

University of Twente B.Sc. Computer Science

Module 1.3: Network Systems

Design of a 15 ECTS Introductory Networking Module for the new Computer Science Bachelor Curriculum, Elective / Option for Electrical Engineering (1 out of 2), others.

History:

Version 0.1, 30/01/2012 (initial version by G. Heijnen)
Version 0.2, 21/02/2012 (small improvements G. Heijnen)
Version 0.3, 21/02/2012 (after discussion with P.T. de Boer & A. Pras)
Version 0.4, 29/02/2012 (with input Paul Havinga, Nirvana Meratnia & Hans Scholten)
Version 0.5, 09/03/2012 (after meeting P. Havinga, N. Meratnia, P.T. de Boer, G. Heijnen)
Version 0.6, 24/04/2012 (after meeting P. Havinga, B. Molenkamp, G. Smit, , A. Pras)
Version 0.7, 08/01/2013 (after first series of meeting of design team: P.T. de Boer, N. Meratnia, G. Heijnen)
Version 0.8, 12/05/2013 (update for OLC: G. Heijnen)
Version 0.9, 14/05/2013 (version for OLC: P.T. de Boer, N. Meratnia, G. Heijnen)

Introduction:

The module Network Systems focuses on computer networking for open infrastructures, such as the Internet and GSM/UMTS, as well as embedded networks, such as sensor, in-car and home-automation networks. Such networks are typically designed using a layered architecture of protocols. This course covers all layers of this architecture: physical (e.g., Shannon limit, error correction, propagation), link (e.g., medium access control, retransmission schemes, switching), network (e.g., routing, addressing, router architecture), transport (e.g., congestion control, flow control), and application (email, web, peer2peer, web) layer. It covers both basic principles of communication systems, networks, and networked applications, as well as the operation of key protocols underlying the operation of the Internet. (e.g., Ethernet, IP, TCP, DNS). Furthermore, fundamentals of reliable protocol design are introduced in this module, including protocol design and implementation, network monitoring and measurement, and performance modeling and evaluation.

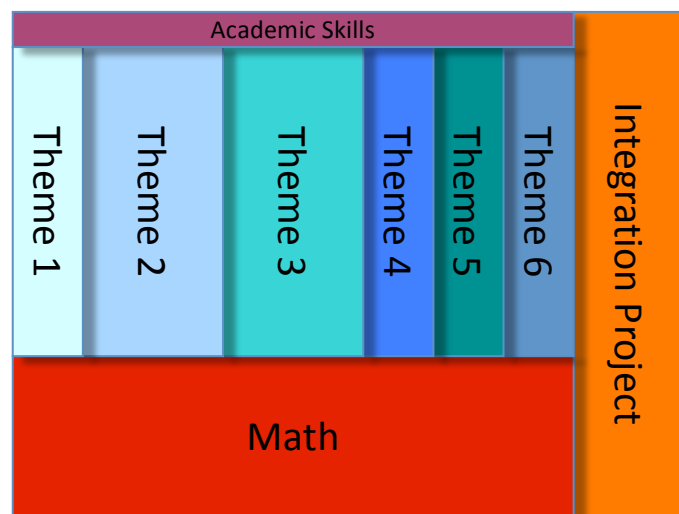
Objectives / Learning goals:

After following this course students should be able to:

- 1) understand **basic principles** in communication systems, networks, and networked applications
- 2) describe and understand **key protocols** underlying the operation of the Internet
- 3) make **simple quantitative models** of network systems, and use them to evaluate these systems
- 4) be able to analyze the behavior of common networking systems using **network monitoring** tools
- 5) be able to **design and implement** basic networking protocols and applications

Structure / Organization:

As much as possible, the module will have a simple, recurring structure. The figure below gives the basic overview of the course:



The main parts of the module are as follows:

- Math (3 ECTS): Linear Algebra. This education will be organized at overall UT-level.
- Academic Skills ($\frac{1}{2}$ ECTS): Presenting and Reporting
- Network Systems in 6 themes (9 ECTS)
- Integration Project ($2\frac{1}{2}$ ECTS)

Network Systems Themes will be taught for 1 or 2 (theme 2 & 3) weeks. For each theme, the following types of activity are foreseen:

- Observation:
 - o students will explore the operation of existing network systems, e.g., using Wireshark
 - o students will be inspired to learn the underlying mechanisms of network systems
- “Colstructie” (mix of Lecture (“Hoorcollege”) & Tutorial (“Werkcollege”)):
 - o students will learn to understand basic principles
 - o students will learn how real networks (the Internet, sensor networks) are working
- Challenge:
 - o students will be challenged to solve a networking problem, which may involve analyzing, reasoning, design, and implementation, as well as a competition element.
 - o students will be motivated / forced to understand underlying concepts and their practical implications.
- Tutorial (“Werkcollege”):
 - o students will learn how to model networks, and how to evaluate network designs using these models
 - o students will interpret results from observation and challenge
- Self Study:
 - o students will prepare for other activities
 - o students will study theory

In the Integration Project

- o students will design and implement a small networked system
- o students will integrate and apply knowledge obtained in this course and develop a system wide view on networking.

