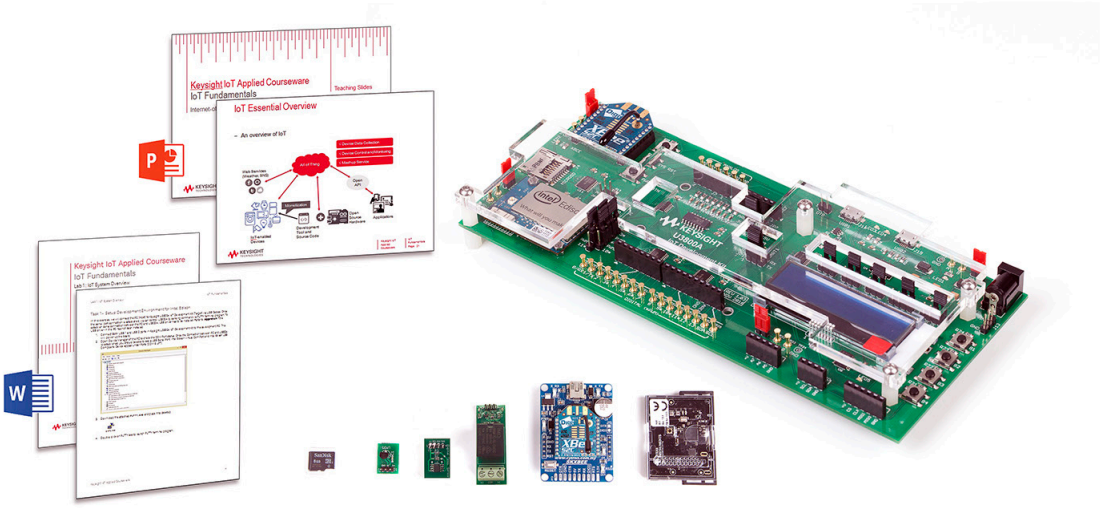
Keysight Technologies
U3801A/02A IoT Fundamentals Applied Courseware

Data Sheet



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Introduction

The Internet of Things (IoT) is the next mega trend that will change the way we live and work, and it is predicted to touch almost every consumer and industrial application. The core technologies that enable the IoT are wireless communication and sensor developments, and ongoing advances in these technologies result in unique challenges. These challenges include new communications standards, increased sensor integrations and power consumption management. This puts a heavy stress on an IoT device's design and validation cycle, and designers must constantly innovate to quickly and successfully develop and deploy IoT devices in the market.

The next generation of engineers will play a key role in the development of the IoT, and it is important that students graduate from an undergraduate engineering program prepared for the electronic design, test and measurement challenges needed to be solved in the industry. To fulfill that goal, education institutes must not only teach students the basics of testing and designing an IoT system, they must provide students with an understanding of the entire IoT ecosystem and also relate these experiences to real-world applications.

With more than 75 years of test and measurement expertise, Keysight Technologies, Inc. is ready to help you to nurture the next generation of IoT-ready professionals. Keysight's ready-to-teach U3800 Series IoT applied courseware focuses on teaching practical design and test techniques and is designed to give students the opportunity to work with industry-grade test and measurement instruments in the lab – the same instruments that they would use when they are out in the industry.

There are four IoT applied courseware:

1. IoT Fundamentals – Introduces the fundamentals of IoT. Students who complete this course will have an overview of the IoT's architecture, technologies and ecosystem.
2. IoT Systems Design – Introduces IoT system design techniques, leveraging embedded systems focusing on specific IoT examples. Students will be able to design and develop an IoT system targeting IoT gateway and sensor network.
3. IoT Wireless Communications – Allows students to develop typical IoT applications with various types of wireless connectivity. Students will be able to perform quick verification and design validation on these IoT applications. This courseware will be available in Fall 2017.
4. IoT Sensors and Power Management – Teaches students how to characterize the power consumption of the IoT device's on-board controller, sensors and wireless modules. Students will understand the principles of power management and will be able to characterize micro electro-mechanical systems (MEMS) devices. This courseware will be available in Fall 2017.

Each courseware comes with a training kit and teaching slides. The training kit consists of a development kit, IoT sensor device, XBee ZigBee® kit, lab sheets, and problem-based assignments. Students can also use this kit to develop their own projects once they have completed the course.

Courseware Overview

The U3801A/02A IoT Fundamentals applied courseware is a ready-to-teach package focusing on the fundamentals of the Internet of Things. It introduces students to the IoT's architecture, technologies and ecosystems. The courseware is designed as a resource for lecturers, and consists of teaching slides and a training kit.

