



Cloud-Based Classroom Labs

Starting With The Client's Needs

To succeed in university Computer Science and Engineering classes, students need practical experience working with real running software. They need to interact with multiple applications running on different machines networked in a realistic way. The specific configuration of the machines and software is important, but knowing how they got that way isn't.

To meet these learning objectives in the past, our client distributed ISO images for students to run on their own machines.

That neatly solved the software configuration problem. Students didn't need to worry about how to install a tool like Wireshark. They could just start the Wireshark image and log in. However, it led to some other difficulties. Running the virtual machines demanded disk space, processing power, and an OS that some students didn't have. Moreover, when students had trouble running an image, they turned to their instructors, requiring faculty to spend time on technical support instead of teaching.

In response, some classes were taught with VMs hosted on university hardware. That relieved the burden on students to provide compute power, but it required instructors to distribute and maintain credentials for each student to access a different VM. None of that was part of the learning objectives for the courses, so it wasn't a good use of an instructor's time.

That was the scene when the client contacted us: students were using a mix of downloaded ISO images and university VMs, turning to their instructors for technical support, and generally spending too much time worrying about things that don't help them learn the course material.

They needed a new approach. The ideal solution would:

- provide students with the right VM images for every assignment
- let students access VMs through their browsers without additional software
- let instructors access the same VMs as students
- not require new passwords or keys
- run VMs only when needed to reduce operating cost
- support linux and Windows machine images
- allow ssh, RDP, and xrdp logins
- free up instructors' time to focus on teaching instead of support
- be ready in time for fall class start

Our client came to Clairvoyant because of our proven track record of delivering cost-effective solutions in the cloud. We started discussing requirements in late spring on the understanding that students needed to use the system on August 1st.

A RACE WITH THE CLOCK

As with most software projects, delivering cloud-based lab curriculum requires a multi-faceted solution. Before we can launch, instructional designers need tools to design VMs and link them to assignments on the course syllabus. Students need access to the right VMs via SSH, RDP, and xrdp. They need to know what assignments are due and they need tools to manage their VMs. Instructors need all of that, plus access to all of their students' machines. Administrators need all of that, plus tools to monitor resource usage and cost at all times. And all of it needs to happen in time for fall classes. Since the client didn't even contact us until late spring, time was very short for a project of this scope.

CURRICULUM BUILDING FEATURES

The university's instructional design team defines the learning objectives and benchmark assessments to be used across all instructors' classes. The assessments already exist, but the team needs tools to define VMs and link them to the assessments. We worked with the client to use a combination of publicly-available cloud administration tools and custom software to get machines ready for class.

ROSTER INTEGRATION

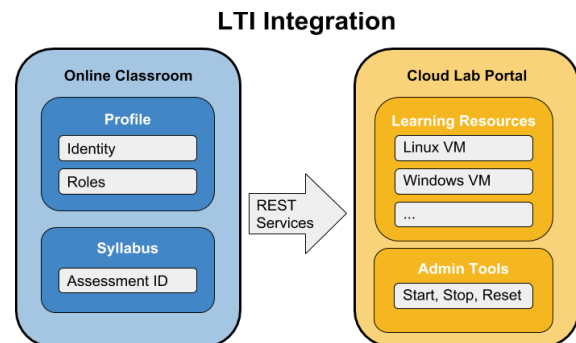
Once a course is defined with all of its assessments and the associated VMs, students can be put into specific class sections starting in the fall. The courses all have the same start date, and section rosters are finalized a week prior to the first class meeting.

We developed an integration layer with the purpose of sending roster information into the cloud where we need it. Because rosters can change even after the class starts, this needs to run all the time.

