



Business Data Communication and Networks

MET CS 625 BHA, Course Format (In-Class/Off-site), Spring 2018

Instructor

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Lecture Time, Dates and Location: 6 - 8:45 PM, Tuesdays, Hanscom AFB (23 Jan. to 08 May)

Office hours: One hour prior to class or by prior arrangement

Office Address: To be confirmed

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Course Description

This course presents the foundations of data communications and takes a bottom-up approach to computer networks. The course concludes with an overview of (a) basic network security and management concepts, and (b) the elements of modern networking like softwareization and virtualization.

Prerequisites

Basic knowledge of information technology fundamentals (computer hardware, operating systems, applications and networking) is required. This information can be found in data communications (https://www.tutorialspoint.com/data_communication_computer_network/) and computer science (<http://www.computersciencestudent.com/>) refresher websites. Successful completion of MET CS 200 or instructor's approval is also required.

This course may not be taken in conjunction with MET CS 425 (undergraduate) or MET CS 535. Only one of these courses can be counted towards degree requirements.

Course Learning Objectives

Upon successful completion of this course you will learn how to:

- Understand data communication networking concepts, terminology, and models
- Design data communication networks including connectivity with any/all networks including the Internet
- Use the Internet related standards/specifications called the Request for Comments (RFCs, available from the IETF website: <http://www.ietf.org>)
- Utilize tools and techniques for hand-on Labs exercise

- Use discrete event simulation for network simulator using NS-3 (<https://www.nsnam.org>) and Riverbed Modeler (<https://www.riverbed.com/>, formerly OpNet)
- Choose a networking technology suitable to satisfy the business challenges (auditing and verification, monitoring, reliability, security, resiliency, etc.)
- Successfully communicate with any networking professional
- Apply basic network and security management techniques
- Understand the elements of emerging networking paradigms/technologies (softwareization and virtualization)
- Advance your knowledge of networking by taking additional courses or self-study

Recommended Course Books

- [1]- **Business Data Communications and Networking**, J. Fitzgerald, A. Dennis, and A. Durcikova, Wiley, ISBN-13: 978-1118891681/ISBN-10:1118891686 (12th Ed., 2014), ISBN: 978-1-119-36883-0 (13th Ed., 2017). Note: 13th Ed. contains minor updates only.

Recommended Articles and Journals/Magazines

- [3]- **Foundations of Modern Networking**, William Stallings, Pearson Education, Inc., 2016, ISBN-13: 978-0-13-417539-3, ISBN-10: 0-13-417539-5
- [2]- **Network Attacks and Exploitation: A Framework**, Matthew Monte, Wiley, 2015, ISBN: 978-1-118-987 {12-4, 08-7, 23-0}
- [F]- *IEEE Network* (<http://www.comsoc.org/netmag>)
- [E]- *Journal of Network and Systems Management* (JNSM, <http://www.springer.com/computer/communication+networks/journal/10922>)
- [D]- *Computer Networks Open Access Articles* (<https://www.journals.elsevier.com/computer-networks/>, <https://www.journals.elsevier.com/computer-networks/open-access-articles>)
- [C]- *Software-Defined Network Forensics: Motivation, Potential Locations, Requirements, And Challenges*, IEEE Network, Vol.30 Issue 6, Nov.-Dec. 2016
- [B]- *Threat Analysis for the SDN Architecture*, Version 1.0, ONF TR-530, 2016
- [A]- *IEEE Communications Magazine* (<http://www.comsoc.org/commag>)

Laptop Requirements

Before you start configuring your laptop for the course assignments and/or experiments, please backup all of your files and system configuration data/information.

You will need a System (e.g., 64 bit Windows) with multi-core CPU (~3.0 GHz), ≥16 GB RAM, and ≥128 GB of free disk space.

You can download the latest version of network simulator using NS3 from the website:

<https://www.nsnam.org/>.

