A

Guidance for Instructors

CONTENTS

Instructor's functions and roadmap

The default registration role is normal user (or student). To get the instructor role (or super user), the user needs to contact system administrator to get the user's privilege upgraded. As an instructor role, you will see a list of "Super user functions" on the left navigation bar shown in Figure A.1.

To illustrate how an instructor uses ThoTh lab, in Figure A.2, we present a roadmap for instructor to follow. Particularly, the roadmap is built based on the main instructor's functions. In the roadmap, it includes four main steps, in which the highlighted (yellow) procedures are optional. The first step is group management including (a) create a group, (b) add group members, and (c) change group members' roles. These three steps are option if the ThoTh lab system retrieve the group information and members' roles information automatically through the SSO and LTI functions. ThoTh lab will be automatically retrieve the roster and users' roles from an integrated learning management system, e.g., canvas or blackboard.

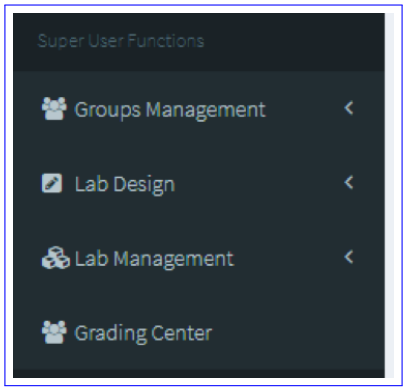

Figure A.1
ThoTh Lab Super User functions.

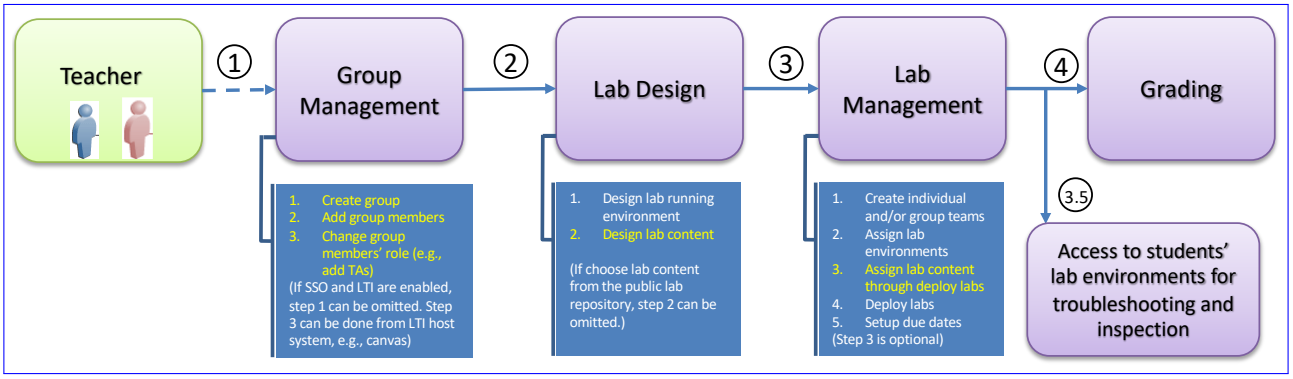

Figure A.2
Roadmap for instructors.

The second step is lab design, in which it includes lab running environment design and lab content design. In ThoTh lab, the we maintain a public lab repository that allow all users to retrieve the lab information and deploy them in their classes. Thus, the design lab content is optional if the instructor selects an already established lab content. In this procedure, the design a lab running environment is a must, in which we need to design a lab running environment and deploy it later.

The third step is the lab management, in which it includes (a) create individual and/or group teams, (b) assign lab environment, (c) assign lab content through deploy lab function, (d) deploy labs, and (5) set up the lab running due date. Among these 5 operations, the step (c) assigning lab content through deploy lab function is optional. This is because ThoTh lab may simply just host lab running environment for students.

If the instructor prefers, he/she can access to students' lab running environments for troubleshooting and lab performance inspection, which is scheduled as step 3.5. However, this step is optional and the instructor may solely base on students' submitted project report to measure his/her hands-on lab performance.

Finally, the last step is grading by using the grading center's policy. It is up to the subjective performance evaluation by the instructor or TA to measure individual users' performance. We must note that ThoTh Lab provide script-based auto-grading approaches. It requires students to provide system set up functions and the system can measure the key milestone to evaluate the overall students' performance.

In the following sections, we will discus how each super user (instructor) to use the presented instructor functions.

Create a new group (class) and recruit students

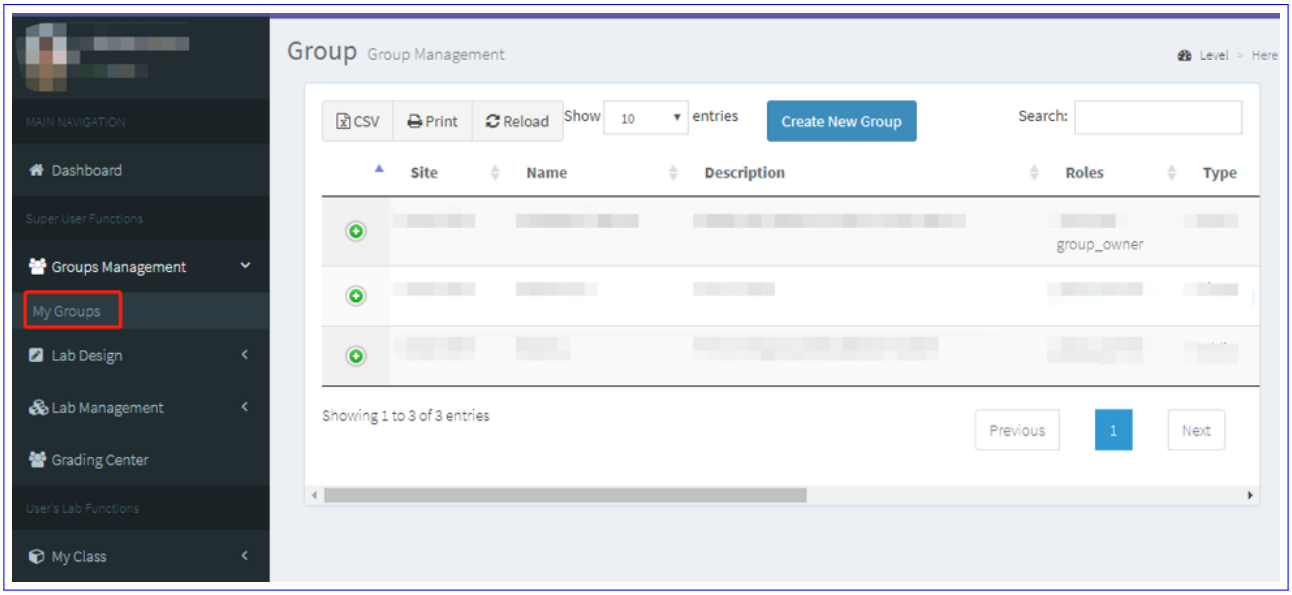

Figure A.3
ThoTh Lab Group management.

To create a new group, on the home page, click on *Group Management*→*My Groups* in the menu on the left. A table of groups will appear, as shown in Figure A.3.

