The European IoT Hub

Growing a sustainable and comprehensive ecosystem

for Next Generation Internet of Things

D4.3: Report on Training Activities

Version 1

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Abstract

This deliverable illustrates the EU-IoT strategy on training and mentoring activities, besides reporting on the activities that were carried out during the first year of the project's lifetime. It also provides insights about the organization of IoT training workshops, the establishment of an IoT training courses catalogue, as well as an overview about a planned IoT skills survey and of future seminars.

Keywords: IoT, Training, Mentoring, Courses, Skills, Seminars, Operator 4.0, Education, IoT Profiles

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Nature of the deliverable:	Report on Training Activities Version 1	
Dissemination Level		
PU	Public, fully open, e.g. web	√
CI	Classified, information as referred to in Commission Decision 2001/844/EC	
CO	Confidential to EU-IoT project and Commission Services	

* R: Document, report (excluding the periodic and final reports)

DEM: Demonstrator, pilot, prototype, plan designs

DEC: Websites, patents filing, press & media actions, videos, etc.

OTHER: Software, technical diagram, etc

EXECUTIVE SUMMARY

One of the main objectives of the EU-IoT project is to coordinate training activities of recent EC-funded H2020 projects on IoT technologies, but also to support the broader IoT community in addressing the increasing training, skilling, and reskilling needs. By pulling training resources across the IoT ecosystem together, the aim is to maximise the benefits for all its participants, also considering the project's limited resources for the development of new courses and materials. In-line with this strategy, the project has already carried out a set of training sessions engaging several IoT projects and stakeholders and planned more to be carried out until the end of the project. This deliverable focuses on reporting year's 1 activities.

The main tangible outcomes of the work done so far, include:

- The specification of the project's training strategy, including a plan comprising several activities.

- The creation of an initial database of available IoT training courses (notably on-line courses and seminars), which has been made available on-line in the form of an expandable catalogue of IoT courses and training resources via the ngiot.eu portal. The catalogue serves as a single entry to point to available IoT trainings: EU-IoT basically provides a directory of training resources and the community can use the catalogue to promote their training offering.

- The organization of a series of training seminars on cutting edge IoT technologies in close collaboration with H2020 ICT-56 funded projects. The seminars focus on specific themes that are not adequately covered by most of available IoT training courses. During the first year of the project three on-line training seminars have been organized and three more have been planned for year 2. Every seminar is also a source of training materials and additional resources (e.g., recordings, external links) that are made available through the EU-IoT portal.

- The creation of a skills survey, which is destined to identify key skills that are high in-demand in the IoT market. The skills survey will provide a foundation for specifying learning paths, along with ways for following them based on existing IoT courses and seminars. As part of this process, the EU-IoT consortium will also explore possible certifications of IoT knowledge that could be established and/or provided by the project.

An updated version of this report will be delivered at the end of the project reporting on the training achievements of the project with emphasis on the second reporting period. As presented in this deliverable, the project has already laid out a sound basis for ensuring sustainable and valuable outcomes. For instance, the training catalogue is planned to be passed on and continue to serve the community also beyond the EU-IoT project. The IoT skills' profiles and learning paths of the project are valuable assets for further exploitable by various IoT stakeholders that engage in IoT-related upskilling and reskilling processes.

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ABBREVIATIONS

AI	**Artificial Intelligence**
AR	**Augmented Reality**
AWS	**Amazon Web Services**
CB	**Coordination Board**
CSA	**Coordination and Support Action**
DL	**Deep Learning**
DMP	**Data Management Plan**
FAIR	**Findable, Accessible, Interoperable, Reusable**
ICIP	**Iot-Inc Certified IoT Professional**
IEEE	**Institute of Electrical and Electronics Engineers**
IoT	**Internet of Things**
IoTF	**Internet of Things Foundation**
IIoT	**Industrial Internet of Things**
IP	**Internet Protocol**
ML	**Machine Learning**
NGIoT	**Next Generation Internet of Things**
ORDP	**Open Research Data Pilot**
RIA	**Research and Innovation Action**
TCP	**Transmission Control Protocol**
VR	**Virtual Reality**
XR	**Extended Reality**

1   INTRODUCTION

1.1   Project Brief and Deliverable Scope

The EC funded EU-IoT Coordination and Support Action (CSA) is destined to support the development of the EU Internet of Things (IoT) ecosystem, with emphasis on the support of the activities of H2020 ICT-56 funded projects, and others as relevant. In this respect, the project undertakes a rich set of activities, which span pre-standardization, community building, IoT ecosystem building, as well as the training and mentoring activities. This also includes support in the development of IoT skills to facilitate the development, operation and adoption of novel IoT solutions. Specifically, EU-IoT acknowledges the importance of IoT skills for the development of effective and innovative solutions, as well as for their successful adoption by enterprises, industrial organizations, and public bodies. Hence, one of the main objectives of the project is to facilitate enterprises and other interested organizations to access training resources and to engage in training and skills development activities.

As part of this objective, the project addresses both the supply side (e.g., IoT solution providers, IoT vendors, IoT solution integrators, IoT applications operators, IoT innovators, high-tech IoT start-ups) and the demand side (e.g., IoT end users in vertical sectors like healthcare, transport and industry). To engage supply side and demand side stakeholders in training and skills development activities. To this purpose, the project has undertaken several activities, such as:

- Development of a catalogue of IoT-related training materials, including courses, videos, presentations, demonstrators, and hands-on exercises. The project is also producing its own training content in niche IoT areas, where there is a lack of training resources and materials.

- Organisation of a series of training workshops, possibly co-located with main IoT events such as the IoT Week. These include webinars and online training programs.

- Mentoring of start-ups and innovators in collaboration with IoT mentors and entrepreneurs.

- Development of IoT curricula for different profiles (i.e., personas) of IoT stakeholders from the supply and the demand side of the IoT ecosystem.

These activities are aligned and streamlined to the overall EU-IoT strategy and plan, including standardization, ecosystem buildings, experts' consultation, best practices documentation, and use cases analysis activities. As mentioned, most of the training and skills development activities are carried out in collaboration with H2020 IoT projects, notably RIAs (Research and Innovation Actions) funded within the ICT-56-2020 Call -"Next Generation Internet of Things"[1]. This deliverable reports on the EU-IoT training and skills development activities carried out during the first year of the project. Moreover, the deliverable illustrates the overall training and skills development strategy of the project, which drives the planning of future activities as well.

1.2   Purpose and Scope of the Document

The current deliverable presents the project's overall strategy for training and skills development. It reports on year 1 activities, including:

- The project's overall strategy for training and skills development support, including information about how the project facilitates access to training resources and supports enterprises to engage with training activities.

- The EU-IoT catalogue of training courses, which aims to facilitate interested parties to find

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[1] https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/ict-56-2020

their way in the rich set of training materials and courses that are available in the global IoT ecosystem.

- The series of training seminars/workshops that were planned and conducted by the projects, including information on the training materials developed as part of them.

- The project's activities towards identifying IoT learners' profiles and developing related learning paths.

