RYERSON UNIVERSITY

Faculty of Engineering and Architectural Science
Computer Networks Program

CN8824: Server Networks

Calendar Description

The last decade has introduced a number of changes to the way that computing facilities are organized and used. The Internet became a strong motivating factor to decentralize computing and storage facilities. The new network-based computing architectures have emerged that enable combining geographically distributed resources to create world-wide super computers. The processing power and the storage resources of these powerful new systems can now be more easily and efficiently distributed among the end users through specialized communication networks forming virtual data centers.
The decentralized computing model inevitably leads to significant revisions in both individual and corporate computing practices. The ability to share computing and storage resources over the network on an unprecedented scale among an infinite number of geographically distributed groups results in a general-purpose, utility approach to computing. Ultimately, the computing and storage resources will have to be made available on demand, allocated from a pool of available resources and delivered immediately to the end user through the network.
The individual building blocks of these emerging computing environments represent a mix of networking, computing and storage technologies. The ability to design and manage such environments requires a solid understanding of theory and implementation procedures associated with each of the technologies. The goal of this course is to explore the individual building blocks and the integration procedures of the technologies driving this transformation -from the traditional server-centric to the virtual computing and storage architectures.

Course Details

1. Server and Storage Interconnect Technologies — 12 Hours
    - 1.1 Fibre Channel
        - 1.1.1 Overview
        - 1.1.2 Fibre Channel Protocol
        - 1.1.3 Fibre Channel Topologies and Operation
    - 1.2. Infiniband
        - 1.2.1 Core Concepts
        - 1.2.2 Queue Pair Creation and Operation
        - 1.2.3 Protection Mechanisms
        - 1.2.4 Transport Services
        - 1.2.5 Link and Physical Layers

- 1.2.6 Subnet Manager and Subnet Administration
- 1.2.7 General Services
- 1.3. FICON
  - 1.3.1 FICON Topologies and Modes
  - 1.3.2 FICON Elements
  - 1.3.3 FICON Support
- 1.4. Gigabit Ethernet
  - 1.4.1 Ethernet Protocol
  - 1.4.2 Gigabit Ethernet Topologies and Operation
  - 1.4.3 Throughput and Latency Calculation

2. Computer Virtualization 12 Hours
- 2.1 Computer Clustering
  - 2.1.1 Introduction to Cluster Concepts
  - 2.1.2 Cluster Architecture and Hardware Components
  - 2.1.3 Cluster Software Architecture
  - 2.1.4 Building and Deploying a Cluster
- 2.2 Grid Computing
  - 2.2.1 Grid Computing Technology
  - 2.2.2 Grid Computing Applications
  - 2.2.3 Grid Computing Worldwide Initiatives
- 2.3 Virtual Machines
  - 2.3.1 Technology Overview
  - 2.3.2 Virtual Networking
  - 2.3.3 Server Consolidation
  - 2.3.4 Administering a Virtual Infrastructure
- 2.4 Utility Computing
  - 2.4.1 Goals and Benefits of On-Demand Computing
  - 2.4.2 Utility Computing Tools and Applications

3. Storage Virtualization 12 Hours
- 3.1. File System
  - 3.1.1 File System Fundamentals
  - 3.1.2 Network File System (NFS)
- 3.2. Disk Systems and RAID
  - 3.2.1 Increasing Storage Capacity
  - 3.2.2 Improving Reliability
  - 3.2.3 Improving Speed
  - 3.2.4 Raid Levels
- 3.3. Bus Technologies
  - 3.3.1 Parallel SCSI
  - 3.3.2 Fibre Channel
  - 3.3.3 ATA
  - 3.3.4 SATA
- 3.4. SCSI
  - 3.4.1 SCSI Standard
  - 3.4.2 Introduction to SCSI Operation
  - 3.4.3 SCSI Command Descriptor Block (CDB)
  - 3.4.4 SCSI over Fibre Channel in Storage Networks
  - 3.4.5 ISCSI
- 3.5. Virtualization Techniques
  - 3.5.1 In-Band and Out-of-Band Virtualization
  - 3.5.2 Host-Based Storage Virtualization
  - 3.5.3 Interconnect-Based Storage Virtualization
  - 3.5.4 Storage-Based Virtualization
  - 3.5.5 File System Virtualization

3.6. Storage Network Design
3.6.1 The Network Attached Storage Approach
3.6.2 SAN Environments

Laboratory Assignments

1. Fibre Channel
2. Infiniband
3. Virtual Machine Configuration Using Xen or VMware.
4. Grid computing with Globus and Cisco VFrame
5. Linux Cluster Implementation (OSCAR, Rocks or OpenMosix)
6. Windows Server Clustering Service and Network Load Balancing Implementation
7. Windows Domain Implementation
    a. Domain User and Computer Accounts
    b. Windows Web and FTP Services
    c. Windows DNS and DHCP Servers
    d. Windows Remote Access and VPN
    e. Windows Routing
    f. Windows Certificate Services
8. Microsoft Exchange Server Setup
9. Microsoft ISA (Internet Security and Acceleration) Server Setup
10. RAID Implementation using FreeBSD or RedHat
11. ISCSI Target Implementation on RedHat.
12. ISCSI ISNS Service and Initiator Implementation on Windows and Linux