INTEGRATION WITH THE CLASSROOM

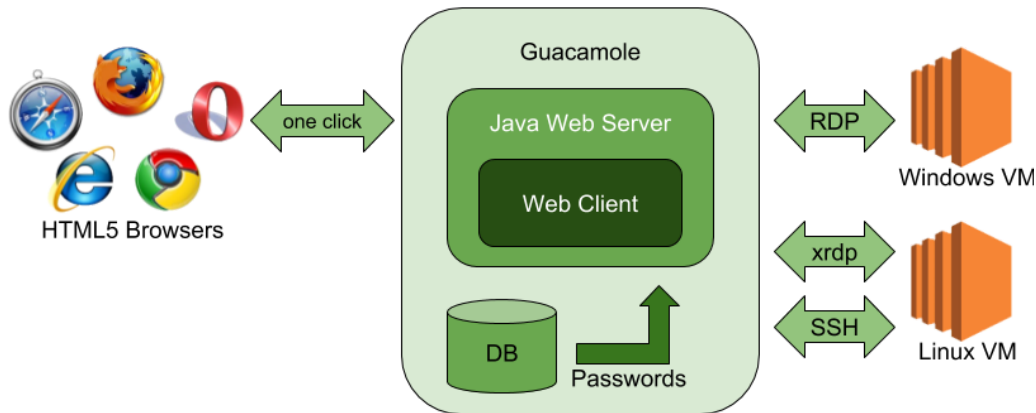
The university's online classroom already authenticates users against the university's directory. It supports Learning Tools Interoperability (LTI), a standard that facilitates integration with external tools. That lets us delegate user authentication to the online classroom and grant users access based on the identity it provides.

We use another custom layer to synchronize syllabus data from the classroom to give students and faculty access to the right VMs for the right assignments.



