Master of Engineering in
Internetworking

Laboratory Guide

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LIST OF SYMBOLS AND ABBREVIATIONS

CLI Command Line Interface

INWK Internetworking Program

NIC Network Interface Card

OSI Open System Interconnection

VLAN Virtual Local Area Network

1 INTRODUCTION

This document is prepared by the Program Instructors at the Master's of Engineering in Internetworking (INWK) program to introduce students to the laboratory facilities and the proper way to use them. Students are encouraged to take full advantage of the available facilities to gain the hands-on experience they need to acquire knowledge and advance their careers within the parameters set by the program's administration.

The Program Instructors are always ready to help students with any problem regarding access to the laboratory facilities and welcomes any suggestion that may improve their operations.

2 EQUIPMENT

Network devices are classified according to the OSI (Open System Interconnect) layer in which they work. For instance, a hub is a layer 1 device, bridges and switches are layer 2 devices, and routers are layer 3 devices. Moreover, some devices can work in two or more layers depending on their configuration. The laboratory includes devices that work in almost all OSI layers.
Network devices can be also classified as either enterprise level devices or carrier level devices. Enterprise level devices are usually used in small and medium sized networks. They are easily configured for a wide range of purposes. The laboratory includes a large number of devices that belong to this category. Most of these devices are from Cisco Systems.

Most of the work in the laboratory will be conducted using the following set of devices:

1. Cisco 3925 routers
2. Cisco's Catalyst 3560 switches
3. Cisco's Catalyst 3550 switches
4. Cisco's Catalyst 2950 switches
5. Cisco`s 1261N (Access Point)
6. Sniffer PCs (for traffic analysis)
7. Workstation PCs
8. WLAN Controllers Version 7.0.116.0

Occasionally, other devices will be used as well.

3 EQUIPMENT ROOM

All networking devices are located in the equipment room. The devices are mounted in racks. Figure 3-1 shows a top view of the equipment room floor and the location of the racks. Equipment in racks is further arranged in pods according to the usage.

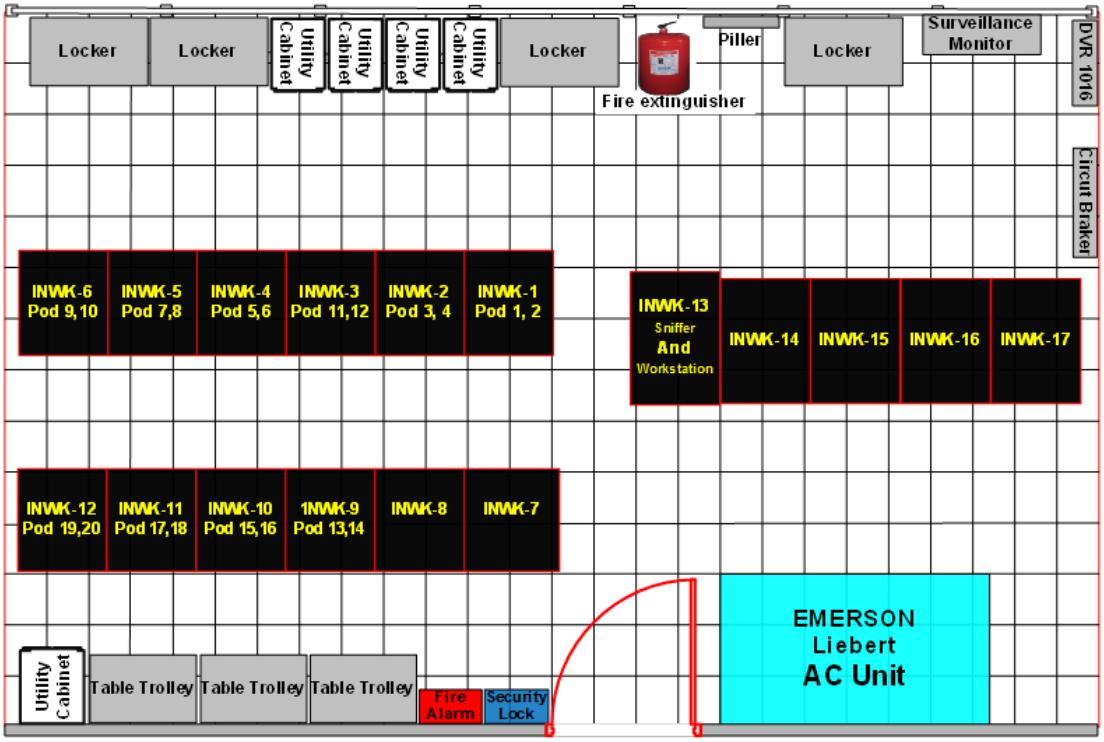


Figure 3-1 View of Equipment Room

The enterprise level devices, which will be used extensively throughout the program, are mounted in twenty functionally identical pods. These pods will be referred to as *Student Pods*. Figure 3.1 shows the location of *Student Pods* in the equipment room. Each student pod has the set of devices shown in Table 3-1.

