Designing Large-Scale Networked Systems

CS 595-xx, Spring’22

Instructor
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Course Description
Many important services—including Internet services many of us use—rely on large-scale, high-performance networked systems to carry out a rich variety of data processing. This course provides a comprehensive overview of the design of such systems. It will teach practical skills and cover a wide range of topics as it connects low-level to high-level features. Topics include network architecture, routing, software-defined networking, traffic patterns, monitoring, distributed data models, security, failure modeling, and in-network computing. This course will involve lectures, seminars, and project work.

Course Objectives
The main learning goals of this course are the following:

- Get exposure to state-of-the-art ideas and research in this domain.
- Understand decisions and trade-offs when designing a large-scale network.
- Understand main routing algorithms used in large-scale networks.
- An introduction to the P4 language, and experience using its toolchain. (https://p4.org/)
- Several advanced examples of Software-Defined Networking.

Prerequisites
This will be a “hands-on” course that requires active implementation. Knowledge of networking, Python and basic OS features is needed for students to make the most out of this course. This knowledge includes the ability to write and understand shell scripts, and use network-related shell commands such as `ifconfig` and `ping`. In terms of IIT’s CS curriculum, this is roughly captured by “CS351 or CS450 or CS455 or CS542”. Contact the instructor if in doubt.

Draft Syllabus

1. Introduction to Designing Large-Scale Networked Systems (1.5 hours)
2. Network architecture (6 hours)
3. Routing (6 hours)
4. Software-Defined Networking (3 hours)
5. P4 (6 hours)
6. Traffic patterns (3 hours)
7. Network monitoring (3 hours)
8. Distributed data models (3 hours)
9. Security (3 hours)
10. Failure modeling (3 hours)
11. In-network computing (6 hours)
Course Material
There is no required textbook. The course will rely on select research articles and tool documentation.

Workload
- Present and discuss recent or influential research papers from the course syllabus.
- Prepare and present two projects. Each project involves implementing a switch extension in P4. Students can propose their own project ideas based on their interests. The instructor will help scope the proposals.

Grading
A=90-100, B=76-89, C=60-75, D=40-59, else F.

Grade break-down:
- Participation: 10%
- Presentation: 30%
- Project 1: 20%
- Project 2: 40%