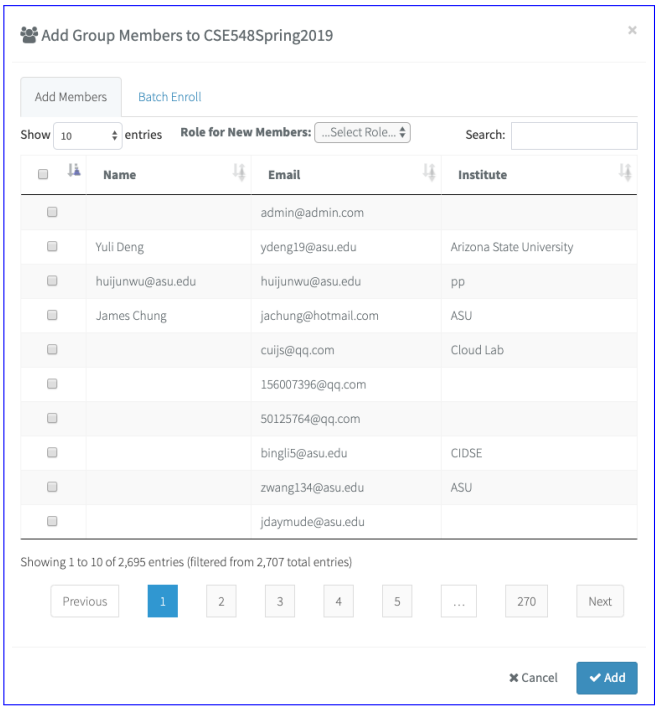

Figure A.4
ThoTh Lab add group member.

As a new user, you will see an empty table. To create a new group, please click on *Create New Group*, input group name and description and then click on *Create*. The next step is to add your students into the newly create group. Click on the Green icon *Next* to your group, you will see a sub-table with *Add Members* and *Remove Member* options. Click on *Add Members*, you will see a new pop-up window as shown in Figure A.4.

In the add group members window, there are two ways to add users. The first way is to search and locate users in the ThoTh Lab users' database, and the second way is done via the *Batch Enroll*, which allow you to create accounts for your students even if they have not registered in the system. For using the *Batch Enrollment* function, please click on *Batch Enroll*, and in the box, input user emails separated by ";", then click on *Add*. After the *Batch Enrollment*, if the user's email already registered in ThoTh lab, the user will be automatically enrolled into the group, otherwise they will receive an email invitation and they will need to follow the instruction to register in the system to accomplish the enrollment.

Once the group is formed and the enrollment is done, the next step is to design and assign labs to this group, which will be illustrated the next.

Another useful feature of the group management is to monitor users' lab activities. You can select a group by clicking on the green sign to show existing group members. An example is shown in Figure A.5.

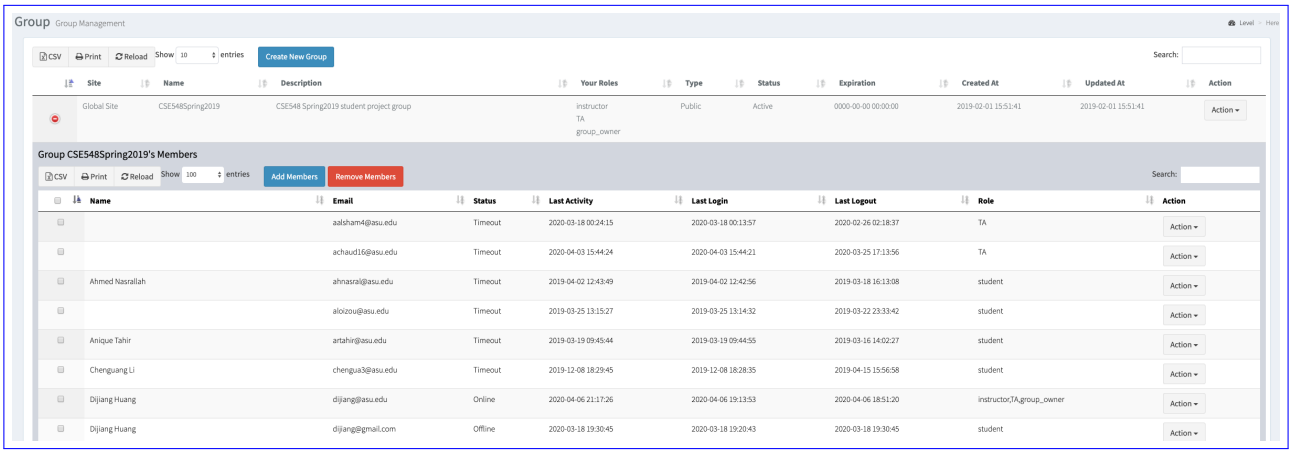

Figure A.5
Show group members' status.

In this group management portal, you can check when the last time sign-in of a group member and his/her current sign-in status. You can also change group members' roles, e.g., student, Teaching Assistant (TA), instructor, etc. Note that the TA have similar privilege as the instructor in current ThoTh lab's role management setup.

Lab Design

In ThoTh Lab, a lab is composed by two parts: Lab content (or guidance) and Lab running environment. Students need both to conduct their hands-on projects. Shown in Figure A.6, Lab Design function include the following three sub functions that allow instructors to use existing or design new lab contents and running environments:

- *Lab Repository*: access to a public lab content repository that are pre-built for instructors to choose for their students. They can deploy the labs from the lab repository to their students in the Lab Management function.
- *Lab Environment*: designs a lab running environment including virtual machines and how they access to Internet and how they are interconnected. They can deploy the lab running environment for their students in the Lab Management function.
- *Lab Content*: creates and updates private lab descriptions for instructors. They can deploy lab contents later for their students in the Lab Management function.

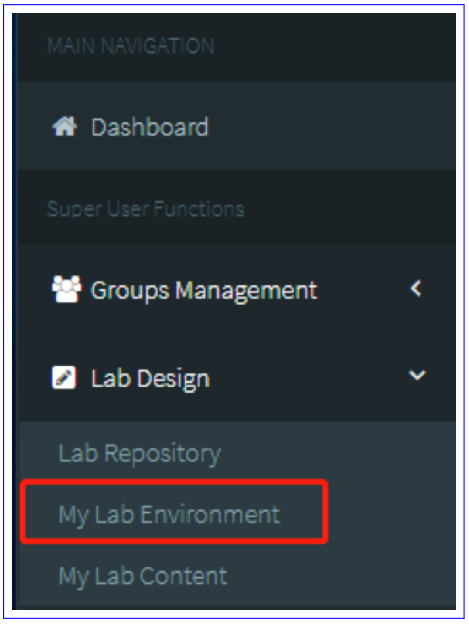

Figure A.6
Lab Design.

Lab Repository

The lab repository includes two types of labs:

- *Public*: public labs are provided by the ThoTh lab system.
- *Private*: private labs are designed/created by individual user.

As shown in Figure A.7, you can choose *All Labs* in the *Lab Type* field to view both public and private labs.

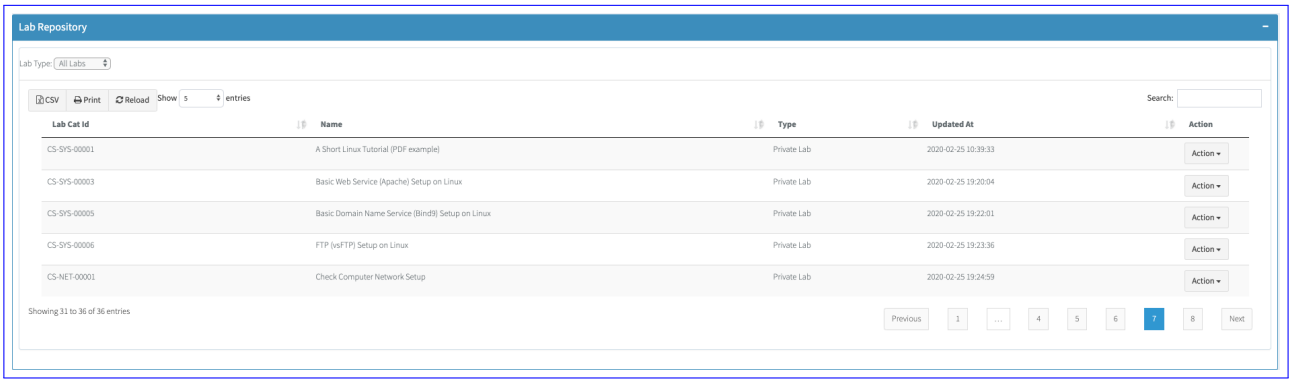

Figure A.7
Lab repository.

