

Computer Networks and Distributed Systems

Programme course

8 credits

Datornät och distribuerade system

TDTS04

Valid from: 2018 Spring semester

Determined by

Board of Studies for Computer Science and
Media Technology

Date determined

Main field of study

Computer Science and Engineering, Programming

Course level

First cycle

Advancement level

G2X

Course offered for

- Programming, Bachelor's Programme
- Computer Engineering, B Sc in Engineering
- Industrial Engineering and Management - International, M Sc in Engineering
- Industrial Engineering and Management, M Sc in Engineering

Entry requirements

Note: Admission requirements for non-programme students usually also include admission requirements for the programme and threshold requirements for progression within the programme, or corresponding.

Prerequisites

Knowledge of C, C++ or Java are required in order to be able to manage the laborations in the course. The student is also assumed to know how to construct and test programs in a Unix/Solaris environment.

Intended learning outcomes

Computer networks are playing an increasingly important role in the society. It is predicted that there will be 50 billion devices connected to the Internet by 2020. With an enormous increase in the number of wired and wireless devices connected through the Internet, as well as improved network bandwidth and computer capabilities, we are moving towards a society in which users expect to access anything they want, whenever and wherever they are. To enable this trend and all the emerging services provided over

the Internet (e.g., social networks, video streaming, and the Internet of things) it is therefore critical for today's computer science students to have a good understanding for computer networks.

TDTS04 is a basic course in computer networks and distributed systems. The course covers the basics for how a network and its applications operate; what a protocol is; how they work, and what the most important applications of the Internet are. It also covers the fundamentals of distributed systems, and some of the design tradeoffs that these systems commonly must take into consideration. In the labs you will learn more about the mechanisms in some important and fundamental Internet protocols and some basic programming of distributed systems. The final exam will test your understanding and knowledge of the subject. After the course, you are expected to be able to:

- Explain, describe, and analyze a typical network architecture, including the importance of network layers and encapsulation
- Explain the different basic types of protocols, communication channels, and network types

You should have a deep understanding of the network architecture and the protocols associated with the different layers:

- Describe and analyze the most common application architectures in the Internet, how the most important application-layer protocols work and the service they provide
- Analyze and explain important design considerations at the transport layer, including describing how TCP's flow control and congestion control works, and how reliable data transfer is implemented in TCP
- Motivate and explain how routing and forwarding is implemented on the Internet, including describing how IP addressing and fragmentation works
- Describe and explain different link-layer technologies and how they work

You are also expected to understand how distributed systems can be built on-top of the network architecture. More specifically, you should be able to:

- Define what a distributed system is and its most important goals
- Explain the relationship between architectures, processes and communication
- Exemplify different types of transparency, scaling techniques
- Analyze and explain some of the fundamental differences in different system architectures
- Describe and explain how to achieve synchronization, consistency and replication
- Implement, motivate, and explain the design of various types of distributed system architectures, including object-based distributed systems (e.g., using Java RMI), MapReduce, and Web-based distributed systems (including how a proxy cache works)

Course content

Basics for distributed systems, definitions, transparency, scaling, architectures, execution techniques for remote procedure calls (rpc and port mapping), and socket-based communication between processes. Pitfalls when implementing distributed systems. Object-based distributed systems (Corba and Java RMI) and web-based distributed systems (HTTP and web services). Communication and process models, naming, synchronization, consistency, caching, replication, and fault tolerance. UTC, NTP. Lamport and vector clocks. Mutual exclusion. Application architectures: client-server (centralized, decentralized/p2p, multi-tiered) and hybrid, exemplified with HTTP, e-mail, file transfer, DNS, Bittorrent, and Skype. CDN and Akamai. Protocol terminology. Protocol layer concept. Reference models for network architectures. System architectures. Application areas for computer networks and distributed systems and examples of commercial network services. Network types, their characteristics and components (router, switch, hub, repeater). Protocol mechanisms and channels. Access network techniques. Different types of MAC protocols. The collision domain concept. The sliding window protocol. Error detection. Local area networks (IEEE 802.3). Wireless networks (Bluetooth, WiFi, WiMax). Extending LANs. Internet and standardization. The TCP/IP protocol family. Distance vector and link-state routing. ICMP. ARP. NAT. DHCP. Naming, addressing and routing in the Internet. TCP's retransmission timer, flow control and congestion control. Reliable data delivery in TCP. Three-way handshake. Network performance issues. Internet applications (the domain name system, e-mail, file transfer, the web, and network mangement). IP telephony. P2P networks. The DHT data structure. Internet history. Internet design principles. Lan background. Trends.