You can download VirtualBox from the Website: <https://www.virtualbox.org/wiki/Downloads> .

Courseware

This course uses Online Campus (Blackboard). Once the course starts all students must use the Online Campus Dashboard internal messages service. Students are required to use On-line campus:

- for reading and submitting assignments
- Submitting lab exercises and Taking on-line exams and quizzes
- Participating in discussion threads
- All course related email correspondence

Class Policies

1) Attendance & Absences

- Students are requested to attend all of the in-class lectures
- Students are encouraged to notify the instructor in advance if unable to attend any in-class lecture

2) Classroom Etiquette

- To be determined and announced/discussed

3) Assignment, Lab Exercise and Discussion Completion & Late Work

- Homework assignments are mandatory, must be completed and submitted in a timely manner, and are required to be submitted via Online Campus for this course. For each day after the submission date a homework assignment is due will result in a penalty of 3 points. Homework assignments passed in that are over 5 days late will receive a grade of zero (0). If a student will be unable to submit an assignment by its due date, the student must contact the instructor **in advance** to avoid the late submission penalty.
- Lab exercises: are mandatory, must be completed and submitted in a timely manner, and are required to be submitted via Online Campus for this course. For each day after the submission date a lab exercise is due will result in a penalty of 3 points. Lab exercises passed in that are over 5 days late will receive a grade of zero (0). If a student will be unable to submit a Lab exercise by its due date, the student must contact the instructor **in advance** to avoid the late submission penalty.
- Student postings to discussion topic after the listed closing dates will not be

counted when calculating a student's discussion grades.

- 4) **Academic Conduct Code** – Cheating and plagiarism will not be tolerated in any Metropolitan College course. Such activities/behavior will result in no credit for the assignment or examination and may lead to disciplinary actions. Please take the time to review the Student Academic Conduct Code:

http://www.bu.edu/met/metropolitan_college_people/student/resources/conduct/code.html.

Such activities/behavior includes copying (even with modifications) of another student's work or letting your work to be copied. Your participation in interactions with the instructor and your classmates is encouraged, but the work you submit must be your own. Collaboration is not permitted.

Grading Criteria

Students will have to do homework assignments to help you master the material. You will also have to read the textbooks and to be ready to discuss the issues related to the current class topics. Grades will be based on:

- homework assignments (20%)
- lab exercises and/or project (20%)
- attendance (15%)
- in-class/on-line discussion participation (15%)
- proctored final exam (30%)

Grade ranges (approximate) are as follows:

- A's: {90-94.9 is an A-(3.7), and 95+ is an A (4.0)}
- B's: {80-82.9 is a B-(2.7), 83-86.9 is a B(3.0), and 87-89.9 is a B+(3.3)}
- C's: {70-72.9 is a C-(1.7), 73-76.9 is a C(2.0), and 77-79.9 is a C+(2.3)}
- D {60-69.9(1.0)}
- F {0-59.9(0)}

Assignment/Homework/Exercise/Project Submission Guideline

PLEASE submit the completed tasks in MS Word or PPT file(s) via email before the due date. File names for the documents must be as follows:

<student's first name>-CS625-Abcd<number>-ddMnt2017.doc

An example of the document file name for assignment no. 3 submitted by the Instructor on the 15th of August is as follows:

Bhumip-CS625-Asgn3-15Aug2017.doc

Note: Abcd=Asgn for Assignment submission, Abcd=Hwrk for Assignment submission, Abcd=Labs for Lab/Exercise submission, and Abcd=Proj for Project submission; *dd* is the two digit Date of submission, *Mnt* is the first three letters of the Month of submission.

Include the file name in the header and a page number in the footer of your assignment submission document. Quoted materials and citations must follow the Modern Language

Association (MLA, <https://style.mla.org/>) format with a reference section at the end of a student’s submitted work.

Then, *print* the first page of your email on one side of a paper, and the first page of your assignment submission file on the other side of the same paper.