You can click on *Actions* and select *Preview Lab* to view individual lab contents. For details on how to create users' private lab content, please refer to the section on *Create Private Lab Content*.

Design New Lab Running Environment

To design a new lab running environment, click on:

Lab Design→
My Lab Environment→
Create New Lab Environment.

This operation will open a new lab design panel that is shown in Figure A.8.

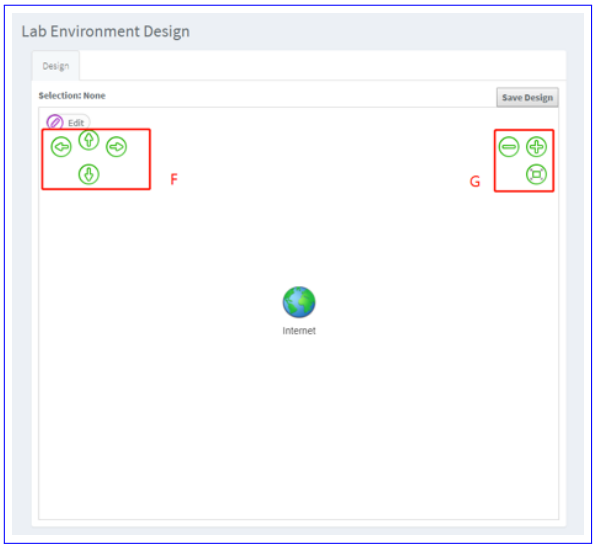

Figure A.8
Lab design panel.

You may type *f* and *g* on your keyboard to move the design penal, zoom-in/zoom-out, or center it, which is presented in Figure A.8.

Before we demonstrate how to design an lab, let's look at an example of lab running environment that is presented in Figure A.9.

A lab may have 3 different nodes: Virtual Machine (VM) nodes (*H* in Figure A.9), Virtual Switch (VS) nodes (*I* in Figure A.9) and Virtual Router (VR) node (*J* in Figure A.9). During the design, you can create a lab running template by adding the following networking components and setting up their interconnections:

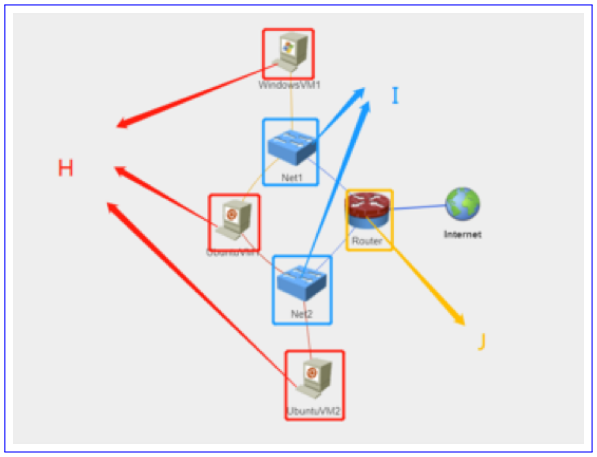

Figure A.9
A lab design example.

1. Multiple VM images such as various Linux and Windows pre-built OS images can be selected when adding a VM component in the running environment.

2. A virtual switch is a virtual private network with CIDR network address configuration setup, e.g., 192.168.0.0/24, 10.0.0.0/8, 172.16.0.0/12, during the design.

3. A virtual router is a gateway that connect virtual switches to Internet. It is not configurable, and adding it to a switch will allow VMs on that switch to have Internet connections. Note that only one virtual router is configurable in the current lab running environment. If you do not want your students to access Internet, then do not add the virtual router in your design.

Finally, the link between the virtual router to Internet shows the lab running environment traffic can be routed to the internet via the virtual router, and other links among networking components show how they are connected at the layer 2. Now, let's get into more details.

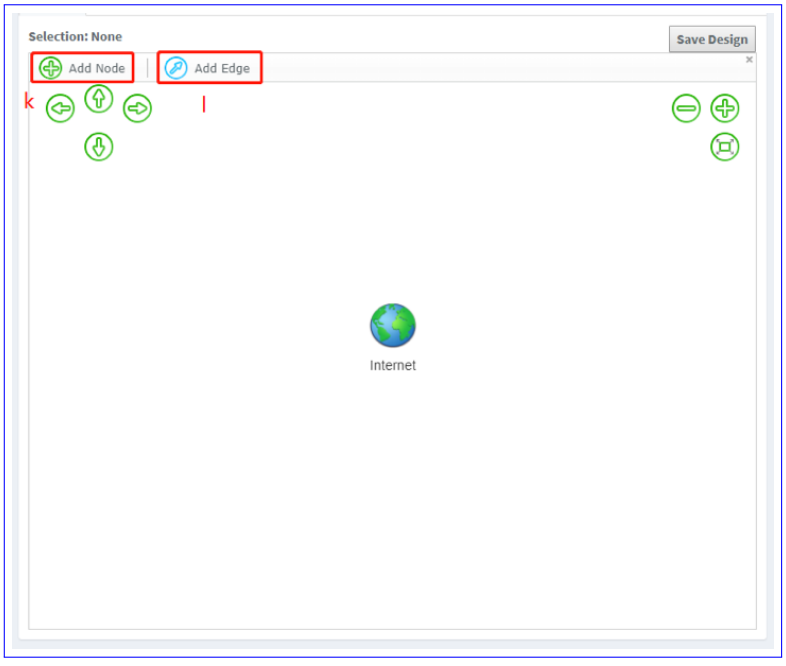

Figure A.10
A lab design example: add VMs.

Add A VM

A VM node is a virtual machine with different images and configurations, it is the basic for a lab environment. Please note that at least one VM is required in a lab design. Click on *Edit* to start adding nodes and edges in lab design shown in Figure A.10. Now, you can save the VM and you may continue to add more VMs into the design. Note that the ThoTh lab system currently limits the number of VMs in one lab running environment to 10. If more VMs are needed, please contact ThoTh lab administrator to enable more VMs in your lab running environment.

To add a VM, click on *k* in Figure A.10 and click anywhere on the drawing panel first, an *Add Node* pop-up window will appear, which is shown in Figure A.11. Then select VM from the drop-down menu *m* in Figure A.11. Then you will see the updated pop-window shown in Figure A.12.

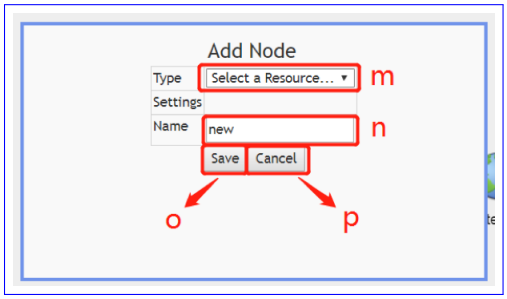

Figure A.11
A lab design example: VM configuration.

