

Distributed Objects for Cloud Computing Project

Title: JPetStore Application

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TABLE OF CONTENTS

Application Overview: JPetStore

JPetStore6 is an online website that allows its registered users to purchase animals. It allows for various operations such as user sign-up\login, browse catalogue of animals, selecting items to cart, checkout and complete purchase order.

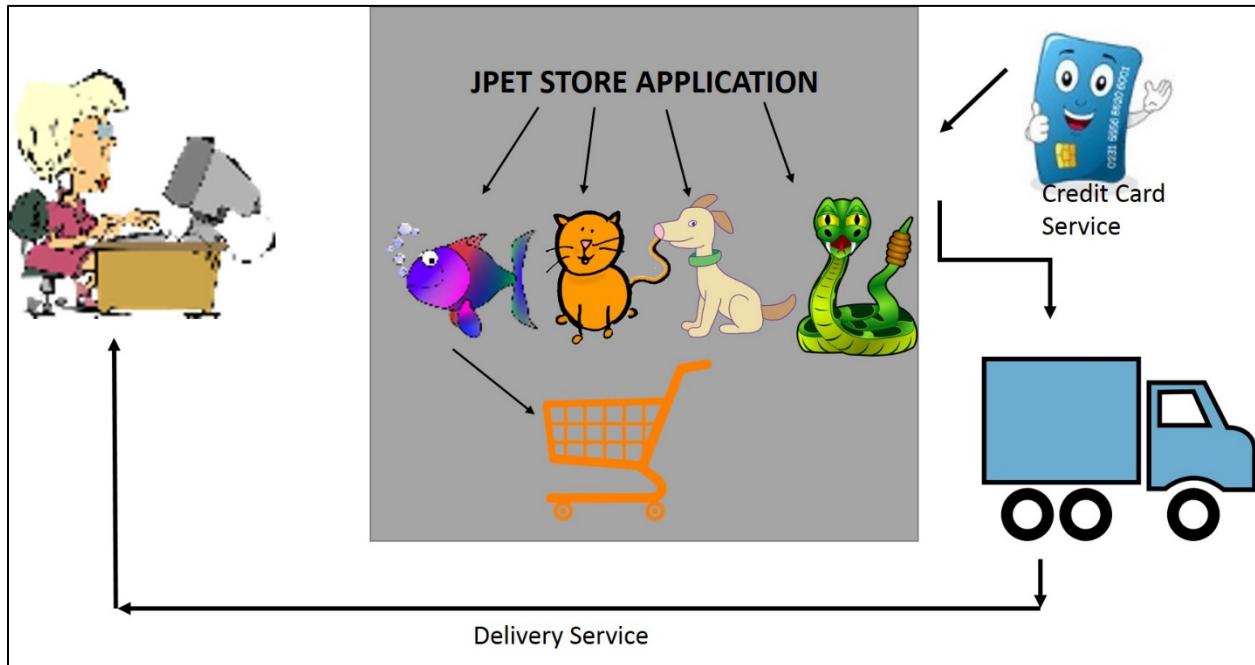


Fig: Overview of JPetStore application

Any user can search through a catalog of pets that are of various types and traits. When the customer likes an item, they select it and add to their shopping cart. Once they have completed their shopping, they proceed to checkout page (before which the user must sign in\register as new user, if not already done) and submit an order which contains details like their shipping & billing address, payment type and card information. Each customer's account is unique by their userid and stores details like name, address, contacts, etc.

MyBatis JPetStore6 is a Java EE web application based on Spring and Stripes, which is implemented using open-source freeware. It consists of around 28 classes, several JSP files and XML configuration files. To host this application we have chosen the Tomcat container. The below figure shows a simple sitemap of the application.

JPetStore Site Map

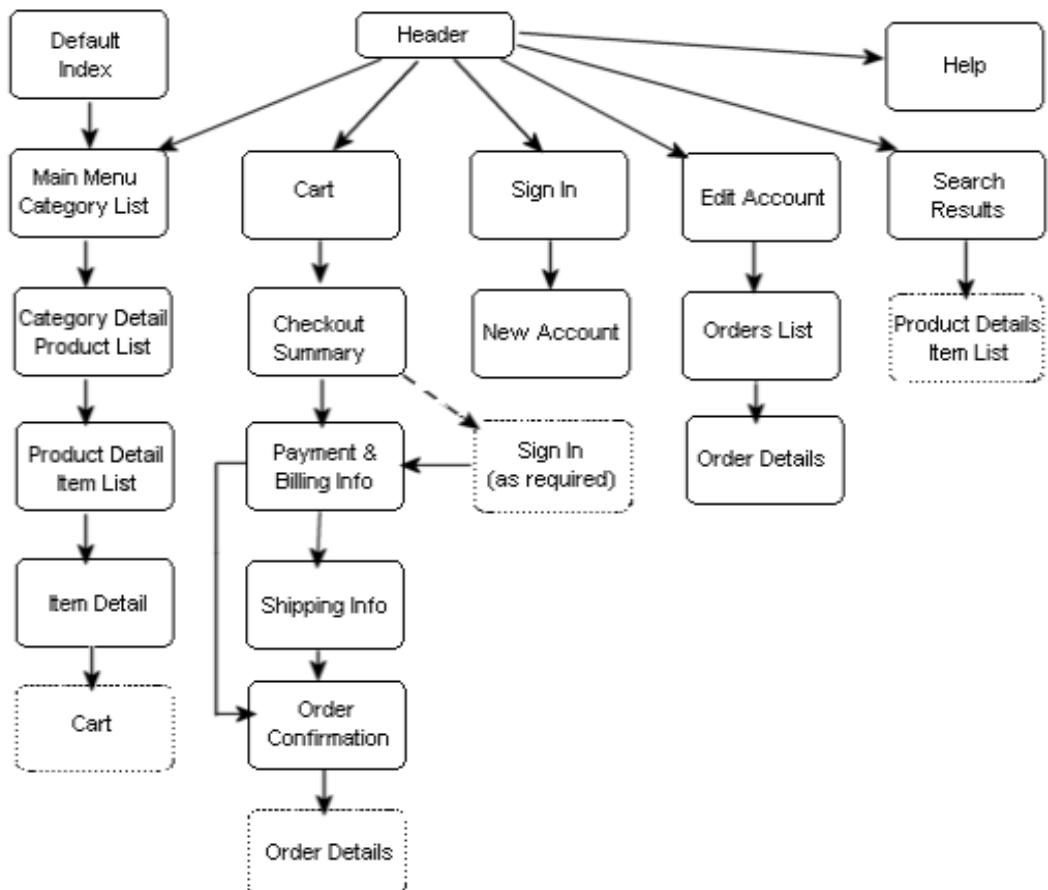


Fig: Site Map of JPetStore Application

Technical Characteristics of Application:

Development IDE: Eclipse or NetBeans

Supported Web Server: Tomcat or Jetty

Programming Language: Java

Framework: Java Structs and Spring (gives a Model-View-Controller framework which allows for easy separation of business concerns)

Database\ Object Mapping: Framework called iBATIS Database (uses simple XML descriptor file to describe the inputs and outputs of an SQL statement. It allows the programmer to simply pass a JavaBean into a Mapped Statement as a parameter (input) and receive a JavaBean as a result (output))

Complier\Software Development Kit: Sun JAVA SDK

Goal of the Report:

The goal of this report is to explain efforts made to host the JPetStore6 application onto the cloud using provider MS Azure, with best possible provisioning\de-provisioning strategies. In order to perform this we required the application to be under some form of load, which is achieved using JMeter.

For this purpose, the steps performed under this report can be summarized as:

- ❖ JPetStore application is divided into various business transactions, each depicting a sequence of steps followed to achieve a single task
- ❖ JMeter scripts are written for each transaction, keeping validations and checks as necessary
- ❖ Application is hosted on the cloud by choosing one among the various deployment techniques
- ❖ Load is managed onto the application in the cloud using JMeter provided parameters
- ❖ Different strategies are tested for scaling up\down in MS Azure and results are documented
- ❖ Conclusion presents the best possible strategies for given load amounts

Local Deployment

For deployment, JPetStore needs to be built with Apache Maven. The only requirements are JDK >=1.5 and Maven >= 2.0.8

Running JpetStore with Tomcat:

1. Download and Unzip Tomcat
2. Download JpetStore source code
3. From Eclipse, Import -> Maven -> Existing Maven Projects -> unzipped jpetstore source
4. Delete parent pom references from pom.xml
5. Change the stripe dependency
6. Run as maven project to build war files. The war file gets created in the “target” directory
7. JpetStore is now accessible from the browser

Cloud Deployment of the application:

Since, the JPetStore application is not a heavy weight application, we do not need complete control over the deployment environment. Hence we choose to deploy the application as a Web App and concentrate on writing provisioning rules.

