# WLab: Virtual Machines as Learning Objects for ICT Teaching

Graham Alsop (*g.alsop@kingston.ac.uk*)
David Livingstone (*d.livingstone@kingston.ac.uk*)

**Luke Hebbes (*l.hebbes@kingston.ac.uk*)**
**Paul Neve (*paul@paulneve.com*)**

## 1. The difficulties of delivering practical workshop exercises in ICT teaching

ICT subjects present unique difficulties when attempting to deliver practical workshops as part of the learning experience. Institutional IT labs often contain outdated equipment, pre-configured to a "lowest common denominator" template, ill-suited to the needs of ICT teaching. Many subjects within ICT require administrative access to a server if the student is to be able to practice the skills being taught. Finally, distance-learning students present their own problems, and are usually expected to acquire and/or reconfigure home equipment for use during a course.

## 2. Introducing WLab

The WLab project addresses these issues by using virtual machines to deliver a workshop environment to the student which can be designed by the tutor to specifically suit the needs of the course being taught. At the heart of the system is an innovative composite learnng object:
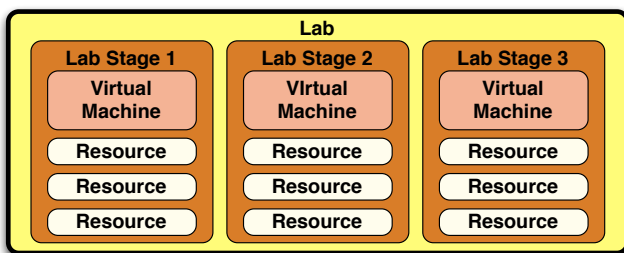


**Figure 1 - WLab's composite learning object**

Lab exercises are divided into stages, each of which contains a distinct virtual machine. This virtual machine contains all of the software and data required for this stage of the lab. Alongside the virtual machine, static learning materials are presented which describe the activities and provide a learning context:
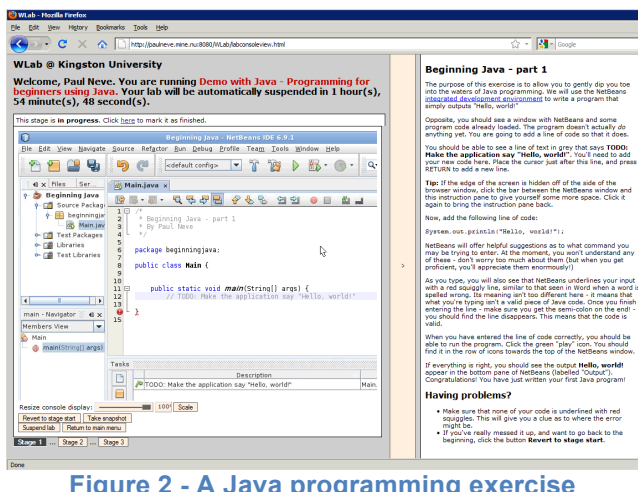


**Figure 2 - A Java programming exercise**

WLab can be used during conventional, on-campus workshop sessions to alleviate the issues presented by limited equipment available in on-site IT labs. It can also be used to deliver a consistent workshop environment to distance learning students. However, WLab not only resolves these infrastructural difficulties, but also provides pedagogic benefits.

## 4. The authoring and delivery processes in a nutshell

- The tutor designs a lab exercise by using an existing virtual machine (supplied by a system administrator, or a previous one created by them or another tutor) as an initial template.
- The tutor modifies the virtual machine to provide an environment for the 1st stage of the lab exercise.
- The tutor creates subsequent virtual machines for the next stages, by cloning the previous and using that as the base. This essentially means that the tutor "works through" the activity of the lab as they author it:
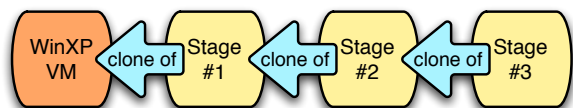


**Figure 3 - Virtual machines within lab stages build on previous stages**

- The tutor creates lab stages, and assigns the virtual machines to them.
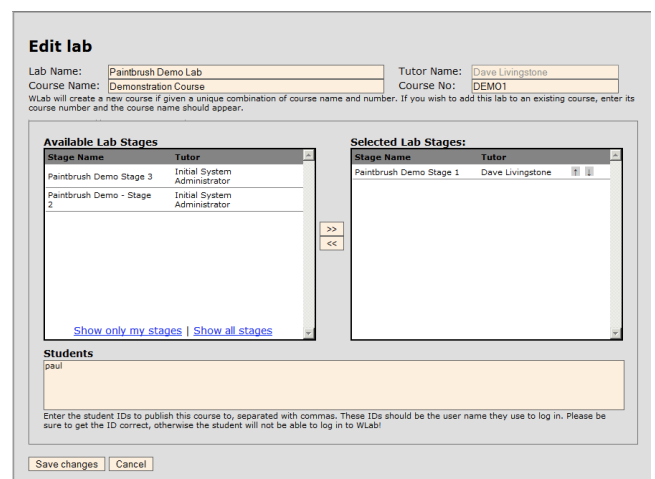- The tutor publishes the lab to students.