Material:

The following material will be used in the module. Some of the information will be made available electronically:

Network systems in 6 themes:

- Computer Networks – a systems approach, Larry L. Peterson and Bruce S. Davie, Morgan Kaufmann, 5th edition, international student edition, ISBN 978-0-12-385138-3, 2012
- Reader
- Observation lab manual
- Challenge manual
- Exercises

Academic Skills: see description of academic skills description

(proposed book is: Skill Sheets – an integrated approach to research, study and management, Rob van Tulder, Pearson, ISBN 978-90-430-2313-9

Math: see math description

Network Systems in 6 themes:

The following themes constitute the body of knowledge of the Network Systems Module:

Theme 1 (1 week): **Introduction and Applications**

Topics addressed: structure and scale of the Internet, layered architectures, packets, multiplexing, packet switching vs circuit switching, sockets, web-technology, email, real-time applications and protocols.

Classes: 2h obs, 6h colstr, 2h wc, 8h chall

Theory: P&D (Peterson & Davie) Chapter 1 (excl 1.4)
P&D Section 9.1 & 9.2
reader: web-services

Theme 2 (2 weeks): **Transferring Packets over a Link**

Topics addressed: media (optical, wireless, etc.) waves, frequencies, modulation, framing, encoding, random access, polling, carrier sense, collision detection, (slotted) Aloha, Ethernet, wireless LAN, cellular networks, information theory and channel capacity, sources of errors and losses, coding, error detection and – correction, reliable data transfer (ARQ)

Classes: 2h obs, 8h colstr, 4h wc, 16h challenge

Theory: P&D Chapter 2
reader: information theory, error correction, media, Aloha, polling

Theme 3 (2 weeks): **Internetworking**

Topics addressed: datagram vs. virtual circuit networks, ARP, DNS, hierarchical addressing, CIDR, host-density ratio, network layer mobility, IPv4, IPv6, DHCP, ICMP, link state routing, distance vector routing, self-learning switches, spanning tree, broadcast, multicast, BGP, OSPF, ad-hoc networks, AODV, router architecture

Classes: 4h obs, 8h colstr, 4h wc, 16h challenge

Theory: P&D Chapter 3
P&D Chapter 4 (excl. 4.3)
P&D Section 9.3
reader: host-density ratio, AODV

Theme 4 (1 week): **End-to-End Protocols**

Topics addressed: multiplexing, reliable data transfer, sliding window, TCP, UDP

Classes: 2h obs, 2h colstr, 2h wc, 8h challenge

Theory: P&D Chapter 5 (excl. 5.4 & 5.4)

Theme 5 (1 week): **Congestion Control & Resource Allocation**

Topics addressed: scheduling, queueing, queueing delays, flow control, congestion control, TCP congestion control

Classes: 2h obs, 4h colstr, 4h wc

Theory: P&D Chapter 6 (excl. 6.5.2)

Theme 6 (1 week): **System-wide aspects**

Topics addressed: network security, synchronization, localization, discovery protocols and mechanisms, p2p, routing overlays, content distribution networks

Classes: 6h colstr, 4h wc, 8h chall

Theory: P&D Chapter 8 (selection?)
P&D Section 9.4
reader: synchronization, localization, discovery

Testing

Math will be tested in week 3 and week 7, with the option of a retake in week 10. All material of Network Systems in 6 themes (including book, reader, colstr., werkcollege, observation, and challenge material) and will be tested in four written exams in week 2, 4, 6, and 8, with the option of a retake of one of the exams in week 10. The integration project will also be graded; no retake is possible, but insufficient performance will be notified before finishing, and some extra time is available in week 10 to increase performance. Results from challenges and exercises for werkcollege and observation will be checked, and if insufficient, have to be supplemented within a week. Furthermore, the results from the challenges are also taken into account for the final grade.

Composition of the final grade is done as follows. How subgrades are composed out of different parts is still to be determined.