To create a WebApp:

1. We implemented the application in MS Azure as a webapp
2. It was deployed on Tomcat server8.0
3. A new webapp was created from the marketplace

4. A new Resource Group was created as “webappmysql-group” and the corresponding “App Service plan/Location” was selected
5. A unique URL for the webapp was also given

To deploy the application:

1. Go to the URL <https://jpetstore123.scm.azurewebsites.net/> to find the Kudu Services
2. Go to Powershell under Debug Control tab and go to the following path
site/wwwroot/bin/apache-tomcat8..0.27/webapps
(D:\home\site\wwwroot\bin\apache-tomcat-8.0.27\webapps)
3. Import jpetstore.war file inside this directory.
4. The entire application is now imported under the directory jpetstore and the homepage can now be accessed from the link <http://jpetstore123.azurewebsites.net/jpetstore/>

JpetStore Program Structure:

```

/jpetstore          <-- Maven pom.xml present here.
/src
/main/
  /java           <-- Java code present here.
  /org/
    /mybatis
      /jpetstore
        /domain     <-- Business domain objects present here.
        /persistence <-- Mapper interfaces present here.
        /service      <-- Application logic present here.
        /web
          /actions    <-- Presentation logic (actions) present here.
/resources         <-- Non java files present here.
/org
  /mybatis
/jpetstore
  /persistence <-- Mapper XML files present here
  /database
/webapp
/css
/images
/WEB-INF          <-- web.xml and applicationContext.xml present here.
/jsp              <-- JSP files present here.

```

Fig: Structure of JPet Project

Business Transactions of JPetStore6:

For this project we have divided the application into 6 major transactions. Each transaction has a specific set of steps to be completed in order to achieve an end result. Further, each step is documented as a HTTP request in the corresponding JMeter Script. A brief description of all transactions are given below:

1. Register New Users
2. Browsing Items, Adding to Cart and completing Checkout
3. Cart Operations - Updating\Removing items from cart
4. Manage Account - Editing user account information
5. View Orders - For users to view all orders purchased

Description of Business Transactions:

Transaction# 1

Transaction Name: Register New Users:

ID	Name	STEPS	VALIDATIONS
1	Enter the Store	1. Open the JPetStore application 2. Select “Enter the Store” link	
2	Catalog Home Page	1. User is redirected to view the catalog home page	
3	Sign In	1. Select “Sign-In” link on the top of the page	
4	New User Sign Up	1. Select “New User Registration” present on the bottom	
5	Register Now	2. Enter Username 3. Enter Password 4. Enter Password again for confirmation 5. Click on “Submit”	Userid should be unique for first time users to sign up
6	Catalog Page	1. On Successful account creation the user is redirected to catalog home page	If user sign up is unsuccessful, Exception is encountered. If user sign up is successful, user is redirected to catalog page
7	Sign Up	1. Select the “Sign-In” option at the top of the page	
8	User Sign- In	2. On catalog page, select “User Sign-In” option 3. Enter Username 4. Enter Password	User and Password must be authenticated. If authentication fails, Invalid User login message is displayed.

		5. Click on “Submit”	
9	User Home Page	1. After sign in user is shown their home page	Sign in is successful when user name is displayed in the home page as “Welcome <User_Name>”
10	Sign-Out	1. Select Sign-out option present on the top of the page	

Fig: Table showing steps of New User Registration

Transaction# 2

Transaction Name: Browsing Items, Adding to Cart and completing Checkout

ID	Name	STEPS	VALIDATIONS
1	Enter the Store	1. Open the JPetStore application 2. Select “Enter the Store” link	
2	Catalog Home Page	1. User is redirected to view the catalog home page	
3	Sign In	1. Select “Sign-In” link on the top of the page	
4	Default User Sign-In	1. Enter Username 2. Enter Password 3. Click on “Submit”	User and Password must be authenticated. If authentication fails, Invalid User login message is displayed. If successful, Welcome “<Username>” is displayed on the home page
5	Browsing through Multiple Items and adding to cart (Loop through multiple times)	1. Select Type of Animal (Fish, Dog, Cat, Reptile, Bird) 2. Select from the sub items of main category 3. Select “Add to cart” (or) 4. Select Item name to view details of the item 5. Select “Add to Cart”	
6	Checkout Cart	1. On completion of shopping, go to Cart by selecting the symbol on top of the page 2. Select Proceed to Checkout	

		3. Validate all information (billing details, address), select “Continue”	
7	Confirm Order	1. After validating all information, select “Confirm”	Unique Order ID is generated for each order. If successful, Thank you message is displayed. If unsuccessful , Exception is returned
8	Sign-Out	1. Select Sign-out option present on the top of the page	

Fig: Table showing steps of Browsing Catalog, Adding to cart and checking out

Transaction# 3

Transaction Name: Cart Operations (Update\Remove items from Cart)

ID	Name	STEPS	VALIDATIONS
1	Enter the Store	1. Open the JPetStore application 2. Select “Enter the Store” link	
2	Catalog Home Page	1. User is redirected to view the catalog home page	
3	Sign In	1. Select “Sign-In” link on the top of the page	
4	Default User Sign-In	1. Enter Username 2. Enter Password 3. Click on “Submit”	User and Password must be authenticated. If authentication fails, Invalid User login message is displayed. If successful, Welcome “<Username” is displayed on the home page
5	Browsing through Multiple Items and adding to cart (Adding 10 items to cart –repeat steps 10 times)	1. Select Type of as Fish/Dog/Cat/Bird 2. Select from the sub items of main category 3. Select “Add to cart” option against the item desired	
6	Update Cart (Multiple times change quantity of	1. On completion of shopping, go to Cart by selecting the symbol on top of the page	Check if cart is empty before updating. If empty, “Your cart is empty”

	cart items)	2. Update the quantity of the items in the cart 3. Select “Update” option	message is displayed to the user
7	Remove Items from Cart	1. On completion of shopping, go to Cart by selecting the symbol on top of the page 2. Select the product to remove 3. Select “Remove from Cart” option	Check if cart is empty before removing item. If empty, “Your cart is empty” message is displayed to the user
8	Sign-Out	1. Select Sign-out option present on the top of the page	

Fig: Table showing steps of Cart Operations (Update and Remove)

Transaction# 4

Transaction Name: Manage Account

ID	Name	STEPS	VALIDATIONS
1	Enter the Store	1. Open the JPetStore application 2. Select “Enter the Store” link	
2	Catalog Home Page	1. User is redirected to view the catalog home page	
3	Sign In	1. Select “Sign-In” link on the top of the page	
4	Default User Sign-In	1. Enter Username 2. Enter Password 3. Click on “Submit”	User and Password must be authenticated. If authentication fails, Invalid User login message is displayed. If successful, Welcome “<Username” is displayed on the home page
5	My Account	1. Select the “My Account” option from the top of the page	User information, Account information and Profile information is displayed on the page
6	Update User Info	1. Update values in various fields of user information 2. Select “Save” button	Information should be updated on the page
7	Sign-Out	1. Select Sign-out option present	

		on the top of the page	
--	--	------------------------	--

Fig: Table showing steps of Manage Account

Transaction# 5

Transaction Name: View Orders

ID	Name	STEPS	VALIDATIONS
1	Enter the Store	3. Open the JPetStore application 4. Select “Enter the Store” link	
2	Catalog Home Page	2. User is redirected to view the catalog home page	
3	Sign In	2. Select “Sign-In” link on the top of the page	
4	Default User Sign-In	4. Enter Username 5. Enter Password 6. Click on “Submit”	User and Password must be authenticated. If authentication fails, Invalid User login message is displayed. If successful, Welcome “<Username” is displayed on the home page
5	Browsing through Multiple Items and adding to cart (Loop through multiple times)	1. Select Type of Animal (Fish/Bird) 2. Select from the sub items of main category 3. Select “Add to cart” option against the item desired	
6	Checkout Cart	1. On completion of shopping, go to Cart by selecting the symbol on top of the page 2. Select Proceed to Checkout 3. Validate all information (billing details, address), select “Continue”	
7	Confirm Order	1. After validating all information, select “Confirm”	Unique Order ID is generated for each order. If successful, Thank you message is displayed. If unsuccessful , Exception is returned Note ORDERID generated, for viewing purpose

8	List Orders	2. Select the “My Account” option from the top of the page 3. Select “My Orders” option present on bottom of the page	Verify that “My orders” are displayed for the user
9	View Order	3. Select confirmed order ID 4. View the order details	User should see the completed order details
10	View Item	1. Select any of the listed items from the list within the order	Check if correct item details are displayed
10	Sign-Out	2. Select Sign-out option present on the top of the page	

Fig: Table showing steps of View orders

JMeter Scripts:

JMeter is used to load the application with user requests and monitor results. Each business transaction described above is made into a set of HTTP Requests and grouped into various Thread Groups. The technique followed is explained below.

1. Each business transaction is made as an Individual THREAD GROUP
2. Each step in the transaction is a HTTP REQUEST
3. Validations of the transactions are achieved using ASSERTIONS for each of the HTTP requests
4. CONTROLLERS are used to group number of steps for looping\various patterns of URL hits
5. Load is managed using thread group parameters of No. of users, No. of Iterations and Ramp up period
6. Different LISTERNERS are used for monitoring results or test runs

General JMeter Settings:

- a) **HTTP Cookie Manager:** For each iteration we have choose to clear the cookies. This is reasoned as, cookies improves the speed of a request since it involves client side caching. Removing the cookies will ensure the application is tested for worst case scenarios and in the presence of cookies the performance metrics will improve.

