Hands-On Tech Challenge

Abstract

While many MIS programs produce students who do excellent analysis and design work, in some cases these same students show weaknesses when it comes to creating and deploying the solutions they envision. Even if students take a number of courses in programming and can develop applications, few of these students have the skills needed to roll out an end-to-end solution because they don’t understand the infrastructure requirements for providing the platform to support their solution.

As part of our Enterprise IT Architecture class, students complete a series of “Hands-On Tech Challenges”. Working in the cloud using Microsoft Azure, students create and configure a collection of virtual machines including a domain controller, DNS server, workstations, file server, database server, network monitor and web server. This virtual network provides each student with a complete platform upon which they can deploy systems that they have developed in their application programming and database courses. As part of creating this virtual network, students develop the skills they need to roll out an end-to-end solution, not just design solutions that are never implemented.

In this paper we will discuss these hands-on tech challenges and give examples of how students can build upon the platform they create.

Keywords

Cloud, Virtual Network, Infrastructure, Hands-On, MIS Education

Introduction

Many MIS programs produce students who are very good at doing analysis and design work. They can collect requirements, model processes and the information requirements to perform these processes, specify the requirements for application and often build applications and the required databases. However, students are unable to deploy solutions that they envision because they lack a basic understanding of the infrastructure required to support their solutions.

Lecturing as a teaching technique only goes so far. Using lectures alone, we have observed a pattern of students knowing concepts but being unable to apply them to even rudimentary business problems. After exploring this further, we discovered we were not alone in this observation. A quick literature review showed similar concerns in fields as diverse as organic chemistry and political science.

“The average student was able to mimic simple problems but did not have the ability to apply the ideas to new problems or situations” (Jones-Wilson, 2005)

“Students were not yet able to be either analytical or creative in their thinking about the materials I presented, and I did not know what to do about developing their thinking.” (Moreland-Young, 1983)

Learning is facilitated by hands-on activities (Feisel & Rosa 2005; Hoffa 2006). This set of “Nifty Assignments” known as “Hands-On Tech Challenges” exposes students to the infrastructure required to deploy solutions that they envision by having them create the infrastructure needed to support a start-up in the cloud using Microsoft Azure.
**What Do They Build?**

Using an account on Microsoft Azure, each and every student builds out the infrastructure for a fictitious startup:

**DC1** – This server is a combination domain controller/DNS server and provides the foundation for the entire virtual network. Being built on Microsoft Azure, this is a Windows based network and active directory provides the database for machines, groups, users and is used for manage policies for the network.

**FS1** – This server provides file services to the users of the network. Shares are created to share information between all users of the organization. Departmental shares are created so users, based on group membership, can share information within their departments (i.e. Accounting, Marketing and Finance).

**WS1/WS2** – These virtual machines act as workstations so that users can login and access resources within our virtual network.

**SQL1** – This server provides database services in our network and runs MySQL Server.

**NMON1** – This is a network monitor that keeps an eye on all of our systems and notifies the student via e-Mail and/or text messages when a system is down or having some other problem.

**IIS1** – This is a web server with PHP installed. Students can install applications that they develop in their application programming course which query the databases running on SQL1. Students would run these applications from one of the two workstations and DNS services are provided by DC1.
What is a Tech Challenge?

This set of “Nifty Assignments” included six tech challenges (appendix A). Each tech challenge takes two 120-minute class periods. Students must complete some web based research before each tech challenge (i.e. research what a domain controller and a DNS server are) and the instructor leads a brief discussion about what these things are and how they relate to the tech challenge that we are about to begin.

The instructor then launches their browser, logs into Azure and walks students through the tech challenge pointing out things students should note and things they need to develop a deeper understanding of as they work through the tech challenge.

During the second class period the instructor walks through the tech challenge a second time from beginning to end but this time students work along with the instructor and complete the tech challenge themselves.