Finally, *bring* that paper for submission before the lecture immediately following the submission date.

Class Meetings, Lectures & Assignments

Module /Date	Topics	Readings Guide/Due	Assignments Due
01 / 23 Jan.	-Introduction to Networking: -ISO’s Open System Interconnection (OSI), Internet, and Modern Networking Models -Application and Physical Layers	Ch.1, 2, & 3 of Ref.[1], Part I of Ref.[3]	A 500-word report on your background and expectations from this course. Please bring the printed report to the class.
02 / 30 Jan.	Data Link Layer	Ch.4 of Ref.[1]	Q.1, 7, 13, 16, & 20 of Ch.1 [1]; Q.11, 17, & 25 of Ch.2 [1]; Q.14, 32, 36, & 40 of Ch.3 [1] Hand-on Activity: 1B,2A, 2B, 3A, 3B, and 3C (optional)
03 / 06 Feb.	Networking and Transport Layers	Ch.5 of Ref.[1]	Q. 5, 13, 25 & 27 of Ch.4[1] Hand-on Activity: 4A *Finalize Project Selection*
04 / 13 Feb.	Network Design	Ch.6 of Ref.[1], Ch.1-2 of Ref.[2]	Q. 6, 15, 25 & 27 of Ch.5 [1] Hand-on Activity: 5 {A, B, E and F}
05 / 20 Feb.	Wired and Wireless Local Area Networks (LANs)	Ch.7 of Ref.[1]	Q. 10, 17 & 21 of Ch.6 [1] Hand-on Activity: 6A
06 / 27 Feb.	Backbone Networks Wide-Area Networks (WANs)	Ch.8 & 9 of Ref.[1]	Q. 11, 16, 18, 28 & 31 of Ch.7 [1] Hand-on Activity: 7B and 7D *Report Project Progress*

Module / Date	Topics	Readings Guide/Due	Assignments Due
07 / [BU Spring Recess Time, 3-11 Mar.] 06 Mar.	The Internet (Architecture Protocols and Operations)	Ch.10 of Ref.[1], Ch.3-4 of Ref.[2]	Q. 3, 4, 8, 15 & 20 of Ch.8 [1] Q. 3, 8, 13, 16 & 22 of Ch.9 [1] Hand-on Activity: 8A, 8B, 9B, and 9C
08 / 13 Mar.	Network Security	Ch.11 of Ref.[1], Ch. 5 of Ref.[2]	Q. 3, 4, 11, 18 & 22 of Ch.10 [1] Hand-on Activity: 10A and 10B
09 / 20 Mar.	Network Management	Ch.12 of Ref.[1], Ch. 6 of Ref.[2]	Q. 3, 9, 15, 20, 25, 27, 34, 37, 46, 48 & 53 of Ch.11 [1] Hand-on Activity: 11 {A, B, and C} *Report Project Progress*
10 / 27 Mar.	Software-Defined Networking (SDN)	Part II of Ref.[3], ONF SDN Def. (https://www.opennetworking.org/sdn-definition/)	Q. 1, 10, 15, 19, 26 & 27 of Ch.12 [1] Hand-on Activity: 12A and 12B
11 / 03 Apr.	Impact of SDN on Business Data Communications	ONF Technical Recommendations and Specifications(https://www.opennetworking.org/software-defined-standards/archives/)	A report on SDN and its impact on your Role in Networking (one page; please print on both sides)
12 / 10 Apr.	Network Functions Virtualization (NFV)	Part III of Ref.[3] and ETSI ISG NFV White papers (http://docbox.etsi.org/ISG/NFV/Open/)	A report on impact of SDNization on your Role in Networking (one page; please print on both sides)