Recommended Texts

- *Building Clustered Linux Systems* by Robert W. Lucke, Prentice Hall, 2004, ISBN 0-13-144853-6
- *High Performance Linux Clusters with OSCAR, Rocks, OpenMosix, and MPI* by Joseph D. Sloan, O'Reilly, 2004, ISBN 0-596-00570-9
- *Grid Computing* by Joshy Joseph, Craig Fellenstein, IBM Press, 2003, ISBN 0-13-145660-1
- *Storage Networking Protocol Fundamentals* by James Long, Cisco Press, 2006, ISBN 1-58705-160-5
- *Designing Storage Area Networks: A Practical Reference for Implementing Fibre Channel and IP SANs*, Second Edition by Tom Clark, Addison Wesley Professional, 2003, ISBN 0-321-13650-0
- *Storage Virtualization: Technologies for Simplifying Data Storage and Management* by Tom Clark, Addison Wesley Professional, 2005, ISBN 0-321-26251-4
- *IP SANs: A Guide to iSCSI, iFCP, and FCIP Protocols for Storage Area Networks* by Tom Clark, Addison Wesley Professional, 2001, ISBN 0-201-75277-8
- *Storage Networking Fundamentals: An Introduction to Storage Devices, Subsystems, Applications, Management, and Filing Systems* by Marc Farley, Cisco Press, 2004, ISBN 1-58705-162-1

- *InfiniBand Network Architecture* by MindShare, Inc. , Tom Shanley, Addison Wesley Professional, 2002 ISBN 0-321-11765-4
- *Virtualization with VMware ESX Server* by Al Muller, Seburn Wilson, Syngress, 2005, ISBN 1-59749-019-9
- *Microsoft Windows Server 2003 Administrator's Companion*, Second Edition by Charlie Russel, Sharon Crawford, Jason Gerend, Microsoft Press, 2006, ISBN 0-7356-2047-4

Course Evaluation

Lab Participation and Reports	35%
Mid-Term Test	25%
Final Exam	40%

Missed Classes and/or Evaluations

Students are required to inform their instructors of any situation which arises during the semester which may have an adverse effect upon their academic performance, and must request any considerations and accommodations according to the relevant policies and well in advance. Failure to do so will jeopardize any academic appeals.

- *Medical certificates* – If a student misses the deadline for submitting an assignment, or the date of an exam or other evaluation component because of illness, he or she must submit a Ryerson Student Medical Certificate AND an Academic Consideration form within 3 working days of the missed date. Both documents are available at www.ryerson.ca/senate/forms/medical.pdf. If you are a full-time or part-time degree student, then you submit your forms to your own program department or school. If you are a certificate or non-certificate student, then you submit your forms to the staff at the front desk of the Chang School.
- *Religious observance* – If a student needs accommodation because of religious observance, he or she must submit a Request for Accommodation of Student Religious, Aboriginal and Spiritual Observance AND an Academic Consideration form within the first 2 weeks of the class or, for a final examination, within 2 weeks of the posting of the examination schedule. If the required absence occurs within the first 2 weeks of classes, or the dates are not known well in advance as they are linked to other conditions, these forms should be submitted with as much lead time as possible in advance of the required absence. Both documents are available at http://www.ryerson.ca/senate/forms/relobservforminstr.pdf. If you are a full-time or part-time degree student, then you submit the forms to your own program department or school. If you are a certificate or non-certificate student, then you submit the forms to the staff at the front desk of the Chang School.
- *Students with disabilities* – In order to facilitate the academic success and access of students with disabilities, they should register with the Access Centre http://www.ryerson.ca/studentservices/accesscentre/index.html. Before the first graded work is due, students should also inform their instructor through an "Accommodation

Form for Professors" that they are registered with the Access Centre and what accommodations are required.

Academic Integrity and Plagiarism

Ryerson's Policy 60 (the *Student Code of Academic Conduct)* applies to all students at the University. The policy and its procedures are triggered in the event that the there is a suspicion that a student has engaged in a form of academic misconduct.

Forms of academic misconduct include plagiarism, cheating, supplying false information to the University, and other acts. The most common form of academic misconduct is plagiarism. Plagiarism is a serious academic offence and penalties can be severe. In any academic exercise, plagiarism occurs when one offers as one's own work the words, data, ideas, arguments, calculations, designs or productions of another without appropriate attribution or when one allows one's work to be copied.

All academic work must be submitted using the citation style approved by the instructor. The most common citation style is APA. Students may refer to the Ryerson Library for APA style guide references: http://library.ryerson.ca/guides/toolbox/style/

It is assumed that all examinations and work submitted for evaluation and course credit will be the product of individual effort, except in the case of group projects arranged for and approved by the course instructor. Submitting the same work to more than one course, without instructor approval, is also considered a form of plagiarism.

Students are advised that suspicions of academic misconduct may be referred to the Academic Integrity Office (AIO). Students who are charged with academic misconduct will have a Disciplinary Notation (DN) placed on their academic record (not on their transcript) and will be assigned one or more of the following penalties:

- A grade reduction for the plagiarized work
- A zero for the plagiarized work
- An F in the course
- More serious penalties up to and including expulsion from the University

For more detailed information on these issues, please refer to the full online text for the *Student Code of Academic Conduct* at http://www.ryerson.ca/senate/policies/pol60-F2014.pdf and the Academic Integrity Website at www.ryerson.ca/ai.