A PLM Certificate Program Update: Teaching PLM Online Using VMs in the Cloud

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Abstract

Purdue University Department of Computer Graphics Technology in conjunction with the Boeing Company developed a Product Lifecycle Management (PLM) Certificate Program for Boeing employees. Several cohorts have been through the Certificate Program. This paper will outline the successful fundamental aspects of the program which include curriculum, online delivery and the lecture/lab format. This paper will address changes that have been made in course length and course delivery architecture including using virtual machines in the cloud. Additionally, this paper will discuss strategies for keeping the program viable and relevant to working professionals of the Boeing Company as well as other companies.

Introduction

Product Lifecycle Management (PLM) has been an area of specialization of the Department of Computer Graphics Technology (CGT) Department in the College of Technology at Purdue University for more than a decade. As described by Hartman and Springer (2011) the PLM Certificate Program (PLMCP) began as a collaborative effort between the Boeing Company and Purdue University to address the knowledge gap between management's directive to implement PLM and the workforce's use of PLM tools to perform their job function. Once the corporate decision is made to practice PLM, the key to PLM success, by the very definition of PLM, is to have everyone in the organization understand PLM. Product lifecycle management is generally defined as managing a product from concept to disposal in an effort to make better business decisions and leverage a competitive advantage (Hartman & Springer 2011). As a product moves through its lifecycle from concept to disposal, everyone in the organization in the course of performing their job duties comes into contact with some aspect of the product. In this way, everyone in the organization becomes part of the practice of PLM and would benefit from an overview of PLM.

CGT had experience with PLM curriculum that could be leveraged for such an overview. Boeing's internal training and development organization provided access to subject matter experts and training coaches. The Center for Professional Studies and Applied Research (ProSTAR) in the College of Technology addressed the logistics of managing a professional educational program. It was the combined efforts of these three organizations working together as described in Hartman

and Springer (2011) that the PLM Certificate Program content was derived and in June 2007 the first cohort of 20 participants started their coursework. With three 10 week courses covering the three core areas of PLM: CAD, PDM and manufacturing, the first cohort concluded in March 2008 with 12 participants receiving completion certificates (Hartman & Springer, 2011). The first cohort had a 60% completion rate. Participant and employer feedback gathered at the end of each course validated the curriculum but required major changes to the laboratory portion of the program. As a result, the start of the second cohort was delayed until September 2009 with 22 participants. The second cohort completed the certificate program in April 2011 with 12 participants receiving completion certificates (Hartman & Springer, 2011). The second cohort had a 54% completion rate.

Building on Success

The author joined the faculty portion of Purdue's PLM Certificate Program team specifically to teach the third cohort and build on the successful characteristics that emerged from the first two cohorts. The third cohort began in September 2012 with 13 participants using the adult learning strategies and synchronous online delivery model described by Hartman and Springer (2011). The three course format with the same goals and weekly topics as described in Hartman and Springer (2011) were also used but the length of each course was reduced to 8 weeks. The weekly lecture covered concepts but emphasized tool independence and was not industry specific. The weekly lab exercise gave participants experience working with PLM tools without being typical tool training. The software tool used for the lab exercises was for illustration purposes only and the core processes and methods could then be applied to any PLM toolset. This would ensure anyone looking to enhance their knowledge of PLM would benefit from the courses regardless of which PLM tools their organization used. In Boeing's case, different PLM tools were used at different business units. Participants were awarded Continuing Education Units (CEUs) as they successfully completed each course and awarded a Purdue University Certificate after completing all three courses. The third cohort concluded when seven participants completed the certificate in May 2013. The third cohort had a 54% completion rate. There were nine participants in each of the second and third courses because the requirement that the courses be taken in order was dropped. This change was made to give participants more flexibility in how they could complete all three courses based on reasons cited for dropping out of the program in end of course surveys described in Hartman and Springer (2011) including change in work assignment, scope or priorities and personal reasons. The change also increased enrollment by almost 29% which helped lower breakeven point for the course budget.