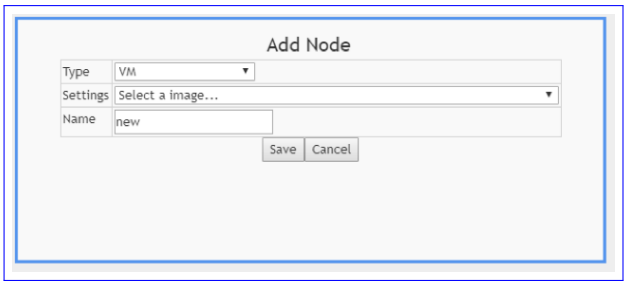

Figure A.12
A lab design example: choose VM.

Now you need to select a VM image from the *Settings* field in the drop-down menu. Note that, currently, there a set of Windows and Ubuntu image that is pre-installed in ThoTh lab. New VM images can be created based on requests. Once a VM is chosen as shown in Figure A.13, the number in the image name usually

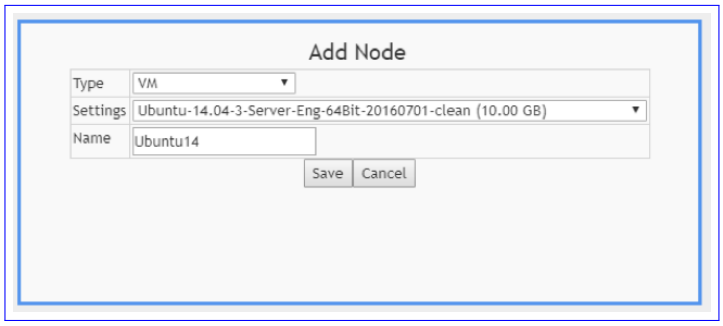

Figure A.13
A lab design example: choose VM configuration.

represents the hard disk size of the image. CPU and Memory size have been pre-set to values that meet the operating systems requirement, and these values are also customizable based on requests. Then, give you VM a unique name in the *Name* filed. We must note that components in the same lab environment design cannot have the same name regardless their node types (vm, switch, router, etc.).

Add A Virtual Switch

A Virtual Switch (VS) is a virtual private network. To add a VS in your lab running environment, click on *Edit* to start adding nodes and edges in the lab design. To add a VS, click on *k* in Figure A.10 and click anywhere on the drawing panel first, an *Add Node* pop-up will appear. Then select *Switch* from the drop-down menu *m* in Figure A.11, and the updated pop-window is shown in Figure A.14.

In the *Setting* field, you need to setup CIDR for this virtual network, for example *192.168.0.0/24*, and save it with a unique name. Note that the ThoTh lab system currently limits the number of VS in one lab running

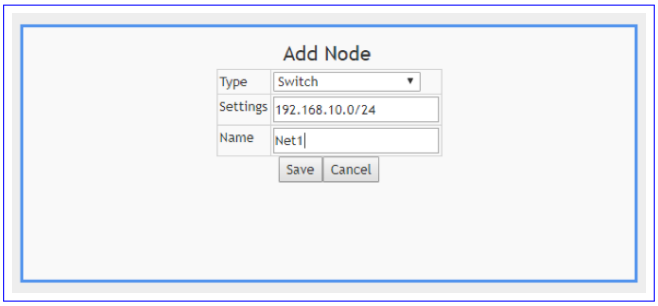

Figure A.14
A lab design example: choose VS configuration.

environment to 3. If more VSes are needed, please contact ThoTh lab administrator to enable more VSes in your lab running environment.

Add A Virtual Router

A Virtual Router (VR) is a gateway that connect the lab networks to Internet. A VR is not mandatory in a lab design, which means VMs do not have the Internet access. To add a VR, click on *Edit* to start adding nodes and edges in the lab environment, then click on *k* in Figure A.10 and click anywhere on the drawing panel first, an *Add Node* pop-up window will appear. Then select *Router* from the drop-down menu *m* in Figure A.11. The updated pop-up windows is presented in Figure A.15.

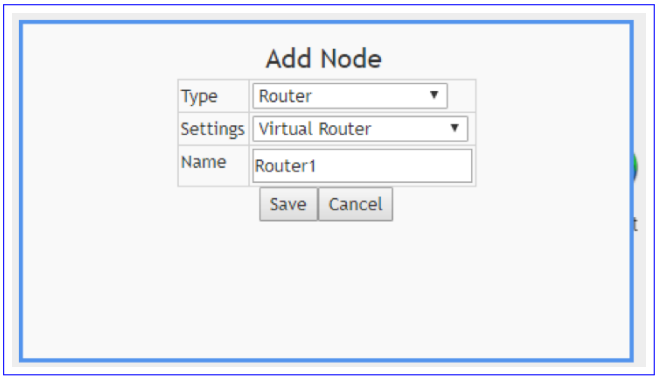

Figure A.15
A lab design example: choose VR configuration.

Then, provide VR a unique name and save the added VR. Note that the ThoTh lab system currently limits the number of VR in one lab running environment to 1.

Add Edges among Components

In a virtual lab running environment, an edge represents the network connection between two nodes, which means they are attached to each other. To add edges, you can click on *Edit* in Figure A.8 to start adding nodes or edges in the lab design. As shown in Figure A.16, to add a connection between two nodes, click on *Add Edge* (*l* in Figure A.10). Then click on the first node, hold the click and drag your mouse to the second node, then release the mouse to add a link between two components.

To connect another two nodes, repeat the same procedure. There are several rules to follow when connect components:

1. A VM can only be connected to one or multiple virtual switch(s). Each VM has to be connected to a least one virtual switch.
2. A virtual switch may connect to VMs and the VR.

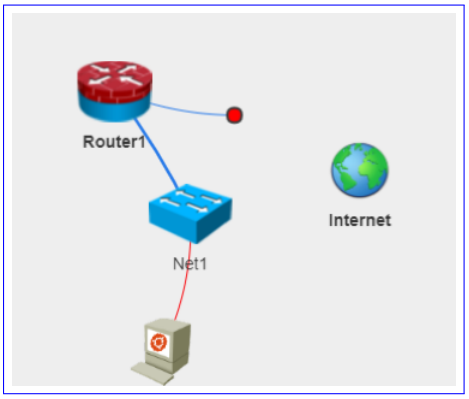

Figure A.16
A lab design example: add an edge.

3. Only the VR can be connected to internet.

Create Private Lab Content

To create a new Lab Content, click on

Lab Design→
My Lab Environment→
Create New Lab Content.

An content editor as shown in Figure A.17 will be shown at the bottom of the page, where you may create Lab materials.

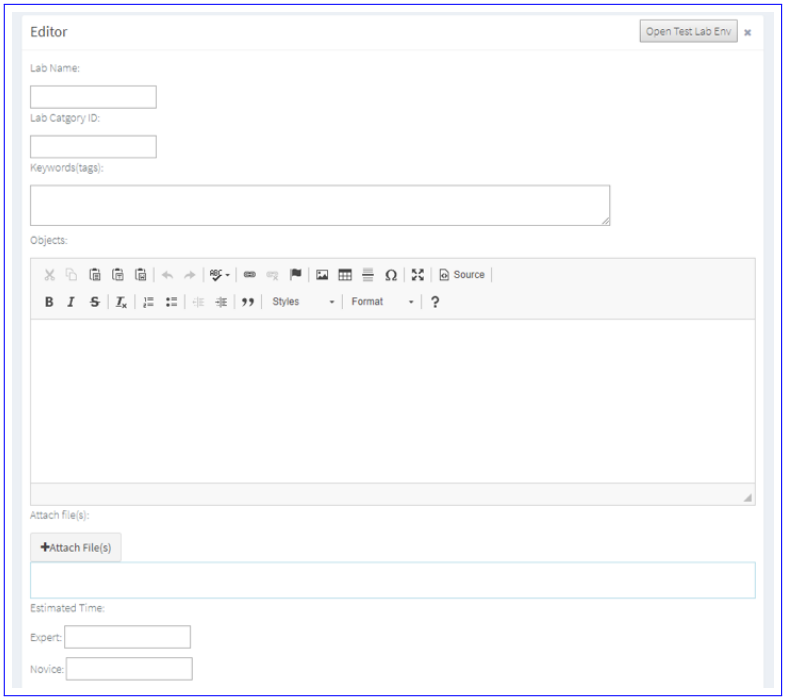

Figure A.17
A lab design example: create lab content.

