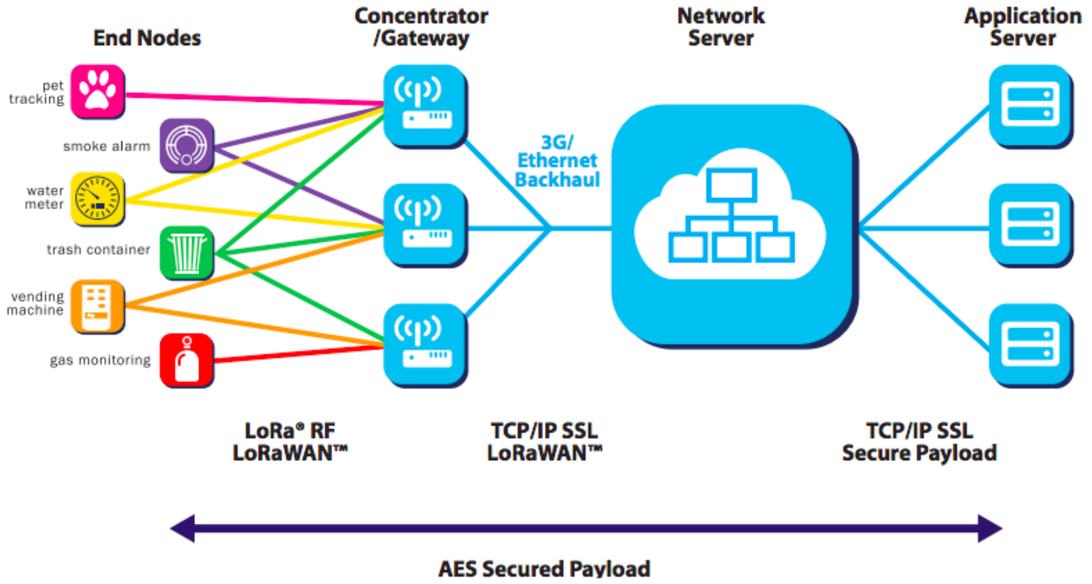
LoRaWAN nodes

- **End Nodes** transmit directly to all gateways within range, using LoRa.
- **Gateways** relay messages between end-nodes and a central network server using IP.



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NB– IoT

- NB-IoT (Narrowband IoT) is an initiative by the Third Generation Partnership Project (3GPP), the organization behind the standardization of cellular systems.

- NB-IoT uses OFDM modulation
  - chips are more complex, but the link budgets are better.
  - users get the high-performance level associated with cellular connections
  - but at the cost of more complexity and greater power consumption.

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NB– IoT

- It works in one of three ways:
  1. Independently
  2. In unused 200-kHz bands that have previously been used for GSM
  3. On LTE base stations allocating a resource block to NB-IoT operations or in their guard bands.

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LTE – M

- LTE-M is the abbreviation for LTE Cat-M1
- 3GPP standardized technology using licensed spectrum.
- Allows the Internet of Things devices to connect directly to a 4G network, without a gateway and on batteries.

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LTE – M

- LTE-M is a more powerful technology
- Supports voice and mobility
- Ideal for:
  - mobile applications,
  - Real-time applications,
  - applications where higher data transfer speeds and volumes are needed

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Sigfox

- SigFox is a French company based in Labège, France.
- The SigFox network consists of these elements:
  - Objects (devices)
  - Base stations (gateways)
  - Cloud (Internet)
- The SigFox network consists of these three processes:
  - Ultra narrowband (UNB) technology
  - Differential Phase Shift Keying (DPSK)
  - Frequency Shift Keying (FSK)

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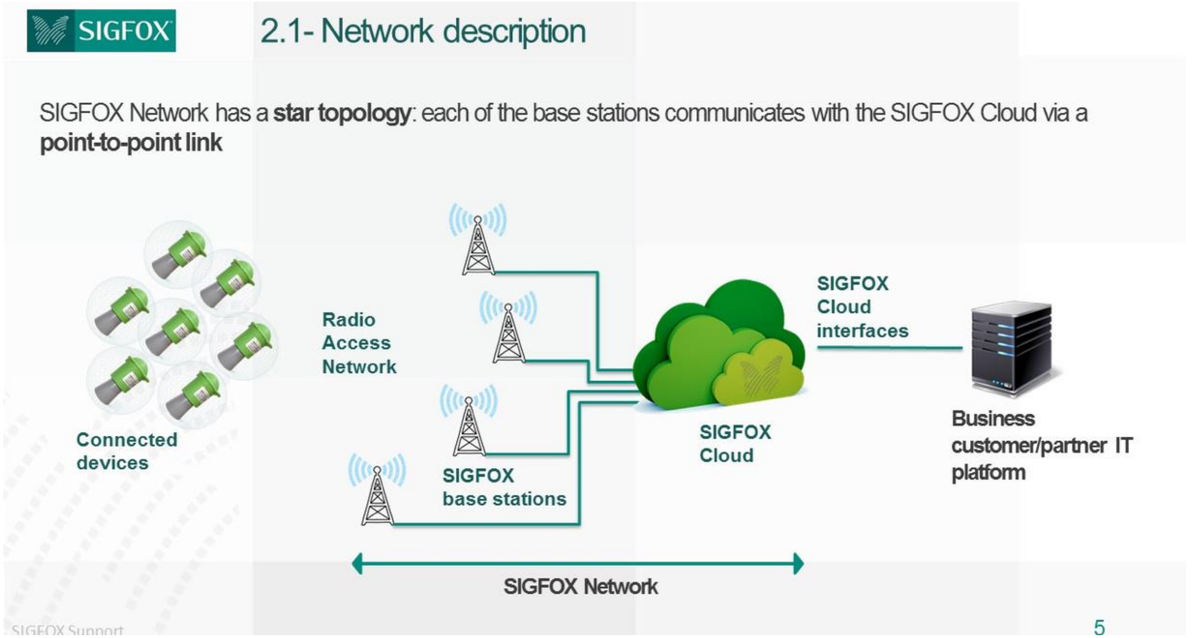
Sigfox

- Devices are connected to the Internet send data through the SigFox network to a SigFox base station (gateway).
- The base station then detects, demodulates, and reports the messages to the SigFox cloud across 3 channels, at least every 10 minutes.
- The SigFox cloud then pushes these messages to many customer servers and IT platforms based on the client's application.



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Summary

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- IoT Communication Protocols and Technologies
- LWPaN
- Technologies and standards
  - LoRaWAN
  - NB-IoT
  - LTE-M
  - Sigfox

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