- Targeted university subject: IoT systems, IoT fundamentals
- Targeted year of study: Second to final year undergraduates
- Prerequisites(s): Basic programming

Teaching slides	Training kit
Editable Microsoft PowerPoint slides	IoT development kit
Covers 36+ hours of classroom sessions	IoT sensor device
	XBee ZigBee kit
	Lab sheets (Microsoft Word) and model answers
	Problem-based learning assignments
	Covers 18 hours of lab sessions

Key features and benefits

- The IoT Fundamentals applied courseware is designed for a full semester of teaching, and comes with teaching slides and a training kit. Educators can use this complete solution to accelerate the setup of a new IoT-focused course.
- The courseware integrates hands-on industry-relevant experiences and real-world applications in IoT design and testing, allowing students learn the design and test techniques practiced by the industry.
- The courseware material will be updated yearly for three years at no additional cost. This allows educators and students to keep pace with evolving IoT trends and technologies, which will change rapidly over the next several years.
- The IoT development kit is based on a carrier board with Arduino UNO form factor interface and an add-on ZigBee module. Various external sensor devices can be connected to the board, allowing students to implement different types of IoT applications.
- The development kit allows students to experiment with wireless local area network (WLAN) 802.11, *Bluetooth*® Low Energy (LE) and ZigBee wireless connectivity. Due to the kit's modular design, it can be easily expanded to include other wireless connectivity and sensors.
- The development kit provides various test points for troubleshooting, current-drain consumption measurement on sub-circuits, and sensor verification.
- The hardware building blocks are visible on the development board.
- The development kit is equipped with an Intel Edison compute module that runs on Yocto Linux and is compatible with Intel System Studio IoT Edition, which is an Eclipse-based integrated development environment (IDE). This allows students to compile C/C++ files or to run Python scripts.

Learning outcomes

Students will be able to:

- Understand IoT concepts and the various building blocks, applications and ecosystems associated with the IoT
- Understand the architecture, standards and connectivity protocols in IoT
- Understand the workflow of hardware and software development in IoT from sensors to mobile devices
- Set up related software modules and connectivity from an IoT node, gateway, cloud or end-user client
- Understand high-level design and implement proof-of-concept for IoT applications with a focus in end-user applications

Courseware Contents

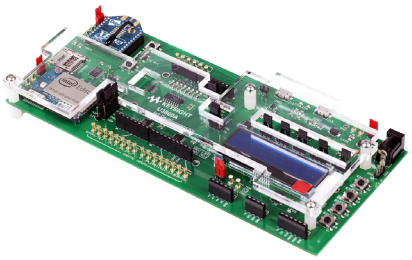
Teaching slides

The teaching slides are editable and cover 36+ hours of teaching for one full semester. The slides cover the following topics:

IoT essentials	Introduction to the essential elements of an IoT-enabled embedded system, IoT hardware platform (such as gateway and sensor node), IoT building blocks (such as sensors, connectivity and data), IoT applications and ecosystem.
Hardware for IoT	Introduction to different types of hardware used at an IoT sensor node, such as sensors, components, chips and boards.
Software for IoT	Introduction to the various programming languages (such as Python, Java and C) that can be used in IoT embedded system, cloud and end-user applications.
IoT connectivity protocols	Introduction to various wired and wireless connectivity protocols (such as SPI, I^2C, Bluetooth LE, WLAN 802.11, Z-wave, 6LoWPAN, NFC, etc.) as well as emerging standards (such as MQTT) used in the implementation of IoT-enabled embedded systems.
IoT application design essentials	Introduction to the concept of application programming interface for cloud computing and mobile devices (such as REST and JSON) for interoperability among IoT solutions. This topic includes security and identity management.
From IoT to data analytics	Introduction to the basics of data analytics and visualization using cloud computing technologies
Case studies	Case studies covering smart home and industrial/commercial automation applications.

Training kit

IoT development kit



This hardware kit is a customizable embedded system development kit that can be configured as a gateway or a sensor device. It incorporates an Intel Edison compute module that is designed for expert makers, entrepreneurs, and industrial IoT applications. The system runs on Yocto Linux with open source software development compatible with Eclipse (C, C++, Python). Samples of start projects are also available to enhance the learning process and allow a wide range of potential applications.

All IoT applied courseware use the same development kit.

The development kit comes with the following features:

- Open source software development environment
- High performance, dual-core CPU and single core micro-controller support complex data collection in a low power package
- Integrated WLAN 802.11, *Bluetooth* LE and ZigBee wireless connectivity support
- 1 GB DDR and 4 GB flash memory, simplifying configuration and increasing scalability
- Arduino UNO and XBee form factor interfaces support
- UARTs, I^2C, SPI, 40 GPIO, SD card connector and LCD
- Micro USB (UART), micro USB OTG
- Flexible power supply options: AC power adapter or USB host
- Various test points for verification
- Sensor connectors for both analog and digital sensor signals

IoT sensor device

The TI SensorTag kit includes ten low-power sensors: ambient light, digital microphone, magnetic sensor, humidity, pressure, accelerometer, gyroscope, magnetometer, object temperature, and ambient temperature.