Table 3-1 Contents of Student Pods (Pods 1 to 20)

Devices	*Quantity*
Cisco 2800 Terminal Server	1 per rack
Cisco 3925 routers	4
Catalyst 3560 switch	1
Catalyst 3550 switch	1
Catalyst 2950 switch	1
Cisco 1261N Access Point	2
Sniffer PC for Traffic analysis	1
Workstation PC`s	1
WLAN Controller	1

The head racks at the far end of the room contain patch panels and devices that connect all equipment to classroom computers and the Internet

4 LABORATORIES

The 2 main laboratories, A201 and A222, are where some of the lectures and presentations are delivered, and all laboratory work is performed. For this purpose they are equipped with whiteboard, projector, screens, and comfortable desks and chairs.
A201 contains 36 workstations and A222 contains 30. A222 is also the student training room and contains the training racks. Each workstation has all software applications that complement the program's requirements. Linux OS is installed on the lab room computers, among others, office 365 applications (word processor and spreadsheet etc.) are available from internet through myDal website.

Internet access from the laboratories allows students to do the following:

1. Access network devices in the equipment room remotely
2. Access the universities libraries and their recourses
3. Exchange emails and receive notices about current events in the INWK program.

The laboratories are also equipped with Printers so that students can submit their assignments and reports in hardcopy format if they are required to do so.
To access the workstations, students have to get an account on the local server (this is not the same as Dalhousie's account). Program Instructors can provide the username and password for each student account.

5 ACCESS TO EQUIPMENT ROOM DEVICES

Networking devices can be accessed and configured out-of-band using CLI (Command Line Interface) or Menu driven interface. The most common, and the simplest, method to configure a device is to attach a PC to the device's console port using RS-232 cable and use terminal emulation software to access the CLI. However in the INWK case the equipment in the Equipment Room must be accessed through Terminal Servers as noted below.

The laboratory is designed to enable students to access the CLI of most devices remotely through the Internet. Each pod is equipped with a terminal server. The terminal servers use a technique called Reverse Telnet to connect the devices' console ports to the Internet. Authorized students who have access to the Internet can establish a Telnet session to the terminal server and log into the device as though they are connected to it directly.

To access the devices in student pods, use either one of the following methods:

a) Follow the links in http://inwk01.inwk.dal.ca.
b) Establish a Telnet session from a Linux PC (using a Telnet application) with the URL termsrv***xx***.inwk.dal.ca: ***yyyy***

The information of xx and yy can be obtained from Appendix A.

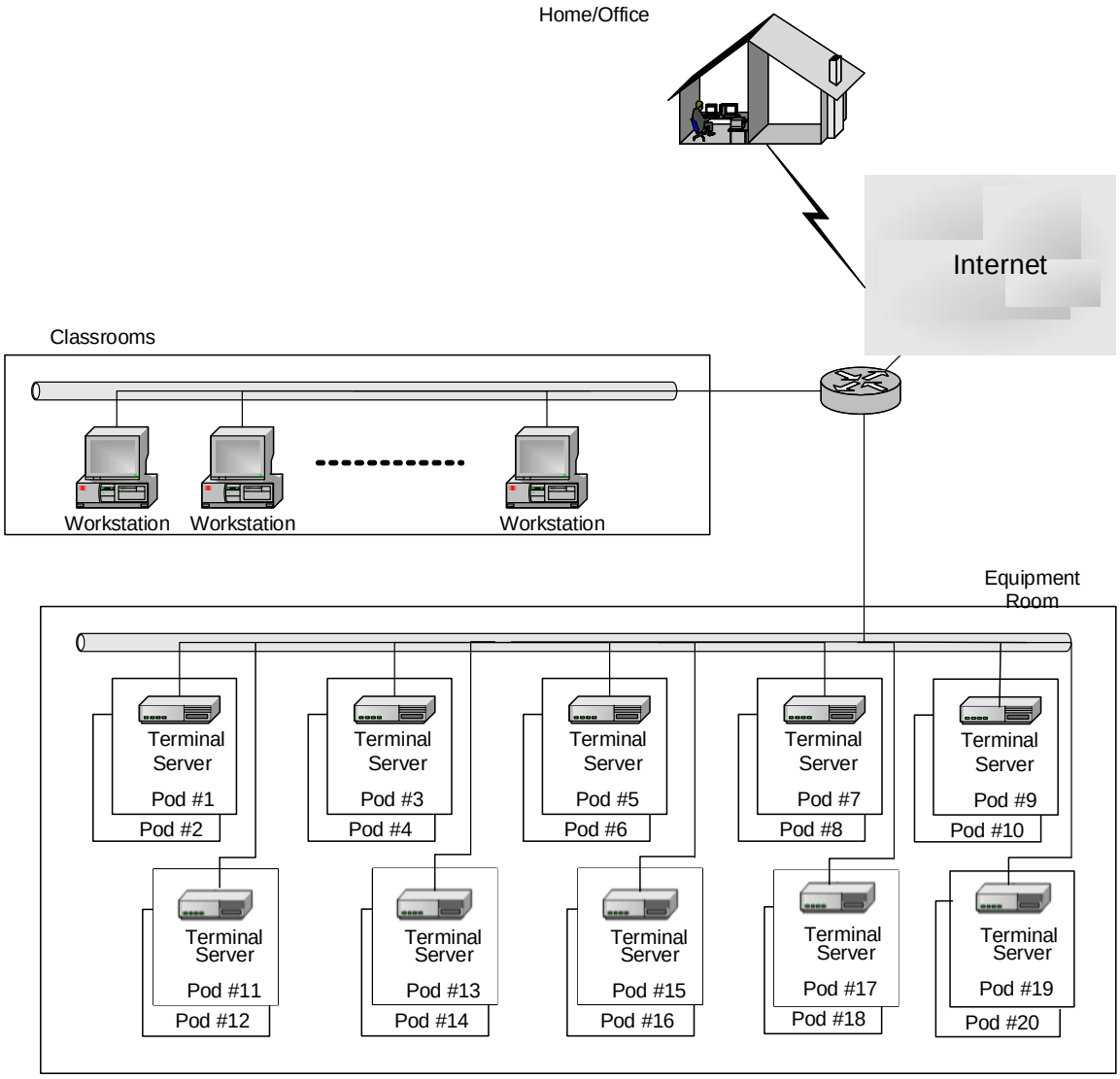
Only one user at a time can access the router using the above procedure. If the attempt to establish a connection refused, another user is probably using the router. The remote connection is considered a console connection. It remains active even if the device is powered off.

