CSCI 599: Introduction to Networked Systems for Cloud Computing
Units: 4.0
Spring 2024  MonWed  4:00-5:50pm

Location: TBA

Instructor: Ramesh Govindan
Office: SAL 212
Office Hours: TBA
Contact info: ramesh@usc.edu
Catalogue Description

Systems and network designs and protocols for cloud computing and data center networks.

Course Description

Today, most online services are hosted on large public clouds. Beneath the hood, cloud computing is powered by large, complex networked systems. Most cloud compute and storage is hosted in massive data centers connected by extremely high capacity networks. In turn, these data centers are interconnected by global private WANs. On this infrastructure, cloud providers run innovative networked systems that enable them to offer high availability, high throughput and low latency to their customers at low cost. These networked systems form the subject matter for the course. The course will be based on readings from representative papers published in top systems and networking conferences.

Note: This is the MS-equivalent of the PhD-level CS 656 (Networked Systems for Cloud Computing). The two courses are substantially the same, and are intended to be co-offered to MS and PhD students. PhD students will be evaluated slightly differently: they will be required to prepare and present 1-2 papers each in class.

Learning Objectives

In this course, we will visit the critical technology trends and new challenges in cloud and data center designs for different trade-offs of performance, scalability, manageability, and cost across the application, infrastructure, and network layers. The course will include student reviews, discussions, lectures, and in-class quizzes. The readings will be selected from recent papers published in top systems and networking conferences. Critical evaluation of the readings will be conducted through independent reviews and student led discussions.

Recommended Preparation

Knowledge at the level of CSCI 551 or CSCI 651

Course Notes

The course is for letter grade. The instructor will make available copies of lecture notes if any, and lecture video recordings when possible.

Technological Proficiency and Hardware/Software Required

Proficiency in C/C++ and Python.

Required Readings and Supplementary Materials

Data center design

Routing


WAN design


Transport protocols


Virtualization


Fast communication


Load-balancers


Global traffic control


Reliability


Programmable switches


Optional Readings and Supplementary Materials

None.

Description of Assignments and How They Will Be Assessed

Reviews: Students are expected to write reviews for each class. Your review should look similar to reviews of papers submitted to conferences, which usually have four parts:

1. Paper summary: What problem does the paper address (1-2 sentences or bullets)? What are the core novel ideas or technical contributions of the work (1-2 sentences or bullets)? What is the paper’s approach, what specific techniques/mechanisms does it use, and what are its main findings? (3-5 sentences)
2. Strengths: 2-4 bulleted points (Explain in more details in the detailed comments)
3. Weaknesses: 2-4 bulleted points (Explain in more details in the detailed comments)
4. Detailed comments on the paper: Elaborate in a few sentences each of the strengths and weaknesses.

Quizzes: There will be four short (30 min) quizzes, evenly spaced through the semester, to test your understanding of the papers in the class.

Research project: The semester-long project is an open-ended systems research project. Project topics are of your choice but should be related to networked systems for cloud computing. Projects should be done in groups of two or three and should include a systems building component.

The purpose of the class project is for students to have some research experience on problems related to cloud computing. Students are encouraged to identify new research projects based on their own reading of papers from recent conferences. The instructor will also provide sample projects for students at the beginning of the semester. Students are encouraged to work in groups of 2 or 3 students.
**Project Timeline**

- Week 1-2: Identify team members and project topics
- Week 3: Proposal due (team member, topics and milestone)
- Week 9: Mid-term report due (data description, preliminary results)
- Week 15: Project presentation (open to all students)
- Week 16: Final report due (similar to a 6-page workshop research paper)

**Grade breakdown of the course project**

- Proposal: 5%
- Mid-term report: 10% · Final report: 20%
- Presentation: 15%

**Grading Breakdown**

<table>
<thead>
<tr>
<th>Assessment Tool (assignments)</th>
<th>% of Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reviews</td>
<td>20</td>
</tr>
<tr>
<td>Quizzes</td>
<td>30</td>
</tr>
<tr>
<td>Research project</td>
<td>50</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100</td>
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**Grading Scale**

Students will be graded on a curve based on the total numerical score.

