CSC0056 Data Communication

Course Introduction

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Agenda

1. Introduction
   - Essense
   - Grading policy
   - Academic integrity
2. A tour de course
   - Networked systems model
   - Networked systems design
   - Networked systems implementation
   - Networked systems evaluation
   - Scientific literature study
3. Recap

Course information

- Instructor: Chao Wang 王超
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  - Office hours: Mondays and Wednesdays, 2–4PM (by appointment)
- Teaching assistant: Yu-Ting Chiang 蔣毓庭
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- Course web page: (link here)
  - A one-page summary of this course
- Course Moodle: (link here)
  - Course slides, homework assignments, discussions, etc.
- Students taking this course should already have some *working knowledge* in both C and Linux

Topics this course will *not* cover

- Topics this course will not cover:
  - covered in an introductory course for computer networks (e.g., TCP/IP, Ethernet, OSPF, link-state routing, etc.)
  - Wireless communication standards (e.g., Wi-Fi, Bluetooth, ZigBee, 5G, etc.) (exception: LoRaWAN, which we will cover in this course)
- Related courses for the above topics:
  - CSU0019 Introduction to Computer Networks
  - CSU0038 Local Area Networks
  - CSC0010 Wireless Communication
  - CSC0052 Queueing Theory
  - CSC9004 Introduction to Internet of Things

Topics this course will cover

- Analytical and empirical skill set for data communication systems design, implementation, and evaluation
  - Broker-based data communication
  - Queueing analysis
  - Remote procedure calls
  - Data communication buses
  - ... see the course schedule on Moodle or here

Textbooks and additional references

- Harchol-Balter, Mor. *Performance modeling and design of computer systems: queueing theory in action.* Cambridge University Press, 2013. ISBN 9781107027503.
  - Our library has both a hard-copy and an e-copy; you may access the e-copy via campus network.
- Bertsekas, Dimitri and Gallager, Robert. *Data networks (2nd edition).* Prentice Hall, 1992. ISBN 0132009161.
  - Our library has a hard-copy; also, you may get a copy of the text from the author's web page.
- More references will be posted on the Moodle (also, see page 16)

Grading policy

- Homework assignments 60%
- Final exam 30%
- Online/Offline participation 10%
- All homework assignments must be submitted via Moodle.

Academic integrity

Figure: NTNU's motto.

- Sincerity
  - No hypocrisy. No cheating.
- Integrity
  - Walk in the light.
- Diligence
  - Preserverence and patience.
- Simplicity
  - Keep it simple but no simpler.

The rest of today's lecture

Seeing from 8,500 light-years away..

Figure: Carina Nebula. (By: NASA's James Webb Space Telescope)

A course overview from five aspects

- Networked systems *model*
- Networked systems *design*
- Networked systems *implementation*
- Networked systems *evaluation*
- Scientific literature study

Networked systems model

A model is a description of some properties of the subject of interest, as well as how it works *in general*

- The publish-subscribe model (aka the pub-sub model)
- The delay model (aka the queueing model)
  - Queueing theory
    - Little's law
    - Poisson process
    - Markov chains

Networked systems design

A design is a formal way to describe how things work *specifically* in order to meet certain *requirements*

- An example design in the context of the pub-sub model
  - MQTT: A broker-based, lightweight, widely used messaging protocol
  - The Quality-of-Service (QoS) requirements

Networked systems implementation

An implementation is a way to concretize the proposed design

- A design may be implemented in different ways, using different languages, on different platforms
- An example implementation of MQTT
  - Eclipse Mosquitto (https://mosquitto.org/): an open source implementation of the MQTT protocol, supported by the Eclipse Foundation

Pragmatic software development environment

- Some examples of Linux shell commands:

```
1 $ ls                    # what about 'ls -lh'?
2 $ grep keyword *        # what about 'grep -R keyword *'?
3 $ cat someFile
4 $ man top
```

- An example Bash script:

```
1 #!/bin/bash
2 for idx in 'seq 5 2 10'; do
3   echo idx
4   echo $idx
5 done
```

- Code tracing
- Project version control
- Some pointers:
  1. A quick tutorial
  2. Bash Reference Manual
  3. The Missing Semester of Your CS Education

Networked systems evaluation

- Evaluation: in which ways should we compare different systems design and/or implementation?
- Performance metrics
  - throughput
  - timeliness
  - fault tolerance
  - energy efficiency
- Theoretical evaluation vs. empirical evaluation

Scientific literature study

- Why do we need to study research papers?
  - Catch up with the cutting-edge research findings
  - Learn from the original text
  - Trace and compare a school of thoughts
- Some online gateways to find research papers:
  - Google Scholar
  - ACM Digital Library
  - IEEE Xplore

Demo: using the Google Scholar

- Search by keywords
  - specific technology
  - conference/journal names
  - author names
- Backward reference v.s. forward references
- Building your own research library

Elements in a CS systems research paper

- Typical sections include
  - Abstract
  - Introduction
  - Related work
  - System model
  - System design and implementation
  - Experimental results
  - Conclusions
  - References
- Example
  - C. Wang, C. Gill and C. Lu, "FRAME: Fault Tolerant and Real-Time Messaging for Edge Computing," 2019 IEEE 39th International Conference on Distributed Computing Systems (ICDCS), 2019, pp. 976-985, doi: 10.1109/ICDCS.2019.00101.

Takeaways today

- Course logistics
- Four aspects of the study of networked systems, their definition, and their relation
  - model
  - design
  - implementation
  - evaluation
- An introduction to scientific literature (i.e., research papers)