Subgrade	Percentage of final grade	Minimum
Math	20 %	4.5
Observation	0 %	5.5
Werkcolleges	0 %	5.5
Challenges	15 %	5.5
NS in 6 themes (tests)	50 %	5.5
Integration Project	15 %	4.5

Schedule

Network Systems

14 - 05 - 2013

EC : 12
 Studiejaar : 2013 - 2014
 Opleidingsjaar : B1
 Blok : 2A

Wiskunde:(2e werkcollege van do naar vr.)

- verplicht tijdstip
- keuze tijdstip
- diagnostische toets met feedback
- schriftelijke toets (deelcijfer)

weeknr	uren	46 (1)	47 (2)	48 (3)	49 (4)	50 (5)	51 (6)	2 (7)	3 (8)	4 (9)	5 (10)
MAANDAG	1										
	2	colstr	D- Toets	D- Toets	ZS	S- Toets	D- Toets	D- Toets	ZS	P	ZS
	3	obs	HC	HC		HC	HC	HC	colstr	P	toets
	4	obs									
	5										
	6	obs	ZS	obs	obs	obs	obs	ZS	ZS	P	P
	7										
	8	colstr	colstr	colstr	colstr	colstr	colstr	colstr	colstr	P	P
	9										

DINSDAG	1	ac.va.	ac.va.	ac.va.	ac.va.	ac.va.	ac.va.	ac.va.	ac.va.	P	P
	2										
	3	ZS	ZS	ZS	ZS	ZS	ZS	ZS	ZS	P	P
	4										
	5										
	6										
	7	wc	wc	wc	wc	wc	wc	wc	wc	P	P
	8										
	9	ZS	ZS	ZS	ZS	ZS	ZS	ZS	ZS	P	P

WOENSDAG	1	Begleide	BZS	BZS	CASE	BZS	BZS	BZS	ZS	P	P
	2	Zelfstudie									
	3	Werk	WC	WC	CASE	WC	WC	WC	wc	P	P
	4	College									
	5										
	6	colstr	colstr	colstr	colstr	colstr	colstr	colstr	colstr	P	ZS
	7										
	8	ZS	ZS	ZS	ZS	ZS	ZS	ZS	ZS	P	toets
	9										(herkans)

DONDERDAG	1	chall	chall	chall	chall	chall	chall	ZS	chall	P	repair
	2										
	3	chall	chall	chall	chall	chall	chall	wc	chall	P	repair
	4										
	5										
	6	chall	chall	chall	chall	chall	chall	obs	chall	P	repair
	7										
	8	chall	chall	chall	chall	chall	chall	ZS	chall	P	repair
	9										

VRIJDAG	1	ZS	ZS	ZS	ZS	ZS	ZS	ZS	ZS	P	Goede
	2										
	3	WC	WC	WC	ZS	WC	WC	WC	ZS	P	Vrijdag
	4										
	5										
	6	ZS	ZS	ZS	ZS	ZS	ZS	ZS	ZS	P	
	7										
	8	ZS	test	S- Toets	test	ZS	test	S- Toets	test	P	
	9										

Uren:	HC	WC/CASE (B)ZS	D-Toets + fb	S-Toets + zs	Totaal	%
	2	4	0	0	12	14
	2	4	2	0	26	31
	2	4	2	0	28	33
	0	2	2	0	8	10
	0	0	4	0	12	14
Totaal:	10	12	16	4	86	102

ac.va.	2	2	2	2	2	2	2	2	2	16	ac.va.	
Intro & Applications	28									28	Intro & Applications	
Transferring packets		24	22							46	Transferring packets	
Internetworking				32	26					58	Internetworking	
end-to-end protocols						22				22	end-to-end protocols	
resource control							22			22	resource control	
system-wide aspects								36		36	system-wide aspects	
toets		2		2				2		4	test	
integration project						2			40	16	58	integration project
Totaal	40	40	40	40	40	40	40	40	40	24	384	Totaal

afkorting	betekenis	benodigde zaalruimte
colstr:	colstructie	zaal voor alle studenten met losse tafels (werkcollegeopstelling)
obs:	observatie	labzaal voor alle studenten
wc:	werkcollege	werkcollegezalen met max. 30 studenten per zaal
chall:	challenge	labzaal voor alle studenten
ac.va.	academische vaardigheden	zaal voor alle studenten met losse tafels (werkcollegeopstelling)
toets	toets	extra grote zaal: tentamenopstelling
P	integratie project	labzaal voor alle studenten
ZS	zelfstudie	hoef niet verroosterd te worden