1.3 Structure of the Document

Following this introductory section, the deliverable is structured as follows:

- Section 2 outlines the project's approach to training and mentoring. This is useful not only for understanding the activities presented in this document but also for the future planned work.

- Section 3 illustrates the project's catalogues of training courses and materials, which aim at facilitating enterprises and other interested parties to access the training resources they need in the scope of the IoT ecosystem.

- Section 4 reports on the series of EU-IoT training seminars, notably online seminars organized in 2021.

- Section 5 presents the project's activities towards identifying IoT skills that are high in demand. It also explains how these skills will drive the development of learning paths and training programs.

- Section 6 concludes the deliverable. It also outlines some of the future training and mentoring activities, which will be carried and documented in the next reporting period.

2 EU-IOT TRAINING AND MENTORING STRATEGY

2.1 Driving Requirements

The training and mentoring strategy of the project has been driven by the following requirements and principles:

- **R1 (Access to Training Resources)**: The need to facilitate access to training resources and materials for participants to the European IoT ecosystem.

- **R2 (Easing and Maximizing "Reuse"):** A "reuse" principle regarding training materials i.e., a requirement for reusing courses, training materials and other resources that are already available in the global IoT ecosystem.

- **R3 (IoT Themes Requirements – Alignment to the EC Strategy):** Requirements provided by the EC regarding the IoT topics that have to be prioritised by EU-IoT.

- **R4 (Skills Development Requirements)**: IoT skills development requirements as outlined in various analysis documents and related surveys.

- **R5 (Streamlining with other EU-IoT Activities)**: The need to align training and mentoring activities with other activities of the project, including standardization, open-source ecosystem development, IoT community and ecosystem building, documentation of best practices and case studies, as well as other coordination and support activities undertaken by the project.

- **R6 (DoA Requirements)**: Other requirements laid out in the DoA document of the project.

The EU-IoT training strategy, as described in the following subsection has accounted for these requirements, gathering input via the project's meetings with the EC, with experts' and other stakeholders', for instance, to identify the specific topics of the offered trainings.

2.2 Background and Motivation

The EU-IoT training activities are motivated by the existing gaps in IoT skills and talents. These gaps are outlined in the many surveys and studies about IoT development, evolution, and adoption, including studies from EU projects (e.g., [NGIOT-D1.1]), consulting firms (e.g., [PwC19], [McKinsey18]), researchers (e.g., the 2017 North-eastern University-Silicon Valley's survey[2]) and industry practitioners (e.g., [Newman19]). While a detailed analysis of these surveys and studies is beyond the scope of this deliverable, the main findings of that shape EU-IoT's training strategy, which can be summarised as follows:

- **IoT Skills Gap**: A gap in IoT skills is generally reported, which is considered as an important setback to the pace of IoT adoption.

- **Diversified Technological Skills**: IoT solutions are not based on a single technology, but rather on the integration of a wide array of cutting-edge technologies [Whitmore15], [Soldatos20]. Hence, IoT skills surveys outline the importance of a diversified set of skills, which should co-exist in enterprises that wish to excel in IoT deployment. While there is no absolute convergence on a single set of technical skills, most surveys highlight the importance of technical/technological skills in areas like sensors, microcontrollers and microsystems, communication gateways, cloud platforms, big data platforms, cybersecurity solutions, and more. EU-IoT prioritizes the provision of support for acquiring such technical and technological skills, with an emphasis on skills associated with cutting edge IoT

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[2] https://bayarea.northeastern.edu/news-events/broad-survey-ieee-engineers-reveals-surprising-iot-trends/

technologies. Technical knowledge at various levels of depths must be owned both by IoT vendors and field workers using IoT systems (i.e., IoT end-users).

- **Non-Technical IoT Skills**: Beyond technological skills, there is a need for IoT stakeholder enterprises to own non-technical skills. Many surveys highlight the importance of soft skills easing communication and collaboration in IoT teams and IoT projects. Nevertheless, the required IoT skills extend beyond soft skills to five different types of skillsets that are identified in [VanDeursen18], including operational skills, formal skills, information skills, communication skills, content creation skills, as well as strategic skills. These types of skills are not prioritized by EU-IoT, as the project is a coordination and support action with technological focus. Nevertheless, non-technical skills must not be ignored when developing certain IoT learning paths, as well as when considering the skillsets required by different personas.

- **Importance of Domain Knowledge**: Most IoT deployments are destined to solve specific problems in vertical sectors such as manufacturing, trade, healthcare, transport and industry. Domain knowledge of the problem at hand is very important for successfully developing and deploying an IoT system. As a prominent example, domain knowledge is required to analyse properly IoT data and extract knowledge in each application context. Likewise, the selection of the techno-economic characteristics of an IoT hardware system is not possible without proper domain knowledge and information about business requirements and constraints.

The diversity of IoT skills has given rise to the development of a wide range of course and training programs, which target different skillsets for different personas.

Certified Course	Provider	Description
AWS IoT Foundation Series	AWS	Consists of a set of courses that cover IoT Core topics and associated services. A business scenario-based learning approach is used in the scope of the course: The student is presented with business challenges that must be solved through IoT. The courses provide foundational knowledge and skills about AWS IoT, along with hands-on experience on a wide range of IoT technologies and applications.
Certified IoT Architect	Arcitura	Consists of three courses that develop skills in IoT technologies with emphasis on skills for architecting IoT systems. It also comprises topics related to radio protocols, telemetry messaging and IoT architecture layers. In addition to theoretical training, the course comprises lab exercises, where students solve real world problems.
Introduction to Internet of Things	Stanford University, School of Engineering	Provides an overview of various technical areas that relate to IoT technologies. It is structured in five modules, namely Cool Applications, Sensors Embedded Systems, Networking, Circuits.
Internet of Things Foundation certification (IoTF)	Cloud Credential Council	Online self-study, certified course that covers basic concepts, terminology, and key components of IoT. It also provides a business perspective based on information about IoT business modelling, adoption and monetization models. The latter are presented in conjunction with case studies, use cases and adoption scenarios.
Iot-Inc Certified IoT Professional (ICIP)	Iot-Inc	Delivered through three complete courses, including technology, business and strategy aspects. Comprises 45 modules with 163 lessons and 28 quizzes, reinforced with a final exam. The curriculum covers key IoT concepts and principles, along with a variety of Case Studies.
Cisco Certified Training	CISCO	IoT technology is covered as part of Cisco's training portfolio for latest technologies. The portfolio is associated with career paths.

Table 1 presents a sample list of certified IoT courses that address different IoT skillsets based on diverse learning paths. As clear from the table, the various courses are tailored to different profiles, like IoT developers, IoT engineers, data engineers, security engineers and IoT architects. EU-IoT is destined to support several research and engineering roles in the IoT ecosystem.