5.1 Connection procedure to workstation and sniffers:

1. The IP addresses of workstations and sniffers can be obtained from Appendix B.
2. Access the workstation or sniffer by using the private IP address through rdesktop in the Linux command line.
3. The workstation or sniffer can be accessed by using the username (student) and password (Obtained from instructor).
4. As per LAB requirement change the IP address of the LAN Card named "Sniff".

CAUTION!! Do not change the IP address of the LAN card named **"Internet / Public"**

Figure 5-1 shows a simplified illustration of the laboratory's network:



Twenty Pods are connected to the internet through terminal servers

Figure 5-1 Remote Access

6 FIXED WIRING

The collection of network devices available to the students allows them to build networks of numerous combinations of topologies and configurations. Since not all laboratory users can be physically present in the equipment room, the devices are wired in a manner that allows users to construct networks of different topologies without the need to change the physical wiring. The fixed wiring provides students with the flexibility to work from home, if such access is granted by the Administrative Office, to finish their assignments or practice configuring networks to acquire industrial certifications.

Connection and configuration is accomplished using different techniques including the use of Virtual LANs (VLAN) for Ethernet networks.

Figure 6-1 shows an example of how VLANs can be used to build Ethernet networks of different topologies using nodes attached to an Ethernet switch.

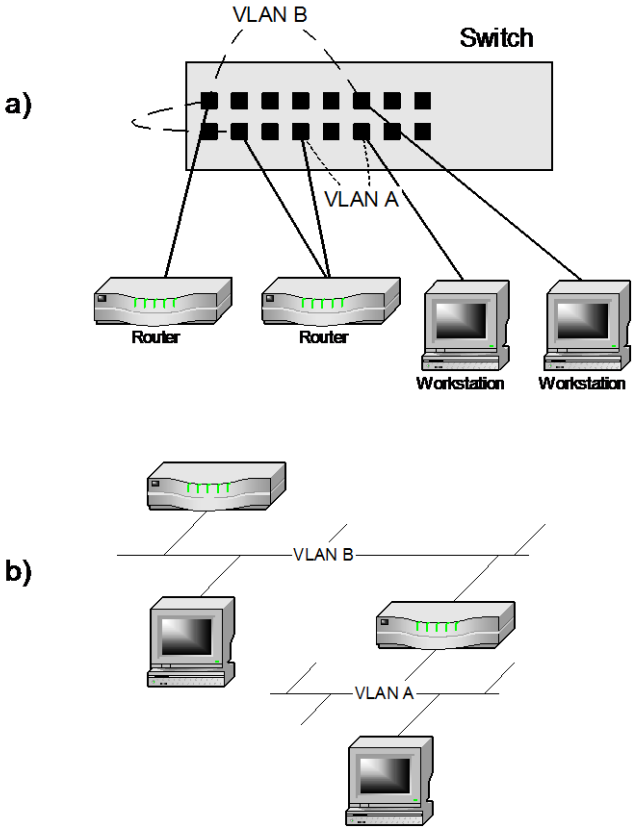


Figure 6-1 a) Physical connections; b) Logical connections

Figure 6-2 shows the current layout of a single student pod. All four routers are connected to the switch S1.