Once you created a new lab content, you may click on the Green sign to add lab content, and click on *Add New Task* to add new lab tasks. The editor section will be changed to a task editor, where you may input lab requirements and select submission types, as shown in Figure A.18.

In ThoTh Lab, there are three submission types an instructor can choose for students:

- *Screenshots*: students can submit a sequence of screenshots with explanation of each as the project report. This submission is suitable when the instructor wants to inspect the procedure of actions and corresponding outputs from the system to assess students' lab performance. Note that students can only capture the screenshots from the lab build-in screenshot function in the lab running environment, and they cannot submit an uploaded screenshot from external resource.
- *Files*: students can submit regular report in word or PDF format.
- *Texts*: students can submit simple texts.

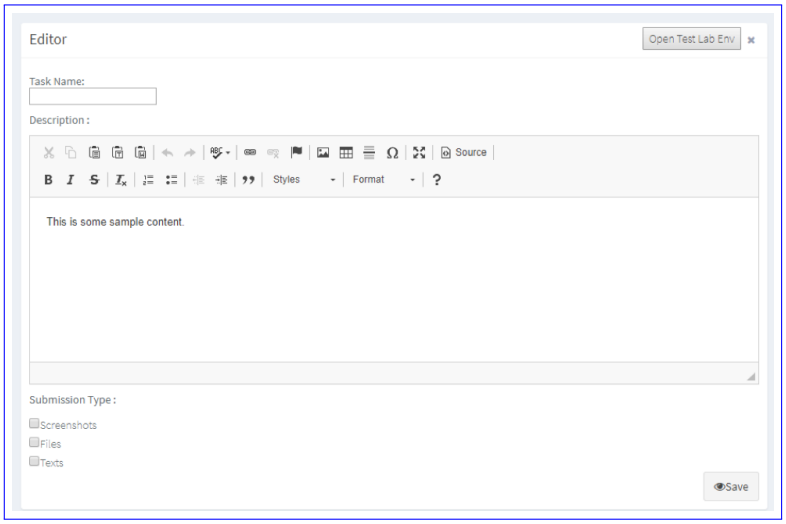

Figure A.18
A lab design example: select lab submission types.

Lab Management

Once you set up both a lab environment and lab content for your students, then you will be able to assign them to students in your group and request ThoTh Lab to deploy them.

Team & Lab Assignment

First, you need to use *Team & Lab Assignment* function by clicking on

Lab Management →
Team & Lab Assignment.

Then, select your managed students' group using the drop-down menu as shown in Figure A.19.

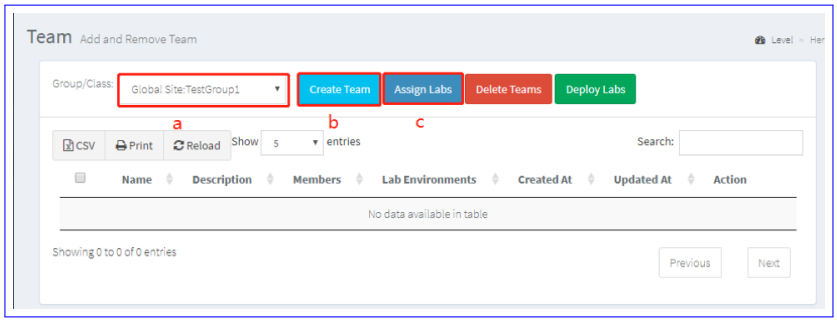

Figure A.19
ThoTh Lab management functions.

Using the *Group Management* to create a group is to recruit students in the group (or class). In order to assign lab content and running environment to students, you need to create teams including both individual or sub-group teams within the group. Note that **ONLY** after you create teams, you can assign lab content and lab running environment to teams. Thus, your next step is to create teams. There are two types of teams exist:

- *Individual team*: only one member of the group. The individual team is used for assigning labs that are dedicated for individual student.
- *Sub-group team*: there are two or more students in the team. The sub-group team is used for assigning labs that are dedicated for a group of students and they collaboratively work on a hands-on lab.

To start, click on *b* in Figure A.19, then choose either *individual* or *group* options for individual team or sub-group team, respectively. Then select students from enrolled in the group and save by clicking on *Create*, as shown in Figure A.20.

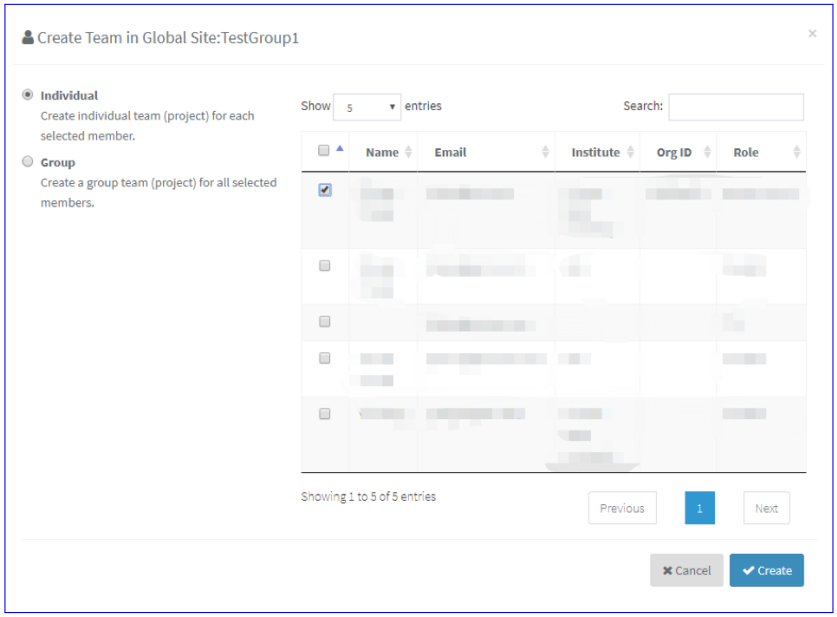

Figure A.20
ThoTh Lab management functions: create a team.

To create an individual team for every student in the group, you can simply choose the individual option and check the box in the title row and click on *Create*.

Next, we need to assign a lab running environment to teams that you had created, you can do the following procedure:

1. Check teams you want to assign lab running environment.
2. Click on *c Assign Labs* in Figure A.19.
3. Select Lab running environment available and click *Assign*.

Lab content assignment and Lab deployment

The next step is to deploy labs including both lab content and lab running environment that was assigned to students. In the previous step, we only assigned lab running environment to students. Now, you need to assign lab content (i.e., lab guidance) to students. Note that assigning lab content to students is optional. You can deploy lab running environments without assigning lab contents.

To deploy labs, you can click on *Deploy Labs* in Figure A.19. Then, it will redirect you to the lab deployment interface shown in Figure A.21.