Certified Course	Provider	Description
AWS IoT Foundation Series[3]	AWS	Consists of a set of courses that cover IoT Core topics and associated services. A business scenario-based learning approach is used in the scope of the course: The student is presented with business challenges that must be solved through IoT. The courses provide foundational knowledge and skills about AWS IoT, along with hands-on experience on a wide range of IoT technologies and applications.
Certified IoT Architect[4]	Arcitura	Consists of three courses that develop skills in IoT technologies with emphasis on skills for architecting IoT systems. It also comprises topics related to radio protocols, telemetry messaging and IoT architecture layers. In addition to theoretical training, the course comprises lab exercises, where students solve real world problems.
Introduction to Internet of Things[5]	Stanford University, School of Engineering	Provides an overview of various technical areas that relate to IoT technologies. It is structured in five modules, namely Cool Applications, Sensors Embedded Systems, Networking, Circuits.
Internet of Things Foundation certification (IoTF)[6]	Cloud Credential Council	Online self-study, certified course that covers basic concepts, terminology, and key components of IoT. It also provides a business perspective based on information about IoT business modelling, adoption and monetization models. The latter are presented in conjunction with case studies, use cases and adoption scenarios.
Iot-Inc Certified IoT Professional (ICIP)[7]	Iot-Inc	Delivered through three complete courses, including technology, business and strategy aspects. Comprises 45 modules with 163 lessons and 28 quizzes, reinforced with a final exam. The curriculum covers key IoT concepts and principles, along with a variety of Case Studies.
Cisco Certified Training[8]	CISCO	IoT technology is covered as part of Cisco's training portfolio for latest technologies. The portfolio is associated with career paths.

Table 1: Sample List of Certified IoT Courses

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[3] https://www.aws.training/Details/Curriculum?id=27289

[4] https://www.arcitura.com/next-gen-it-academy/certifications/certified-iot-architect/

[5] https://online.stanford.edu/courses/xee100-introduction-internet-things

[6] https://www.cloudcredential.org/certifications/internet-of-things/iotf/

[7] https://www.iot-inc.com/#Training

[8] https://learningnetwork.cisco.com/s/certifications

2.3 EU-IoT Training Strategy

2.3.1 Strategy for Training Content, Materials and Courses

In-line with the above-listed principles, the project's strategy for the development and offering of training resources includes the following main pillars:

- **Ease access and facilitate reuse of IoT training resources on conventional topics**: Rather than developing courses and materials for themes where many similar resources are available, the project facilitated access to existing resources. This was deemed for more practical and cost-effective than re-developing some of the already available training materials. In this direction, the project developed a searchable catalogue of existing IoT courses and training materials[9]. The latter cover introductory and intermediate training on conventional IoT training topics, ranging from tutorial introductions to IoT and working with various boards/devices, to topics associated with the integration of IoT with cloud computing and BigData infrastructures. The EU-IoT catalogue is destined to facilitate the IoT community to discover and access these resources through a single-entry point.

- **Develop training materials in "niche" IoT topics and areas**: EU-IoT opts to develop and offer resources in technology areas that are not adequately covered by existing courses materials and training programs. This is fully in-line with the mission of H2020 projects on IoT, which conduct research and developing in cutting edge IoT technologies such as edge computing, machine learning at the edge, tactile applications, and their integration with IoT systems, as well as the use of distributed ledger technologies for decentralized IoT applications. EU-IoT collaborates with other H2020 IoT projects (most notably ICT-56 RIAs) in the development of training presentations, the delivery of webinars, the organization of tutorials and training workshops, and more. As outlined, these training resources target novel IoT research and innovation development topics such as edge AIoT, 5G deployments for IoT, the tactile internet and more.

The above listed resources can serve as a basis for the development of integrated learning paths, which will enable researchers, industry practitioners, domain experts and other stakeholders to acquire entire skillsets that correspond to trainee "personas". The development of such learning path will be driven by the specific skillsets that must be possessed by certain profiles. In this direction, relevant surveys (e.g., skills surveys) and background information will be considered. A high-level overview of the EU-IoT strategy for the development of training programs, materials, courses, and related learning paths is illustrated in Figure 1: EU-IoT Training Strategy for Access to Training Materials and Resources

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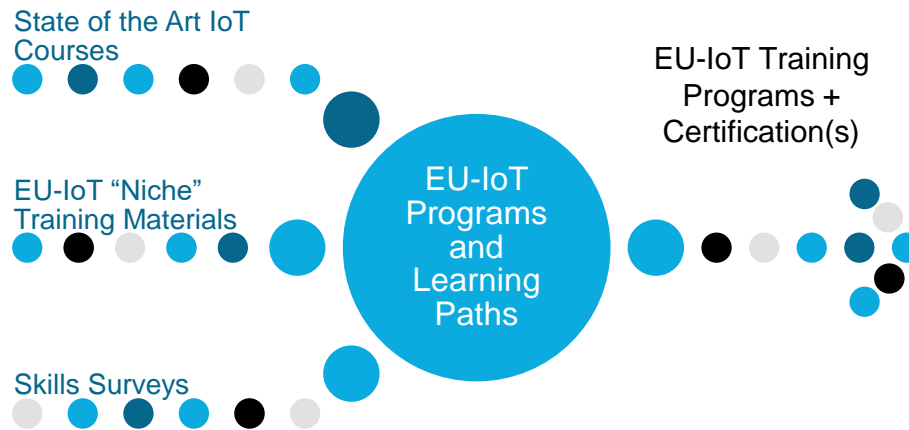[9] https://www.ngiot.eu/archive-ngiot-training/

Figure 1: EU-IoT Training Strategy for Access to Training Materials and Resources

2.3.2 Learning Paths Specification and Trainings Certification Strategy

EU-IoT leverages existing training materials and resources developed in the scope of the project to support IoT stakeholders in acquiring the ever-important IoT skillsets. In this direction, the project aims to highlight some learning paths over the resources that are developed by the project and/or aggregated in the project's training catalogue. As already outlined, these learning paths will primarily cover technical and technological skills.

Leveraging existing courses and materials the project will have the opportunity to specify many different learning paths that cover various skillsets for different personas of the IoT ecosystem. Specifically, each "persona" represents a knowledge profile, which maps to a set of key IoT skills. Hence, the specification of learning path for a "persona" can be driven by its key skills.
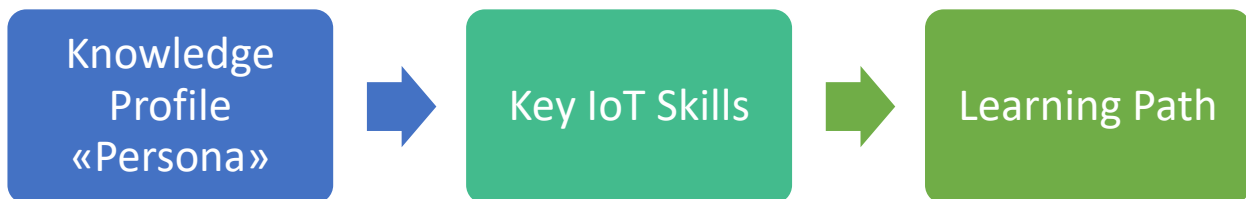
Figure 2: An IoT Learning Path is Driven by the Key Skills that comprise the Knowledge Profile of the Learner ("Persona")

Figure 3 illustrates the project's approach to specify learning paths and certification programmes for IoT skillsets. The approach comprises three main types of activities:

- **IoT Training Materials Development and Training Catalogue (M1-M30)**: This is the group of activities to provide and maintain the online catalogue of IoT training resources, while also developing training materials (e.g., webinars, presentations) in collaboration with other projects and initiatives (e.g., the H2020 ICT-56 projects).