The instructor answers questions as they go but intentionally move through the tech challenge fairly rapidly so that students really can’t take a lot of detailed notes. The instructions for the tech challenges specify what the student needs to accomplish but does not include detailed, step-by-step instructions on how to accomplish these goals. Students are strongly encouraged to perform the tech challenges many times outside of the classroom and, for every item that they need to develop a deeper understanding, research these topics, learn what they are all about and learn why understanding these topics is essential to being successful with these technologies and the exams for this course.

Individual Tech Challenges

**Tech Challenge #1 – Building Your First Domain Controller and DNS server**

In the first tech challenge student crate an account in Microsoft Azure and create their first virtual machine. This machine will run Windows Server 2016. The student logs into the machine and, via Server Manager, adds the roles of Active Directory Domain Services and DNS. Once these roles are created the student then promotes their first virtual machine to become the domain controller for their virtual network.

**Tech Challenge #2 – DNS and Network Build Out**

In the second tech challenge students are creating new systems which will function as workstations that users will be able to login to and access the virtual network along with a new system which will become the file server for our fictitious organization in tech challenge #3. Students also begin to learn how to work with DNS, examining the values of entries in their forward lookup zone and creating aliases in DNS which can be used in future tech challenges.

**Tech Challenge #3 – File Service and Login Scripts**

In the next tech challenge students learn about users and groups within active directory and create groups for the people that work in specific departments in the fictitious organization (Accounting, Finance and Marketing). A collection of users is created and placed into these groups. Using the file server that was created in tech challenge #2, students create a number of shares. One share will be used to share information across the entire organization and the other three shares are used to share information within the department for which we just created groups. Students learn about access control for these shares and how access control is managed by group membership through active directory. Students learn about login scripts and create a login script that will map drives when a user logs in based on group (department) membership. Students learn about policies in active directory and configure this script to execute whenever a user logs in, mapping their drives so they can share information across the organization and within their department.

**Tech Challenge #4 – MySQL Server Installation**

After learning a bit about storage (RAID 5 and mirroring drives), students create their next server and add five virtual disk drive to this server. Students create a RAID array out of three of these virtual disk drives and create a mirrored volume out of the last two drives. Students then download and install MySQL onto this machine and then reconfigure MySQL so that the data files for the database reside on the RAID array. Students also enable transaction logs (binary logs) and store these transaction logs on the mirrored volume. On a very small scale, this disk configuration mirrors they type of database servers they will create in the real world. Students then run a number of SQL scripts to create and populated databases on the MySQL server. These are the same databases that students are exposed to in their databases and application development classes so these databases are very
familiar to these students. Students run a variety of simple queries against these databases to ensure that everything is working properly.

**Tech Challenge #5 – Network Monitor Installation and Configuration**

Earlier in the semester students learned about the cost of downtime to organizations when important systems are down. In this tech challenge students create another virtual machine and install the free version of Servers Alive, a simple but useful network monitor. Students configure Servers Alive to monitor their network and to alert them when systems are down. Students also configure Servers Alive to monitor for minor problems before they become major problems. For example, if the transaction logs on the database server fill, the database server will stop working so students explore how to use Servers Alive to send an e-Mail based warning when the disk utilization of the transaction logs exceeds 60% utilization and to send out text messages when disk utilization of transaction logs exceeds 80%.

**Tech Challenge #6 – Web Server Installation**

All students are required to take two programming classes which use PHP and a database course which uses MySQL. Between these three courses students learn to create web based applications that query a database. In this tech challenge students create a new virtual machine and add the role of web server, installing IIS. In addition, students install PHP for IIS on this server. Students create the world’s simplest PHP program and then, after logging into one of the workstations in the network, launch their browser and execute this program on the web server. After discussing what we have created and what students have learned in their programming and database courses, students are challenged to port their databases from their database course to their new MySQL server and to port the applications they developed in their programming courses to their web server and executing their web based applications from the browser across their virtual network on the web server.

**Exams**

Two of the four exams in this course are hands-on tech challenges (sample exams available upon request). Students walk in the room and are presented with a tech challenge that is very similar to the tech challenges we completed in the classroom and which they were challenged to develop both skills with and a deeper understanding of on their own outside of the classroom. These exams allow students to demonstrate the hands-on technology skills that students have developed.