Then choose which team(s) you want to assign lab content, click on *Assign Lab Content*, then you will be redirected to the lab content assignment interface shown in Figure A.22.

Now, you can select a lab content from the list and click on *Assign* to finish the lab content assignment for student teams.

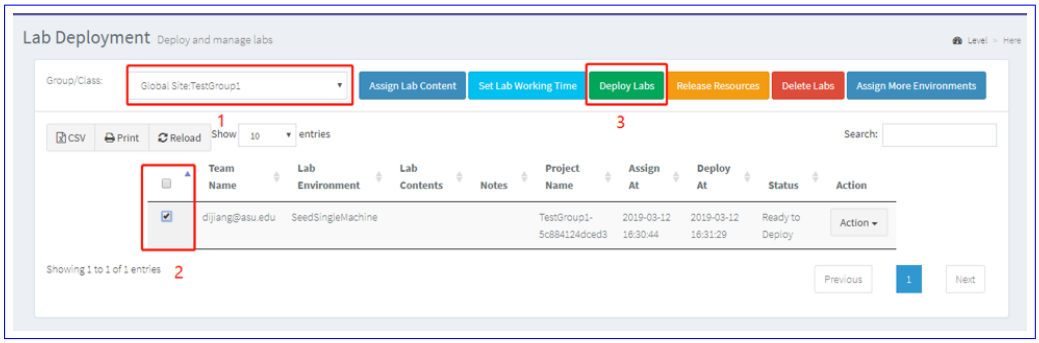

Figure A.21
ThoTh Lab management functions: lab deployment.

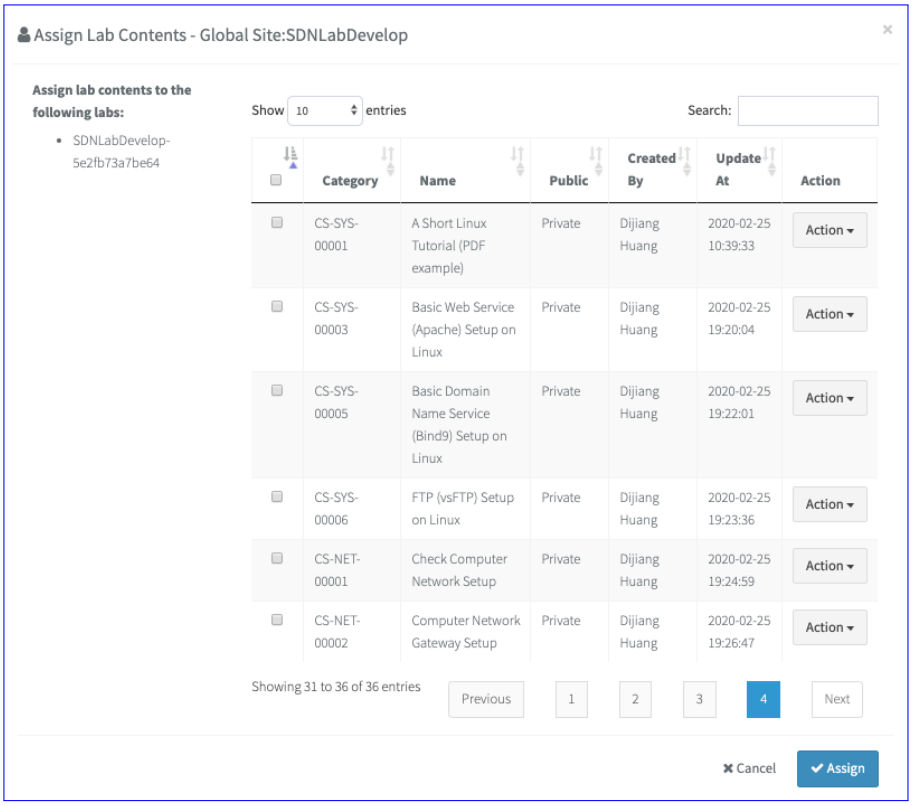

Figure A.22
ThoTh Lab management functions: lab content assignment.

After selecting lab content, it is time to deploy labs. In ThoTh lab, lab deployment means that the system will deploy computing and networking resource according to the chosen lab running environment template and allocate a unique lab running environment for each team. The selected lab content will be also viewable for each team member. The lab deployment can be conducted in a three-step procedure:

1. Select the group you want to management form the dropdown menu: *1* in Figure A.21.
2. Select the team you want to deployment the lab: *2* in Figure A.21.
3. Click *Deploy Labs* and confirm again: : *3* in Figure A.21 .

By receiving the lab deployment request, ThoTh lab will run its resource management procedure to allocate

resource for students. The status field in Figure A.21 will update the deployment status. Once it is done, it will show a *Green* check mark to indicate the deployment is accomplished, which is shown in Figure A.23.

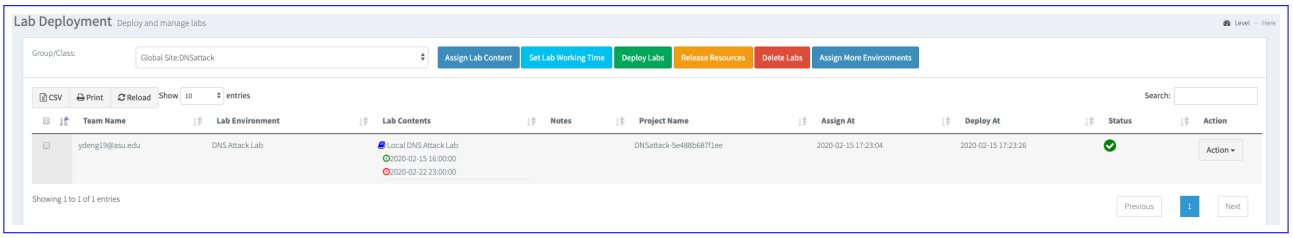

Figure A.23
ThoTh Lab has been deployed.

In order to schedule the lab performance time duration, ThoTh Lab provide a scheduler to set up the lab starting and due date. As shown in Figure A.23, you can select student teams and click on the *Set Lab Working Time* to schedule the starting and ending time for the lab. for individual team, you can click on *Action* and then *Edit* to set or update the lab performing time due dates. Once the due dates are set, the scheduled time duration is presented in the *Lab Content* column of the lab deployment table shown in Figure A.23.

Access Deployed Lab Environments

As an instructor, you can access any of your deployed lab environments for your students. On the home page, as shown in Figure A.24, click on *My Class* in the menu on the left-side of the ThoTh Lab web portal. Then, a drop-down list classes will present. As an instructor, you will have the access to all created students' lab running environment, which means you can access and monitor students' working progress, and help them debug issues at any time. This feature is very convenient for help student figure out lab running issues as well.

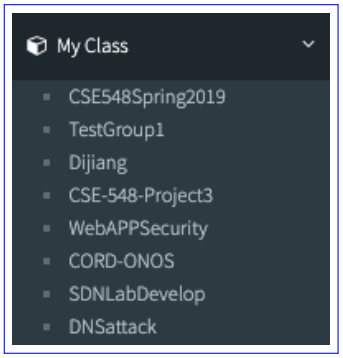

Figure A.24
Access to labs.

Then, you can click on *Action* → *Start Lab* to access students' labs. Then, you can access the lab environment and lab content that is shown in Figure A.26.

In the lab running environment window that is called workspace, the left side is the lab description, and the right side is the lab environment access portal. You can drag the middle bar to change the size of both windows or you can close the lab content window to maximize the width of the lab running environment.

In the lab running environment window as shown in Figure A.27, the workspace shows a topology of your virtual lab running environment, in which the example includes internet, an external router (i.e., a virtual router), a local network, and a VM.