- **IoT Profiles and Key Skills Identification (M10-M24)**: Following the development of a critical mass of training resources, this group of activities deals with the specification of IoT Learning Profiles and "Personas", including the key skills that they comprise. In this direction, the project reviews the state of the art in IoT skills development and conducts various IoT skills surveys towards receiving and analysing market feedback about the IoT skills that are high in demand.

- **Learning Paths Specifications (M14-M30)**: This activity group will focus on specifying learning paths in-line with the key skills identified for each profile. The learning paths will be

mapped to one of more courses and other training resources from the EU-IoT catalogue and training resources. Hence, the specification of a learning path for a given profile (e.g., IoT Developer, IoT Data Engineer, IoT Business Analyst, IoT Architect) will be based on the selection and clustering of training resources for the EU-IoT catalogue and library of training materials. For instance, the specification of learning paths for the profile of an "IoT Architect" will involve the identification of collections of IoT courses that enable a learner to acquire the skills needed for the given profile. The ultimate outcome of a learning path can be a certification. The latter can be based on the selection of certified courses.
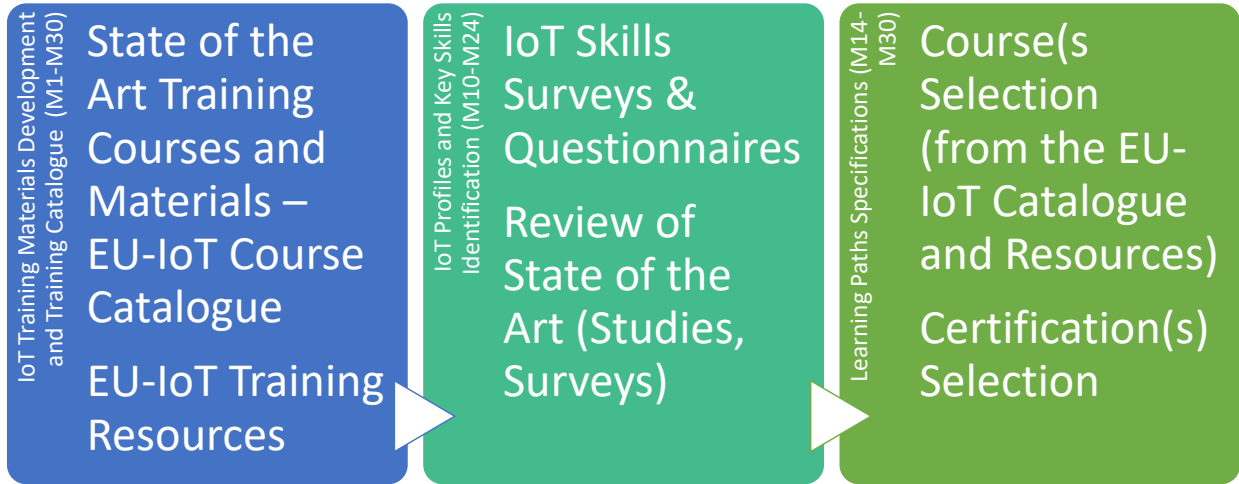
IoT Training Materials Development and Training Catalogue (M1-M30)

State of the Art Training Courses and Materials – EU-IoT Course Catalogue

EU-IoT Training Resources

IoT Profiles and Key Skills Identification (M10-M24)

IoT Skills Surveys & Questionnaires

Review of State of the Art (Studies, Surveys)

Learning Paths Specifications (M14-M30)

Course(s) Selection (from the EU-IoT Catalogue and Resources)

Certification(s) Selection

Figure 3: EU-IoT Approach to Learning Paths Specification and Trainings Certifications

There are interdependencies among the above lists of activities. Specifically, the aggregation and development of a critical mass of courses is a key prerequisite to specifying learning paths as collections of course and other training resources. Likewise, the analysis and specification of IoT learning profiles is a prerequisite for the specification of learning paths. Note also that each of the activity groups is associated with an indicative timeline. At the time of writing of this deliverable, the EU-IoT activities keep up with the indicative timeline that has been presented above.

Specification of Persona & Learning Path

Selection of Learning Path

Policy Maker

Mapping of Courses to Key Skills – Selection of Courses

Course(s) Attendance

Student

IoT Course Provider

Specification of IoT Personas

Certification for the key skills of the "Persona"
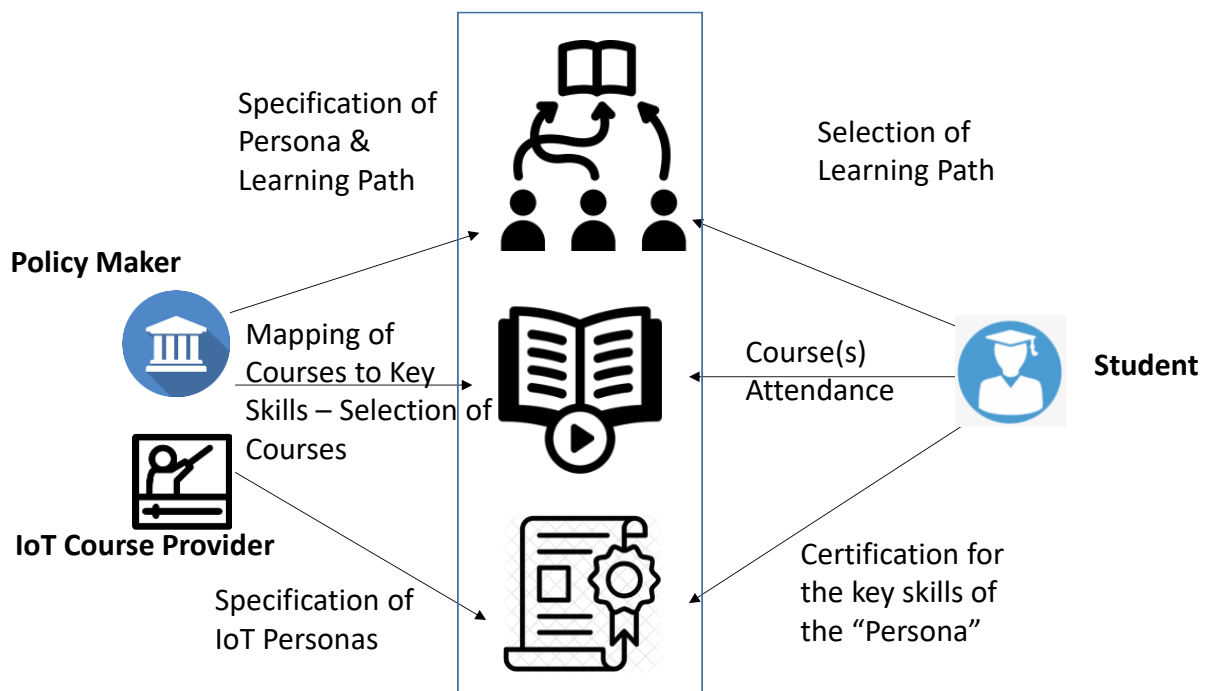
Figure 4: How Different IoT Stakeholders will benefit from EU-IoT's Training Resources

The EU-IoT training resources and the above-listed process, provides benefits for various stakeholders of the IoT ecosystem, as shown in Figure 4. Specifically:

- **IoT Course Providers** can associate their offerings to specific IoT skills and indicate how their courses can support the training journeys of different personas. Moreover, they can map their courses to key skills as part of a learning path specification.