ONE-CLICK ACCESS

Browser-Based VM Desktops

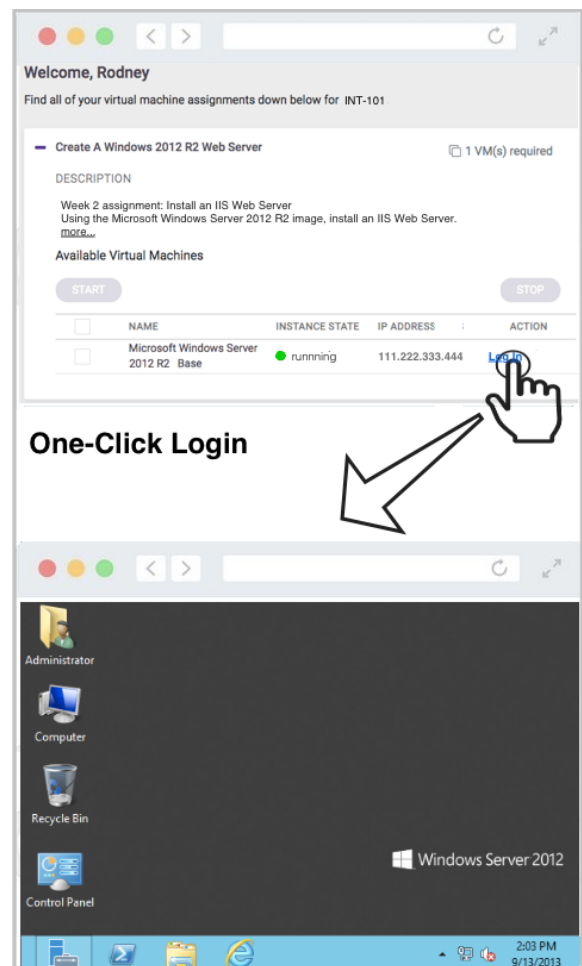


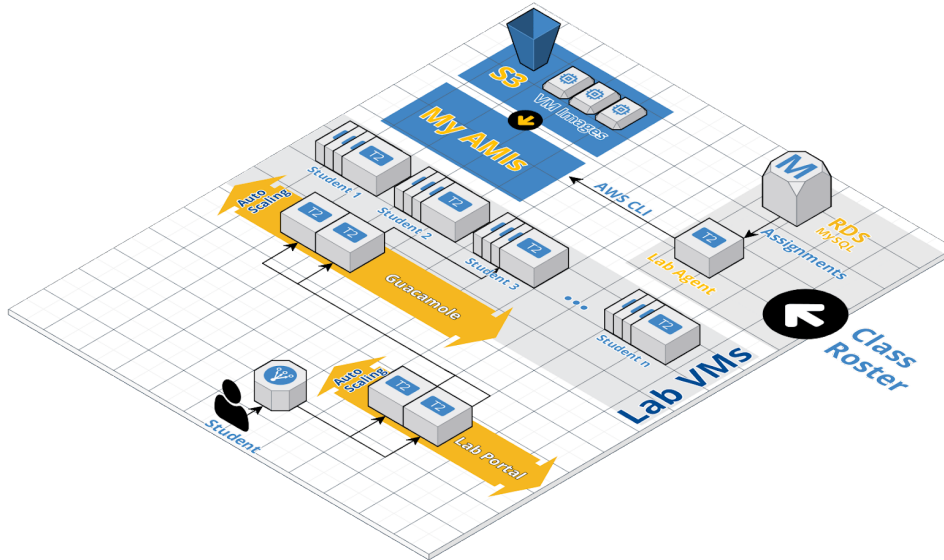
Remote access to machines varies by platform. Windows VMs need RDP, and Linux can be accessed via ssh or xrdp. Apache Guacamole can provide access to remote desktops using any of those through an HTML5 browser.

Once the VMs are created, we need a process for students to log into each one. It would be possible to configure VMs with well-known passwords that appear in the syllabus, but that's not desirable from a security perspective. It would be better to have each machine use a unique password. We could distribute unique passwords for every student, but that would be harder to use, and it would require technical support to handle password reset requests. The best process for this is to further leverage the LTI authentication and store unique passwords in Guacamole's private database at roster build time. Once we have established the identity of users, we can show them one-click login links to each of their machines.

A GOOD FIT FOR THE CLOUD

AWS provides a lot of tools that make it a good fit for this project. For any project, cost is a concern. This is especially true for higher education. Rising tuition threatens to put education out of reach of middle class families in the US. Universities demand tools to reduce the per-student cost of learning tools without sacrificing quality. Large universities have an additional concern that staff can't handle administrative tasks by hand. Automation is a key feature to support large numbers of students. AWS can help with each of these.





COST CONTROL

Using CloudWatch and custom monitoring tools, we can shut down student instances that are not in use. This saves on compute cost without affecting the user experience. We can also leverage Elastic Beanstalk to only run as many instances of web servers and Guacamole hosts as we need to support student volume. This is especially valuable in an online classroom where user traffic tends to be low during the daytime, but higher during US evening hours and very high right when homework is due.

AUTOMATION

AWS allows control of everything in the environment using an API, with no need for university staff to do things repeatedly for every student. Rosters are built, VMs are provisioned, and everything is monitored without intervention by university staff. Instructors no longer spend time helping students provision VMs, troubleshoot access issues, or reset VMs to factory images. All of those operations are automated or self-service for students.S

RESULTS

Let's revisit the ideal system. At the start of the project, we established that it needed to accomplish 9 key goals, including a launch date in time for fall classes. All of them are met and our client has a complete set of tools to meet their needs in future terms.

The Ideal System

- ✓ provide students with the right VM images for every assignment
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- ✓ ready in time for fall class start

We always start by understanding our client's goals. In this project we were able to blend custom software with native cloud capabilities and off-the-shelf software to meet our client's goals on a short timeline.



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ABOUT CLAIRVOYANT

Clairvoyant is a global technology consulting and services company. We help organizations build innovative products and solutions using big data, analytics, and the cloud. We provide the best-in-class solutions and services that leverage big data and continually exceed client expectations. Our deep vertical knowledge combined with expertise on multiple, enterprise-grade big data platforms helps support purpose-built solutions to meet our client's business needs.