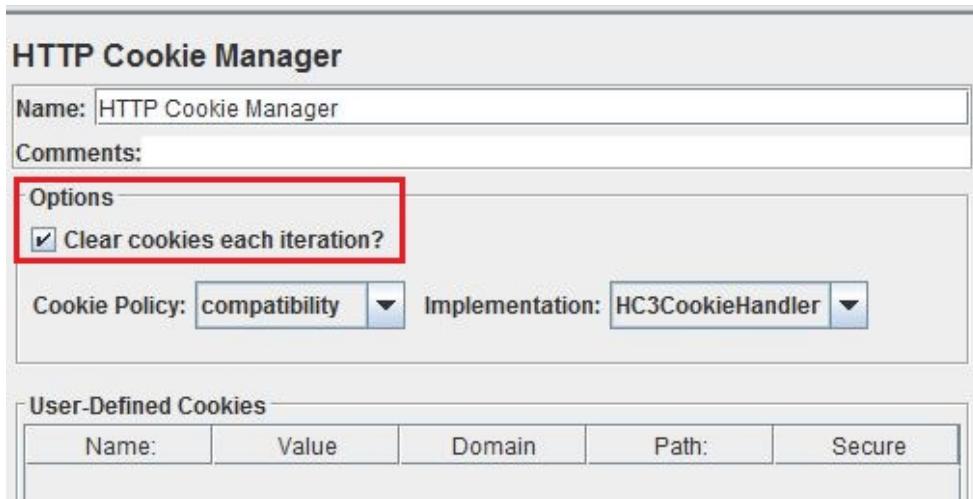


Fig: Cookie Manager Setting

- b) **HTTP Cache Manager:** For each iteration the cache is also cleared. Since, caching speeds up response rates, removing this ensures we test the application for peak loads. In the presence of caching the performance metrics would improve.

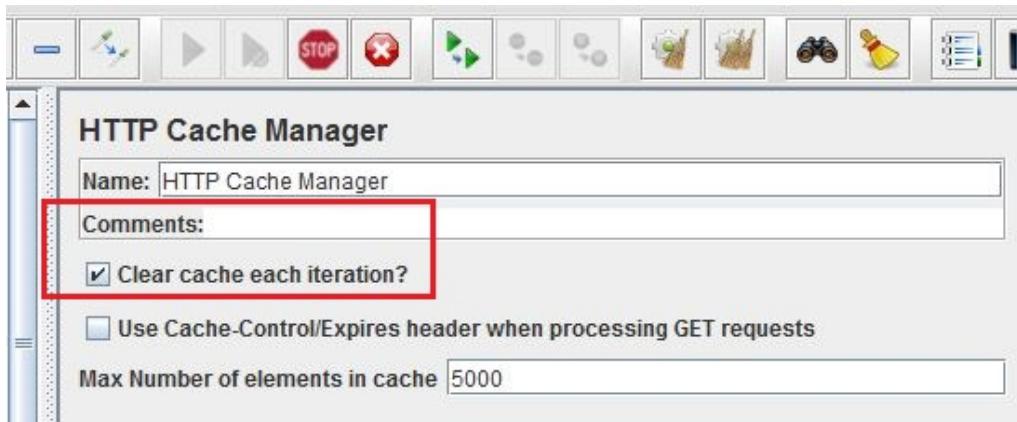


Fig: Cache Manager Setting

- c) **Thread Groups:** Each business transaction is implemented as a thread group. Hence, the entire JMeter script consists of 5 major thread groups run individually as well as consecutively to document performance results.
- d) **Thread Group Settings:** For locally deployed testing, the metrics were maintained to 100 users, 10 iterations with a ramp up of 5 seconds. For testing of the application deployed on the cloud, various loads were used which are documented in each test. The entire load is calculated as SAMPLES, which was derived with a combination of

SAMPLES = NO OF USERS * NO. OF ITERATIONS * NO. OF URL HITS\ITERATION

Eg: 10,000 hits\samples = 100 users*10 iterations * 10 URL hits\ iteration

Thread Group

Name:	Register New Users -Thread Group
Comments:	Action to be taken after a Sampler error
<input checked="" type="radio"/> Continue <input type="radio"/> Start Next Thread Loop <input type="radio"/> Stop Thread	
Thread Properties	
Number of Threads (users):	100
Ramp-Up Period (in seconds):	5
Loop Count:	<input type="checkbox"/> Forever 10 <input type="checkbox"/> Delay Thread creation until needed <input type="checkbox"/> Scheduler

Fig: Thread Group Settings

- e) **User Defined variables:** User defined variable “PATH” is used in all iterations in order to refer to the URL path (local\cloud) commonly. Hence, the home path for testing can be easily changed in one place, instead of changing multiple URL definitions. The Path variable is declared and used as,

Path <http://localhost:8080/jpetstore>
 Usage: \${PATH}/catalog.action

User Defined Variables

Name:	Path Variable-User Defined Variables	
Comments:	common home path for all url directs (Remove if running entire test together)	
User Defined Variables		
Name:	Value	Description
PATH	http://localhost:8080/jpetstore	common URL path

Fig: User Defined “PATH” variable

- f) **Counter Variables:** Counter variables are used to increment values sequentially in order to satisfy unique key constraints within the application.

E.g.: USERID, QUANTITYNO
 Usage: \${USERID}

Counter

Name:	UserID Counter
Comments:	Increments user id in each iteration.(Ensure to give a unique starting point)
Start	3200
Increment	1
Maximum	3400
Number format	
Reference Name	USERID
<input type="checkbox"/> Track counter independently for each user	

Fig: Counter for “USERID” variable

- g) **Assertions:** Assertions are used to fulfil all validations in each step. Mostly Response Assertions verifying the Text Response to desired values.
- h) **Controller:** Simple, Loop and Interleave controllers are used to obtain desired URL hits in specific patterns.

JMeter Scripts Detailed Descriptions:

Transaction# 1

Transaction Name: Register New Users

The JMeter script contains all steps in the above described transaction. Assertions are added for validations of successful new user sign up and log in. Some brief points of the JMeter script are explained below with necessary screenshots.

All JMeter general settings described in the above section are used for this script. The entire transaction is written within a “Simple Controller”. This controller was chosen as it was desired to have step up step execution of each http request.



Fig: Screen shot showing steps of New User Registration

- User ID Counter:** This counter is set to increment by 1 for every user. It is reset to start from a new value on every test run to ensure that unique users are added to the application. This fulfills the primary key constraint of the Users table. If is used during the POST operation of the HTTP request as a parameter.

The screenshot shows the "Counter" configuration dialog. The "Name" field is set to "UserID Counter". The "Comments" field contains the note "Increments user id in each iteration.(Ensure to give a unique starting point)". The "Start" field is set to "3200" with the note "Unique Number for UserID". The "Increment" field is set to "1". The "Maximum" field is set to "3400". The "Number format" field is empty. The "Reference Name" field is set to "USERID". The "Track counter independently for each user" checkbox is checked.

Fig: Screen Shot showing UserId counter

Parameters	Body Data
Send Parameters With	
Name:	
username	user\${USERID}
password	password
repeatedPassword	password

Fig: Screen Shot for Usage of UserID counter

- 2. Register Now- HTTP Request:** This is a POST http request which sends user entered data to be saved. The response is a page redirection if successful, else an exception occurs

HTTP Request	
Name: 5 Register Now-HTTP Request	
Comments:Detected the start of a redirect chain	
Web Server Server Name or IP: _____ Port Number: _____	
Timeouts (milliseconds) Connect: _____ Response: _____	
HTTP Request Implementation: _____ Protocol [http]: http Method: POST Content encoding: UTF-8	
POST request Path: \${CLOUDPATH}/actions/Account.action <input type="checkbox"/> Redirect Automatically <input checked="" type="checkbox"/> Follow Redirects <input checked="" type="checkbox"/> Use KeepAlive <input type="checkbox"/> Use multipartform-data for POST <input type="checkbox"/> Browser-compatible headers	
Parameters	Body Data
Send Parameters With the Request: User entered values sent as parameters	
Name:	Value
repeatedPassword	password
account.firstName	username\${USERID}
account.lastName	surname\${USERID}
<input type="button" value="Detail"/> <input type="button" value="Add"/> <input type="button" value="Add from Clipboard"/> <input type="button" value="Delete"/> <input type="button" value="Up"/> <input type="button" value="Down"/>	
Send Files With the Request:	
File Path:	Parameter Name: MIME Type:

Fig: Screenshot of HTTP Request-Register Now

Response Assertion

Name: 6 Verify User Data Saved Response Assertion

Comments:

Apply to:

Main sample and sub-samples Main sample only Sub-samples

Response Field to Test

Text Response Document (text) URL Sampled

Pattern Matching Rules

Contains
Checking if page is redirected
to Catalog home page, with
"JPetStore Demo" as heading

Patterns to Test

```
<title>JPetStore Demo</title>
```

Fig: Screenshot of HTTP Request-Register Now Assertion

3. Sign in- HTTP Request: This is a POST http request which sends user entered credentials for validation. The response is a page redirection to home page, else an exception occurs. In the assertion we validate the User welcome message and invalid message error.