- **IoT Policy Makers** (e.g., ICT skills policy makers) can also take advantage of EU-IoT collection of training resources to specify educational policies that are well aligned to the requirements of the industry. Likewise, they can analyse information on the available courses towards boosting their evidence-based decision making and taking educated decisions.

- **Students** are provided with easy and flexible access to training resources of the EU-IoT project and other providers. They can attend courses (including certified courses) from different providers to gain the key skills mandated by specific profiles of their choice.

Based on Figure 4, different IoT stakeholders can benefit from the EU-IoT training resources. This is a foundation for the sustainability and wider use of the EU-IoT training resources and results.

3   EU-IOT COURSES AND TRAINING PROGRAMMES CATALOGUE

3.1 Catalogue Structure

The EU-IoT courses and training programs catalogue is destined to provide a single entry to point to several selected IoT training resources. Specifically, the catalogue includes a critical mass of IoT courses, notably on-line courses from the most popular IoT training ecosystems and platforms, i.e., platforms like Coursera, edX and Udemy. Moreover, it also aggregates courses provided by university and academic institutions. A snapshot of the initial contents of the catalogue is provided in Appendix B. For each course, the following information is recorded:

- **Name/Title**: The title of the course.

- **Short description**: A short description presenting what the course is all about and summarizing its contents.

- **Instructor/Institution**: The provider institution/organization of the course, along with information about the instructor (if available).

- **Provider/Course Platform**: The course platform or ecosystem that facilitates access to the course. Many of the listed courses come from platforms like Udemy and Coursera.

- **Price/Cost**: The price of the cost, when not for free.

- **Duration**: The duration of the course.

- **Keywords**: Metadata that can be used for searching different courses.

- **URL**: A link to the course dedicated online page/site. With the courses that are integrated into some course platform, the URL points to the web page of the course in the platform.
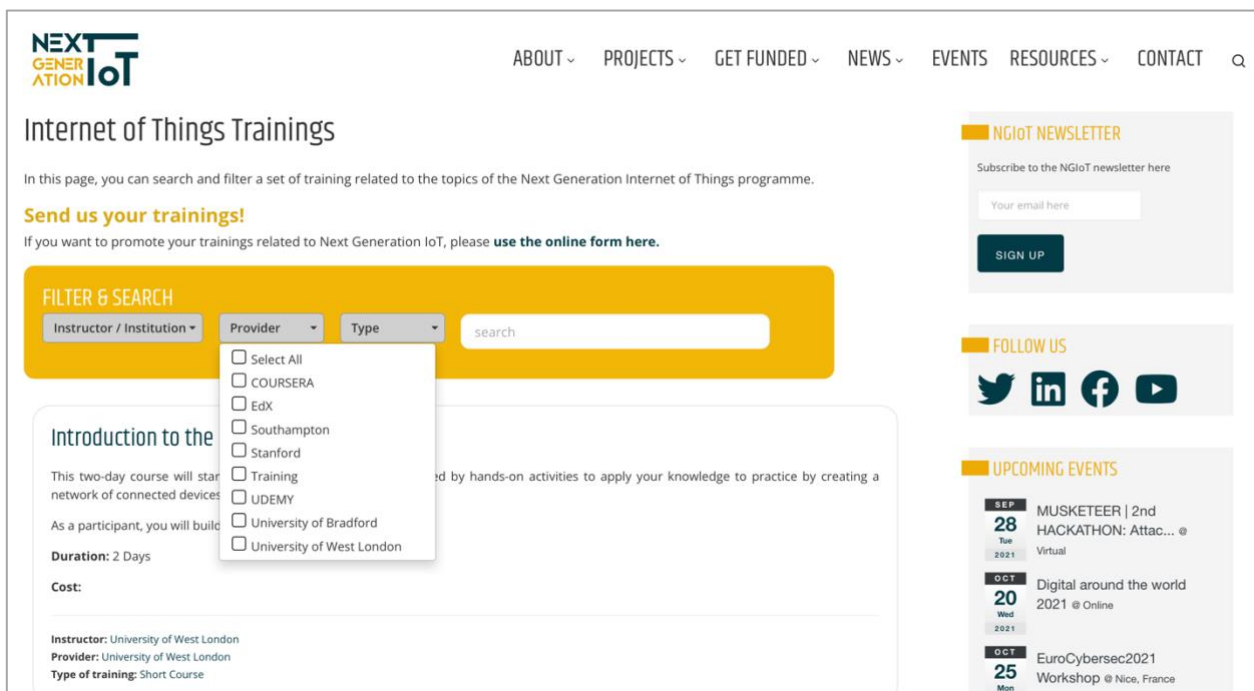

Figure 5: Snapshot of the first version of the Internet of Things Training Catalogue

3.2 Catalogue Implementation

To initialize the catalogue an initial list of approx. 100 courses has been created. The catalogue is already available in a beta-landing page of the NGIOT/EU-IoT web site with the following characteristics:

- **Searchable**: It will be possible to search courses in the catalogue based on criteria like their topics, cost, and metadata keywords. Searching based on multiple criteria (e.g., price and duration) will be also possible.

- Extensible: It is possible to add a new course in the catalogue. To this end, a dedicated form is offered, which enables visitors to the NGIOT portal to propose additions to the catalogue. Additions will be reviewed by the EU-IoT consortium prior to their final integration in the catalogue.

A version of the catalogue of training resources is available at: https://www.ngiot.eu/archive-ngiot-training/

4 EU-IOT SERIES TRAINING SEMINARS

4.1 Overview

To support the training strategy of the project, EU-IoT has been organizing and conducting a series of training seminars. The goals of this series of seminars are:

- To create training resources in cutting edge IoT technologies, i.e., where IoT training resources and materials are not widely available. Note that all materials developed as part of the webinars, including the presentations and the recordings of the webinars, are made available through the dedicated training resources page on the NGIOT portal.

- To coordinate and support the training agendas of the H2020 ICT-56 projects. Several ICT-56 projects include training tasks and EU-IoT provides coordination and support towards maximizing the impact of these tasks. The seminars are set in this direction.

- To create a community of interested stakeholders around the EU-IoT and ICT-56 projects training activities. To this purpose, participation in the seminars requires registration. The members of this community will be provided with access to the training resources and tools of the project, such as the EU-IoT training catalogue.

- To raise awareness on cutting edge IoT topics, notably technical and research areas that fall in the scope of the ICT-56 projects activities. EU-IoT and ICT-56 projects are particularly interested in raising awareness about IoT technologies and solutions that related to AI at the edge, the tactile internet, 5G/6G networks, as well as novel IoT architectures and technologies (e.g., blockchain based IoT systems).