The grade distributions for these exams are always the same. Students almost always earn an “A” (90-100%) or an “F” (0-40%). It turns out that every student falls into one of three broad categories.

1. The students who “get it” – These are the students that really dig into these tech challenges and complete these tech challenges over and over again outside of the classroom. Over time, they run into and figure out how to get around every possible problem. These students also research and develop a more genuine understanding of every setting and why every setting is set the way it is. These students coast through the exams and earn perfect scores.

2. The students who memorize the steps – Some students perform the tech challenges many times outside of the classroom. They know the steps that need to be completed and how to complete these steps. However, most of these students don’t develop a more genuine understanding of every setting and why every setting is set that way. When these students encounter a minor problem during the exam or when the exam asks for something that is slightly different than what they expected, these students then really struggle to be successful on these exams.

3. The students who tried it once – The final group of students is the group of students that came to class, watched the instructor compete each tech challenge once, tried it once themselves and thought they would be successful on the exams. These students always struggle with these exams and usually fail the course.
Conclusion

While many programs produce students with exceptional analysis and design skills, if the students do not have both the knowledge and skills to roll out an end-to-end solution, they will struggle to deliver solutions to the organizations that they work for. One of the missing components in many programs is an understanding of and hands-on experience with the infrastructure that will support their solutions. One of the best ways to learn about infrastructure and to develop the skills to work with infrastructure is to build infrastructure and this set of "Nifty Assignments" provides an example of doing this in the classroom.

REFERENCES

Jones-Wilson, M., (September, 2005) ”Teaching Problem-Solving Skills without Sacrificing Course Content” Journal of College Science Teaching 351
Moreland-Young, C., (September, 1983) “Teaching Analytical and Thinking Skills in a Content Course”, New Directions for Teaching and Learning 15: 41-47

Appendix A – Tech Challenges

Below you will find copies of the six tech challenges that are completed by students. Note that students are not given detailed steps. They are given the goals that they are required to accomplish. Students are expected to follow along in class and spend significant time outside of the classroom learning the detailed steps along with understanding what they are doing and why they are doing it. If they do not understand what they are doing and why they are doing it, the odds are slim that they will be successful on the hands-on tech challenge exams.

Tech Challenge #1 - Build Your First AD DC/DNS Server

1) If you are a Mac user, install Microsoft Remote Desktop from the App Store.
2) Log in to Azure at portal.azure.com with your Temple AccessNet account/password.
3) Create a resource group called “MIS2501”. You will create all of your virtual machines in this resource group.
4) Create a new virtual machine with these settings:
   a. The server should be a “Windows Server 2016 Datacenter”.
   b. Deployment model should be “Resource Manager”.
   c. Name your VM the same as your TU AccessNet account with “-DC1” appended to it. For example, if your Temple University AccessNet account was “TUA12345” then the machine name would be “TUA12345-DC1”.
   d. Set the user name as your TU AccessNet account. For example, if your Temple University AccessNet account was “TUA12345” then set the user name to “TUA12345”.
   e. Set the password to “Password1234”.
   f. Set the Resource group to “MIS2501”.
   g. For size, choose “A1 Standard”.
5) Login to your VM to check if it is working.
6) Start a command prompt, issue the command “ipconfig /all”. Record the IP address of the current DNS server.
7) Give your VM a static IP address with a host address of 10 (i.e. 10.0.0.10).
8) Set up your DNS servers:
   a. Set primary DNS server to the static IP you set in the previous step
   b. Set secondary DNS server to the address Azure DNS server (recorded above)
9) Login to TUA12345-DC1 using the account TUA12345 and the password of Password1234.
10) Update your server so that it plays the roles of both “Active Directory Domain Services” server (AD DS) and a “DNS Server” (DNS)
   a. Create a new forest and specify a root domain name that matches your Temple University AccessNet account with the string “.LOCAL” appended to it. For example, if your AccessNet account is “TUA12345” then specify “TUA12345.LOCAL” as your root domain.
   b. Specify “Password1234” for the DSRM password.
   c. Specify your Temple University AccessNet account for the NetBios domain name. For example, if your AccessNet account is “TUA12345” then specify “TUA12345” for the NetBios domain name.
11) Turn off the Windows firewall for the domain.

