Internet of Things:
a path within the Master degree in Telecommunications Engineering @ UniBO.

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There are seven facts, which have an impact on the way the IoT should be taught within a University degree, to train an IoT expert.

Fact #1. The IoT is relevant. IoT technologies are among the pillars of **Industry 4.0**, the fourth industrial revolution, which is based on the adoption of the most recent advances in ICT for the benefit of many industrial sectors. Industry 4.0 is going to create an enormous request for competence in the field of the IoT.
Fact #2. The IoT is pervasive. IoT technologies apply to the many **application domains**: Smart Cities, Smart Agriculture, Smart Manufacturing and others. The diverse requirements of these domains make the IoT a topic that needs to be discussed in the context of a precise application.
Fact #3. The IoT is not trivial. Zigbee, WiFi, LoRa, NB-IOT, 4G, 5G, ... IoT experts must have good knowledge and skills of **communication technologies, protocols and network architectures**, to choose the best option for each application.
Fact #4. The IoT is easily accessible. IoT technologies are enabled by **platforms** like Arduino, Raspberry Pi, which allow makers to quickly learn how to build a sensor/actuator board and connect it to the Internet. Ease of access is good, but it might lead to efforts without a vision.
Fact #5. The IoT is not an island. The IoT is not just connecting sensor/actuator boards to the Internet. Big Data, AI, Cloud technologies are intimately connected to IoT developments.
Fact #6. The IoT is business. IoT technologies are the base for many successful **startups**. An IoT startupper needs to have basic knowledge of project management, and economic aspects.
Fact #7. The IoT is relations. An IoT enthusiast must have good **inter-personal communication** skills, because he/she has to manage relations with people of very different background.

The observation of these facts brings to the conclusion that teaching the IoT at the University requires a multi-layer approach. In fact, an IoT expert must have:
1) **specialised competence** (on communication protocols, network architectures) at the highest level;
2) **accessory competence** (on Cloud, AI, Big Data, etc) at basic level;
3) **transversal competences** (project management, communication skills, team working, etc.).

These considerations have led to set up a number of courses at UNIBO in the past years, whose overall vision is coherent with the above picture. As a result, the Radio Networks group offers the following courses:
- **Internet of Things**: this course emphasises the link between IoT technologies and application domains; it provides a holistic view of the IoT ecosystem. LoRa is introduced, as reference technology. Additionally, it trains towards the steps to take, before creating an innovative startup. (Facts #1, #2, #4, #6)
- **Wireless Sensor Networks:** this course goes deep into the design of networks of IoT devices; lab activities train to the programming of MAC/NET protocol layers of a Zigbee platform. (Fact #3)
- **Mobile Radio Networks:** this course introduces to cellular networks, from 2G to 5G, including the technologies implemented for IoT applications managed by telecom operators (like NB-IOT). (Fact #3)
- **Project Management and Soft Skills:** this course provides an introduction to the transversal competences needed for an IoT expert, including project management, communication and presentation skills, team working. (Fact #7)

The four courses together address most aspects that are relevant to the IoT ecosystem. Additional courses suggested to an IoT enthusiast, not taught by the Radio Networks group, are in the area of networking, Internet technologies, big data, and artificial intelligence (Facts #3, #5).