

TCOM xxx: Network Design For Cloud Computing

Course Description: The emergence of cloud computing drives networking changes within datacenters, across the wide area network and at the network edge. In fact, cloud computing blurs the boundary between networking and IT services, and forces us to re-think networking beyond the traditional "smart host dumb network" paradigm that has driven the internet. Looking out a decade, we expect that the sharp distinction between the network and its applications will continue to erode. In addition to "dumb network" functions of basic connectivity and QoS, telecom networks will routinely provide identity, security, mapping, location, mobility, billing and other services not only to users, but also to third-parties who will then build applications based on these services.

Some elements of such future applications are already visible today -- Google Maps and Search APIs, Amazon EC2, Salesforce PaaS, Verizon Open Development Initiative, etc. However, a complete understanding of the exact piece parts and standards that will constitute the future network are still emerging.

This course will seek to introduce students to a systematic understanding of the future Cloud Service Provider network in terms of different functions -- transport, service delivery and control, hosting, security, service enablement and assurance and application delivery – while providing with the tools required to conceptualize, rationalize and communicate complex engineering systems.

We will start off a rigorous definition of cloud services and understanding the drivers for clouds including basic technologies relating virtualization, convergence and consolidation. Students will then be introduced to techniques for describing complex systems using advanced architectural methods including system context diagrams, use cases, requirement presentation, decision rationalization, architectural overview diagrams and specified designs. We use these techniques to understand current technologies and architectures of today's Service Provider and Enterprise networks.

Having established the fundamental tools, we dissect some basic cloud services in terms of their functionality and design. Examples here will include storage clouds, computing clouds and software clouds. Through the latter part of the course students will be collaborating to define, design and describe their own innovative proposal for a cloud service, together with the complex IT and network architecture required to deliver it.

The course assumes that the student is fully armed with a graduate level course in IP networks, and is capable of independent reading and presentation. The course will be instructor led (~60%) with supplementary student presentations (~40%)

Students will be evaluated on two metrics – presentations on advanced topics interspersed through the term, and a final group project involving proposing and systematically designing a cloud service using techniques and technologies learned in the class.

Prerequisite: First Graduate class in Layer 2 and Layer 3 Networking technologies. A general background in computing would also help.

Main Text: TBD

Course Grade:

- One project - (200 Points)
- One Examination - in class, open book, open notes (100 Points)
- Presentation – (100 points)
- Attendance and participation (100 Points)
- Total: 500 points

Grading Policy on Projects

- A: Creative, Systematic and Excellent Communication.
- B: Two of the three above.
- C: One of the three above.
- Below C: Did not get it.

Course Outline

Week	Major Topic
1	Course Introduction What is a cloud? Concepts and drivers
2	Virtualization, Consolidation, Convergence
4	Architectural Methods: System Context, Use Cases
4	Architectural Methods: Functional + Non-functional requirements, Decisions, Overview Diagrams
5	The Data Center Network: Architecture and Evolution
6	Macro-Architecture of the Service Provider Network
7	Exam (in class)
8	Case Study: Computing Cloud Data Center
9	Case Study: Storage Cloud Data Center Project Kickoff
10	Performance/QoS considerations in Cloud Design
11	Security and Trust considerations in Cloud Design
12	Application acceleration, caching and dynamic hand-off techniques
13	Cloud OSS/ BSS
14	Design of the NGN Cloud Service Provider Network
15	Project presentations

Discussion of case studies, examples, commercial products, and trends:

The course uses several case studies, examples, and commercial products at different points in the course. Students will read-up and present most of this material.

Sample Team Project:

Pick an infrastructure, middleware or software application that can be delivered over the cloud. Systematically present the market motivation, system context, use cases, functional and non-functional requirements, architectural decisions and design of the Data Center, WAN and LAN components (including security, OSS, application acceleration and QoS) used to deliver the service. Further, consider the scaling requirements for your service on a world-wide scale and recommend a macro-service delivery architecture that will be used to host and distribute your service. You will be judged on the creativity of your proposed service, innovative use/suggestions for new technology components, systematic justification of the key architectural decisions made in designing the back-end delivery architecture, as well as your ability to communicate complex design in clear, compelling language.