

An Overview of the Virtual PLC Simulator (Accomplished through DOL TAACCCT grant funding)

The purpose of this document is to explain what the Virtual PLC Simulator is, how it compares to a PLC hardware simulator, how the virtual simulator works, and how it can be used in a college level PLC (Programmable Logic Controller) course. This document will also explain what a virtual machine is, and how it is used with the Virtual PLC Simulator.

PLC Hardware Simulators: The students in the Northwest State PLC courses have hardware PLC simulators they will use in the laboratory environment. All students will have to pass the hands-on assessments utilizing these training units. These are the SLC-500 training units, the CompactLogix training unit, and the ControlLogix training unit, all based on the Allen Bradley PLCs and PACs (see Figure 1). The PLC lab will also have 16-18 desktop computers that will have the appropriate Rockwell Software packages loaded to learn and perform the required hands-on tasks. Having taught PLCs for over 30 years, I have saw the complexity of the PLC programming software increase, and with limited access to the software (driving to the college campus, and hoping to find a PLC lab computer that is available), the technology team has moved to individual student VMs (Virtual Machines) and Virtual PLC Simulators, to give students better access to learning the software and hardware, without coming to the college campus. Some would term this as an acceleration strategy, and it is, if the student has the drive, and the access, they can complete modules faster, if used in a competency-based instructional model.

PLC Hardware Simulators that are used in the NSCC PLC Lab



Figure 1. The PLC Hardware Simulators.

Virtual Machine: A Virtual Machine is a virtual computer. Actually a VM is a computer emulator (a software that functions exactly like a computer) that is created from virtualization

software that is ran on a server. The VM is allocated resources from the server, by the virtualization software, such as RAM, processor speed, and hard drive space. Each student VM is allotted 4 GByte of RAM, 2.5 MHz processor speed, and a 146 GByte hard drive (see Figure 2). If a student is registered for a PLC course at Northwest State, they will have a VM created for them that they can use for the duration of the course. The students can then connect to their VM using an internet connected computer (MAC or PC), from home, the library, or a computer lab at the college. Their VM will disappear approximately 2 weeks after the course is complete.

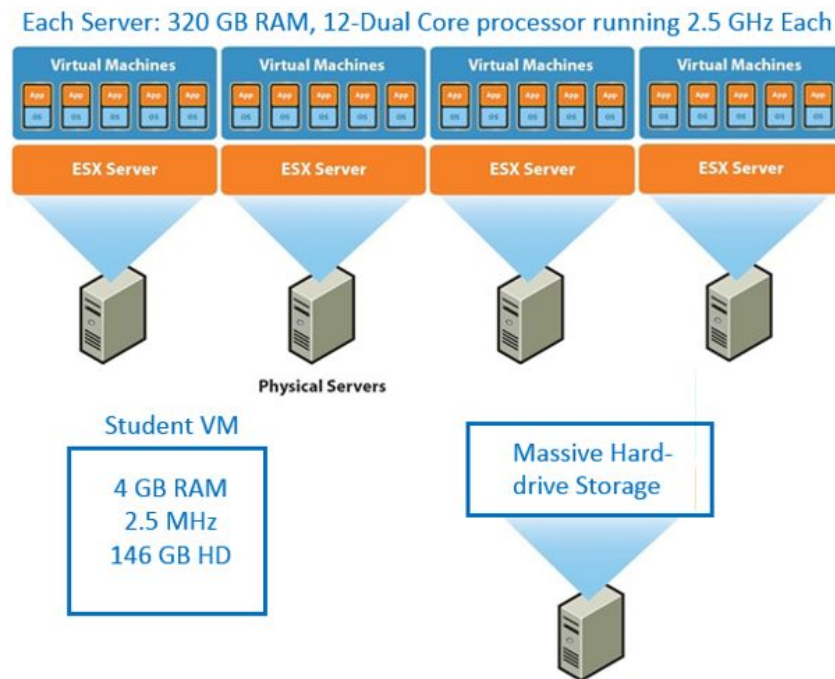


Figure 2. A Student VM is part of a physical server.