HTTP Request

Name: 8 Sign In-HTTP Request

Comments: Detected the start of a redirect chain

Web Server

Server Name or IP: _____ Port Number: _____ Connect: _____ Response: _____

Timeouts (milliseconds)

HTTP Request

Implementation: _____ Protocol [http]: http Method: POST Content encoding: UTF-8

Path: \${CLOUDPATH}/actions/Account.action

Redirect Automatically Follow Redirects Use KeepAlive Use multipart/form-data for POST Browser-compatible headers

Parameters	Body Data	User Credentials
Send Parameters With the Request: passed as parameters for authentication		
Name:	Value	Encode? <input type="checkbox"/>
username	user\${USERID}	<input type="checkbox"/> <input checked="" type="checkbox"/>
password	password	<input type="checkbox"/> <input checked="" type="checkbox"/>
sighon	Login	<input type="checkbox"/> <input checked="" type="checkbox"/>

Detail Add Add from Clipboard Delete Up Down

Fig: Screenshot of HTTP Request-Sign In of new user

Response Assertion

Name: 8 Verifying Credentials Response Assertion

Comments:

Apply to:

Main sample and sub-samples Main sample only Sub-samples only JMeter Variable

Response Field to Test

Text Response Document (text) URL Sampled Response Code Response Message

Pattern Matching Rules

Contains Matches Equals Substring Not

Patterns to Test

Patterns to Test
Invalid username or password. Signon failed.

Fig: Screenshot of HTTP Response Assertion-Checking that Invalid username message is NOT present in response

Response Assertion

Name: 9 Verify Welcome Message-Response Assertion

Comments:

Apply to:

Main sample and sub-samples Main sample only Sub-samples

Response Field to Test

Text Response Document (text) URL Sampled

Pattern Matching Rules

Contains

Patterns to Test

Patterns to Test
<div id="WelcomeContent"> Welcome username\${USERID}! </div>

Fig: Screenshot of HTTP Response Assertion-Checking Welcome <Username> is present in response

When we run this thread group, we see multiple URL's generated. For this thread group the rough URL hits per iteration is 10. All assertions can be checked for pass\fail criteria by observing the “View results as a Tree” listener. If all assertions are passed, the results are all shown in green with 0% error.

View Results Tree

Name: View Results Tree
Comments:

Write results to file / Read from file

Filename Browse... Log/Display Only: Err

Text ▼

1 Enter The Store- HTTP Request
 http://jpetstoreapp1.azurewe
 http://jpetstoreapp1.azurewe
2 Catalog Home Page- HTTP Re
3 Sign In-HTTP Request
4 New User Register Now-HTTP
5 Register Now-HTTP Request
 http://jpetstoreapp1.azurewe
 http://jpetstoreapp1.azurewe
6 Catalog - HTTP Request
7 Sign In Page-HTTP Request
8 Sign In-HTTP Request
 http://jpetstoreapp1.azurewe
 http://jpetstoreapp1.azurewe
9 Successful Login into Catalog H
10 SignOut-HTTP Request

Sampler result Request Response

Sample Start: 2015-12-03 22:55:03 GMT

Load time: 98
Connect Time: 0
Latency: 98
Size in bytes: 236
Headers size in bytes: 236
Body size in bytes: 0
Sample Count: 1
Error Count: 0
Response code: 302
Response message: Found

Response headers:
HTTP/1.1 302 Found
Content-Length: 0
Content-Language: en-US
Location: http://jpetstoreapp1.azurewebsites.net/jpetst
Server: Microsoft-IIS/8.0
X-Powered-By: ASP.NET
Date: Thu, 10 Dec 2015 04:32:30 GMT

HTTPSampleResult fields:
ContentType:
DataEncoding: null

Fig: Screenshot of Thread Group Run- displaying all URL and their assertion values

Response Assertion

Name: 9 Verify Welcome Message-Response Assertion

Comments:

Apply to: Main sample and sub-samples Main sample

Response Field to Test: Text Response Document (text) UI

Pattern Matching Rules: Case-insensitive

Patterns to Test:

```
<div id="WelcomeContent">
    Welcome username${USERID}
</div>
```

Text

1 Enter The Store- HTTP Request
http://jetstoreapp1.azurewebsites.net/
http://jetstoreapp1.azurewebsites.net/

2 Catalog Home Page- HTTP Request

3 Sign In-HTTP Request

4 New User Register Now-HTTP Request

5 Register Now-HTTP Request
http://jetstoreapp1.azurewebsites.net/
http://jetstoreapp1.azurewebsites.net/

6 Catalog - HTTP Request

7 Sign In Page-HTTP Request

8 Sign In-HTTP Request
http://jetstoreapp1.azurewebsites.net/
http://jetstoreapp1.azurewebsites.net/

9 Successful Login into Catalog Home Page-HTTP Request
http://jetstoreapp1.azurewebsites.net/

10 SignOut-HTTP Request

Sampler result Request

```
</div></div>

<div id="Content">

<div id="Welcome">
<div id="WelcomeContent">

    Welcome username52010!

</div>
</div>

<div id="Main">
<div id="Sidebar">
<div id="SidebarContent"><a href="/jetstore/actions/Catalog.action?viewCategoryID=FISH"><br />Saltwater, Freshwater<br /><a href="/jetstore/actions/Catalog.action?viewCategoryID=DOGS"></a><br />Various Breeds <br /><a href="/jetstore/actions/Catalog.action?viewCategoryID=CATS"></a><br />
```

Fig: Screenshot of Thread Group Run displaying Assertion in rule and the assertion value

Transaction# 2

Transaction Name: Browsing, Adding to Cart and Checkout

This JMeter script contains all steps in business transaction 2 described above. All JMeter general settings are used as well. Multiple simple controllers are used to group together common operations. Brief points are described below:

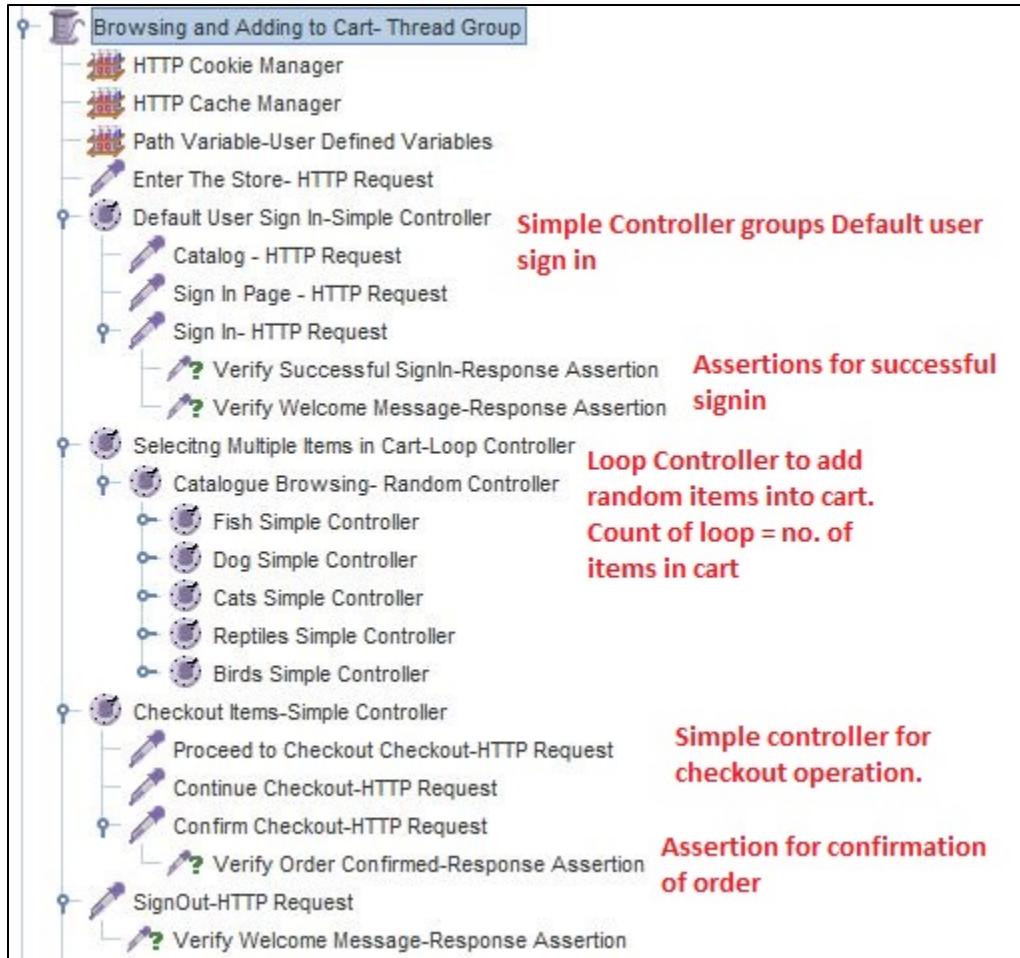


Fig: Screenshot of complete Transaction#2

- 1. Default User Sign in- Simple Controller:** This controller groups the operations of the default user sign in (“j2ee” user). And confirms the successful sign in by validating the “Welcome ABC” message.
 - 2. Selecting Multiple Items in Cart- Loop Controller:** This loop controller contains nested random controller which gives us the flexibility to generate random items In the cart from the available list of choices. The value of the loop is the number of items that will be added to the cart.
- The user can add an item to the cart in 2 ways:
- By selecting the “Add to Cart” next to the listed item
 - By selecting the “Add to Cart”, present at the bottom of the page in the details of the item

Both ways are generated by the written script. This ensures maximum realistic hits on the application, as different users can use the application differently.