This completes Tech Challenge #1

Tech Challenge #2
DNS and Network Build Out

1) Create the following VMs:

<table>
<thead>
<tr>
<th>Role</th>
<th>Workstation 1</th>
<th>Workstation 2</th>
<th>File Server</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>TUA12345-WS1</td>
<td>TUA12345-WS2</td>
<td>TUA12345-FS1</td>
</tr>
<tr>
<td>Size</td>
<td>A1 Standard</td>
<td>A1 Standard</td>
<td>A1 Standard</td>
</tr>
<tr>
<td>IP address</td>
<td>Dynamic</td>
<td>Dynamic</td>
<td>.11</td>
</tr>
<tr>
<td>Virtual Network</td>
<td>Same as DC1</td>
<td>Same as DC1</td>
<td>Same as DC1</td>
</tr>
<tr>
<td>DNS Server (2nd step)</td>
<td>IP Address of DC1</td>
<td>IP Address of DC1</td>
<td>IP Address of DC1</td>
</tr>
</tbody>
</table>

Note: Replace TUA12345 with your AccessNet account.

2) Login to each VM and have the VM join your domain.
3) Disable the Windows firewall for the domain on TUA12345-FS1
4) Login to TUA12345-DC1 and create an alias for TUA12345-FS1 called “File_Server”.
5) Show DNS entries for FS1, WS1, and WS2. Take a screen shot of these entries in DNS that clearly shows the name, the type and the data associated with each DNS entry. Paste screen shots of these DNS entries here:
6) Launch “Active Directory Users and Computers” and create a screen shot that clearly shows all of the computers that are part of your network. Paste the screen shot here:

7) Add “Domain Users” to the “Remote Desktop Users” group on TUA12345-WS1 & TUA12345-WS2 (you’ll need this for the next lab).
Tech Challenge #3

File Services and Login Scripts

1) Login to TUA12345-DC1 and create the following groups:
   a. Accounting
   b. Finance
   c. Marketing

2) Create the following accounts each with a password of “Password1234” and make them members of the appropriate group.
   a. Anne – Member of Accounting
   b. Alex – Member of Accounting
   c. Frank – Member of Finance
   d. Fannie – Member of Finance
   e. Mork – Member of Marketing
   f. Mindy – Member of Marketing

3) Login to TUA12345-FS1, create the following folders on the C-Drive and grant the following groups access to these drives:
   a. Company Shared – Domain Users – Full Access
   b. Accounting – Member of Accounting Group – Full Access
   c. Finance – Member of Finance Group – Full Access
   d. Marketing – Member of Marketing Group – Full Access

4) Launch “Active Directory Users and Computers” and take a legible screen shot of the members of the Marketing group. Paste this screen shot here:

5) Create a login script that maps the shared drives:
   ```
   NET USE L: /DELETE /Y
   NET USE L: \"TUA12345-FS1\Company Shared" /PERSISTENT:No
   NET USE M: /DELETE /Y
   NET GROUP Marketing /DOMAIN | FINDSTR /R /I:/C:"%UserName%" >NUL
   IF NOT ERRORLEVEL 1 (NET USE M: \"TUA12345-FS1\Finance" /PERSISTENT:No)
   NET GROUP Finance /DOMAIN | FINDSTR /R /I:/C:"%UserName%" >NUL
   IF NOT ERRORLEVEL 1 (NET USE M: \"TUA12345-FS1\Accounting" /PERSISTENT:No)
   ```