Continuous Improvement Continues

As noted in Hartman and Springer (2011), the method of delivery of the hands-on labs to online participants has undergone the most dramatic changes and presented the most challenges. The initial goal was to come up with a solution that would work on any computer that had internet access. At first, this was accomplished by giving participants a guest account to access to Purdue's software access utility called Software Remote. This is a Citrix based technology that gives students access to software that they would normally have to go to a computer lab on campus for. This was marginal at best to access CAD software but to use it to access the client-server environment that PDM requires turned it into an administrative headache. For Course 2 and 3, CAD and the PDM rich (or thick) client had to be packaged and served up as an application on the Software Remote web site. Any mid-course changes made to the course required the package be remade and reposted. Making changes was a hassle but it was a solution. During the lab sessions CAD performance was poor as it depended on the participant's proximity to the university.

Despite the poor performance, the hands-on lab sessions were the most popular part of the courses and consistently received high marks on course surveys. Finding a solution that would provide the best lab experience to PLMCP participants was a high priority for the third cohort. "As such, the PLMCP is moving in the direction of using a hosted virtual machine solution from an external solution provider" (Hartman & Springer, 2011). The third cohort was the first to use such a configuration: VMs in the cloud. Boeing had experience with cloud services and recommended one of their cloud service providers, Skytap.

The Skytap configuration for the third cohort was designed to provide participants the flexibility to work on the labs anytime and not just during normal labs hours with a PDM server that was up 24/7. This is very similar to how a typical physical PDM network would be set up. A typical PDM set up includes an application server, database server, file server(s), license server and optionally a web server. The clients are all pointing to the same instance of the database on the application server (see Figure 1) and it is available 24/7.

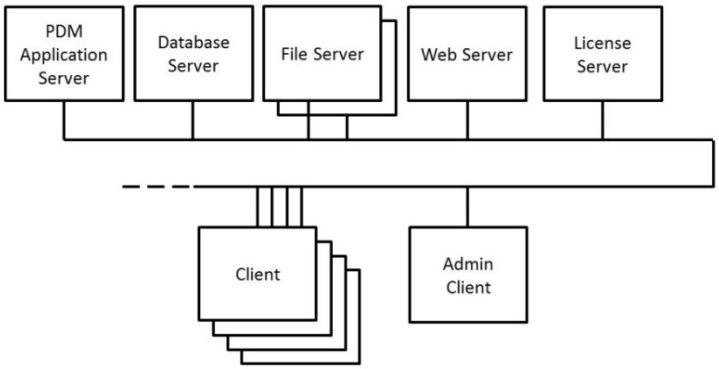

Figure 1 Typical Physical PDM Components

A simplified configuration was used in the cloud with virtual computers. The application server, database server and file server were combined into one virtual "server" that would be on all the time. Each participant had a client virtual machine (VM) and the instructor had a client with administrative privileges (see Figure 2). As in the typical scenario, all the clients pointed to the single PDM instance on the application server. The client VMs were powered up only when needed. The license server was on the Purdue network so the client VMs would get license authorization from the Purdue pool of licenses. With this configuration labs were included that illustrated issues involved with multiple clients hitting a single PDM instance such as file naming, part numbering and workflows.