Fig: Loop Controller Count

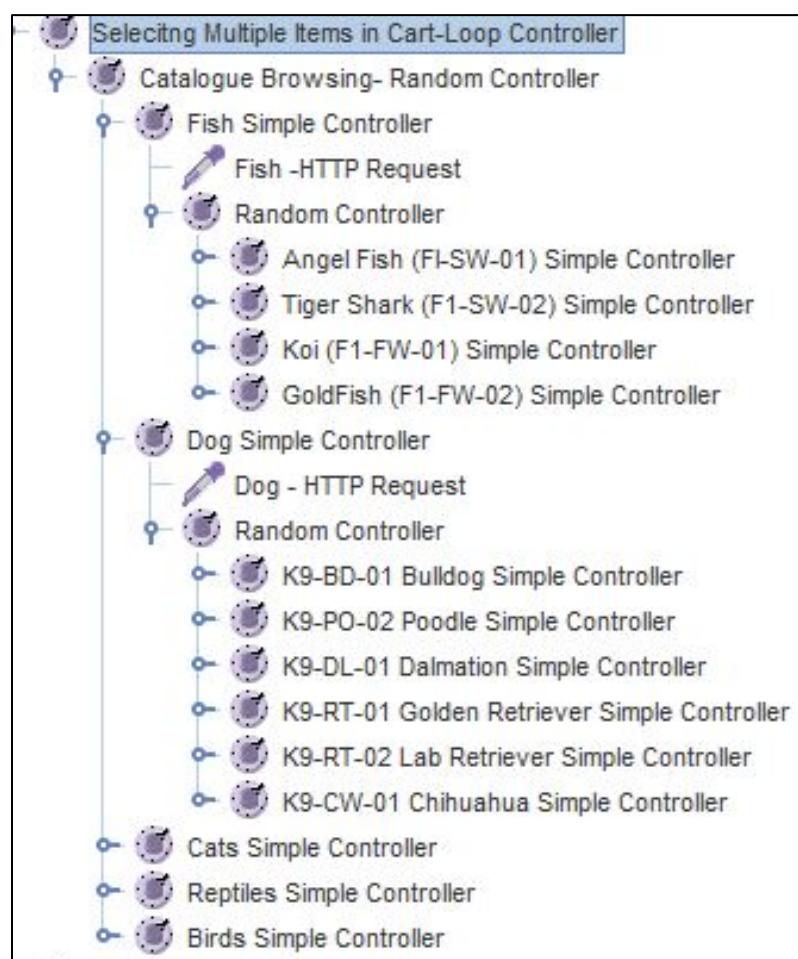


Fig: Screen shot – Selecting random items into cart

3. Checkout Items- Simple Controller: This controller groups the operations of checking out cart items and confirming purchase order. It validates the confirmation message “Thank you for your order” in the response text.

HTTP Request

Name:	Confirm Checkout-HTTP Request																	
Comments:																		
Web Server	Timeouts (milliseconds)																	
Server Name or IP:	Port Number:	Connect:	Response:															
HTTP Request																		
Implementation:	Protocol [http]:	Method: POST	Content encoding:															
Path: \${CLOUDPATH}/actions/Order.action?newOrder=&confirmed=true																		
<input type="checkbox"/> Redirect Automatically <input checked="" type="checkbox"/> Follow Redirects <input checked="" type="checkbox"/> Use KeepAlive <input type="checkbox"/> Use multipart/form-data for POST <input type="checkbox"/> Browser-compatible headers																		
Parameters Body Data <div style="float: right; color: red; margin-right: 10px;">POST request for confirming purchase order</div>																		
Send Parameters With the Request:																		
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Name:</th> <th>Value</th> <th>Encode?</th> <th>Include Equal</th> </tr> </thead> <tbody> <tr> <td>username</td> <td>j2ee</td> <td><input type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> </tr> <tr> <td>orderDate</td> <td>2015/11/27 09:48:37</td> <td><input type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> </tr> <tr> <td>shipAddress1</td> <td>901 San Antonio Road</td> <td><input type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> </tr> </tbody> </table>		Name:	Value	Encode?	Include Equal	username	j2ee	<input type="checkbox"/>	<input checked="" type="checkbox"/>	orderDate	2015/11/27 09:48:37	<input type="checkbox"/>	<input checked="" type="checkbox"/>	shipAddress1	901 San Antonio Road	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="button" value="Detail"/> <input type="button" value="Add"/> <input type="button" value="Add from Clipboard"/> <input type="button" value="Delete"/> <input type="button" value="Up"/> <input type="button" value="Down"/>
Name:	Value	Encode?	Include Equal															
username	j2ee	<input type="checkbox"/>	<input checked="" type="checkbox"/>															
orderDate	2015/11/27 09:48:37	<input type="checkbox"/>	<input checked="" type="checkbox"/>															
shipAddress1	901 San Antonio Road	<input type="checkbox"/>	<input checked="" type="checkbox"/>															

Fig: Screen shot – HTTP Request to confirm checkout

Response Assertion

Name:	Verify Order Confirmed-Response Assertion
Comments:	
Apply to:	<input type="radio"/> Main sample and sub-samples <input checked="" type="radio"/> Main sample only <input type="radio"/>
Response Field to Test	<input checked="" type="radio"/> Text Response <input type="radio"/> Document (text)
Pattern Matching Rules	Assertion for confirming successful purchase order
Patterns to Test	<pre>Thank you, your order has been submitted.</pre>

Fig: Screen shot – Assertion to check validation of confirmation message

When we run this thread group, we see multiple URL's generated. For this thread group the rough URL hits per iteration is 20. All assertions can be checked for pass\fail criteria

by observing the “View results as a Tree” listener. If all assertions are passed, the results are all shown in green with 0% error.

View Results Tree

Name: View Results Tree

Comments:

Write results to file / Read from file

Filename Browse...

Text

Sam

Enter The Store- HTTP Request

- http://jpetstoreapp1.azurewebsites.net/
- http://jpetstoreapp1.azurewebsites.net/
- Catalog – HTTP Request
- Sign In Page – HTTP Request
- Sign In- HTTP Request
- Dog – HTTP Request
- addItemToCart EST-26
- CAT-HTTP Request
- EST-17
- addItemToCart EST-17
- Fish –HTTP Request
- EST-5 HTTP Request
- addItemToCart EST-5 HTTP Req
- Birds – HTTP Request
- addItemToCart EST-18
- Birds – HTTP Request
- addItemToCart EST-18
- Proceed to Checkout Checkout-H
- Continue Checkout-HTTP Requests
- Confirm Checkout-HTTP Request
- SignOut-HTTP Request

Connect timer: 0
 Latency: 124
 Size in bytes: 1072
 Headers size in bytes: 574
 Body size in bytes: 498
 Sample Count: 1
 Error Count: 0
 Response code: 200
 Response message: OK

Response headers:
 HTTP/1.1 200 OK
 Content-Length: 498
 Content-Type: text/html
 Last-Modified: Fri, 20 Nov
 Accept-Ranges: bytes
 ETag: W/"498-1448037188"
 Server: Microsoft-IIS/8.0
 X-Powered-By: ASP.NET
 Date: Thu, 10 Dec 2015 04

HTTPSampleResult fields:
 ContentType: text/html
 DataEncoding: null

Fig: Screenshot of Thread Group Run- displaying all URL's and their assertion values

Transaction# 3 Transaction Name: Cart Operations (Update\Remove) items from cart

This thread group contains all requests to sign in, add items to cart and update the cart by performing update of quantities and remove item from cart operations. It contains several controllers are validations as described below. Items are added one by one and update is

performed on the added items followed up delete, and the next item is added ad process continues.

