Unit 45:   Internet of Things

Unit code   **J/618/7481**

Unit level   **5**

Credit value   **15**

Introduction

The Internet of Things (IoT) is a network of physical objects – devices, vehicles, drones and other objects embedded with electronics, software, sensors and network connectivity – that enables those objects to collect and exchange data. The objective of the IoT is to enable almost any object to become smart, accessible and data capable, thereby benefitting from advances in communications, computation and interconnectivity. IoT explores the mixture of hardware, software, data, platforms and services that can be combined to create innovative opportunities for more direct integration of the physical world and objects into computer-based systems, resulting in improved efficiency, accuracy, social and economic benefit to people.

This unit introduces students to the role, basic concepts and benefits of IoT in the design and development process of computer applications. The aim of the unit is to enhance understanding of the methodology, terminology and benefits of IoT in the design and development of software applications.

Among the topics included in this unit are: classification and terminology of IoT, the hardware, software, data, platforms and services used to enable IoT, common architecture, frameworks, tools, hardware and APIs that can be utilised to design IoT-enabled objects, problems and solutions resulting from widespread deployment and adoption of IoT, software application methodology for IoT-specific software application design and development, data models, network complexity, security, privacy, enabling technologies and how to simulate and test an IoT concept.

On successful completion of this unit, students will be able to explain the basic concepts of IoT; design, build and simulate an IoT application using any combination of hardware, software, data, platforms and services; be able to discuss the problems that IoT applications solve; the potential impact on society, business and the end user, and the problems encountered when integrating into the wider IoT ecosystem. As a result, students will develop skills such as communication literacy, design thinking, team working, critical thinking, analysis, reasoning and interpretation and computer software literacy, which are crucial for gaining employment and developing academic competence.

Learning Outcomes

By the end of this unit students will be able to:

LO1 Analyse what aspects of IoT are necessary and appropriate when designing software applications

LO2 Outline a plan for an appropriate IoT application, using common architecture, frameworks, tools, hardware and APIs

LO3 Develop an IoT application using any combination of hardware, software, data, platforms and services

LO4 Evaluate your IoT application and the problems it might encounter when integrating into the wider IoT ecosystem.

Essential Content

LO1 **Analyse what aspects of IoT are necessary and appropriate when designing software application**

Identify role, formats and characteristics of IoT:

Present an overview of IoT and its appropriate use in software development.

Investigate what IoT is by researching its role, purpose, terminology and methodology.

Explore NB-IoT and eLTE-IoT, including standards evolution and industry development; related technologies, differences, and similarities between NB-IoT and eLTE-IoT.

Appropriateness of various architecture, frameworks, tools, hardware and APIs for different problem-solving requirements, including architecture of NB-IoT solution and eLTE-IoT solutions, NB-IoT physical Layer, key NB-IoT Features, open Modules for integration, E2E Ecosystems, lightweight devices.

Describe application scenarios of NB-IoT and eLTE-IoT.

Recognise the various forms of IoT by researching its history, current trends and use in relation to, and in conjunction with, traditional computer-based systems and networks.

Define the characteristics of IoT by investigating how it can be used and how it can interact with existing computer-based networks and the physical world.

Recognise the use of appropriate IoT applications to solve specific problems.

Research specific forms of IoT functionality:

Explore various forms of IoT functionality.

Research, debate and agree current functionality, technology and trends for IoT. Investigate the advantages and disadvantages of using IoT.

Common problems in smart campuses and cities, pain points, corresponding solutions.

Requirements of IoT technologies, including: ensuring appropriate functionality; the need to reduce power consumption of the smart grid and how this achieved, smart

Driving forces of IoT development and corresponding solutions.

Define standard architecture, frameworks, tools, hardware and APIs available for use in IoT application development:

Review architecture, frameworks, tools, hardware and APIs available to develop IoT applications.

The advantages and disadvantages of IoT architecture, frameworks, tools, hardware and APIs.