- To support IoT stakeholders engaging in parallel activities of EU-IoT and ICT-56 such as the open calls of these projects. The series of EU-IoT training seminars provides ideas and up-to-date information that can be used to support participants in the open calls and in call to the Horizon Europe program.

During the first year of the project's lifetime, three seminars were conducted, while three more have been planned for the next months. More information about the conducted and planned seminars in provided in following paragraphs.

4.2 Conducted Seminars

4.2.1 "AIoT and Edge Machine Learning", May 21st, 2021

4.2.1.1 Overview

A seminar titled "AIoT and Edge Machine Learning" was organized on May 21st, 2021 (Figure 6). The seminar aimed at presenting different approaches for AI and machine learning at the edge, such as federated machine learning, machine learning on embedded devices and TinyML. It was performed with contributions from several ICT-56 projects, including ASSIST-IoT, IntelloT, VEDLIoT, iNGENIOUS, IoT-NGIN, beyond presentations from EU-IoT. The agenda of the seminar is provided in Appendix A. Presentations and materials used in the seminar, along with the recording of the seminar, are available in the NGIOT portal and will be also made available in the EU-IoT training page.

4.2.1.2 Attendance

There were 175 registrations for the online event. 100 of them connected to the seminar, with

approx. 90 of them connected for almost the full duration of the seminar.

4.2.1.3 Audience Feedback

There was very positive feedback about the seminar, including positive feedback about the quality of the presentations and the organization in general. Such feedback was received during the seminar, but also through social media (e.g., in relevant LinkedIn posts). There were approx. 2-3 questions from the audience in each presentation and relevant discussions followed. In this respect, one comment also concerned the need for allowing more time for discussion after the presentations.

Figure 6: Banner of the "AIoT and Edge Machine Learning" Workshop

4.2.2 "Enabling the Tactile Internet with IoT", July 8th, 2021

4.2.2.1 Overview

A seminar titled "Enabling the Tactile Internet with IoT" was organized on July 8st, 2021 (Figure 7). The seminar aimed at presenting different approaches for Virtual Reality (VR), Augmented Reality (AR) and Extended Reality (XR) IoT applications. Use cases with proper video demonstrations were presented as well. The importance of high-performance networking infrastructures to support the VR/AR/XR applications was adequately explained and emphasized as well. The seminar was organized with the participation and contributions from several ICT-56 projects including ASSIST-IoT, IntelloT, iNGENIOUS, IoT-NGIN, beyond presentations from EU-IoT. The agenda of the seminar is provided in Appendix A. Presentations and materials used in the seminar, along with the recording of the seminar are available in the NGIOT portal and will be also made available in the EU-IoT training page.

4.2.2.2 Attendance

There were 56 registrations for the online event. 48 of them connected to the seminar, and approx. 42 of them were connected for almost the full duration of the seminar. The lower numbers when compared to the 1st seminar were partly due to the period of the seminar (i.e., July 2021) where the availability of European participants was generally lower than in May 2021. This is a trend that was observed in other on-line events as well. Moreover, the topic of the seminar was more

specialized than AI and edge computing, and as such address to a smaller audience.

Figure 7: Banner of the "Enabling the Tactile Internet with IoT" Workshop

4.2.2.3 Audience Feedback

There was extremely positive feedback about the content of the seminar: it was pointed out that there are no very widely available resources for AR/XR IoT applications. 1-2 technical questions were received in each one of the presentations and demonstrations.

4.2.3 "Machine Learning at the Edge and the Far-Edge", August 30th, 2021

4.2.3.1 Overview

The seminar was organized in the scope of the online edition of the IoT Week 2021, in collaboration with IoT-NGIN and VEDLIoT. It was held in August 30th 2021 (Figure 8). The content of the seminar was focused on the presentation of different edge machine learning paradigms. In this respect, there were some similarities to the 1st seminar of the series. Emphasis was also paid to cybersecurity issues of Federated Machine Learning (FML), as well as on hardware acceleration issues for edge machine learning. Presentations and materials used in the seminar, along with the recording of the seminar are available through the IoT Week website and will be also made available in the EU-IoT training pages.
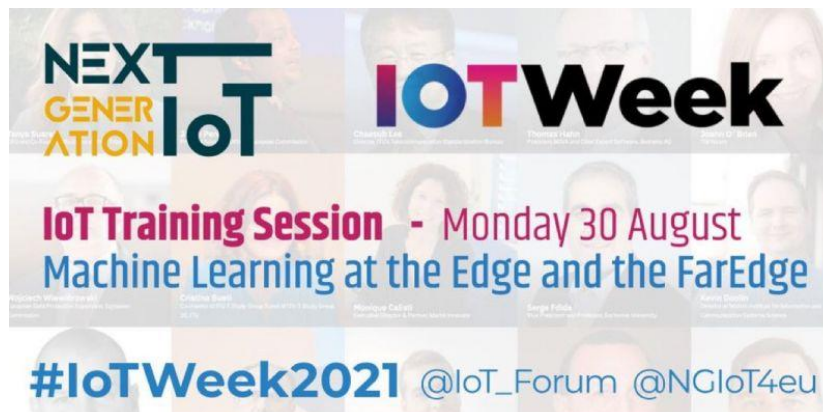

Figure 8: Banner of the "Machine Learning at the Edge and the FarEdge" Workshop held in the scope of the 2021 Online IoT Week

4.2.3.2   Attendance and Feedback

The seminar was attended by over 100 participants, notably IoT Week's registered participants. However, there were no questions and discussion following the presentations, partly due to the limited time allocated to this session. This was a known issue yet imposed due to the constraints of the IoT Week, which offered a very rich and diversified online program.

4.3   Planned Seminars

Table 2 presents the seminars planned till March 2022, i.e. M18 of the project. They also cover cutting edge technological topics, including:

- **Next generation IoT architectures**. The seminar will focus on the evolution of IoT architectures in the light of IoT's integration with cutting edge technologies like 5G networks, Distributed Ledger Technologies (DLTs) and Machine Learning in edge/cloud computing contexts.

- **Enabling Networking infrastructure for IoT applications**. The seminar will shed light on how 5G and 6G technologies unlock IoT's innovation potential. It will present 5G and 6G solutions for IoT, along with use cases that benefit the most from 5G/6G.

- **Distributed Ledger Technologies for IoT Decentralization**. The seminar will illustrate how IoT architectures and applications can benefit from decentralized architectures and blockchain technology. The merits of blockchain technology for the security, privacy, and scalability of edge/cloud IoT applications will be presented as well.

Title	Tentative Date
"*Next Generation IoT Architectures*" Taking Full Advantage of Emerging IoT Technologies	October 2021
"*Enabling Networking Infrastructures for IoT: From 5G to 6G*" Why and how 5G/6G Unblock IoT Innovation	December 2021
"*Distributed Ledger Technologies for IoT Decentralization*" Enabling the Next Generation of Scalable and Massively Decentralized IoT Applications with Blockchain Technologies	February 2022

Table 2: List of EU-IoT Coming Training Seminars (M1-M18 of EU-IoT Project)

As evident from the above-listed seminars, EU-IoT will cover several leading edge IoT topics as part of its training activities. Nevertheless, the flow of seminars will continue till the end of the project. Additional seminars will be planned in the coming months for 2022 and 2023. The planning will consider feedback from the IoT community, including participants to previous seminars and team members of the ICT-56 projects.