Teaching and working methods

The course consists of lectures and laborations.

Examination

TEN1	Written examination	U, 3, 4, 5	5 credits
LAB1	Laboratory work	U, G	3 credits

Grades

Four-grade scale, LiU, U, 3, 4, 5

Other information

Supplementary courses:
Advanced Networking, System installation.

Department

Institutionen för datavetenskap

Director of Studies or equivalent

Patrick Lambrix

Examiner

Andrei Gurtov

Course website and other links

<http://www.ida.liu.se/~TDTS04/>

Education components

Preliminary scheduled hours: 54 h

Recommended self-study hours: 159 h

Course literature

Huvudbok: Kurose, J. F. & Ross, K. W. (2017), Computer networking: a top-down approach. Seventh Edition. Pearson.

Common rules

Course syllabus

A syllabus has been established for each course. The syllabus specifies the aim and contents of the course, and the prior knowledge that a student must have in order to be able to benefit from the course.

Timetabling

Courses are timetabled after a decision has been made for this course concerning its assignment to a timetable module. A central timetable is not drawn up for courses with fewer than five participants. Most project courses do not have a central timetable.

Interrupting a course

The vice-chancellor's decision concerning regulations for registration, deregistration and reporting results (Dnr LiU-2015-01241) states that interruptions in study are to be recorded in Ladok. Thus, all students who do not participate in a course for which they have registered must record the interruption, such that the registration on the course can be removed. Deregistration from a course is carried out using a web-based form: www.lith.liu.se/for-studenter/kurskomplettering?f=sv.

Cancelled courses

Courses with few participants (fewer than 10) may be cancelled or organised in a manner that differs from that stated in the course syllabus. The board of studies is to deliberate and decide whether a course is to be cancelled or changed from the course syllabus.

Regulations relating to examinations and examiners

Details are given in a decision in the university's rule book:
<http://styrdokument.liu.se/Regelsamling/VisaBeslut/622678>.

Forms of examination

Examination

Written and oral examinations are held at least three times a year: once immediately after the end of the course, once in August, and once (usually) in one of the re-examination periods. Examinations held at other times are to follow a decision of the board of studies.

Principles for examination scheduling for courses that follow the study periods:

- courses given in VT1 are examined for the first time in March, with re-examination in June and August
- courses given in VT2 are examined for the first time in May, with re-examination in August and October
- courses given in HT1 are examined for the first time in October, with re-examination in January and August
- courses given in HT2 are examined for the first time in January, with re-examination at Easter and in August.

The examination schedule is based on the structure of timetable modules, but there may be deviations from this, mainly in the case of courses that are studied and examined for several programmes and in lower grades (i.e. 1 and 2).

- Examinations for courses that the board of studies has decided are to be held in alternate years are held only three times during the year in which the course is given.
- Examinations for courses that are cancelled or rescheduled such that they are not given in one or several years are held three times during the year that immediately follows the course, with examination scheduling that corresponds to the scheduling that was in force before the course was cancelled or rescheduled.
- If teaching is no longer given for a course, three examination occurrences are held during the immediately subsequent year, while examinations are at the same time held for any replacement course that is given, or alternatively in association with other re-examination opportunities. Furthermore, an examination is held on one further occasion during the next subsequent year, unless the board of studies determines otherwise.
- If a course is given during several periods of the year (for programmes, or on

different occasions for different programmes) the board or boards of studies determine together the scheduling and frequency of re-examination occasions.