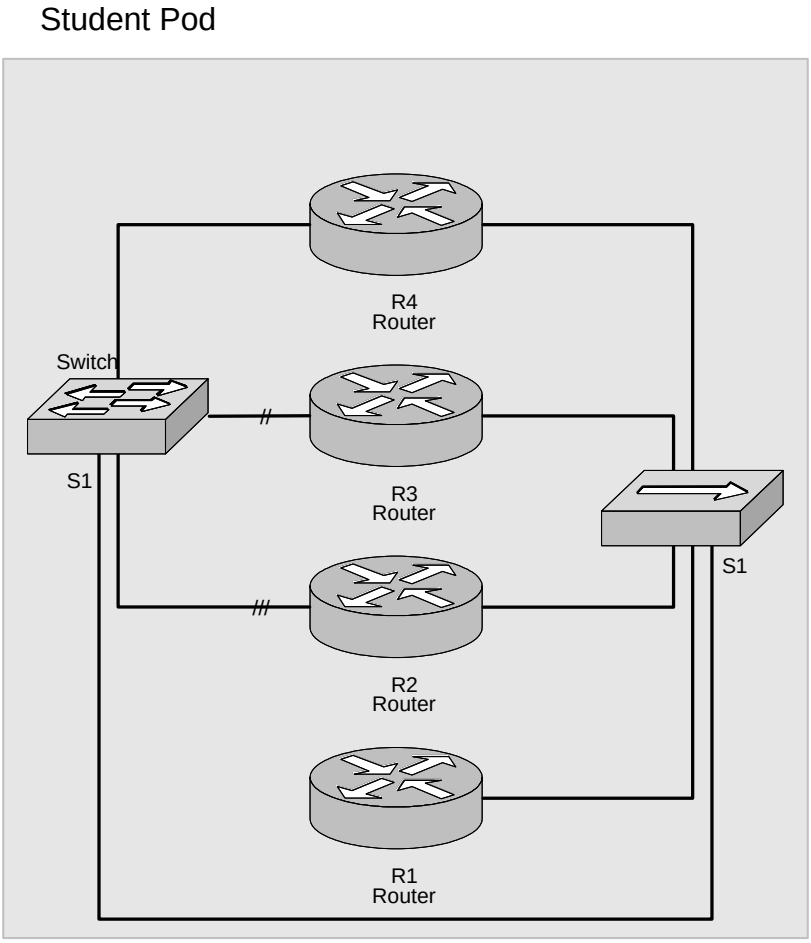


Figure 6-2 Ethernet Connections

Students can consult the Q&A section of the laboratory web site for more details about how to set up different network topologies using the laboratory's fixed wiring scheme.

7 LAN SNIFFERS/WORKSTATIONS

Students can use sniffers / workstations installed in all pods to monitor the network traffic. Wire Shark software uses the network interface card (NIC) in promiscuous mode to capture the traffic of the local area network. Each of the above pods is equipped with one sniffer PC and one Workstation PC. Each PC has three NICs. The first NIC is for sniffing, the second NIC is for access and the third is connected to the Pod. The IP address given in "Appendix B" can be used to setup a connection which enable access from Laboratory PC to the sniffer PC in a particular pod. Figure 7-1 illustrates the connection in more details.