**Assignment Submission Policy**

Reviews can be submitted on Gradescope and quizzes will be online on Gradescope. Students may submit project code and reports via a Github repository.

**Academic Integrity**

Unless otherwise noted, this course will follow the expectations for academic integrity as stated in the USC Student Handbook. The general USC guidelines on Academic Integrity and Course Content Distribution are provided in the subsequent “Statement on Academic Conduct and Support Systems” section.

For this class you may collaborate on the projects, but all work on the reviews and quizzes must be your own. If found responsible for an academic violation, students may be assigned university outcomes, such as suspension or expulsion from the university, and grade penalties, such as an “F” grade on the assignment, exam, and/or in the course.

Please ask the instructor [and/or TA(s)] if you are unsure about what constitutes unauthorized assistance on an exam or assignment, or what information requires citation and/or attribution.

You may not record this class without the express permission of the instructor and all other students in the class. Distribution of any notes, recordings, exams, or other materials from a university class or lectures — other than for individual or class group study — is prohibited without the express permission of the instructor.
Use of Generative AI in this Course

Generative AI is not permitted: Since creating, analytical, and critical thinking skills are part of the learning outcomes of this course, all assignments should be prepared by the student working individually or in groups as described on each assignment. Students may not have another person or entity complete any portion of the assignment. Developing strong competencies in these areas will prepare you for a competitive workplace. Therefore, using AI-generated tools is prohibited in this course, will be identified as plagiarism, and will be reported to the Office of Academic Integrity.
## Course Schedule

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<thead>
<tr>
<th>Week</th>
<th>Topics/Daily Activities</th>
<th>Readings/Preparation</th>
<th>Deliverables</th>
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</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>Data Center Designs</td>
<td>[JupiterRising], [JupiterEvolving]</td>
<td>Identify project team</td>
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<td>Week 2</td>
<td>Routing</td>
<td>[FaceBookBGP]</td>
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<tr>
<td>Week 3</td>
<td>Routing</td>
<td>[Orion], [Fastpass]</td>
<td>Project proposal Due</td>
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<tr>
<td>Week 4</td>
<td>WAN Designs</td>
<td>[B4], [SWAN]</td>
<td>Quiz 1</td>
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<td>Week 5</td>
<td>Transport Protocols</td>
<td>[DCTCP]</td>
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<tr>
<td>Week 6</td>
<td>Transport Protocols</td>
<td>[Swift]</td>
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<tr>
<td>Week 7</td>
<td>Virtualization</td>
<td>[Andromeda], [VMWare]</td>
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<tr>
<td>Week 8</td>
<td>Fast Communication</td>
<td>[Firestone]</td>
<td>Quiz 2</td>
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<tr>
<td>Week 9</td>
<td>Fast Communication</td>
<td>[Snap], [1RMA]</td>
<td>Mid-term report</td>
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<td>Week 10</td>
<td>Load Balancers</td>
<td>[Maglev], [Ananta]</td>
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<tr>
<td>Week 11</td>
<td>Global Traffic Control</td>
<td>[Mapping], [AnycastCDN]</td>
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<tr>
<td>Week 12</td>
<td>Global Traffic Control</td>
<td>[Espresso], [EdgeFabric]</td>
<td>Quiz 3</td>
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<td>Week 13</td>
<td>Reliability</td>
<td>[TailatScale], [EvolveorDie]</td>
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<td>Week 14</td>
<td>Programmable Switches</td>
<td>[P4], [FBOSS]</td>
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<tr>
<td>Week 15</td>
<td>Student Presentations</td>
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<td>Quiz 4</td>
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| FINAL | Final Report                |                                | Due on the university-scheduled date of the final exam. Refer to the final exam schedule in the USC Schedule of Classes at classes.usc.edu.
Statement on Academic Conduct and Support Systems

Academic Integrity:
The University of Southern California is a learning community committed to developing successful scholars and researchers dedicated to the pursuit of knowledge and the dissemination of ideas. Academic misconduct, which includes any act of dishonesty in the production or submission of academic work, comprises the integrity of the person who commits the act and can impugn the perceived integrity of the entire university community. It stands in opposition to the university’s mission to research, educate, and contribute productively to our community and the world.

