

Module Code	CSU44031 / CS7NS3 / EEU44C04 / EEP55C27
Module Name	Next Generation Networks
ECTS Weighting¹	5 ECTS
Semester taught	Semester 1
Module Coordinator/s	Prof Marco Ruffini and Prof Nicola Marchetti
<u>Module Learning Outcomes</u>	<p>On successful completion of this module a student will be able to:</p> <ul style="list-style-type: none"> 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 in relation to UN SDG no. 7 Affordable and Clean Energy. 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.
Module Content	<p>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.</p> <p>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.</p> <p>The module also aims to highlight some of the relevant ongoing research and innovation in the space taking place within Ireland and internationally.</p> <p>Specific topics addressed in this module include:</p> <ol style="list-style-type: none"> 1. Optical Transmission systems <ul style="list-style-type: none"> a. Propagation in fibre, dispersion and nonlinearities b. Optical transmitters, modulation, direct detection and coherent receivers c. Link design, BER curves, optical amplification, OSNR, GOSNR, physical impairments and Margins, WDM and flexgrid

¹ [TEP Glossary](#)

- d. Machine learning use case: characterisation of optical components
2. Contemporary and emerging fixed telecommunication network architecture and systems:
 - a. Fixed telecom operator network architectures
 - b. Next generation fixed access network technologies (latest copper and fibre access technologies)
3. 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, 5G New Radio
 - c. Wireless local area networks: IEEE 802.11, small cell deployments, mmWave, Terahertz
4. Convergence of mobile and fixed architectures: backhaul, fronthaul, midhaul and protocol convergence
5. Multi-service networks and quality of service assurance
6. Quantum communications networks and protocols
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. Role of AI/ML in wireless networks
 - b. Internet of Things, Machine-type communication
 - c. Vehicular communications
 - d. Other trends in 6G: autonomous networks, integrated communications and sensing, intelligent reflectors, digital twin

Teaching and Learning Methods

Teaching and learning will be based on lectures and tutorials.

Assessment Details²

Assessment Component	Brief Description	Learning Outcomes Addressed	% of total	Week set	Week due
Examination	2 hour written examination	LO1, LO2, LO3, LO4, LO5, LO6, LO7	70%	n/a	n/a
In class quiz	Multiple choice quiz	LO1, LO2, LO3, LO4, LO5, LO6, LO7	15%	6	6

² [TEP Guidelines on Workload and Assessment](#)

In class quiz	Multiple choice quiz	LO1, LO2, LO3, LO4, LO5, LO6, LO7	15%	12	12
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Reassessment Details

Examination (2 hours, 100%)

Contact Hours and Indicative Student Workload

Contact Hours (scheduled hours per student over full module), broken down by:	33 hours
lecture	26 hours
tutorial or seminar	4 hours
Invited talks from industry	3 hours
other	0 hours
Independent study (outside scheduled contact hours), broken down by:	80 hours
preparation for classes and review of material (including preparation for examination, if applicable)	76 hours
completion of assessments (including examination, if applicable)	4 hours
Total Hours	113 hours

Recommended Reading List

- Wireless Networking, Understanding Internetworking Challenges, J. L. Burbank, J. Andrusenko, J.S. Everett, W.T.M. Kasch, Wiley, 2013.
- Computer Networks and Systems: Queuing Theory and Performance Evaluation, 3rd edition, T.G. Robertazzi, Springer, 2000.
- QOS-Enabled Networks: Tools and Foundations, 2nd edition, Miguel Barreiros, Peter Lundqvist, Wiley, 2016.
- Optical Networks: A Practical Perspective, 3rd Edition, R. Ramaswami, K. N. Sivarajan, G. H. Sasaki, Morgan Kaufmann, 2010

Module Pre-requisites

Other/alternative non-module prerequisites: General knowledge of networking protocols and transmission.

Module Co-requisites

N/A

Module Website

Material available on black board

Last Update

05/07/2024 by Nicola Marchetti