

<b>Module Code</b>	<b>EEU44C04</b>
<b>Module Name</b>	Next Generation Networks
<b>ECTS Weighting<sup>2</sup></b>	5 ECTS
<b>Semester taught</b>	Semester 1
<b>Module Coordinator/s</b>	Prof Marco Ruffini and Prof Nicola Marchetti

**Module Learning Outcomes with reference to the Graduate Attributes and how they are developed in discipline**

On successful completion of this module, students should be able to:

- LO1. Describe the basic characteristics, structure and operation of wired and wireless networks.
- LO2. Identify appropriate architectural models, systems strategies and use cases for a range of modern network concepts.
- LO3. Reason about the challenges and impediments that new, disruptive networking paradigms encounter, as well as their appropriate application.
- LO4. Implement solutions to key challenges in modern network architecture, e.g., scalability, cost effectiveness and energy efficiency.
- LO5. Implement solutions to key challenges in the wireless space e.g. mobility, interference, energy consumption.
- LO6. Evaluate the performance of queues and develop network traffic models.
- LO7. Assess the operation of medium access protocols in contemporary wireless standards for local and wide area networks, and Internet of Things, and discuss co-existence between different types of systems.

**Graduate Attributes: levels of attainment**

To act responsibly - Enhanced

To think independently - Enhanced

To develop continuously - Enhanced

To communicate effectively - Enhanced

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<sup>1</sup> [An Introduction to Module Design](#) from AISHE provides a great deal of information on designing and re-designing modules.

<sup>2</sup> [TEP Glossary](#)

## Module Content

This module aims to provide both a theoretical and practical understanding of modern and next generation networking and systems concepts, principles, practices and technologies. Contemporary and emerging wired and wireless network systems are targeted.

Students will be exposed to a variety of system platforms, architectures, protocols, models and algorithms, with a strong focus on key design principles and practices e.g. performance, scalability, mobility, virtualization.

The module also aims to highlight some of the relevant ongoing research and innovation in the space taking place within Ireland and internationally.

Specific topics addressed in this module include:

1. Contemporary and emerging fixed telecommunication network architecture and systems:
  - a. Fixed telecom operator network architectures
  - b. Optical networking and transmission technology
  - c. Next generation fixed access network technologies (latest copper and fibre access technologies)
2. Contemporary and emerging wireless network architecture and systems:
  - a. Wireless channel impairments and mitigation techniques, overview of wireless networks
  - b. Mobile architectures: LTE, LTE-A, LTE-A-PRO
  - c. Wireless local area networks: IEEE 802.11, HetNet and small cell deployments, mmWave
3. Convergence of mobile and fixed architectures: backhaul, fronthaul, midhaul and protocol convergence
4. Multi-service networks and quality of service assurance
5. Centralised network control plane and protocols: Path Computation Element (PCE), Q-in-Q, MAC-in-MAC, MPLS
6. Next generation software-defined network (SDN) controlled systems
7. Traffic modelling
  - a. Introduction to queuing theory: M/M/1 queue, other M/M queues, M/G/1 queue
  - b. Network traffic models: Poisson arrival process, self-similarity
8. Recent trends in wireless networking
  - a. Cognitive radio self-organising networks and spectrum sharing
  - b. 5G and Internet of Things

<b>Teaching and Learning Methods</b>	Teaching and learning will be based on lectures and tutorials.
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<b>Assessment Details<sup>3</sup></b> <b>Please include the following:</b> <ul style="list-style-type: none"> <li>• <b>Assessment Component</b></li> <li>• <b>Assessment description</b></li> <li>• <b>Learning Outcome(s) addressed</b></li> <li>• <b>% of total</b></li> <li>• <b>Assessment due date</b></li> </ul>	<b>Assessment Component</b>	<b>Assessment Description</b>	<b>LO Addressed</b>	<b>% of total</b>	<b>Week due</b>
	Examination	2 hour written examination	LO1, LO2, LO3, LO4, LO5, LO6, LO7	70%	n/a
	In class quiz	Multiple choice quiz	LO1, LO2, LO3, LO4, LO5, LO6, LO7	15%	6
	In class quiz	Multiple choice quiz	LO1, LO2, LO3, LO4, LO5, LO6, LO7	15%	12

<b>Reassessment Requirements</b>	Examination (2 hours, 100%)
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<b>Contact Hours and Indicative Student Workload<sup>3</sup></b>	<b>Contact hours:</b> 33
	<b>Independent Study (preparation for course and review of materials):</b> 76
	<b>Independent Study (preparation for assessment, incl. completion of assessment):</b> 4

<b>Recommended Reading List</b>	<ul style="list-style-type: none"> <li>• Wireless Networking, Understanding Internetworking Challenges, J. L. Burbank, J. Andrusenko, J.S. Everett, W.T.M. Kasch, Wiley, 2013.</li> <li>• Computer Networks and Systems: Queuing Theory and Performance Evaluation, 3<sup>rd</sup> edition, T.G. Robertazzi, Springer, 2000.</li> <li>• QOS-Enabled Networks: Tools and Foundations, 2<sup>nd</sup> edition, Miguel Barreiros, Peter Lundqvist, Wiley, 2016.</li> </ul>
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<sup>3</sup> [TEP Guidelines on Workload and Assessment](#)

	<ul style="list-style-type: none"> <li>Optical Networks: A Practical Perspective, 3<sup>rd</sup> Edition, R. Ramaswami, K. N. Sivarajan, G. H. Sasaki, Morgan Kaufmann, 2010</li> </ul>
<b>Module Pre-requisite</b>	<p><b>Prerequisite module:</b> EEU3C05 Telecommunications.</p> <p><b>Other/alternative non-module prerequisites:</b> General knowledge of networking protocols and transmission.</p>
<b>Module Co-requisite</b>	N/A
<b>Module Website</b>	Material available on black board
<b>Are other Schools/Departments involved in the delivery of this module? If yes, please provide details.</b>	School of Computer Science and Statistics: module is co-lectured by Prof Marco Ruffini.
<b>Module Approval Date</b>	
<b>Approved by</b>	
<b>Academic Start Year</b>	
<b>Academic Year of Date</b>	