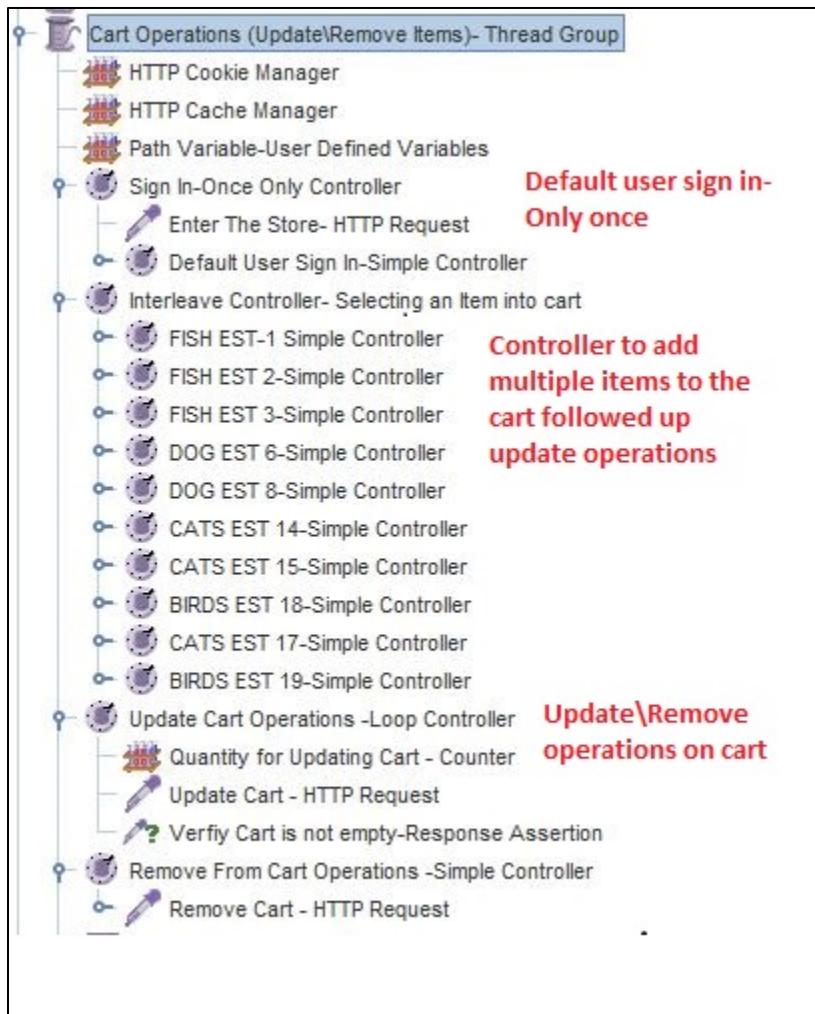


Fig: Screen shot- Thread group for Update Cart operations

- Sign in- Only once controller-** This controller executes only once for each user, this is added to ensure that the user can perform update operations specifically and no extra burden is added to sign in each time. The validations are checked (same as above scripts) for successful user login.
- Interleave Controller-Selecting an item to cart:** This is an interleave controller which allows us to select one random item (among Fish, Dog, Bird, Cat) add to the bag and proceed to perform update on this item, followed by removing the item and adding the next one. The count of iterations on the thread group decides the number of items added to cart.
- Update Cart Operations- Loop Controller:** This is a loop controller that indicates the number of items the item will be updated and saved. We increase the quantity of each item in the cart by 1 for the number of times the loop runs. And with each update we

check the validation that the cart is not empty. A counter is used to update the quantity of items in the cart.

Response Assertion

Name: Verify Cart is not empty-Response Assertion

Comments:

Apply to:

Main sample and sub-samples Main sample only Sub-samples only JMeter Variable

Response Field to Test

Text Response Document (text) URL Sampled Response Code Response Message

Pattern Matching Rules

Contains Matches Equals Substring Not

Patterns to Test

Your cart is empty.

Patterns to Test

Fig: Assertion checking that cart is NOT empty

Counter

Name: Quantity for Updating Cart - Counter

Comments:

Start

Increment

Maximum

Number format

Reference Name

Track counter independently for each user

Reset counter on each Thread Group Iteration

Fig: Counter to increment the number of items in the cart

HTTP Request

Name: Update Cart - HTTP Request

Comments:

Web Server

Server Name or IP: _____ Port Number: _____

HTTP Request

Implementation: _____ Protocol [http]: http Method: POST Content encoding: _____

Path: \${CLOUDPATH}/actions/Cart.action

Redirect Automatically Follow Redirects Use KeepAlive Use multipart/form-data for POST Browse

Parameters	Body Data
Send Parameters With the Request:	
Name:	Value
EST-1	\${QUANTITYNO}
EST-2	\${QUANTITYNO}
EST-3	\${QUANTITYNO}

[Detail](#) [Add](#) [Add from Clipboard](#) [Delete](#) [U](#)

Fig: Using the counter value to update items in the cart

- 4) **Remove Item From Cart- Simple Controller:** This controller removed the added item from the cart. And check the assertion if cart is empty.

View Results Tree

Name: View Results Tree

Comments:

Write results to file / Read from file

Filename _____ Browse... Log/Display Only:

Text

- ▶ Enter The Store- HTTP Request
- ▶ Catalog – HTTP Request
- ▶ Sign In Page – HTTP Request
- ▶ ▶ Sign In- HTTP Request
- ▶ Selecting FISH EST-1
- ▶ Selecting FISH EST-1
- ▶ Selecting FISH EST-1- Adding to
- ▶ **Update Cart - HTTP Request**
- ▶ Update Cart - HTTP Request
- ▶ Remove Cart - HTTP Request

Sampler result Request

POST http://jpetstoreapp1.azurewebsites.net/jpets

POST data:
EST-1=2&EST-2=2&EST-3=2&EST-6=2&EST-8=2&T-17=2&EST-19=2&updateCartQuantities=UpdateTzXqiEnfv_vQ8x7KzB5bxLgnFp8wS4%3D&__fp=7uc

Cookie Data:
JSESSIONID=7DD8692FCC10403849EB6AB6AFFD3(ARRAffinity=306eda04e47730884e6051f30e332ca1

Request Headers:
Connection: close
Content-Type: application/x-www-form-urlencoded
Content-Length: 196

Fig: Screenshot of Thread Group Run- displaying all URL and their assertion values

Transaction# 4

Transaction Name: Manage Account

This thread group contains all steps explained in transaction 4. It consists of user sign in, updating details of “My Account” and saving multiple times, and resetting all values to prior values for consistency sake.

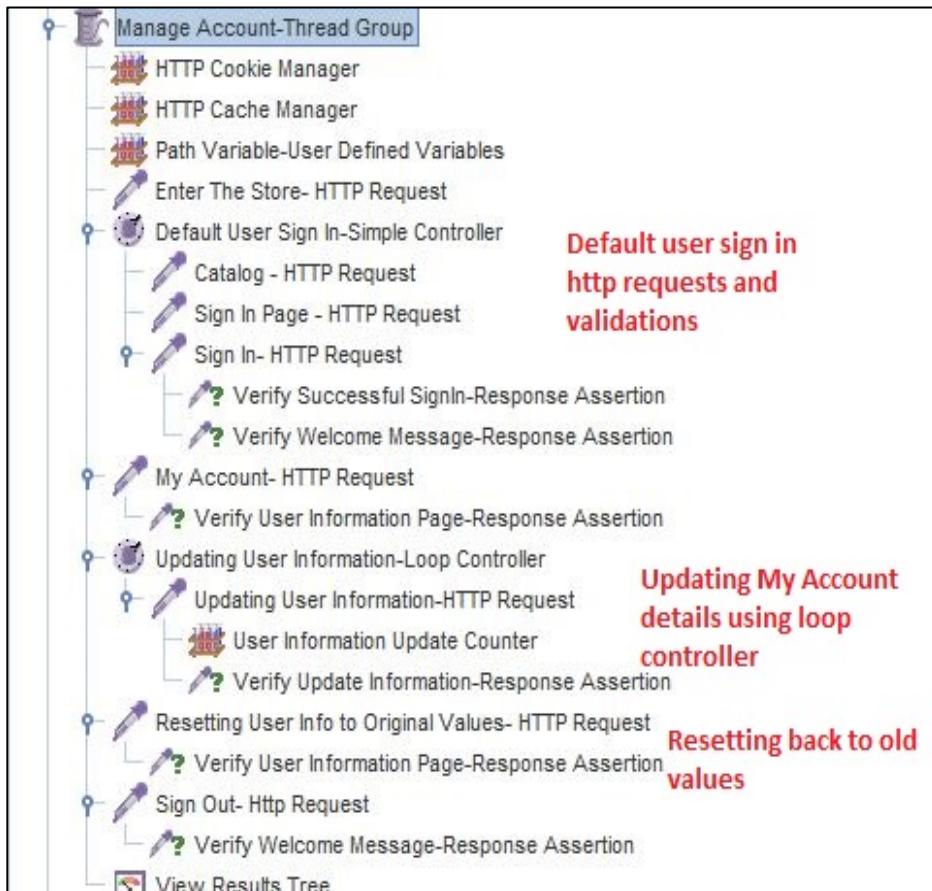


Fig: Screen shot – Thread Group for Updating My Account details

- 1) **Updating User Information- Loop Controller:** This controller updates the user information present on “My Account” page by using a counter variable that appends values to the existing name, address, card details and saves the details. The counter is incremented in steps of 1 to produce a unique value each time

Filename Browse... Log/Display Only:

Text Sampler result

```

> Enter The Store- HTTP Request
  Catalog – HTTP Request
  Sign In Page – HTTP Request
  ▶ Sign In- HTTP Request
    http://jpetstoreapp1.azurewe
    http://jpetstoreapp1.azurew
    My Account- HTTP Request
    Updating User Information-HTTP
    Resetting User Info to Original Va
    Sign Out- Http Request

</div>
<div id="Content">
<div id="Welcome">
<div id="WelcomeContent">
  Welcome ABC!
</div>
</div>

<div id="Main">

```

Fig: Screenshot of Thread Group Run- displaying all URL and their assertion values

Transaction# 5

Transaction Name: View orders

This thread group contains steps for sign in, add items to cart, confirm order and view the order details in the “My Orders” section.