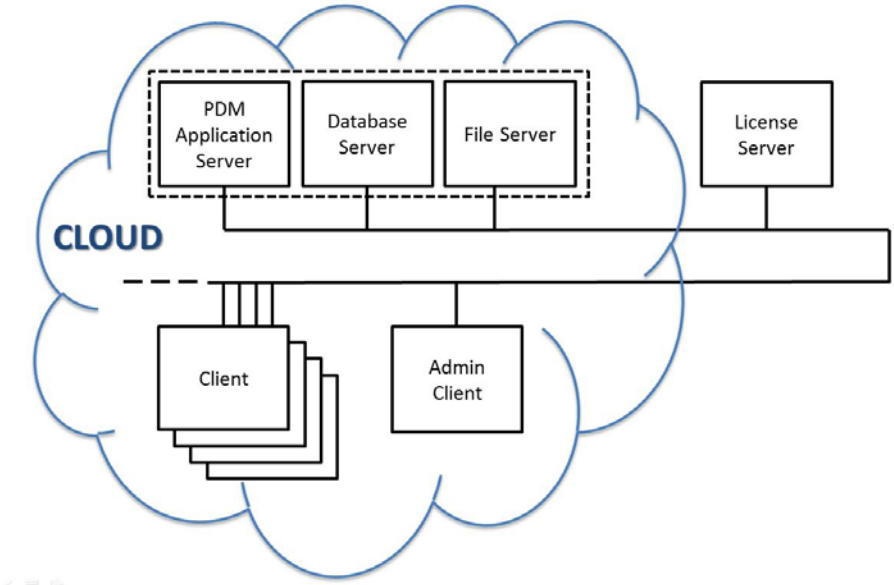

Figure 2 Cloud configuration for PDM with a single 24/7 server

Running an application server 24/7 was not typical for a cloud pricing structure which is oriented to on-demand usage. Even though the lab portion of the course is designed for the participants to be online with the instructor for 2 hours once a week, if participants didn't finish the lab or missed the preset time for the lab, they could log into their virtual computer in the cloud and complete the lab when it was convenient for them. This outside of class time availability was what required the server to be running 24/7. The fourth cohort began August 2013 with 23 participants and the configuration being used is one where each participant gets their own application server as well as their own client. The participant's client points to the instance of PDM on the participant's server (see Figure 3). This means that the server VM (as well as the client VM) is only powered up when the participant is online. The plan is that this will make the lab portion of the course more cost effective and efficient and scalable to an asynchronous version of the PLM Certificate Program as well.

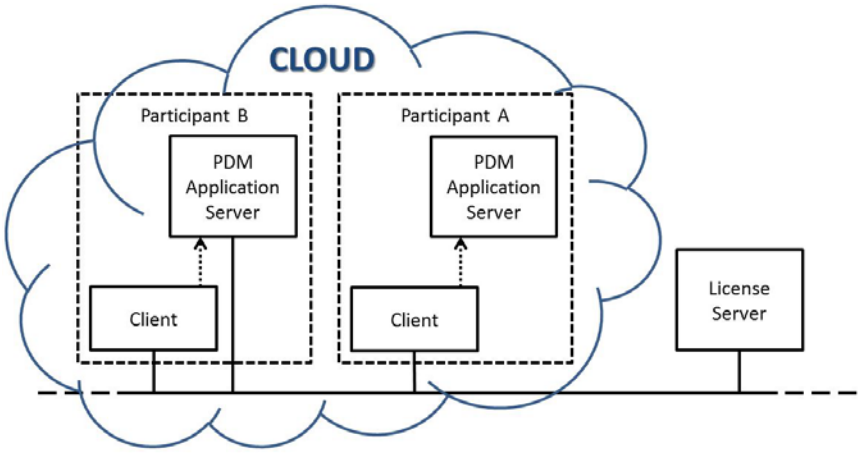

Figure 3 Cloud configuration with on demand servers

Running the labs on the virtual computers in the cloud worked well from an access and control point of view. Initially, however the mouse keys did not map correctly for the CAD application. This made model manipulation tedious at best. Spinning shaded images was hard for the graphics processor to keep up with initially as well. These issues were resolved mid-way through the second course. Another issue with virtual computers running on a cloud was latency or lag time. If latency was high, users would get frustrated. High latency was attributed to distance from the servers on the west coast and internet band width. The cloud service provider brought an east coast service center online before the third course started and we saw improvement for our participants east of the Mississippi including the instructor. We also emphasized that a broad band, high speed internet connection was required for labs.

Evolution Continues

In addition to adjusting the number of weeks in each course and the method of delivery for the labs, the PLM Certificate Program at Purdue has evolved and will continue to evolve. Course 1 started out with standalone CAD, now PDM is integrated with CAD from the beginning. The course has become less industry specific by not having a Boeing subject matter expert participate. The content features examples from a wide range of industries as participants from companies other than Boeing are actively solicited. The fourth cohort features the first non-Boeing employee. An asynchronous version is being developed so participants can take the courses at a time convenient for them instead of a set time each week. The curriculum is being reorganized into smaller modules partly to facilitate the asynchronous version of the program but also to keep it flexible enough so that different PLM toolsets could be used for the labs. Delivering dynamic

interactive experience with the PLM toolsets has been challenging but using VMs in the cloud looks promising.

Reference

Hartman, N. W. & Springer, M. L. (2011). *A distance learning Product lifecycle management (PLM) certificate program in technology.* Paper presented at the 2011 Annual Conference and Exposition of the American Society for Engineering Education, Vancouver, B. C., Canada, June 28, 2011.