**Figure 4 – Assembling the lab stages into a lab**

- When a student runs the lab, on demand WLab will create clones of the virtual machines within the lab for the student's exclusive use.
- Students are also provided with a booking system, so that they can specify times that suit them for their workshop activities.

## 4. What IT people will need to know

WLab is a Java web application that requires Apache Tomcat or similar servlet container. The virtualisation backend currently supported is Microsoft Hyper-V (although the application is written so that developers could easily write support for other products e.g. VMWare). The application authenticates against an LDAP server – currently Microsoft Active Directory is tested and supported.

To provide access to virtual machine consoles, the TightVNC Java Applet (1) is used; virtual machines will thus require a VNC server to be installed within them.

For access remotely (i.e. outside your institution) the port forwarding application Jumpgate (2) is used to forward traffic from a single external network address/port to internally addressed virtual machines.
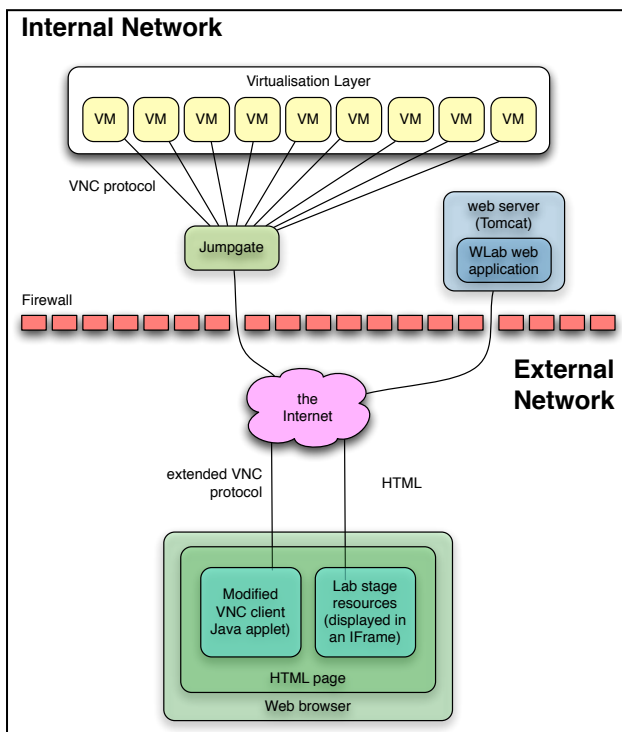


**Figure 5 – The topology of a WLab installation**

## 5. The pedagogic advantages of the WLab approach

• A student can navigate between lab stages and compare their current work with the exemplar provided by subsequent or future stages. This quick navigation provides worthwhile learning content that has no obvious analogue in a conventional workshop environment.
• Williams notes the importance of the context of learning objects (3). In WLab, a practical activity is put into context via its accompanying static materials. These will always be delivered alongside the practical aspect of the lab activity as a composite, coherent learning object. In a conventional approach, one might use printed handouts as an analogue. However, consider the scenario of a student who takes such a printed handout away from a workshop for home study. Without having the equipment and software environment discussed in the handout available to refer to, the handout may be of limited or even no value to the student in isolation.
• An entire lab exercise is represented as computer files. Tutors can share their ICT labs as fully self contained, ready to run learning objects, which can then be deployed with little or no changes on any WLab installation. This opens up the possibility of an inter-institutional repository of such labs as open educational resources.

## 5. Future work

WLab represents an iteration of KU's work to create learning objects that describe a complete ICT workshop exercise, and the tools required to deliver them to students:
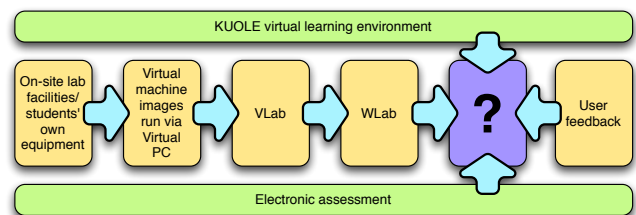


The WLab application has recently reached the end of its first development phase and is considered to be in a usable state for an initial rollout. Work in the short term will therefore concentrate on its roll out to students and tutors within Kingston University, and the subsequent analysis of the application's effectiveness within a real-world teaching environment. The authors would be extremely interested in collaborating with other institutions and/or individuals who can see a role for WLab in their own activities, and who wish to experiment with the application in their own environment.

Future work will seek to integrate WLab with other e-learning research occurring at KU. Work on electronic assessment and integration with VLEs, including KU's home-grown KUOLE is also seen as key.

## 6. For more information

The WLab web site contains comprehensive documentation, with sections targeted at tutors, IT support staff, developers and students. There is also a community forum for discussion and collaboration. It can be found at http://www.paulneve.com/wlab.

## 7. References
1. TightVNC website [online]. Available from http://www.tightvnc.com. (Accessed 17th August 2010).
2. Jumpgate website [online]. Available from http://sourceforge.jumpgate.net. (Accessed 17th August 2010).
3. Williams DD. Evaluation of learning objects and instruction using learning objects. In: Wiley DA (ed.) *The Instructional Use of Learning Objects* [online]. Association for Instructional Technology; 2001. Available from http://www.reusability.org/read/chapters/williams.doc.