Registration for examination

In order to take an examination, a student must register in advance at the Student Portal during the registration period, which opens 30 days before the date of the examination and closes 10 days before it. Candidates are informed of the location of the examination by email, four days in advance. Students who have not registered for an examination run the risk of being refused admittance to the examination, if space is not available.

Symbols used in the examination registration system:

** denotes that the examination is being given for the penultimate time.

* denotes that the examination is being given for the last time.

Code of conduct for students during examinations

Details are given in a decision in the university's rule book:
<http://styrdokument.liu.se/Regelsamling/VisaBeslut/622682>.

Retakes for higher grade

Students at the Institute of Technology at LiU have the right to retake written examinations and computer-based examinations in an attempt to achieve a higher grade. This is valid for all examination components with code "TEN" and "DAT". The same right may not be exercised for other examination components, unless otherwise specified in the course syllabus.

Retakes of other forms of examination

Regulations concerning retakes of other forms of examination than written examinations and computer-based examinations are given in the LiU regulations for examinations and examiners,
<http://styrdokument.liu.se/Regelsamling/VisaBeslut/622678>.

Plagiarism

For examinations that involve the writing of reports, in cases in which it can be assumed that the student has had access to other sources (such as during project work, writing essays, etc.), the material submitted must be prepared in accordance with principles for acceptable practice when referring to sources (references or quotations for which the source is specified) when the text, images, ideas, data, etc. of other people are used. It is also to be made clear whether the author has reused his or her own text, images, ideas, data, etc. from previous examinations.

A failure to specify such sources may be regarded as attempted deception during examination.

Attempts to cheat

In the event of a suspected attempt by a student to cheat during an examination, or when study performance is to be assessed as specified in Chapter 10 of the Higher Education Ordinance, the examiner is to report this to the disciplinary board of the university. Possible consequences for the student are suspension from study and a formal warning. More information is available at <https://www.student.liu.se/studenttjanster/lagar-regler-rattigheter?l=sv>.

Grades

The grades that are preferably to be used are Fail (U), Pass (3), Pass not without distinction (4) and Pass with distinction (5). Courses under the auspices of the faculty board of the Faculty of Science and Engineering (Institute of Technology) are to be given special attention in this regard.

1. Grades U, 3, 4, 5 are to be awarded for courses that have written examinations.
2. Grades Fail (U) and Pass (G) may be awarded for courses with a large degree of practical components such as laboratory work, project work and group work.

Examination components

1. Grades U, 3, 4, 5 are to be awarded for written examinations (TEN).
2. Grades Fail (U) and Pass (G) are to be used for undergraduate projects and other independent work.
3. Examination components for which the grades Fail (U) and Pass (G) may be awarded are laboratory work (LAB), project work (PRA), preparatory

written examination (KTR), oral examination (MUN), computer-based examination (DAT), home assignment (HEM), and assignment (UPG).

4. Students receive grades either Fail (U) or Pass (G) for other examination components in which the examination criteria are satisfied principally through active attendance such as other examination (ANN), tutorial group (BAS) or examination item (MOM).

The examination results for a student are reported at the relevant department.

Regulations (apply to LiU in its entirety)

The university is a government agency whose operations are regulated by legislation and ordinances, which include the Higher Education Act and the Higher Education Ordinance. In addition to legislation and ordinances, operations are subject to several policy documents. The Linköping University rule book collects currently valid decisions of a regulatory nature taken by the university board, the vice-chancellor and faculty/department boards.

LiU's rule book for education at first-cycle and second-cycle levels is available at http://styrdokument.liu.se/Regelsamling/Innehall/Utbildning_pa_grund-_och_avancerad_niva.