All students are expected to submit assignments that represent their own original work, and that have been prepared specifically for the course or section for which they have been submitted. You may not submit work written by others or “recycle” work prepared for other courses without obtaining written permission from the instructor(s).

Other violations of academic integrity include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), collusion, knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university. All incidences of academic misconduct will be reported to the Office of Academic Integrity and could result in outcomes such as failure on the assignment, failure in the course, suspension, or even expulsion from the university.

For more information about academic integrity see the student handbook or the Office of Academic Integrity’s website, and university policies on Research and Scholarship Misconduct.

Please ask your instructor if you are unsure what constitutes unauthorized assistance on an exam or assignment, or what information requires citation and/or attribution.

Course Content Distribution and Synchronous Session Recordings Policies
USC has policies that prohibit recording and distribution of any synchronous and asynchronous course content outside of the learning environment.

Recording a university class without the express permission of the instructor and announcement to the class, or unless conducted pursuant to an Office of Student Accessibility Services (OSAS) accommodation. Recording can inhibit free discussion in the future, and thus infringe on the academic freedom of other students as well as the instructor. (Living our Unifying Values: The USC Student Handbook, page 13).

Distribution or use of notes, recordings, exams, or other intellectual property, based on university classes or lectures without the express permission of the instructor for purposes other than individual or group study. This includes but is not limited to providing materials for distribution by services publishing course materials. This restriction on unauthorized use also applies to all information, which had been distributed to students or in any way had been displayed for use in relationship to the class, whether obtained in class, via email, on the internet, or via any other media. (Living our Unifying Values: The USC Student Handbook, page 13).

Students and Disability Accommodations:
USC welcomes students with disabilities into all of the University’s educational programs. The Office of Student Accessibility Services (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each
course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at osas.usc.edu. You may contact OSAS at (213) 740-0776 or via email at osasfrontdesk@usc.edu.

Support Systems:

**Counseling and Mental Health** - (213) 740-9355 – 24/7 on call
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

**988 Suicide and Crisis Lifeline** - 988 for both calls and text messages – 24/7 on call
The 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United States. The Lifeline is comprised of a national network of over 200 local crisis centers, combining custom local care and resources with national standards and best practices. The new, shorter phone number makes it easier for people to remember and access mental health crisis services (though the previous 1 (800) 273-8255 number will continue to function indefinitely) and represents a continued commitment to those in crisis.

**Relationship and Sexual Violence Prevention Services (RSVP)** - (213) 740-9355(WELL) – 24/7 on call
Free and confidential therapy services, workshops, and training for situations related to gender- and power-based harm (including sexual assault, intimate partner violence, and stalking).

**Office for Equity, Equal Opportunity, and Title IX (EOO-TIX)** - (213) 740-5086
Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

**Reporting Incidents of Bias or Harassment** - (213) 740-5086 or (213) 821-8298
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

**The Office of Student Accessibility Services (OSAS)** - (213) 740-0776
OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

**USC Campus Support and Intervention** - (213) 740-0411
Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

**Diversity, Equity and Inclusion** - (213) 740-2101
Information on events, programs and training, the Provost’s Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

**USC Emergency** - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call
Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

**USC Department of Public Safety** - UPC: (213) 740-6000, HSC: (323) 442-1200 – 24/7 on call
Non-emergency assistance or information.

**Office of the Ombuds** - (213) 821-9556 (UPC) / (323-442-0382 (HSC)
A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

*Occupational Therapy Faculty Practice* - (323) 442-2850 or oftp@med.usc.edu
Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.