

Storskaliga Distribuerade System och Nätverk (Large-scale Distributed Systems and Networks)

Slides by Niklas Carlsson

Systems thinking

- We want to understand the full system and the ecosystem it operates within; e.g.,
 - Understanding the full system
 - Looking at the parts and how they interact
- This course provide many examples ...





Components, overall system, service(s)

- Components together provide some service(s)
 - Typically want good overall performance
- Data storage and processing often distributed
 - Data/information stored and moving between components
 - Processing in different components
- How do we best design, utilize, and run systems?





Embedded Systems Game machine Camera Electronic book. Tablet We find microprocessors Smart phone everywhere ... Embedded Mobile phones Car Printer Digital signage Amusement machines

Television

Industry, Airlines,

 Broadcasting, Medical

Space





-1





... looking towards the future ...



NEW DEVICES AND NEW INDUSTRIES BRING NEW BUSINESS OPPORTUNITIES



New telecom cycle: 10x devices, 10x industries

Trends and visions

- Everything that can be connected will be connected
 - 50B devices (perhaps more like 500B ...)
- IoT and smart cities
 - Machine-to-machine
- High-definition 3D streaming/games to heterogeneous clients



Personalized service and personal footprints in a connected world ...



Scalability

- Typically want solutions that "scales"
 - Ability of a system, network, or process to handle a growing amount of work effectively
 - Capability to increase its total output under an increased load when resources are added
- Typically want the costs or resource capacity needed to scale sub-linearly with demand OR the performance to improve at least proportionally to the capacity added

Scalability examples







Power/energy

 The systems and their individual parts consume energy and cost money ...



The Power Issue



- Power = Static (leakage) power + Dynamic (switching) power
- Dynamic power ~ Voltage² * Clock frequency where Clock frequency approx. ~ voltage
 - → Dynamic power ~ Frequency³
- Total power ~ #processors

Processor	#cores	Volt-	Fre-	Perfor-	Power	Power efficien-
architecture		age	quency	mance		cy [Gflops/W]
Classical superscalar	1×	1x	1x	1x	1x	1x
"Faster" superscalar	1×	1.5x	1.5x	1.5x	3.3x	0.45x
Multi-core	2x	0.75x	0.75x	1.5x	0.8x	1.88x
		-				Jacob J. Sergers, 1998

ightarrow Preferable to use multiple slower processors than one superfast processor

... PROVIDED THAT the application can be parallelized efficiently!

Dynamic Power management (cont'd)

Hardware Support (e.g. Intel Xscale Processor)

- RUN: operational
- IDLE: Clocks to the CPU are disabled; recovery is through interrupt.
- SLEEP: Mainly powered off; recovery through wake-up event.
- Other intermediate states: DEEP IDLE, STANDBY, DEEP SLEEP





How do we understand these tradeoffs?

- There are three main methods used in the design of performance evaluation studies:
- <u>Analytic</u> approaches
 - the use of mathematics, Markov chains, queueing theory, Petri Nets, abstract models...
- <u>Simulation</u> approaches
 - design and use of computer simulations and simplified models to assess performance
- Experimental approaches
 - measurement and use of a real system



Recommended follow up courses

- TDTS21 Advanced Networking (6hp)
- TDDD25 Distributed Systems (6hp)
- TDDI08 Embedded Systems Design (4hp)
- TDDI11 Embedded Software, 6 credits (6hp)
- TDDC78 Programming Parallel Computers (6hp)
- TDDD56 Multicore and GPU Programming (6hp)
- ... and lots of interesting thesis projects, of course!

(Other projects are also possible; e.g., on individual basis ...)

The exams 2021

- Exam date:
 - TEN2: June 3 (8-12)
- Please remember to register
 - LiU will not allow late registrations for exams
 - No last-minute participation is allowed, pre-registration is required
- Format TEN2
 - Four parts: each worth a 1/4th of the points ...
 - Bonus question (only on original exam: June 2021)
 - Bonus points from project (only June 2021 exam): Will not be informed of these until AFTER the exam (but will be decided before marking)
- Format TEN1
 - Networking ...
 - No bonus question (only on original exam: Mar. 2021)

... general on exams ...

- Read all instructions carefully
- Please explain how you derived your answers. Your final answers should be clearly stated.
- Where a discourse or discussion is called for, be concise and precise.
- If necessary, state any assumptions you made in answering a question. However, remember to read the instructions for each question carefully and answer the questions as precisely as possible.
- Solving the *wrong question may result in* deductions! It is better to solve the *right question incorrectly, than the wrong* question correctly.
- The grading is U, 3, 4, 5 based on the correctness and clarity of answers, displayed understanding of the material, and how close are the answers to indicated length limit of each question.

... yet more on 2021 exam ...

- Questions will be available via Lisam (https://lisam.liu.se/) room "Submissions" after the exam starts (and on course website as backup).
- Duration of the exam is 4 hours (+ 30 min grace period), and results must be submitted in the course Lisam room before the deadline.
- Answers should be submitted as a single pdf file.
- Please type answers in English. No handwritten answers are allowed.
- Figures can be drawn by hand or by computer. If you draw by hand, please scan (or take a photo) and insert into the file you use to generate your pdf.
- The exam is not anonymous due to the exceptional situation of COVID-19. Please show understanding and tolerance of potential grading delays and technical issues as we switch to the remote examinations.
- You must answer all questions yourself. No group work or outside help is allowed.
- Do not copy-paste text from other sources. Answers may be checked through Urkund for plagiarism.
- By taking the exam, you accept a solemn obligation not to cheat.

Good luck on the exam!!