How various architecture, frameworks, tools, hardware and APIs can be used to create IoT applications.

Explore key technologies that enable and support mobile/cellular communications, e.g. 3G, 4G, 5G.

LO2 **Outline a plan for an appropriate IoT application using common architecture, frameworks, tools, hardware and APIs**

Identify a problem to be solved and select appropriate IoT techniques to solve a problem:

Specific problem to solve using IoT.

Evaluate the benefits, features, advantages and disadvantages of IoT to solve a specific problem.

Review different architecture, frameworks, tools, hardware and API techniques that can be used.

Select the most appropriate IoT architecture, frameworks, tools, hardware and API techniques to include in an application.

Describe a plan for an IoT application to solve a problem:

Outline the problem to solve including how IoT and a planned application addresses this problem.

Select an appropriate IoT application to achieve desired results.

Apply IoT architecture, frameworks, tools, hardware and API techniques appropriate to the problem identified.

Use selected techniques to create an IoT application development plan.

LO3 **Develop an IoT application using any combination of hardware, software, data, platforms and services**

Utilise appropriate tools and techniques to develop an IoT application:

Employ an appropriate set of tools to develop plan into an IoT application.

Run end user experiments and examine feedback.

Reconcile and evaluate end user feedback and determine advantages and disadvantages of chosen IoT techniques.

LO4 Evaluate your IoT application and the problems it might encounter when integrating into the wider IoT ecosystem

Assess the success of an IoT application:

Assemble and appraise end user feedback from IoT application.

Undertake a critical review and compare final application with the original plan.

Evaluate the advantages, disadvantages, strengths and weaknesses of IoT techniques.

Critique the overall success an IoT application including how well it solved problem, potential impact on people, business, society and the end user, possible problems when integrating into the wider IoT ecosystem.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Analyse what aspects of IoT are necessary and appropriate when designing software applications		
P1 Explore various forms of IoT functionality. **P2** Review standard architecture, frameworks, tools, hardware and APIs available for use in IoT development.	**M1** Analyse the impact of common IoT architecture, frameworks, tools, hardware and APIs in the software development lifecycle. **M2** Examine specific forms of IoT architecture, frameworks, tools, hardware and APIs for different problem-solving requirements.	**D1** Evaluate specific forms of IoT architecture and justify their use when designing software applications.
LO2 Outline a plan for an appropriate IoT application, using common architecture, frameworks, tools, hardware and APIs		
P3 Investigate architecture, frameworks, tools, hardware and API techniques available to develop IoT applications. **P4** Discuss a specific problem to solve using IoT.	**M3** Plan the most appropriate IoT architecture, frameworks, tools, hardware and API techniques to include in an application to solve a problem. **M4** Apply selected techniques to create an IoT application development plan.	**D2** Make multiple iterations of the IoT application and modify each iteration with enhancements gathered from user feedback and experimentation.
LO3 Develop an IoT application using any combination of hardware, software, data, platforms and services		
P5 Employ an appropriate set of tools to develop a plan into an IoT application. **P6** Run end-user experiments and examine feedback.	**M5** Reconcile end-user feedback and determine advantages and disadvantages of chosen IoT techniques.	

Pass	Merit	Distinction
LO4 Evaluate your IoT application and the problems it might encounter when integrating into the wider IoT ecosystem		
P7 Review the IoT application, detailing the problems it solves. **P8** Investigate the potential problems the IoT application might encounter when integrating into the wider system.	**M6** Compare the final application with the original plan.	**D3** Critically evaluate the overall success of the application including the potential impact of the IoT application on people, business and society, and the end user.

Recommended Resources

Textbooks

Bahga, A. and Madisetti, V. (2014) *Internet of Things: A Hands-On Approach*. 1st Ed. VPT.

McEwen, A. (2013) *Designing the Internet of Things.* 1st Ed. John Wiley and Sons.

Links

This unit links to the following related units:

Unit 21: Application Program Interfaces

Unit 47: Emerging Technologies.