5 IOT SKILLS SURVEY

To support the identification of "personas" (i.e., IoT skills profiles) and the specification of respective learning paths, the project will collect information from different sources, including direct feedback from stakeholders of the European IoT ecosystem. In this direction, the project has developed an initial set of surveys that will be proposed to different IoT stakeholders, including researchers, engineers, and practitioners. The surveys will be made available on-line and will remain open to allow continuous collection of information. The gathered information will be summarised and combined with review of state of the art in IoT skills, to boost the definition of IoT skills profiles. Profiles will then drive the specification of learning paths as collection of courses and certifications. The skills surveys developed by the project is included in Appendix C and cover four different major families/categories of skills, namely:

- IoT technical and technological skills that are important for developers of IoT systems.

- IoT skills linked to methodologies and tools that are essential and important for developers of IoT systems.

- IoT technical skills that are essential and important to users of IoT systems in the Industry 4.0 era (including Operator 4.0 profiles).

- IoT social and management skills that are essential to users of IoT systems in the Industry 4.0 era (including Operator 4.0 profiles).

The results of the survey, along with the combination of other relevant information (e.g., desk research) will be presented in the next version of this deliverable.

6 CONCLUSIONS AND OUTLOOK

This deliverable has illustrated the training strategy of the EU-IoT project, including the project's approach to have an impact on the IoT training ecosystem. Given the limited resources of the project and its emphasis on coordination and support, EU-IoT opts to take advantage of the rich set of available training resources through organizing them in a structured catalogue. At the same time, the project coordinates the development of training materials in specialized areas, notably areas researched and explored by recent H2020 ICT-56 projects. In this direction, the project has been organizing webinars and developing relevant training materials such as presentations and video webinars. EU-IoT will continue to collect, develop, and organize training materials based on this approach also during the second reporting period.

EU-IoT has also shown its approach to specifying learning paths and providing integrated curricula over the available training materials. This will provide prospective IoT learners and policy makers with insights on important IoT profiles and how they can be supported based on the collection of available courses and materials. In this direction, EU-IoT will work towards identifying important IoT skills profiles that are already high in-demand by the industry or match their future development goals regarding IoT.

EU-IoT acknowledges the importance of ensuring the sustainability of its training outcomes. To this end, the project is aiming at producing results with potential for extensibility and wider use. The IoT training courses and materials catalogue is a step in this direction. We envisage that the IoT community will use the catalogue as a directory of IoT courses beyond the end of the project. This is the reason the catalogue has been organised as an extensible structured, where third parties (i.e., beyond the EU-IoT project) will be able to add pointers to IoT courses and other training resources. Likewise, our approach to mapping IoT skills profiles to collections of courses is one more result with significant sustainability potential. It will allow policy makers and enterprises to specify IoT skills profiles, while mapping them to courses.

The next deliverable on training activities, to be released at the end of the second year of the project, will provide additional information and details about the training activities, including comprehensive information about the training in the second year of the project. This will include the planned seminars, the structuring and integration of the IoT courses catalogue in the NGIOT portal, the enhancement of the catalogue with more courses (i.e., beyond the initial list of 100+ courses), as well as the development of IoT skills profiles and learning paths. EU-IoT is committed to carrying out these activities, while making use of them to boost the sustainability potential of the catalogue and the learning paths development methodology. Finally, the project remains committed to continue its close and effective collaboration with other projects (notably ICT-56 RIA projects) towards coordinating their training activities and using them to support other important activities like their open calls.

APPENDIX A: AGENDAS OF EU-IOT TRAINING SEMINARS

Seminar Title: "AIoT and Edge Machine Learning"

(Unleashing the Power of IoT Analytics at the Edge)

Training Workshop Agenda (Friday, 21 May 09.30-12.00 CEST)

09:30 - 09:40	**"Introduction to the Topic and the Workshop"**, John Soldatos, INTRASOFT International, EU-IoT
09:40 - 10:00	"**Introduction to Federated Learning**", Marcin Paprzycki, Polish Academy of Sciences, ASSIST-IoT
10:00 - 10:20	"**Cybersecurity Contexts of Federated Machine Learning",** Artemis Voulkidis, Synelixis Solutions S.A, IoT-NGIN
10:20- 10:40	"**Federated Machine Learning at the Edge**", Arne Bröring and Sumudu Samarakoon, SIEMENS, IntelloT
10:40- 10:45	**Break**
10:45- 11:05	"**Accelerated Deep Learning for Cognitive Edge Computing**", Jens Hagemeyer, Bielefeld University, VEDLIoT
11:05- 11:25	**"Applications of Machine Learning and Edge Computing in Maritime Logistics"** Jussi Poikonen, Awake.AI, iNGENIOUS
11:25- 11:40	"**Tools and Techniques for Embedded Machine Learning and TinyML development**", John Soldatos, INTRASOFT International, EU-IoT
11:40 - 11:55	**Questions & Answers from Participants**
11:55 - 12:00	**Training Workshop Closing**

Seminar Title: "Enabling the Tactile Internet with IoT"

(How IoT can Break Time & Space Boundaries)

Training Workshop Agenda (Thursday, July 8thth, 2021 (12.00-14.30) CEST)

12:00 - 12:05	**"Introduction to the Topic and the Workshop"**, John Soldatos, INTRASOFT, EU-IoT Project
12:05 - 12:30	"**AR enterprise applications powered by XR streaming**", Luis Bollinger, Holo-Light, Gmbh, IntelliIoT Project,
12:30 - 12:55	"**AR+VR for remote control over Tactile Internet**", Cristina Escribano, NOKIA, iNGENIOUS Project
12:55- 13:20	"**Use of Tactile Internet and Augmented Reality in the Construction Industry**", Piotr Dymarski, Mostostal, ASSIST-IoT Project
13:20- 13:45	**"Designing IoT-powered XR services and applications towards a Tactile Internet",** Stavroula Bourou, Synelixis Solutions SA, IoT-NGIN Project
13:45-14:10	**"Cross-layer framework for tactile applications",** Ahmad Nimr, TU Dresden, iNGENIOUS Project
14:10 - 14:25	**Questions & Answers from Participants**
14:25 - 14:30	Conclusions & Workshop Closing

Seminar Title: "Machine Learning at the Edge and the Far-Edge"

(organized in the scope of the 2021 IoT Week (online event))

Training Workshop Agenda (Monday, August 30thth, 2021 (11.45-12.45) CEST)

11:45 - 12:05	**"Introduction to Federated Machine Learning (FL) and FL Cybersecurity",** Dr. Artemis Voulkidis, Synelixis Solutions SA, H2020 IoT-NGIN Project
12:05 - 12:25	**"VEDLIoT – A heterogeneous hardware platform for next-gen AIoT applications Teaching the IoT to learn",** Dr. Jens Hagemeyer, University of Bielefeld, H2020 VEDLIoT Project
12:25 - 12:45	**"TinyML: AIoT and Machine Learning at the FAR-EDGE",** Dr. John Soldatos, INTRASOFT International S.A, EU-IoT Project

