Université d'Ottawa
Faculté de génie,
École de science informatique et de génie électrique

University of Ottawa
Faculty of Engineering,
School of Electrical Engineering and Computer Science

ELG5369 – Internetwork Technologies

Fall 2017

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Office Hours: **By appointment only**

Please make an appointment if you wish to see me outside class. Contact me by e-mail for the most immediate response.

Lectures:

Wednesdays	17:30-19:00	Class-room :	STE F0126
Fridays	17:30-19:00	Class-room :	STE F0126

Textbooks:

1. Cisco: Internetworking Technology Handbook: http://docwiki.cisco.com/wiki/Internetworking_Technology_Handbook

2. David E. McDysan, *QoS and Traffic Management in IP and ATM Networks*; McGraw-Hilll, 1999; ISBN 0-07-134959-6

3. Uyless Black, *Advanced Internet Technologies*; Prentice Hall, 1998; ISBN 0-13-759515-8

4. Uyless Black, *IP Routing Protocols: RIP, OSPF, BGP, PNNI and Cisco Routing Protocols*; Prentice Hall, 2000; ISBN 0-13-033024-8

5. Grenville Armitage, *Quality of Service in IP Networks*; McMillan Technical Publishing, 2000, ISBN: 1-57870-189-9

Prerequisites:	CEG3185 – Introduction to Computer Networks, or SEG3255 – Communication and Networking CEG4183 – Higher Layer Network Protocols, or CSI4118 – Computer Networks Protocols CEG4185 – Computer Network Design (*recommended*) CEG4395 – Computer Network Management (*recommended*) or equivalent.
Mark Distribution:	40% – Final Exam 20% – Assignments 40% – Project

Rationale

The Internet's most rapidly growing service, the World Wide Web, is not only becoming an indispensable vehicle for human interaction (messaging, real-time communications) and business transactions (tele-banking, tele-advertising, tele-publishing, electronic commerce, and many others) but is also stretching the limits of the original design of the Internet along all possible dimensions. Network designers are scrambling to devise solutions to cope with the situation. High growth in network size and speed, together with the rapid changes of technologies and solutions, has made the Internet the largest distributed system that more and more people depend on, but fewer and fewer understand. Continuous efforts are made to provide communication services with specified quality of service (QoS) parameters. In such a framework the user can select the necessary parameters for communication quality for a given application. Such qualified service will be the basis for the new media-oriented communication services over the Internet, such as Internet-phone and teleconferencing facilities.

The technologies that facilitate the development of Internet applications taking advantage of these new QoS features of the Internet and other high-speed networks, required for providing qualified communication services over the Internet are presented in this course.

QoS management at the application level for teleconferencing applications with a large number of users is presently a hot research topic. Current teleconferencing systems assume that all users will obtain the same end-to-end QoS. However, this assumption is not always realistic. Recent trends aim towards policy based session control and management. Solutions for the above problem are elaborated based on Differentiated and Integrated Services.

Syllabus

1. Network fundamentals. Layered network architectures and reference models: ISO OSI, TCP/IP. Network addressing schemes. Internetworking. Overview of communication media. Network topologies. Shared and point-to-point media; collision domains. Overview of coding. Media characteristics: copper, optical fiber, electromagnetic waves. Characteristics of the physical layer of the most common data communication technologies: Ethernet, SONET/SDH, WDM, Wireless.

2. MAC Sublayer: Overview of framing and error control. Broadcast domains. Data Link Layer technologies: Ethernet, Packet-over-SONET (POS).

3. The Network Layer. The TCP/IP protocol stack: detailed overview of IPv4, IPv6, ICMP. Layer- 3-to-Layer-2 address mapping: ARP. Addressing issues: Address autoconfiguration (RARP, BOOTP, DHCP, ICMPv6 ND); Network Address Translation (NAT).

4. IPv4 and IPv6 unicast routing. Overview of routing protocols: RIP, OSPF, IS-IS, BGP.

5. The Transport Layer. Detailed overview of TCP and UDP. Transport Layer addressing. Congestions Control and Avoidance

6. Higher-Layer network protocols: Brief overview of DNS, HTTP, SMTP, IMAP/POP.

7. Network Management Protocols: SNMP, RMON.

8. IPv4 and IPv6 multicast. Multicast membership management protocols: IGMP, MLD. Multicast routing protocols: PIM.

9. Virtual Private Networks (VPNs). GRE, IPv4 and IPv6 tunnels. Brief overview of IPsec. IPv4 and IPv6 interoperability; dual-stack network devices.

10. Multiprotocol Label Switching (MPLS) Overview. Label Distribution Protocols (LDP, RSVP). MPLS VPNs.

11. Quality-of-Service (QoS) in IP networks. Legacy QoS frameworks: IP ToS, IP precedence. Integrated Services (IntServ); The Resource Reservation Protocol (RSVP). Differentiated Services (DiffServ); Differentiated Services Code Points (DSCP); Per-Hop Behaviours (PHBs): Default, Class Selector (CS), Assured Forwarding (AF), Expedited Forwarding (EF). Queuing management algorithms: tail drop, fair queuing, round-robin, priority queuing, custom queuing. Random Early Detection (RED).

12. MPLS Traffic Engineering (MPLS-TE). Protocol extensions for traffic engineering: CR-LDP, RSVP-TE, OSPF-TE, ISIS-TE.

Project:

The term project is a group effort. Each group of up to three students (as previously established) will choose one of the available projects. A list of projects is on the web page of ELG5469.

All projects are research-oriented.

The research projects will require you to gather, study, and analyze documentation on the project topic. Some of the projects will be on new ideas in regards to present Internetworking technologies, its subject can come from the scientific domain literature and requires you to come up with a solution and to prove that your solution works in reality. You can use network simulators (ns III) for proving correct your solution.

The documentation can come in the form of white papers, journal and/or conference papers, as well as vendor-provided resources. It is highly recommended to study both vendor-independent and vendor-provided resources. The one restriction about the documentation is that it needs to be publicly available and it has to be correctly mentioned into your Project Report.

Deliverables

You **must** fulfill **all** the components of the course (assignments, project, and exams). If you do not, you may receive a mark of EIN (incomplete, equivalent to an F) for the course.

Classroom etiquette.

Everyone is entitled to a productive lecture without being disturbed by others. You are asked to respect the following rules:

1. **Be on time!** Entering the classroom late (or leaving early) is highly disrupttive. If you do want to enter the classroom after the lecture has started, make every effort not to disturb others. But better be on time.
- **Make sure cellphones are switched off.**
- Laptop use: using your laptop to take notes is fine. **Using it for other things during class is distracting for others.**
- **Asking questions** during the lectures is encouraged, **but one at a time**, please!

Disruptive behavior of any kind will not be tolerated which translates in the culprit leaving the course.

Academic Fraud

Most of the course components consist of individual work (lab works and reports, and exams). This means that students must work on their own work and reports providing an individual solution to these components.

I**dentical or very similar submissions may be considered academic fraud.**

Notwithstanding the fact that the course is updated each year and that most requirements change from one year to the next, **appropriating work from the previous years as your own will be treated as academic fraud.**

When answering a question that requires you to formulate an answer (i.e. not a multiple-choice question), make sure that you always acknowledge your references, if you used any. Citing from the work of your classmates is not acceptable.

All academic fraud issues will be submitted to the Faculty of Engineering and to the Faculty of Graduate and Postgraduate Studies for examination.