The greatest value of the student VM, is that it allows the student 24/7 access to all of the proprietary software that they typically would have to come to campus to access. The IT department purchases the annual subscription of Classroom Toolkit from Rockwell Automation, then loads up the PLC VM with software such as RSLogix500, RSLogix5000, RSLinx, RSEmulate 500, and RSEmulate5000. These software packages are also loaded on the computers in the PLC lab. The students can actually access their VM (and all the software on it) from any on-campus, or off-campus location. Most students will access this from home through a wireless broadband internet connection.

The Virtual PLC Trainer: The Virtual PLC Simulator is a graphic with interactive objects (push buttons, lights, power switch, etc). The unit was developed to look very similar to the hardware simulator, as shown in Figure 3. The Virtual PLC Simulator is accessed by the

students through their student VM (Virtual Machine). The Virtual PLC Simulator can be switched between DEMO mode, and RUN mode. In DEMO mode, the user can select any one of the labs used in the basic PLC course (21 labs), and the simulator will run the program as if a processor was running it. So clicking on a pushbutton will typically initiate a program, and the lights will turn on and off, according to the program. The purpose of the DEMO mode is to show the student how the PLC program will control the PLC outputs, based on the condition of inputs. When in the RUN mode, the Virtual PLC Simulator becomes an OPC (OLE for Process Control) client, and will connect to the software package named RSEmulate500 (which emulates a PLC processor), through an RSLinx OPC Topic and RSLinx communication driver. The student can then run their program on the Virtual PLC Simulator, just like they would run it on a hardware simulator.

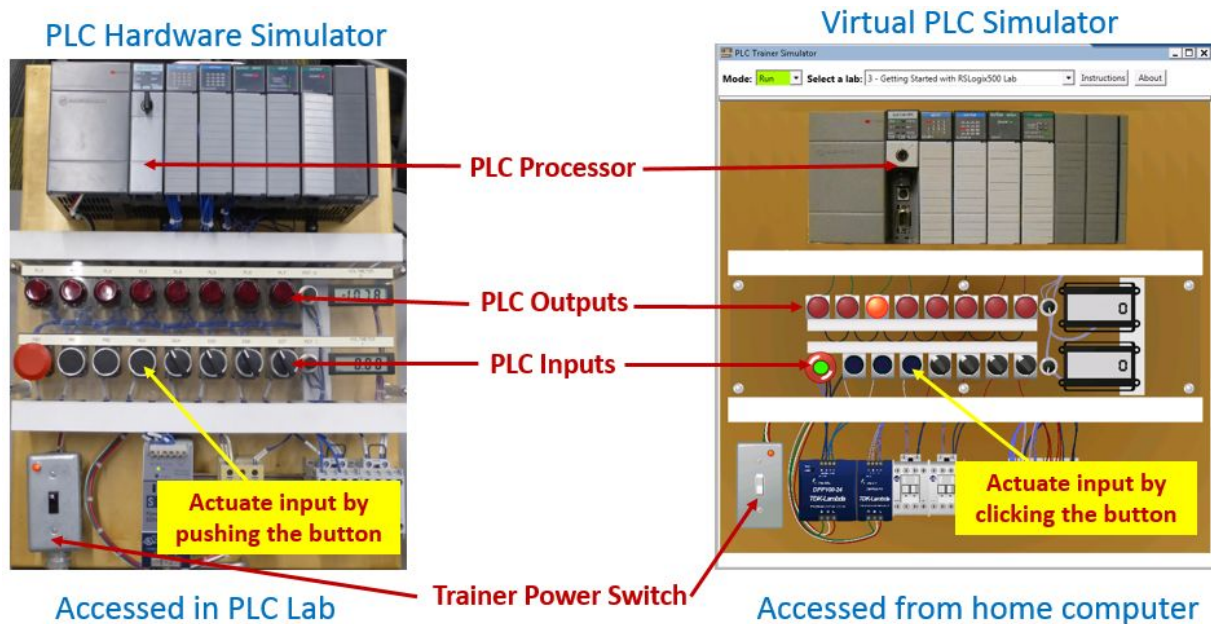


Figure 3. Comparing the PLC Hardware Simulator, and the Virtual PLC Simulator.

Northwest State utilizes two FactoryTalk Activation Servers, which allocates an activation file to the student to run one of the Rockwell applications, such as RSLogix5000. The first activation server supports the students working with the software in the PLC lab. The other activation server supports the students that are accessing the software within the students' virtual machine. The concept graphic that shows this is shown in Figure 4.