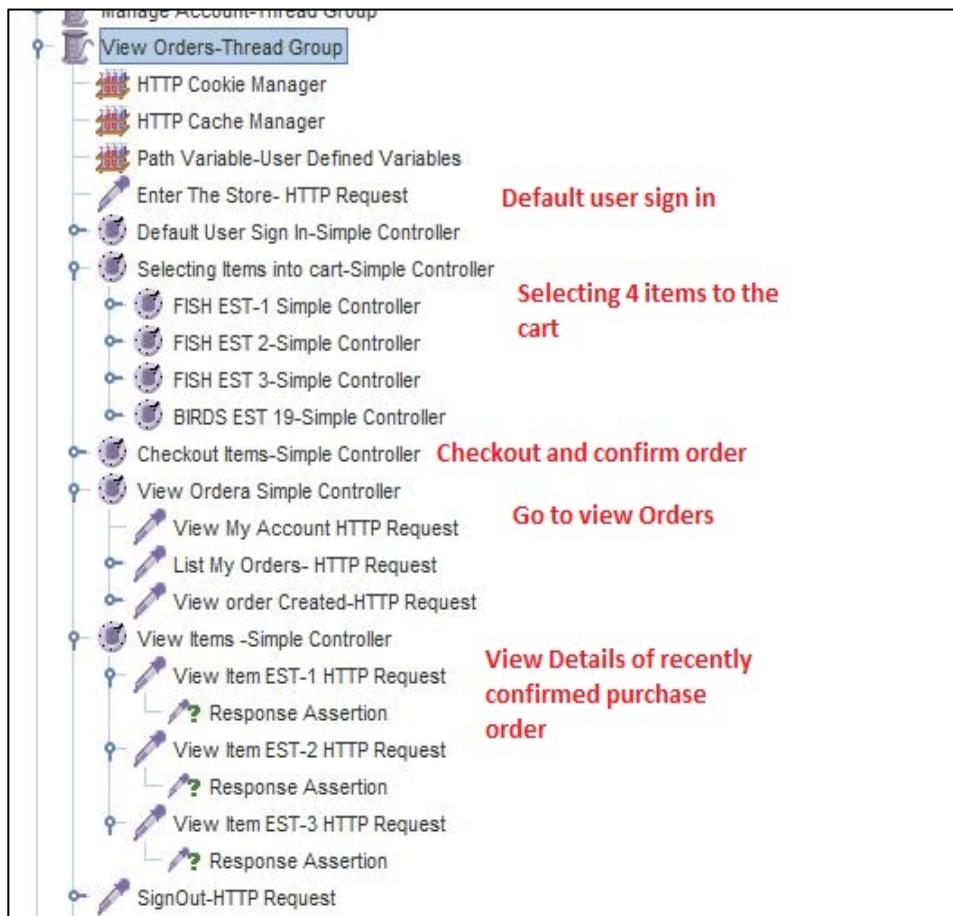


Fig: Screen shot- Thread group for transaction 5

- 1) Checkout Items-Simple Controller:** After confirming all user details, and proceeding with the purchase order a unique ORDERID is generated by the application. We need to store this order id, so that we can view it in my orders. This order ID is extracted from the response of confirm orders using a Regular Expression Extractor.

Regular Expression Extractor

Name:	OrderID-Regular Expression Extractor
Comments:	
Apply to:	<input type="radio"/> Main sample and sub-samples <input checked="" type="radio"/> Main sample only <input type="radio"/> Sub-samples only <input type="radio"/>
Field to check:	<input checked="" type="radio"/> Body <input type="radio"/> Body (unesCAPed) <input type="radio"/> Body as a Document <input type="radio"/> Response
Reference Name:	ORDERID
Regular Expression:	Order #(\d{4,10})
Template:	\$1\$
Match No. (0 for Random):	1
Default Value:	1000

Fig: Regular Expression to extract the ordered generated by the application

HTTP Request

Name:	View order Created-HTTP Request								
Comments:									
Web Server									
Server Name or IP:		Port Number:							
HTTP Request									
Implementation:	<input type="button" value="New"/> ▾	Protocol [http]:	<input type="button" value="New"/> ▾						
Method:	<input type="button" value="GET"/> ▾	Content-Type:	<input type="button" value="New"/> ▾						
Path:	\${CLOUDPATH}/actions/Order.action								
<input type="checkbox"/> Redirect Automatically <input checked="" type="checkbox"/> Follow Redirects <input checked="" type="checkbox"/> Use KeepAlive <input type="checkbox"/> Use multipart/form-data for POST									
<input type="radio"/> Parameters <input checked="" type="radio"/> Body Data		Send Parameters With the Request							
<table border="1"> <thead> <tr> <th>Name:</th> <th></th> </tr> </thead> <tbody> <tr> <td>viewOrder</td> <td></td> </tr> <tr> <td>orderId</td> <td> \${ORDERID}</td> </tr> </tbody> </table>				Name:		viewOrder		orderId	\${ORDERID}
Name:									
viewOrder									
orderId	\${ORDERID}								

Fig: Using the Order ID to View the confirmed order

- 2) **View Orders Simple Controller:** This controller groups together steps to view the recently confirmed order from the “My Account”-> “My Orders” section. Assertion checks that the items are added to my orders section under the specific ordered.

Response Assertion

Name: Response Assertion
Comments:
Apply to:
<input type="radio"/> Main sample and sub-samples <input checked="" type="radio"/> Main sample only
Response Field to Test
<input checked="" type="radio"/> Text Response <input type="radio"/> Document (text)
Pattern Matching Rules
Patterns to Test
<th colspan="2">Payment Details</th>
<th colspan="2">Billing Address</th>
EST-1
EST-2
EST-3

Fig: Assertion to check the items of the order

- 3) **View Items-Simple Controller:** These requests view the individual details of the items in the order. Assertions are added to check if the correct item is visible.

Response Assertion

Name: Response Assertion
Comments:
Apply to:
<input type="radio"/> Main sample and sub-samples <input checked="" type="radio"/> Main sample only <input type="radio"/> Sub-samples only <input type="radio"/> JMeter Variable
Response Field to Test
<input checked="" type="radio"/> Text Response <input type="radio"/> Document (text) <input type="radio"/> URL Sampled <input type="radio"/> Response Code <input type="radio"/>
Pattern Matching Rules
<input checked="" type="radio"/> Contains <input type="radio"/> Matches <input type="radio"/> Equals <input type="radio"/>
Patterns to Test
td> EST-1 </td>
Angelfish

Fig: Assertion to check the correct item is displayed

View Results Tree

Name: View Results Tree

Comments:

Write results to file / Read from file

Filename Browse... Log/Display Only: Errors Successes

Text

The screenshot shows the JMeter 'View Results Tree' listener. On the left, a tree view lists various HTTP requests with green checkmarks. On the right, the 'Response data' tab is selected, displaying the HTML content of a response. The response includes an image reference, a success message, a backlink, a catalog table with a single row for order #1005, and payment details.

```

=&category=BIRDS"></a></div>
</div>
<div id="Content"><ul class="messages"><li>Thank you, your order has been submitted.</li></ul>
<div id="BackLink"><a href="/jpetstore/actions/Catalog.action">Return to Main Menu</a></div>
<div id="Catalog">
<table>
<tr>
<th align="center" colspan="2">Order #1005
Thu Dec 10 05:09:13 GMT 2015</th>
</tr>
<tr>
<th colspan="2">Payment Details</th>
</tr>
<tr>
<td>Card Type:</td>
<td>Visa</td>
</tr>
<tr>

```

Fig: Screenshot of Thread Group Run- displaying all URL and their assertion values

Text

The screenshot shows the JMeter 'View Results Tree' listener. On the left, a tree view lists various HTTP requests with green checkmarks. On the right, the 'Request' tab is selected, displaying the details of a POST request to 'http://jpetstoreapp1.azurewebsites.net/jpetstore/actions/ConfirmCheckout.action'. The request includes POST data ('viewOrder=&orderId=1005'), cookie data ('JSESSIONID=182D9665344CD32A3C0C8C5982CARRAffinity=306eda04e47730884e6051f30e3326342de981391'), and request headers ('Connection: keep-alive', 'Content-Type: application/x-www-form-urlencoded', 'Content-Length: 23', 'Host: jpetstoreapp1.azurewebsites.net', 'User-Agent: Apache-HttpClient/4.2.6 (java 1.5)').

Fig: Screenshot of Thread Group Run- Passing Parameter Order ID as received from previous steps

Auto Scaling Strategies:

Each transaction is tested individually on the cloud and the results are documented with best possible strategies for 2 parameters

1. CPU Utilization
2. Memory Percentage

MS Azure WebApps provides 3 types of possible configurations for scaling, each with different pricing, since in MS Azure we cannot really scale up\down we use these configurations to give us an idea of how different core and memory instances can scale in\out based on our rules.

1. Small
2. Medium
3. Large

Capacity

Autoscale reduced your costs by up to 80%.