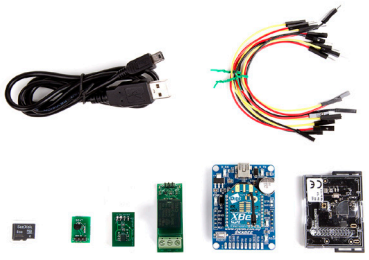
XBee ZigBee Kit

The XBee ZigBee starter kit is a compact platform that provides UART serial communication to an XBee ZigBee module. 5 V TTL logic interface offers a straightforward interface to microcontroller for embedded wireless development.

Accessories

The following accessories are included with the hardware kit:

Item	Quantity
Micro USB cable, 1 m	2
Mini USB cable, 1.2 m	1
TI SensorTag kit	1
XBee ZigBee kit	1
Analog temperature sensor	1
Digital temperature sensor	1
Relay actuator	1
Micro SD card	1



Lab sheets

The IoT Fundamentals applied courseware includes six editable lab sheets. Each lab requires 2-3 hours to complete. Model answers are provided with all lab sheets.

Lab sheet topic
1. IoT System Overview – Perform system setup, connection between host and target, test run a ready-made application using a sample application as the demonstration, and build a simple IoT application to read data from sensors and display the results on an LCD
2. Exploring LAN/PAN Connectivity Protocols and Understanding the Purpose of an IoT Gateway – Use different connectivity protocols to connect the target to sensor devices
3. Exploring the Web-based Cloud Services for IoT – Explore the potential of web services provided by Google and XAMPP, and learn to call and use these cloud services
4. Exploring MQTT Messaging Protocol for IoT – Use different connectivity protocols to connect sensor devices to the cloud, and set up and test IoT downlinks such as MQTT technologies with mobile devices
5. Exploring Data Visualization and Analytics – Modify a ready-made end user application with cloud using supported programming languages with different data analytics approaches
6. Cloud-enabled IoT Application – Based on a smart home IoT application, deploy an IoT node onto cloud and visualize the results on an end-user client device

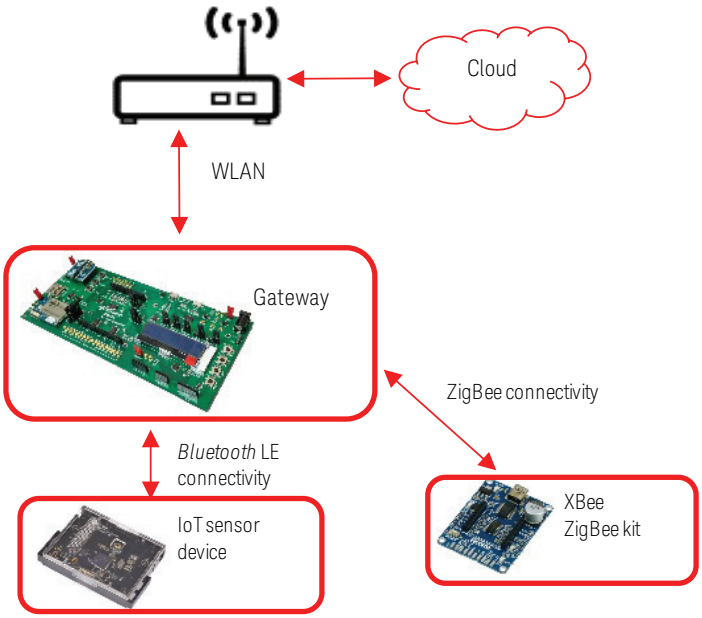


Figure 1. Typical lab setup.

Problem-based assignments

The problem-based assignments below allow students to enhance their problem-solving skills.