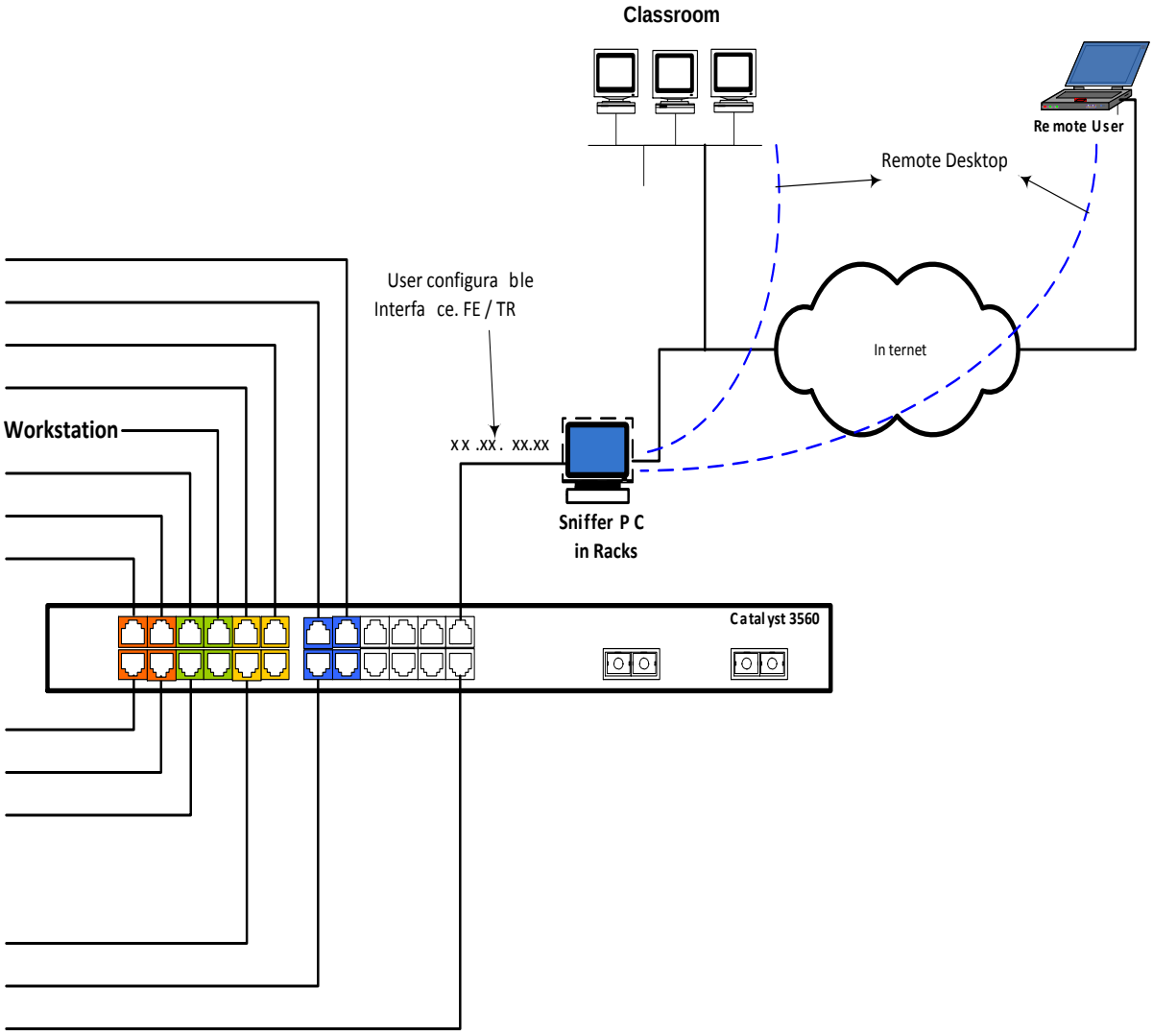


Figure 7-1 Accessing LAN Analyzers for Pods 1 to 20

8 ACCESS RULES

The laboratory facilities are available to students during course time. The use of the equipment outside laboratory times is permitted for experiment completion and troubleshooting exercises. To facilitate this, time is allocated to each group in a class for equipment use linked to laboratory work.

Access to INWK self-training equipment in A222 and at times in the Equipment Room, on an availability basis, is a privilege granted to enrolled students. Access is from the laboratories. Any equipment made available to students must be "signed out" at specific time slots. The equipment in A222 may be self-wired by the students. Other fixed wiring pods in the Equipment Room may from time to time be made available for sign out and remote access, when pre-approved, outside class use for self-training purposes.

A student may only sign out 2 slots and may not sign out another slot until after the second slot has started. If a slot is unused by the signee after 25% of the slot duration has passed another person may use it.

The equipment in A222 is only for self-training outside designated class/laboratory hours scheduled in A222. Once pre-configured, the equipment can be accessed remotely (from off campus) only if a student is granted this privilege by the Administrative Office. (In general access has to be made from with the INWK Facility and only under special circumstance will access from outside the INWK Facility be granted.)

Each week, an assignment sheet like the one shown in Figure 8-1 will be available to students. Students can sign their username in an empty session in accordance with the rules and use the pods within the time indicated in the sheet.

Internetworking Laboratory Equipment Assignment Sheet					
		Pod No.	Month		
	Time slots	08:00 AM - 12.00 PM	12:30 PM - 4.30 PM	5:00 PM - 9.00 PM	09:30 PM - 1.30 AM
1	Friday				
2	Saturday				
3	Sunday				
4	Monday				
5	Tuesday				
6	Wednesday				
7	Thursday				
8	Friday				
9	Saturday				
10	Sunday				
11	Monday				
12	Tuesday				
13	Wednesday				
14	Thursday				
15	Friday				
16	Saturday				
17	Sunday				
18	Monday				
19	Tuesday				
20	Wednesday				
21	Thursday				
22	Friday				
23	Saturday				
24	Sunday				
25	Monday				
26	Tuesday				
27	Wednesday				
28	Thursday				
29	Friday				
30	Saturday				
31	Sunday				

Figure 8-1Assignment Sheet

There are a few rules the govern access to any equipment. These rules are needed to provide fair opportunity to all students:

1. Priority on use of pods of equipment is given to the following groups in descending order:

   - Program staff (for laboratories, laboratory preparation and maintenance, however every attempt will be made to always have some access available for students and one laboratory available to students)
   - Students of currently running courses (for class laboratories)
   - Students currently enrolled in the program (for self-training)
   - Students who have graduated (for self-training). However this privilege is rarely granted due to the high equipment load.

   Groups of lower priority may have their sessions terminated by the technical staff to permit higher priority activities to proceed.
2. A student may not sign up for more than two 4-hour sessions (8 hours) a week at a time (a second 8 hours may only be signed out when a previously signed up session has started.) During course hours no pod may be signed out.
3. Students may only use equipment designated for self-training when they have booked time.
4. The only password allowed on any piece of equipment is *"inwk"*.

