



Title:	Software-Defined Networking APPROVED	
Long Title:	Software-Defined Networking	
Module Code:	COMP8052	
Duration:	1 Semester	
Credits:	5	
NFQ Level:	Advanced	
Field of Study:	Computer Science	
Valid From:	Semester 1 - 2017/18 (September 2017)	
Module Delivered in	2 programme(s)	
Module Coordinator:	Sean McSweeney	
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Module Description:	Software Defined Networking (SDN) is emerging as a key technology to deal with the ever increasing network management burden created by our interconnected world. It does this by separating the data and control functions of network devices through well defined Application Programming Interfaces (APIs). The purpose of this module is to provide students will the knowledge to understand the evolution of SDN, its concepts, and skills to create and configure a SDN network.	
Learning Outcomes		
<i>On successful completion of this module the learner will be able to:</i>		
LO1	Examine the challenges and opportunities associated with adopting SDN compared to traditional approaches to networking.	
LO2	Analyse the functions and components of the SDN architecture.	
LO3	Discuss the major requirements of the design of an SDN protocol.	
LO4	Design and create an SDN network consisting of SDN switches and a centralised controller.	
LO5	Analyse the performance of the SDN network by using verification and troubleshooting techniques.	
Pre-requisite learning		
Module Recommendations		
<i>This is prior learning (or a practical skill) that is strongly recommended before enrolment in this module. You may enrol in this module if you have not acquired the recommended learning but you will have considerable difficulty in passing (i.e. achieving the learning outcomes of) the module. While the prior learning is expressed as named CIT module(s) it also allows for learning (in another module or modules) which is equivalent to the learning specified in the named module(s).</i>		
12702	COMP6027	Networking Fundamentals
12787	COMP7032	Routing and Switching Concepts
Incompatible Modules		
<i>These are modules which have learning outcomes that are too similar to the learning outcomes of this module. You may not earn additional credit for the same learning and therefore you may not enrol in this module if you have successfully completed any modules in the incompatible list.</i>		
No incompatible modules listed		
Co-requisite Modules		
No Co-requisite modules listed		
Requirements		
<i>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.</i>		
No requirements listed		

Module Content & Assessment

Indicative Content

SDN Introduction

Challenges and opportunities. VLANs, Overlay networking, active network, SDN. Other related technologies - FORCES, RCP, Ethane, P4. SDN application areas - network virtualisation, performance, scalability and multi-tenancy. Service and network management.

SDN Architecture

Network Operating System (NOS). SDN Architecture. Planes - data, management and control. Interfaces - northbound and southbound.

SDN Protocols

SDN Protocol specifications: Border Gateway Protocol (BGP); Cisco Application Centric Infrastructure (ACI); OpenFlow. OpenFlow versions. Components of an OpenFlow Switch. Flow and group tables. Rule matching. Action handling. Table misses. Counters, metering and metadata.

SDN vSwitch and Controllers

Languages and functions available for programming SDNs, northbound API. Mininet. Software vs. Hardware SDN switch implementations - Open vSwitch, WhiteBox, ONL. Controller implementations - POX, NOX, Beacon, Floodlight. Special Purpose controllers - Flowvisor, RouteFlow.

Verification and Troubleshooting

Header space analysis, Veriflow, Kinetic.

Present and Future of SDN

Commercial implementations, research directions. SDN in wired and wireless networks. Security challenges.

Assessment Breakdown

	%
Course Work	50.00%
End of Module Formal Examination	50.00%

Course Work

Assessment Type	Assessment Description	Outcome addressed	% of total	Assessment Date
Project	Design and create a simple SDN network with a controller and a switch.	4,5	15.0	Week 8
Project	Design, create and debug an SDN network consisting of multiple network elements (SDN switches and controller).	4,5	35.0	Week 13

End of Module Formal Examination

Assessment Type	Assessment Description	Outcome addressed	% of total	Assessment Date
Formal Exam	End of Semester Formal Examination.	1,2,3,4	50.0	End-of-Semester

Reassessment Requirement

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.

The institute reserves the right to alter the nature and timings of assessment

Module Workload

Workload: Full Time				
<i>Workload Type</i>	<i>Workload Description</i>	<i>Hours</i>	<i>Frequency</i>	<i>Average Weekly Learner Workload</i>
Lecture	Theoretical treatment of relevant topics.	2.0	Every Week	2.00
Lab	Lab-based practical work.	2.0	Every Week	2.00
Independent & Directed Learning (Non-contact)	Study, project work, extra reading	3.0	Every Week	3.00
Total Hours				7.00
Total Weekly Learner Workload				7.00
Total Weekly Contact Hours				4.00

Workload: Part Time				
<i>Workload Type</i>	<i>Workload Description</i>	<i>Hours</i>	<i>Frequency</i>	<i>Average Weekly Learner Workload</i>
Lecture	Theoretical treatment of relevant topics.	2.0	Every Week	2.00
Lab	Lab-based practical work.	2.0	Every Week	2.00
Independent & Directed Learning (Non-contact)	Study, project work, extra reading.	3.0	Every Week	3.00
Total Hours				7.00
Total Weekly Learner Workload				7.00
Total Weekly Contact Hours				4.00

Module Resources

Recommended Book Resources

- Goransson, P; Black, C. 2014, *Software Defined Networks: A Comprehensive Approach*, 1st Ed. Ed., Morgan Kaufmann [ISBN: 9780124166752]

Supplementary Book Resources

- Nadeau, T. D., Gray, K. 2013, *SDN: Software Defined Networks*, 1st Ed., O'Reilly Media [ISBN: 9781449342302]
- William Stallings 2015, *Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud*, Addison-Wesley Professional [ISBN: 9780134175393]

Recommended Article/Paper Resources

- N. McKeown, T. Anderson, H. Balakrishnan et al. 2008, *OpenFlow: enabling innovation in campus networks*, ACM SIGCOMM Computer Communication Review, Volume 38 Issue 2
- Open Networking Foundation 2015, *TR-518 Relationship of SDN and NFV*
- Sherwood, R., Gibb, G., Yap, K. K., Appenzeller, G., Casado, M., McKeown, N., & Parulkar, G 2009, *Flowvisor: A network virtualization layer.*, OpenFlow Switch Consortium, Tech Report, 1
- Feamster, N., Rexford, J., & Zegura, E 2013, *The road to SDN*, Queue, 11(12)
- Stallings, W. 2013, *Software-defined networks and openflow*, The internet protocol Journal, 16(1), 2
- Chowdhury, N. M., Boutaba, R 2009, *Network virtualization: state of the art and research challenges*, IEEE Communications Magazine, 47(7)

Other Resources

- Website: *Open Networking Foundation*
<http://opennetworking.org>
- Website: *Project Floodlight*
<http://www.projectfloodlight.org/floodlight/>
- Website: *OpenDaylight*
<https://www.opendaylight.org/>
- Website: *Mininet - An Instant Virtual Network on your laptop*
<http://mininet.org/>

Module Delivered in

Programme Code	Programme	Semester	Delivery
CR_KDNET_8	<u>Bachelor of Science (Honours) in Computer Systems</u>	7	Mandatory
CR_KITMN_8	<u>Bachelor of Science (Honours) in IT Management</u>	7	Elective