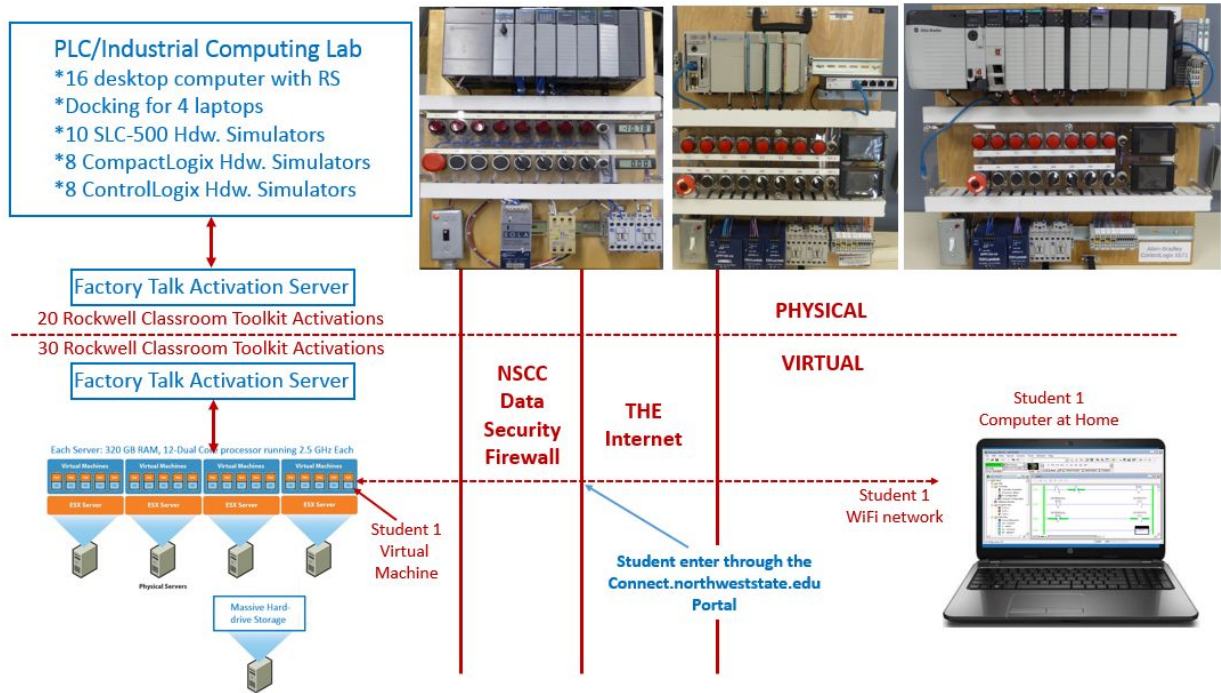


Figure 4. Showing how the student connects to the VM.

The Virtual PLC Simulator Engine: This is a software package programmed in C# (pronounced C sharp), that ties the properties of the objects on the Virtual PLC Simulator to an OPC Client. This will allow the Virtual Simulator to communicate with RSLinx, which is an OPC Server. Though most colleges use RSLinx for PLC communications only, there is a lot of capability within the application to communicate with other applications, such as Microsoft Excel. This software is available on Skillscommons, since it was developed with TAC funds. A college can adapt this software to their own Virtual Simulator, that will look like their PLC trainers at their college. The user must use Visual Studio to open the Virtual PLC Simulator software (which is the zipped file), in order to do edits within the engine.

If any college wishes to get more information on how this system works, and how a college can use the same type of technology to give 24/7 access to the students, please contact Tom Wylie at Northwest State (twylie@northweststate.edu, or by phone at 419.267.1203). Also the following links will take the user to two videos that Tom Wylie created that will explain the operation of the virtual machines, and the Virtual PLC Simulator.

Video: Introduction to Virtual Machines

<https://www.youtube.com/watch?v=3NjX5A-3UCY&feature=youtu.be>

Video: How the Virtual PLC Simulator works:

<https://www.youtube.com/watch?v=8d4s7I8hUFk&feature=youtu.be>

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