6) Login to TUA12345-WS1 as Anne and check the mapped drives and verify that you can write to the drives.
7) Login to TUA12345-WS2 as Alex and check the mapped drives and verify that you can write to the drives.
8) Login with other accounts and see what drives are mapped and if you can share data within the organization and within the department.
Tech Challenge #4
MySQL Server Installation

As a prerequisite for this Tech Challenge, create the following VMs and add them to your domain. In addition, disable the Windows firewall for the domain on each server:

<table>
<thead>
<tr>
<th>Role</th>
<th>Database Server</th>
<th>Web Server</th>
<th>Network Monitor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>TUA12345-SQL1</td>
<td>TUA12345-IIS1</td>
<td>TUA12345-NMON1</td>
</tr>
<tr>
<td>Size</td>
<td>A3 Standard</td>
<td>A1 Standard</td>
<td>A1 Standard</td>
</tr>
<tr>
<td>Static IP with address</td>
<td>.12</td>
<td>.13</td>
<td>.14</td>
</tr>
<tr>
<td>Virtual Network</td>
<td>Same as DC1</td>
<td>Same as DC1</td>
<td>Same as DC1</td>
</tr>
<tr>
<td>DNS Server</td>
<td>IP Address of DC1</td>
<td>IP Address of DC1</td>
<td>IP Address of DC1</td>
</tr>
</tbody>
</table>

In addition, delete the VM that you created as part of Exam #1. There is a limit to the number of cores that you can allocate to your virtual network. If you have followed all of the directions carefully, including those from the exam, you will not have enough cores available to create these three VMs.

1) Attach 5 new 1 GiB disks to TUA12345-SQL.
2) Create a RAID volume out of the 3 disk drives that were just added assigning it the drive letter “M” and a volume label of “RAID-5”.
3) Create a mirrored pair out of the last two drives that were just added with a driver letter of “N” and volume label of “MIRROR”.
4) Download and install MySQL found at: [http://dev.mysql.com/downloads/installer](http://dev.mysql.com/downloads/installer)
5) Move the MySQL data files to the RAID-5 volume.
6) Enable binary logs and store the binary logs to the mirrored volume.
7) Start MySQL and display the location of the data files by executing the SQL command “show variables like ‘datadir’;”. Create a screen shot of the output and paste the screen shot here:
8) Go to Options File…Logging on the MySQL Workbench. Scroll down to show the value of log-bin. Take a screen shot of this and paste the screen shot here:
9) Download the files used to create and populate the databases and tables used in MIS2502 from the class blog. Run this script to create and populate these databases. Run a SQL query to display the faculty and staff. Paste a screen shot of this information here:
10) Display the files that are on the volume that contain your binary logs by going to “Start…This PC” and selecting this volume. Paste a legible screen shot of this information here:

Tech Challenge #5
Network Monitor Installation and Configuration

1. Start-up TUA12345-SQL1, TUA12345-NMON1 and TUA12345-DC1
2. Login to TUA12345-NMON1 as TUA12345
4. Startup Servers Alive.
5. Set up Servers Alive to send Alerts via e-Mail messages.
6. Configure Servers Alive to monitor TUA12345-SQL1 and to send you e-Mail messages when TUA12345-SQL1 does not respond to a ping. Include your name in the e-Mail message (i.e. “The primary support person for this server is Mart Doyle”)
7. Take a screen shot of Servers Alive showing that TUA12345-SQL1 is up and running and paste that screen shot here:
8. Shutdown TUA12345-SQL1 and see if you receive the alert.
9. Take a legible screen shot of the e-Mail message and paste the screen shot here:
10. Bring TUA12345-SQL1 back up and see if the alert clears.

Tech Challenge #6
Web Server Installation

1) Login to TUA12345-IIS1 and install IIS.
2) Install PHP from https://php.iis.net/
3) Create the file C:\inetpub\wwwroot\phptest.php that contains:
   
   <?php
   echo phpinfo();
   ?>

4) Login to TUA12345-WS1 as TUA12345
5) Fire up the browser and go to http://tua12345-iis1/phptest.php and see if PHP is working under IIS.
6) This concludes Tech Challenge #6