5. Students who are not in Halifax must contact the Program Manager by e-mail to seek permission to use the equipment. Permission will be granted/denied at discretion of the Program Manager.
6. Access to equipment outside any pods assigned for student training has to be arranged in advance with the Program Manager.

The same rules apply to any training racks made available to students (the currently running program priority group does not apply.)

The penalty of violating these rules is the possibility of removal of privileges. This may mean disabling of the INWK account or removal of the right of access to the premises outside normal class hours.

9 APPENDIX A

9.1 Telnet Router's and Switch's Information

Table 9-1 POD 1Terminal Servers

URL	Port#	Machine
Termsrv28.inwk.dal.ca	2002	1R1
Termsrv28.inwk.dal.ca	2003	1R2
Termsrv28.inwk.dal.ca	2004	1R3
Termsrv28.inwk.dal.ca	2005	1R4
Termsrv28.inwk.dal.ca	2006	1S1
Termsrv28.inwk.dal.ca	2007	1S2
Termsrv28.inwk.dal.ca	2008	1S3
Termsrv28.inwk.dal.ca	2013	AP1
Termsrv28.inwk.dal.ca	2014	AP2

Table 9-2 POD 2 Terminal Servers

URL	Port#	Machine
Termsrv28.inwk.dal.ca	2018	2R1
Termsrv28.inwk.dal.ca	2019	2R2
Termsrv28.inwk.dal.ca	2020	2R3
Termsrv28.inwk.dal.ca	2021	2R4
Termsrv28.inwk.dal.ca	2022	2S1
Termsrv28.inwk.dal.ca	2023	2S2
Termsrv28.inwk.dal.ca	2024	2S3
Termsrv28.inwk.dal.ca	2029	AP1
Termsrv28.inwk.dal.ca	2030	AP2

Table 9-3 POD 3 Terminal Servers

URL	Port#	Machine
Termsrv27.inwk.dal.ca	2002	3R1

Termsrv27.inwk.dal.ca	2003	3R2
Termsrv27.inwk.dal.ca	2004	3R3
Termsrv27.inwk.dal.ca	2005	3R4
Termsrv27.inwk.dal.ca	2006	3S1
Termsrv27.inwk.dal.ca	2007	3S2
Termsrv27.inwk.dal.ca	2008	3S3
Termsrv27.inwk.dal.ca	2013	AP1
Termsrv27.inwk.dal.ca	2014	AP2

Table 9-4 POD 4 Terminal Servers

URL	**Port#**	**Machine**
Termsrv27.inwk.dal.ca	2018	4R1
Termsrv27.inwk.dal.ca	2019	4R2
Termsrv27.inwk.dal.ca	2020	4R3
Termsrv27.inwk.dal.ca	2021	4R4
Termsrv27.inwk.dal.ca	2022	4S1
Termsrv27.inwk.dal.ca	2023	4S2
Termsrv27.inwk.dal.ca	2024	4S3
Termsrv27.inwk.dal.ca	2029	AP1
Termsrv27.inwk.dal.ca	2030	AP2

Table 9-5 POD 5 Terminal Servers

URL	**Port#**	**Machine**
Termsrv13.inwk.dal.ca	2002	5R1
Termsrv13.inwk.dal.ca	2003	5R2
Termsrv13.inwk.dal.ca	2004	5R3
Termsrv13.inwk.dal.ca	2005	5R4
Termsrv13.inwk.dal.ca	2006	5S1
Termsrv13.inwk.dal.ca	2007	5S2
Termsrv13.inwk.dal.ca	2008	5S3
Termsrv13.inwk.dal.ca	2013	AP1
Termsrv13.inwk.dal.ca	2014	AP2

Table 9-6 POD 6 Terminal Servers

URL	Port#	Machine
Termsrv13.inwk.dal.ca	2018	6R1
Termsrv13.inwk.dal.ca	2019	6R2
Termsrv13.inwk.dal.ca	2020	6R3
Termsrv13.inwk.dal.ca	2021	6R4
Termsrv13.inwk.dal.ca	2022	6S1
Termsrv13.inwk.dal.ca	2023	6S2
Termsrv13.inwk.dal.ca	2024	6S3
Termsrv13.inwk.dal.ca	2029	AP1
Termsrv13.inwk.dal.ca	2030	AP2

Table 9-7 POD 7 Terminal Servers

URL	Port#	Machine
Termsrv31.inwk.dal.ca	2002	7R1
Termsrv31.inwk.dal.ca	2003	7R2
Termsrv31.inwk.dal.ca	2004	7R3
Termsrv31.inwk.dal.ca	2005	7R4
Termsrv31.inwk.dal.ca	2006	7S1
Termsrv31.inwk.dal.ca	2007	7S2
Termsrv31.inwk.dal.ca	2008	7S3
Termsrv31.inwk.dal.ca	2013	AP1
Termsrv31.inwk.dal.ca	2014	AP2