Smart home automation	Develop a smart thermostat using the available sensors and actuators to control electrical appliances
Industrial 4.0 automation	Develop a sensor-based factory automation application such as vibration and temperature monitoring

IoT Development Kit Characteristics

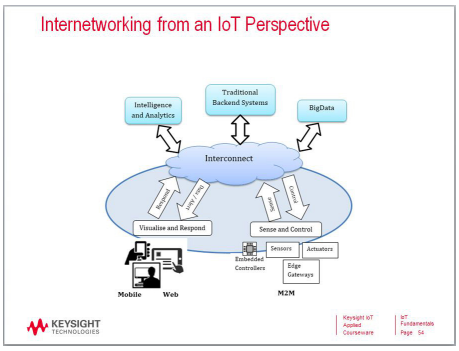
IoT development kit	
Dimensions	20 cm (w) x 8.5 cm (d) x 5 cm (h)
Compute module	Intel Edison (A dual-core, dual-threaded Intel Atom CPU at 500 MHz and a 32-bit Intel Quark microcontroller at 100 MHz)
RAM and flash storage	1 GB LPDDR3 PoP memory and 4 GB eMMC
Wireless communication	WLAN 802.11 a/b/g/n , *Bluetooth* LE (version 4.0) and ZigBee wireless connectivity
General	
Supply voltage	6 to 12 V AC adapter (2 mm DC jack) USB port
Warranty	1 year 3 months for accessories

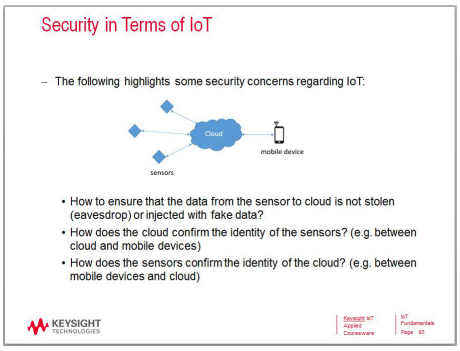
System and installation requirements

PC operating system	Windows 8 and 10 (64-bit)
Interface	USB (3 ports)

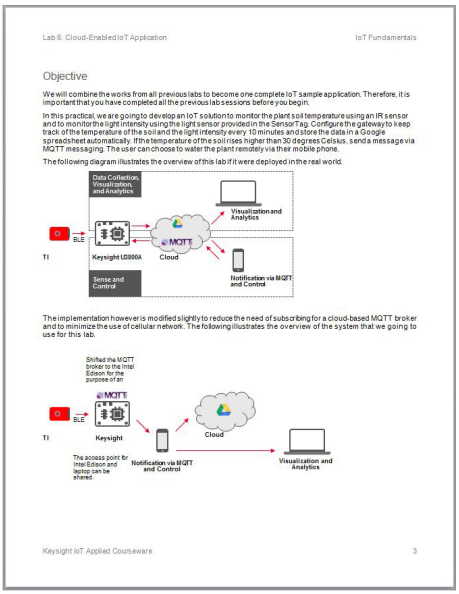
Preview IoT Applied Courseware Contents

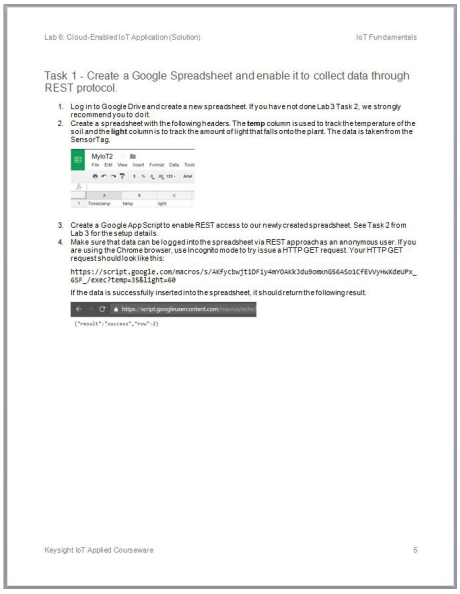
Take a look inside the contents of the IoT applied courseware. Samples of the teaching slides and lab sheets are available at **www.keysight.com/find/TeachIoT**





Samples of the teaching slides – Chapter 5, IoT Application Design Essentials. View more samples at the above link.





Samples of the lab sheets – Lab 6, Cloud-enabled IoT Application. View more samples at the above link.

Watch a video overview or live demonstration

Visit the Keysight Educators playlist on the Keysight YouTube network at **https://www.keysight.com/find/education-videos.** Watch an overview video to understand more about the IoT applied courseware, and take a look at how the training kit can be used in action within your teaching lab.

Ordering Information

Product number	Description
IoT Fundamentals Applied Courseware	
U3801A	IoT Fundamentals applied courseware, with training kit only
U3802A	IoT Fundamentals applied courseware, with training kit and teaching slides

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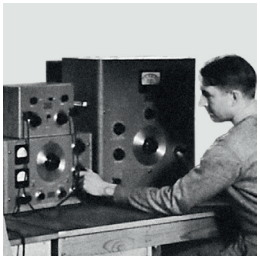

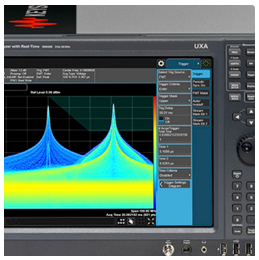

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