Module / Date	Topics	Readings Guide/Due	Assignments Due
13 / 17 Apr	Impact of NFV on Business Data Communications	Part III of Ref.[3] and ETSI NFV documents (http://www.etsi.org/technologies-clusters/technologies/nfv)	A report on Virtualization/NFV and its impact on your Role in Networking (one page; please print on both sides)
14 / 24 Apr.	Presentation of Project	Open Discussion	*Submit FINAL Project Report*
15 / 01 May	Presentation of Project	Open Discussion	*Submit FINAL Project Report*
16 / 08 May	Final Exam <i>[BU Final Exam. Week, 7-11 May]</i>		Project presentation (final version of the slides), <i>and</i> uploading of the video of your presentation

Additional Resources

There are many open source tools for simulating and studying the impact of various parameters on the design and operations of link, transport and networking protocols. Here is a preliminary list of URLs and video clips that you may find useful.

- Network simulator using NS-3:
<https://www.nsnam.org/docs/manual>
- Riverbed Modeler (<https://www.riverbed.com>, formerly OpNet)
- UDP Simulation using NS-3:
<https://www.nsnam.org/docs/manual/html/index.html>
- TCP Models in NS-3:
<https://www.nsnam.org/docs/release/3.10/manual/html/tcp.html>
- IPv4 Network Simulation using NS-3:
<https://www.youtube.com/watch?v=zjLlu2-W6KA>
- Running IPv6 with GNS3 over IPv4 Tunnel:
<https://www.youtube.com/watch?v=oA6wgYxiSWA>
- Simulating Mobile IPv6 with NS-3:
<https://dl.acm.org/citation.cfm?id=1808203>
- Named Data network (NDN) Simulator:
<http://named-data.net/techreport/TR005-ndnsim.pdf>

A Sample of Internet (TCP/IP) Monitoring Tools

- TCPdump: <http://www.tcpdump.org>
- Wireshark/EtherReal: <https://www.wireshark.org>
- NetFlow: <https://en.wikipedia.org/wiki/NetFlow>
- sFlow: <https://en.wikipedia.org/wiki/SFlow>
- IP Flow Information Export (IPFIX):
https://en.wikipedia.org/wiki/IP_Flow_Information_Export
- DNS Tools: <http://www.dnsstuff.com>
- DHCP Server Audit Tools: <https://www.manageengine.com>
- Security Tools for IPv6: <https://github.com/toperaproject/topera#topera-project-page>

Information Services and Technology (IS&T) Technical Support

Assistance with course related technical problems is provided by the BU IS&T Help Center. In order to ensure the fastest possible response, please fill out the online form using the link below (IS&T Help Center Support):

- **Email:** ithelp@bu.edu (<mailto:ithelp@bu.edu>). Please use “BB Learn Question” in the subject line
- **Web:** <http://www.bu.edu/tech/web/coursesites/blackboardlearn>
(<http://www.bu.edu/tech/web/coursesites/blackboardlearn>)
- **Telephone:** +1- (888) 243-4596

Student Conduct Responsibilities

Notice of Criminal, Civil, and Administrative Responsibility

The legal and authorized use of the materials, software, applications, processes, techniques or services described in this course, presented in written or verbal form, are the sole responsibility and liability of the individual student. The course instructor and Boston University assume no liability as for any damages resulting from unauthorized use of the knowledge gained by student(s) from material covered in this course.

The content and use of the course materials, software, applications, processes, techniques or services described in presentation materials or conveyed verbally by the course instructor may be limited or restricted by federal, state or local criminal and/or civil laws or the acceptable use in corporations, businesses or organizations.

It is the responsibility of the student to ensure that they do not perform any action, process or technique that could violate any criminal, civil or administrative laws, regulations and/or policies.

There shall be no liability on the part of the course instructor for any loss or damage, direct or consequential arising from the use of this information or any action by student(s) that is determined to be in violation of any federal, state and/or local civil or criminal law, or for violation of any administrative regulation, policy or acceptable use policy that results in prosecution, or any loss, to include termination of employment, forfeiture, restitution or fines.

Student enrollment in this course will constitute an agreement to the aforementioned terms and conditions of student responsibilities and liabilities.