APPENDIX B: SNAPSHOT OF THE DATA OF THE TRAINING CATALOGUE

Name	Short description	Instructor / Institution		Provider	Duration	URL	Cost
A Simple Framework for Designing IoT Products	PTC IoT Series, Microcourse #2	Ayora Berry	Jordan Cox	UDEMY	32 min	https://www.udemy.com/course/a-simple-framework-for-designing-iot-products/	FREE
AWS IoT: The Hobbyists Guide to Home Automation	Embedded Device to AWS Cloud Integration, Publish MQTT Data to AWS IoT using a Raspberry Pi or ESP32	Nathan Glover		UDEMY	2	https://www.udemy.com/course/aws-iot-automation/	49,99
AWS Serverless Design for IoT	Program the ESP8266/ESP32 in Arduino, then enhance, store, and and visualize IoT data with AWS Serverless design flows	Stephen Borsay		UDEMY	7	https://www.udemy.com/course/aws-serverless-design-for-iot/	54,99
Basic Networking with Node MCU and the IOT	This course deals with implementing basic networking techniques using Node MCU powered by the famous ESP8266.	Jigsaw Academy		UDEMY	1,5	https://www.udemy.com/course/basic-networking-with-node-mcu-and-the-iot/	19,99
Beginners Masterclass into Internet of Things	Learn IoT with Raspberry Pi and Microsoft Azure	Amit Rana		UDEMY	9	https://www.udemy.com/course/internet-of-things-raspberrypi-azure/	129,99
Build IOT Apps using Raspberry Pi, AspNet Core and SignalR	Developing Internet Of Things Applications using Raspberry Pi 3, AspNetCore and SignalR Core	F. Frank Ozz		UDEMY	4	https://www.udemy.com/course/build-iot-apps-using-raspberry-pi-aspnet-core-and-signalr/	79,99
Build your 1st Arduino IOT Project & Game : Arduino for Kids	10 + Projects on Arduino Internet of things (IOT) & Arduino Hardware Gaming for Kids. Easy GUI drag drop programming.	Robolabz STEM School		UDEMY	2,5	https://www.udemy.com/course/arduino-fun-iot-gaming-for-kids-parents-beginners/	19,99
Building a Smart Mirror with Raspberry Pi and the IOT	In this course we a step by step approach to build a smart mirror using Raspberry Pi.	Jigsaw Academy		UDEMY	2	https://www.udemy.com/course/building-a-smart-mirror-with-raspberry-pi-and-the-iot/	29,99
Building a Thing for the Internet of Things IoT	A hands on, step-by-step guide to bringing your idea to life, from start to Kickstarter	Michael Lehman		UDEMY	3,5	https://www.udemy.com/course/building-a-thing-for-the-internet-of-things/	24,99
Building an IOT Device with Node MCU	This course deals with implementing MQTT based networking techniques using Node MCU and core micro-controller concepts	Jigsaw Academy		UDEMY	1,5	https://www.udemy.com/course/building-an-iot-device-with-node-mcu/	29,99
Building Internet of Things Projects with Arduino IOT Cloud	Learn the Internet of Things.Build IoT Projects, Configure IoT Things, Dashboards, Webhooks and build IFTTT Integrations	Lee Assam		UDEMY	4,5	https://www.udemy.com/course/arduino-iot-cloud/	99,99
Complete guide for IoT Testing	Learn concepts about IoT and relevant testing theories	Bhumika Mehta		UDEMY	1	https://www.udemy.com/course/complete-guide-for-iot-testing/	79,99
Complete Guide to Build IOT Things from Scratch to Market	Build IOT products using Arduino, NodeMCU,ESP8266, IOT Platforms, Sensors, Displays, Keypads,Relays, PCB's,Casing & more	Junaid Ahmed		UDEMY	5	https://www.udemy.com/course/complete-guide-to-build-iot-things-from-scratch-to-market/	149,99
Complete Python 3 and Raspberry Pi Masterclass	Learn Python 3 Basics, Advanced Python, Scientific Python, Raspberry Pi, and Hardware projects in a single course	Ashwin Pajankar • 50,000+ Students Worldwide		UDEMY	20,5	https://www.udemy.com/course/complete-python-3-raspberry-pi-masterclass/	19,99
Create an entire Internet Of Things Project in 60 Minutes	Learn how to build an IoT project from A to Z all in less than one hour.	Nidhal Abidi		UDEMY	32 mins	https://www.udemy.com/course/iotcourse/	129,99
Descriptive IOT Data Analysis	This course covers basic Descriptive IOT Analytics.	Jigsaw Academy		UDEMY	1	https://www.udemy.com/course/descriptive-iot-data-analysis/	19,99
ESP8266 IoT Web server Optimization Using Arduino IDE	Learn to use GZIP compression and improve ESP8266 IoT web server performance.	Farrukh Hussain		UDEMY	48 min	https://www.udemy.com/course/gzip-esp8266-webserver-using-arduino-ide/	free

APPENDIX C: IOT SKILLS SURVEY

IoT System Development Skills (Technical Aspects)

Skill / Importance	Very Low	Low	Moderate	High	Very High
4G/5G Networking					
Embedded Programming					
IoT Device Programming					
Robotics					
Smart Objects					
IoT Middleware					
Cloud Computing					
Edge Computing					
BigData					
IoT Security / Cybersecurity					
AI					
Machine Learning					
IoT Tools					
Data Analytics					
Blockchain Technology					
Augmented Reality					
Virtual Reality					

Table 3: Survey/Questionnaire for IoT Systems Development Skills associated with technical and technological knowledge

IoT System Development Skills (Methodologies and Tools)

Skill / Importance	Very Low	Low	Moderate	High	Very High
DevOps					
DataOps					
Java					
JavaScript					
Python					
C/C++					
Solidity					
Scala					
IoT Tools (Eclipse/NODE-RED)					
Data Analytics Methods (CRISP-DM)					
Cloud Development					
Docker					
Kubernetes					
Devices Operating Systems					

Table 4: Survey/Questionnaire for IoT Systems Development Skills associated with methodologies and tools

Operator 4.0 Technical Skills

Skill / Importance	Very Low	Low	Moderate	High	Very High
Equipment maintenance					
Intelligent Asset Management					
Asset Programming					
BigData Visualization					
Augmented Reality					
Quality Control					
Human Centred Technology					
User Journey Design					

Table 5: Survey/Questionnaire for Operator 4.0 Technical Skills

Operator 4.0 Social and Management Skills

Skill / Importance	Very Low	Low	Moderate	High	Very High
Financial Management					
People Management					
Time Management					
System Analysis					
Complex Problem Solving					
Emotional intelligence					
Negotiation					
Persuasion					
Service orientation					
Training & Mentoring					
System Analysis					
IoT Literacy					

Table 6: Survey/Questionnaire for Operator 4.0 Social and Management Skills

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