You may use mouse to interactive with the graphic interface. Hang your mouse over the Router will show its IP address, while hang your mouse over the net will show the local network configuration, which shows 192.168.0.0/24 as in the example. Hanging your mouse over the Virtual Machine, it will show the IP address of the VM, the status of the VM (On, Off, Suspend, Error, etc.), and also a list of action that you can perform on the given VM. The available actions include:

- *Get Console*: It will open the remote desktop of the VM in a new tab.
- *Restart*: It will restart the VM (the system will delay 60 seconds before the restart action.)

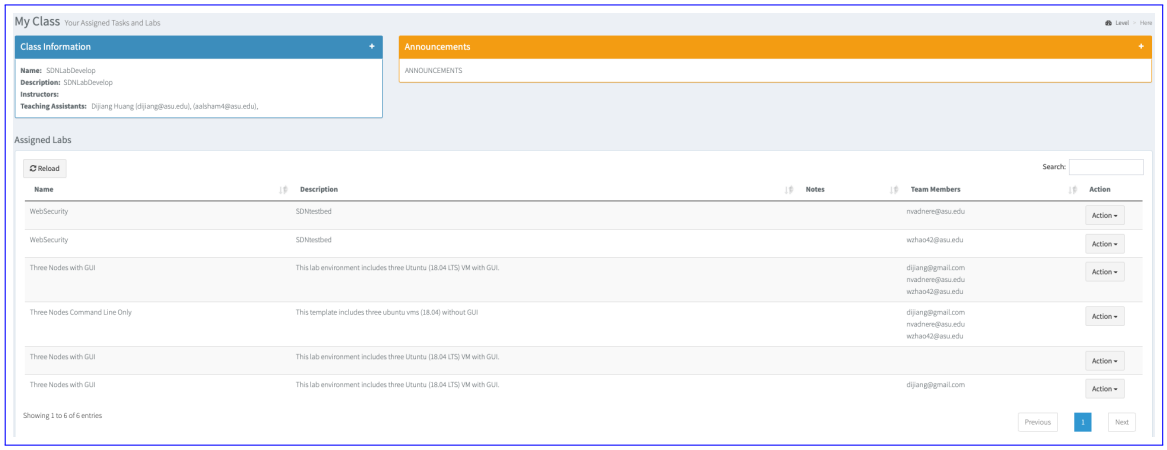

Figure A.25
Access to students' labs.

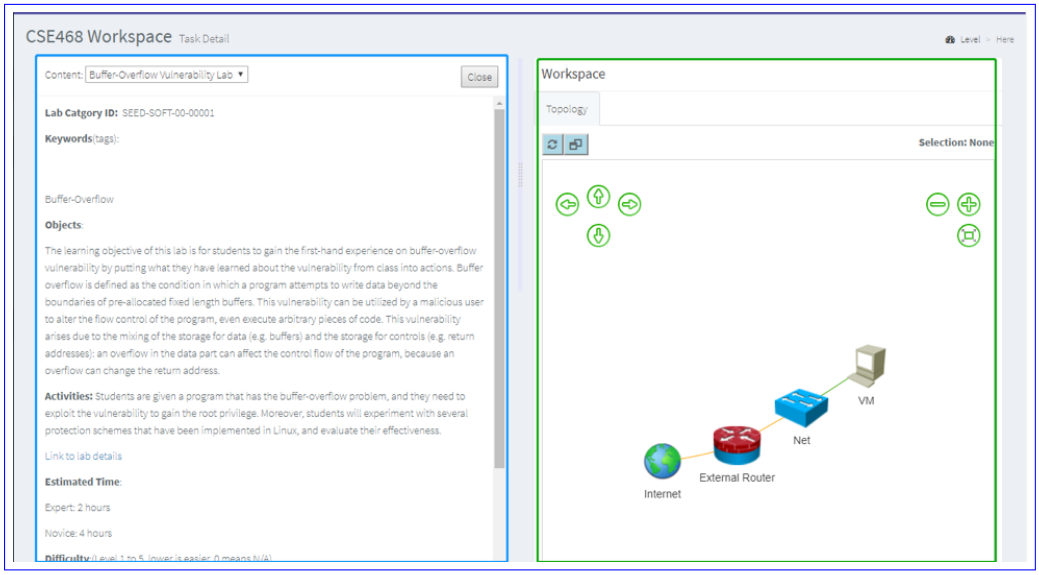

Figure A.26
Lab environment.

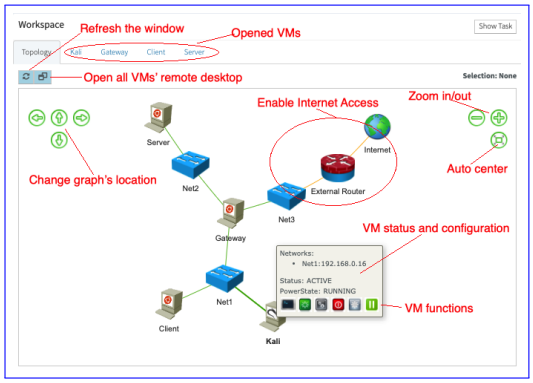

Figure A.27
An example of Lab environment setup in workspace.

- *Rebuild*: It will restore the VM to its original status from the beginning of the lab, i.e., the system will rebuild the VM from its OS image. Note that by doing rebuild, you will lost all data and modifications that you have done on the VM. Be cautious to take this action since you **Do NOT** need to do this unless the vm is corrupted. Please consult to your system admin before doing this action.
- *Shutdown*: VM will shutdown. After shutdown, the VM's states will be lost.
- *Suspend*: VM will be suspended. For suspension, the VM's states will be maintained and it will release the system resource. Thus, if a user does not use the system for longer time, it is better to put the VM in the suspension state to release resource for other users.
- *Pause*: VM will be paused. The pause action will not release system resource for the VM, it simply halts the VM, and the VM can be quickly wake up from the pause state.

