## Module Details

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| **Title:** | Network Stack Implementation PENDING APPROVAL |
| **Long Title:** | Network Stack Implementation |
| **Language of Instruction:** | English |

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| **Module Code:** | EE562 |

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| **Credits:** | 7.5 |

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| **NFQ Level:** | 9 |

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| **Field of Study:** | Electronic Engineering |

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| **Valid From:** | 2017/18 (Sep 2017) |

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| **Module Delivered In** | no programmes |

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| **Administrator:** | Noel Murphy |

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| **Module Coordinator:** | Martin Collier |

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| **Module Department:** | 20 - ELECTRONIC ENGINEERING |

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| **Module Description:** | The aim of the module is to introduce students to the software embedded in network devices such as routers to implement network protocols. Where possible, open source implementations of protocols used in live networks will be studied. Both the data plane and the control plane will be studied, including data-link layer protocols, network layer protocols and transport layer protocols. Optimisation techniques, hardware acceleration and other approaches to achieving "wire speed" operation will be investigated. Protocols appropriate to the Internet of Things, to data centres, and to the future Internet will be considered. |

| Learning Outcomes | |
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| *On successful completion of this module the learner will be able to:* | |
| LO1 | to classify network functionality as belonging to the control plane and the data plane respectively |
| LO2 | explain how a typical operating system processes packets from arrival from an interface card to forwarding to user space |
| LO3 | describe the principles involved in implementing a network stack in software |
| LO4 | decompose the software of "middleboxes" such as network routers into a software architecture |
| LO5 | evaluate the trade-offs involved in hardware versus software implementation of packet processing functions |
| LO6 | demonstrate advanced theoretical knowledge of networking |
| LO7 | add functionality to an open-source network stack |
| LO8 | adapt existing software to meet new networking requirements |

| Pre-requisite learning |
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| ***Module Recommendations*** <br> *This is prior learning (or a practical skill) that is mandatory before enrolment in this module is allowed. You may not enrol on this module if you have not acquired the learning specified in this section.* |
| No recommendations listed |
| ***Co-requisite Modules*** |
| No Co-requisite modules listed |
| ***Pre-Requisite*** <br> *This is prior learning (or a practical skill) that is mandatory before enrolment in this module is allowed. You may not enrol on this module if you have not acquired the learning specified in this section.* |
| Knowledge of a procedural or object-oriented programming language. Knowledge of the basic principles of packet switching. |

## Module Content & Assessment

| Indicative Content and Learning Activities |
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| **Low Level Issues**<br>Bridging overview, Ethernet, 6LoWPAN, Wi-fi, Data rates, hardware vs. software Router architecture, network device drivers, buffer management. |
| **Network Layer**<br>route pinning and datagram routing IPv4, IPv6, firewalling and NAT. |
| **Transport Layer**<br>Review of sockets, TCP protocol description Implementation of TCP Multi-homing, multi-path, congestion |
| **Control Plane**<br>Control Plane vs. Data Plane Internet routing protocols (RIP, OSPF, BGP). Router configuration and network administration. Why is signalling needed? End-to-end signalling SDN and OpenFlow QoS and resource reservation |
| **Advanced Packet Forwarding**<br>Deep packet probes, policy-based routing, Hardware acceleration, network processors |

| Assessment Breakdown | % |
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| Continuous Assessment | 25.00% |
| End of Academic Session | 75.00% |

**Continuous Assessment**

| Assessment Type | Assessment Description | Outcome Addressed | % of total | Assessment Date |
|---|---|---|---|---|
| Research Paper | An evaluation of one or more aspects of network stack implementation in the format of a research paper. | 3,4,5,6,7,8 | 25.00 | Once per semester |

**End of Module Formal Examination**

| Assessment Type | Assessment Description | Outcome Addressed | % of total | Assessment Date |
|---|---|---|---|---|
| Formal Examination | End-of-Semester Final Examination | 1,2,3,4,5,6,7,8 | 75.00 | End-of-Semester |

**Reassessment Pre-Requisite**

**Repeat examination**
*Reassessment of this module will consist of a repeat examination. It is possible that there will also be a requirement to be reassessed in a coursework element.*

**DCU reserves the right to alter the nature and timings of assessment**

## Module Workload

| Full Time hours per semester | | |
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| *WorkLoad Type* | *WorkLoad Description* | *Hours* |
| Lecture | No Description | 36 |
| Assignment Completion | No Description | 44 |
| Independent Study | No Description | 108 |
| | Total Hours | 188.00 |

**This module has no Part Time workload.**

## Module Resources

*Essential Book Resources*

**Christian Benvenuti 2006,** *Understanding Linux Network Internals*, **1st ed. Ed., O'Reilly Media, Inc. [ISBN: 0596002556]**

**Rami Rosen 2014,** *Linux Kernel Networking: Implementation and Theory*, **1st ed. Ed. [ISBN: 9781430261964]**

*This module does not have any article/paper resources*

*Other Resources*

**Blog entry:** *No Title*
http://www.tune2wizard.com/kernel-progra mming-network-programming/

**Blog entry:** *No Title*
https://www.privateinternetaccess.com/bl og/2016/01/linux-networking-stack-from-t he-ground-up-part-1/

**Blog entry:** *No Title*
https://blog.packagecloud.io/eng/2016/06 /22/monitoring-tuning-linux-networking-s tack-receiving-data/

**Blog entry:** *No Title*
http://www.cubrid.org/blog/dev-platform/ understanding-tcp-ip-network-stack/

**Article: Dan Siemon 2013,** *Queueing in the Linux Network Stack*
https://www.coverfire.com/articles/queue ing-in-the-linux-network-stack/

**Article: Arnout Vandecappelle** *Kernel Flow*, **The Linux Foundation**
https://wiki.linuxfoundation.org/network ing/kernel_flow

**Slide Show: Thomas Graf** *Kernel Networking Walkthrough*, **Red Hat**
http://www.slideshare.net/ThomasGraf5/de vconf-2014-kernel-networking-walkthrough

**Blog Entry: 2011** *How to Write a Linux Firewall in Less than 1000 Lines of Code*
http://www.roman10.net/2011/07/23/a-linu x-firewall-using-netfilter-part-1overvie w/

## Module Managers & Teachers

### Module Managers

| Semester | Staff Member | Staff Number |
|---|---|---|
| Semester 1 | Gabriel-Miro Muntean | 80020216 |
| Semester 2 | Gabriel-Miro Muntean | 80020216 |
| Autumn | Martin Collier | 75008157 |

### Module Teachers

| Staff Member | Staff Email |
|---|---|
| Gabriel-Miro Muntean | gabriel.muntean@dcu.ie |
| Martin Collier | Martin.Collier@dcu.ie |