Table 9-8 POD 8 Terminal Servers

URL	Port#	Machine
Termsrv31.inwk.dal.ca	2018	8R1
Termsrv31.inwk.dal.ca	2019	8R2
Termsrv31.inwk.dal.ca	2020	8R3
Termsrv31.inwk.dal.ca	2021	8R4
Termsrv31.inwk.dal.ca	2022	8S1
Termsrv31.inwk.dal.ca	2023	8S2
Termsrv31.inwk.dal.ca	2024	8S3

Termsrv31.inwk.dal.ca	2029	AP1
Termsrv31.inwk.dal.ca	2030	AP2

Table 9-9 POD 9 Terminal Servers

URL	Port#	Machine
Termsrv16.inwk.dal.ca	2002	9R1
Termsrv16.inwk.dal.ca	2003	9R2
Termsrv16.inwk.dal.ca	2004	9R3
Termsrv16.inwk.dal.ca	2005	9R4
Termsrv16.inwk.dal.ca	2006	9S1
Termsrv16.inwk.dal.ca	2007	9S2
Termsrv16.inwk.dal.ca	2008	9S3
Termsrv16.inwk.dal.ca	2013	AP1
Termsrv16.inwk.dal.ca	2014	AP2

Table 9-10 POD 10 Terminal Servers

URL	Port#	Machine
Termsrv16.inwk.dal.ca	2018	10R1
Termsrv16.inwk.dal.ca	2019	10R2
Termsrv16.inwk.dal.ca	2020	10R3
Termsrv16.inwk.dal.ca	2021	10R4
Termsrv16.inwk.dal.ca	2022	10S1
Termsrv16.inwk.dal.ca	2023	10S2
Termsrv16.inwk.dal.ca	2024	10S3
Termsrv16.inwk.dal.ca	2029	AP1
Termsrv16.inwk.dal.ca	2030	AP2

Table 9-11 POD 11 Terminal Servers

URL	Port#	Machine
Termsrv14.inwk.dal.ca	2033	11R1
Termsrv14.inwk.dal.ca	2034	11R2
Termsrv14.inwk.dal.ca	2035	11R3
Termsrv14.inwk.dal.ca	2036	11R4

Termsrv14.inwk.dal.ca	2037	11S1
Termsrv14.inwk.dal.ca	2038	11S2
Termsrv14.inwk.dal.ca	2039	11S3
Termsrv14.inwk.dal.ca	2044	AP1
Termsrv14.inwk.dal.ca	2045	AP2

Table 9-12 POD 12 Terminal Servers

URL	Port#	Machine
Termsrv11.inwk.dal.ca	2033	12R1
Termsrv11.inwk.dal.ca	2034	12R2
Termsrv11.inwk.dal.ca	2035	12R3
Termsrv11.inwk.dal.ca	2036	12R4
Termsrv11.inwk.dal.ca	2037	12S1
Termsrv11.inwk.dal.ca	2038	12S2
Termsrv11.inwk.dal.ca	2039	12S3
Termsrv11.inwk.dal.ca	2044	AP1
Termsrv11.inwk.dal.ca	2045	AP2

Table 9-13 POD 13 Terminal Servers

URL	Port#	Machine
Termsrv26.inwk.dal.ca	2002	13R1
Termsrv26.inwk.dal.ca	2003	13R2
Termsrv26.inwk.dal.ca	2004	13R3
Termsrv26.inwk.dal.ca	2005	13R4
Termsrv26.inwk.dal.ca	2006	13S1
Termsrv26.inwk.dal.ca	2007	13S2
Termsrv26.inwk.dal.ca	2008	13S3
Termsrv26.inwk.dal.ca	2013	AP1
Termsrv26.inwk.dal.ca	2014	AP2

Table 9-14 POD 14 Terminal Servers

URL	Port#	Machine
Termsrv26.inwk.dal.ca	2008	14R1

Termsrv26.inwk.dal.ca	2009	14R2
Termsrv26.inwk.dal.ca	2010	14R3
Termsrv26.inwk.dal.ca	2011	14R4
Termsrv26.inwk.dal.ca	2012	14S1
Termsrv26.inwk.dal.ca	2013	14S2
Termsrv26.inwk.dal.ca	2014	14S3
Termsrv26.inwk.dal.ca	2029	AP1
Termsrv26.inwk.dal.ca	2030	AP2

Table 9-15 POD 15 Terminal Servers

URL	**Port#**	**Machine**
Termsrv34.inwk.dal.ca	2003	15R1
Termsrv34.inwk.dal.ca	2004	15R2
Termsrv34.inwk.dal.ca	2005	15R3
Termsrv34.inwk.dal.ca	2006	15R4
Termsrv34.inwk.dal.ca	2007	15S1
Termsrv34.inwk.dal.ca	2008	15S2
Termsrv34.inwk.dal.ca	2009	15S3
Termsrv34.inwk.dal.ca	2014	AP1
Termsrv34.inwk.dal.ca	2015	AP2