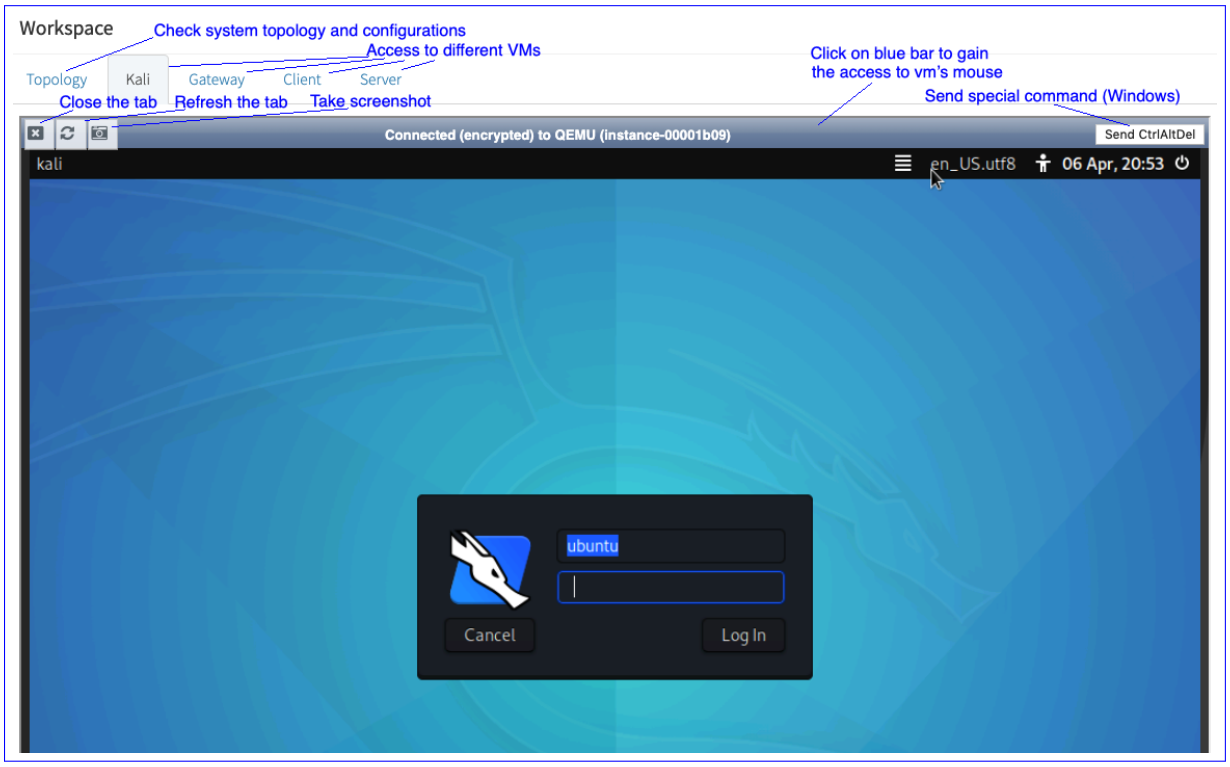

Figure A.28
Access to VM's remote desktop.

For convenience, on the left upper corner of the workspace window, there is an icon . You can click on it to open all the VMs' remote console at the same time. Each console is presented as a tab in the workspace. Then, you can click on a tab to access to its remote desktop. An example is shown in Figure A.28.

Once the remote desktop of a VM is opened in the workspace, you can click on the top *Blue Bar* to allow the remote desktop to *grab* your mouse device. Otherwise, the mouse will only work on your local computer and will not act in the remote desktop. Then, you can switch between VMs to check students' work.

Note that the instructor and the student are sharing the access to the VM. This means that the remote access to VMs is a real-time monitoring system. All student's actions in that VMs will be demonstrated on the instructor's workspace inconstantly. In this way, the instructor can inspect student actions in real-time. This is very useful feature for remote diagnostic and troubleshooting. It is also perfect system for remote demonstration. We must note that, If there is no server-based VM is used, for group-based team project and multiple students sharing the same setup, only one student can work on one VM at a time.

Grading Center

The ThoTh Lab grading center allows instructors to provide grades for evaluating students' performance of hands-on labs. By clicking on *Grading Center* from the home page's menu bar, an instructor can land in the grading center, which is shown in Figure A.29.

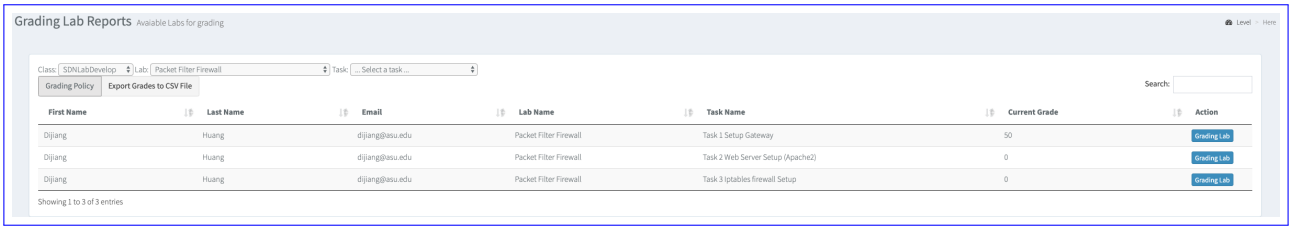

Figure A.29
Grading center.

To access students' submitted lab reports, e.g., a sequence of screenshots with explanation, an instructor needs to choose the *class*, *lab*, and *task* to grade from the top of the grading center. In order to specify grading policy such as how many points for each task, the instructor can click on the *Grading Policy* button below the class selection field to specify how many points for each task. Note that you need to select class and lab before hand to allow grading policy setup feature. The grading policy example is presented in Figure A.30, which shows that the instructor grants 50 points for each task of the firewall lab.

As shown in the presented example, there are three tasks for the packet filter firewall lab performed by the student. The instructor can click on the *Grading Lab* button for a task to access this student submitted lab report.

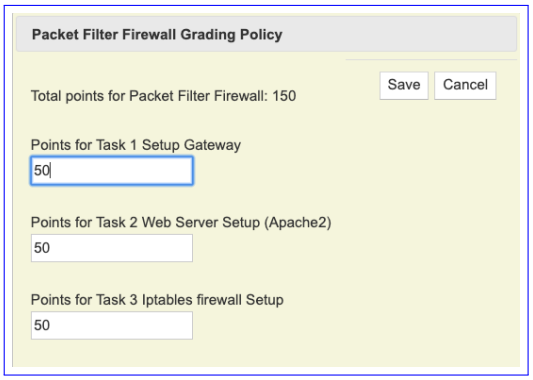

Figure A.30
Grading policy.

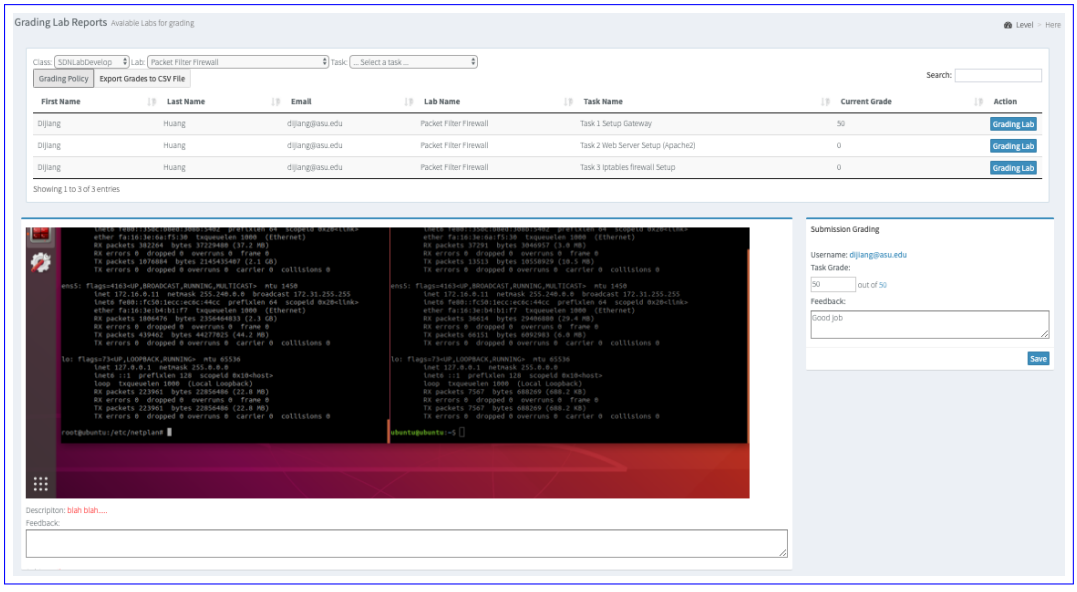

Figure A.31
A grading example.

As presented in Figure A.31, in this example, the student submitted a sequence of screenshots and provided illustration of each of them. The instructor can provide feed back for each individual screenshot at the bottom of each submitted picture. The instructor can provide the overall grading feedback in the right-side the feedback field and provide the overall grading result for this task.