Table 9-16 POD 16 Terminal Servers

URL	**Port#**	**Machine**
Termsrv34.inwk.dal.ca	2019	16R1
Termsrv34.inwk.dal.ca	2020	16R2
Termsrv34.inwk.dal.ca	2021	16R3
Termsrv34.inwk.dal.ca	2022	16R4
Termsrv34.inwk.dal.ca	2023	16S1
Termsrv34.inwk.dal.ca	2024	16S2
Termsrv34.inwk.dal.ca	2025	16S3
Termsrv34.inwk.dal.ca	2030	AP1
Termsrv34.inwk.dal.ca	2031	AP2

Table 9-17 POD 17 Terminal Servers

URL	Port#	Machine
Termsrv35.inwk.dal.ca	2003	17R1
Termsrv35.inwk.dal.ca	2004	17R2
Termsrv35.inwk.dal.ca	2005	17R3
Termsrv35.inwk.dal.ca	2006	17R4
Termsrv35.inwk.dal.ca	2007	17S1
Termsrv35.inwk.dal.ca	2008	17S2
Termsrv35.inwk.dal.ca	2009	17S3
Termsrv35.inwk.dal.ca	2014	AP1
Termsrv35.inwk.dal.ca	2015	AP2

Table 9-18 POD 18 Terminal Servers

URL	Port#	Machine
Termsrv35.inwk.dal.ca	2019	18R1
Termsrv35.inwk.dal.ca	2020	18R2
Termsrv35.inwk.dal.ca	2021	18R3
Termsrv35.inwk.dal.ca	2022	18R4
Termsrv35.inwk.dal.ca	2023	18S1
Termsrv35.inwk.dal.ca	2024	18S2
Termsrv35.inwk.dal.ca	2025	18S3
Termsrv35.inwk.dal.ca	2030	AP1
Termsrv35.inwk.dal.ca	2031	AP2

Table 9-19 POD 19 Terminal Servers

URL	Port#	Machine
Termsrv32.inwk.dal.ca	2002	19R1
Termsrv32.inwk.dal.ca	2003	19R2
Termsrv32.inwk.dal.ca	2004	19R3
Termsrv32.inwk.dal.ca	2005	19R4
Termsrv32.inwk.dal.ca	2006	19S1
Termsrv32.inwk.dal.ca	2007	19S2
Termsrv32.inwk.dal.ca	2008	19S3

Termsrv32.inwk.dal.ca	2013	AP1
Termsrv32.inwk.dal.ca	2014	AP2

Table 9-20 POD 20 Terminal Servers

URL	**Port#**	**Machine**
Termsrv32.inwk.dal.ca	2018	19R1
Termsrv32.inwk.dal.ca	2019	19R2
Termsrv32.inwk.dal.ca	2020	19R3
Termsrv32.inwk.dal.ca	2021	19R4
Termsrv32.inwk.dal.ca	2022	19S1
Termsrv32.inwk.dal.ca	2023	19S2
Termsrv32.inwk.dal.ca	2024	19S3
Termsrv32.inwk.dal.ca	2029	AP1
Termsrv32.inwk.dal.ca	2030	AP2

10 APPENDIX B

10.1 Workstations IP addresses

Table 10-1 Workstation IP Addresses

Hostname	Private IP Address
Workstation01	**192.168.10.11**
Workstation02	**192.168.10.12**
Workstation03	**192.168.10.13**
Workstation04	**192.168.10.14**
Workstation05	**192.168.10.15**
Workstation06	**192.168.10.16**
Workstation07	**192.168.10.17**
Workstation08	**192.168.10.18**
Workstation09	**192.168.10.19**
Workstation10	**192.168.10.20**
Workstation11	**192.168.10.21**
Workstation12	**192.168.10.22**
Workstation13	**192.168.10.23**
Workstation14	**192.168.10.24**
Workstation15	**192.168.10.25**
Workstation16	**192.168.10.26**
Workstation17	**192.168.10.27**
Workstation18	**192.168.10.28**
Workstation19	**192.168.10.29**
Workstation20	**192.168.10.30**

10.2 Sniffers IP addresses

Table 10-2 Sniffer IP Addresses

Hostname	Private IP Address
Sniffer01	**192.168.10.101**
Sniffer02	**192.168.10.102**
Sniffer03	**192.168.10.103**
Sniffer04	**192.168.10.104**
Sniffer05	**192.168.10.105**
Sniffer06	**192.168.10.106**
Sniffer07	**192.168.10.107**
Sniffer08	**192.168.10.108**
Sniffer09	**192.168.10.109**
Sniffer10	**192.168.10.110**
Sniffer11	**192.168.10.111**
Sniffer12	**192.168.10.112**
Sniffer13	**192.168.10.113**
Sniffer14	**192.168.10.114**
Sniffer15	**192.168.10.115**
Sniffer16	**192.168.10.116**
Sniffer17	**192.168.10.117**
Sniffer18	**192.168.10.118**
Sniffer19	**192.168.10.119**
Sniffer20	**192.168.10.120**