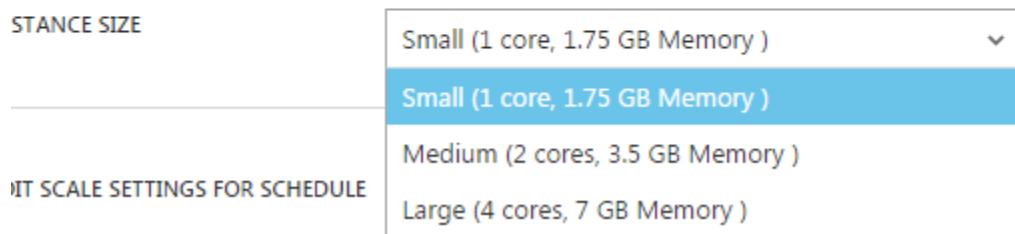
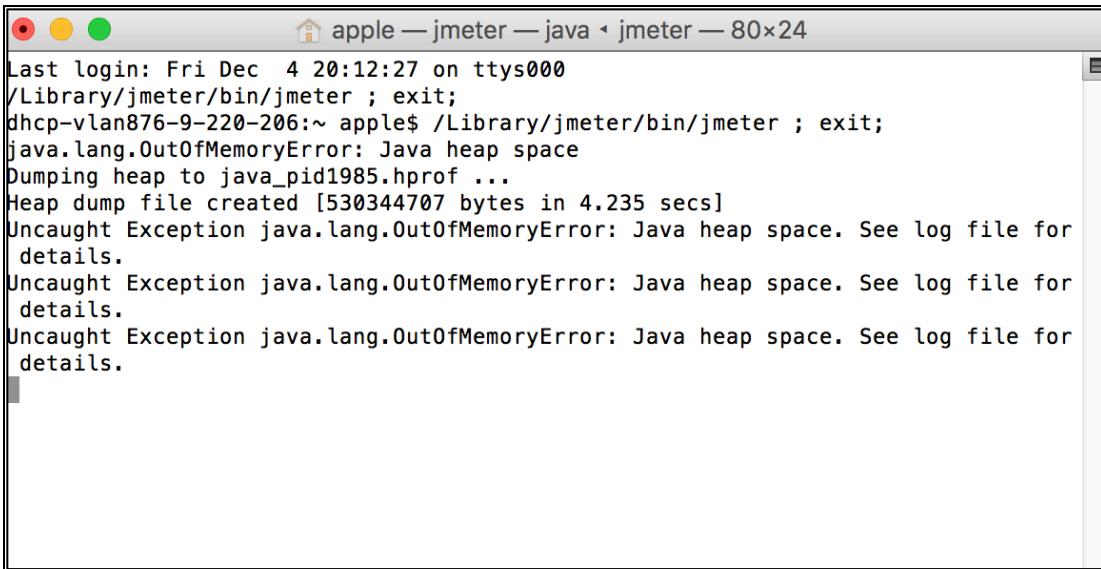


Fig: MS Azure types of Standard Instances

Transaction #1: Register New Users

Local Machine Results:

JMeter script was run for various inputs of samples for a duration of 10 minutes and the following throughput values were noted. For the input of 100 Users * 10 iterations * 10 URL\iteration = 10,000 Samples for a ramp up period of 10 seconds, an out of memory exception was thrown by Java. This was considered as input for testing in the cloud.



The terminal window shows the following text:

```
Last login: Fri Dec 4 20:12:27 on ttys000
/Library/jmeter/bin/jmeter ; exit;
dhcp-vlan876-9-220-206:~ apple$ /Library/jmeter/bin/jmeter ; exit;
java.lang.OutOfMemoryError: Java heap space
Dumping heap to java_pid1985.hprof ...
Heap dump file created [530344707 bytes in 4.235 secs]
Uncaught Exception java.lang.OutOfMemoryError: Java heap space. See log file for
details.
Uncaught Exception java.lang.OutOfMemoryError: Java heap space. See log file for
details.
Uncaught Exception java.lang.OutOfMemoryError: Java heap space. See log file for
details.
```

Fig: Out of Memory Exception throw by JMeter

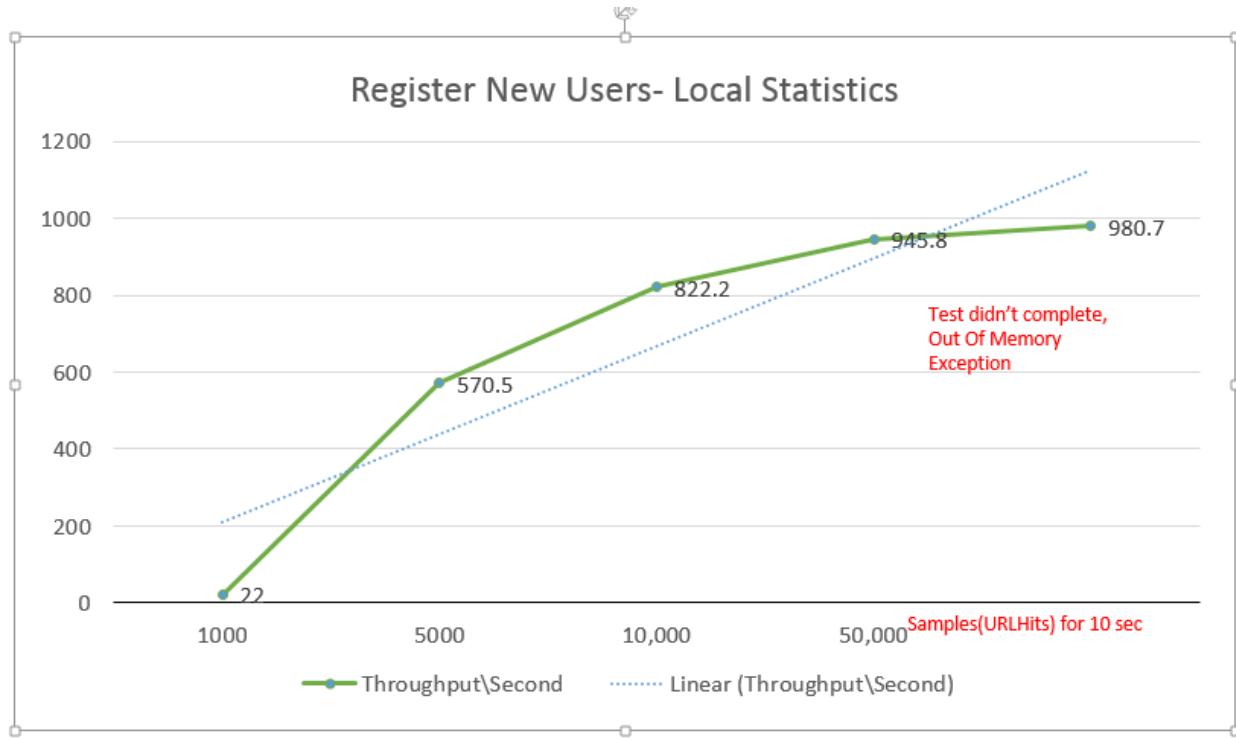


Fig: Graph showing Local statistics of Transaction – 1

CPU % Rules:

Cloud Results:

Input: 10,000 Samples, Ramp Up: 10 seconds

In the cloud, the first run was done for 10,000 samples on a ramp up period of 10 seconds. Various combinations of CPU% were taken on Small, Medium, Large instances scaling rules

were written only for scale up, keeping the scale down value to default CPU<=60%. The results are documents in the below table.

TABLE: 10,000 SAMPLES\10 SECONDS RUN			
Metrics	SMALL	MEDIUM	LARGE
CPU%	75%	75%	75%
Average Response Time:	668 ms	2.89s	Not Recorded as can stand higher %
Throughput\sec:	130.7	174.7	
CPU Time in sec:	5.48	6.01	80%
CPU%	80%	80%	
Average Response Time:	1.87	3.32	1.55
Throughput\sec:	79.4	342.8	306.6
CPU Time in sec:	2.83	8.38	15.21
CPU%	85%	85%	85%
Average Response Time:	2.51	951ms	1.67
Throughput\sec:	44.7	183.6	310.9
CPU Time in sec:	6.28	6.01	8.65
CPU%	90%	90%	90%
Average Response Time:	Not Recorded as cannot stand higher%	Not Recorded as cannot stand higher%	2.18
Throughput\sec:			235.5
CPU Time in sec:			7.16
CPU%	95%	95%	95%
Average Response Time:	Not Recorded as cannot stand higher%	Not Recorded as cannot stand higher%	3.83
Throughput\sec:			316.4
CPU Time in sec:			8.38

Fig: Table showing metric values for 10,000 samples run for 10 seconds ramp up time (Screen shots attached in zip file “10,000Samples- 10 sec-CPU%”)- Scale down values CPU<=60%

Highlighted sections show that for the below values the response times is below 2 seconds:

1. Small Instances: CPU%>=75
2. Medium Instances: CPU%>=85%
3. Large Instances: CPU%>=90%

Taking these values the scale down CPU% was adjusted for SMALL instances and results are noted below.

TABLE: 10,000 SAMPLES\10 SECONDS RUN		
Metrics	SMALL	SMALL
CPU%>= (Scale Up)	75%	75%
CPU%<= (Scale Down)	55%	65%
Average Response Time:	3.91	5.21s
Throughput\sec:	70.3	83.7
CPU Time in sec:	12.7	11.98

Fig: Table showing metric values for 10,000 samples run for 10 seconds ramp up time (Screen shots attached in zip file- 10,000Samples- 10 sec-CPU%)- Scale up values CPU>=75%

Cloud Results:

Input: 10,000 Samples, Ramp Up: 10 minutes

Once a vague idea of the load and scaling strategies of the application was figured, the test on the cloud was conducted for higher ramp up times of 10 minutes and results are noted below:

TABLE: 10,000 SAMPLES\10 Minutes Runs			
Metrics	SMALL	MEDIUM	LARGE
CPU%>= (Scale up)	75%	80%	85%
CPU%<= (Scale down)	60%	60%	65%
No of Requests at server:	885.6	650	730
Average Response Time:	2.19	165ms	18ms
Throughput\sec:	16.6	16.6	16.6
CPU Time in sec:	6.01	5.61	6.17
No of Requests at server:	1.81K	652	
CPU%>= (Scale up)	80%	85%	
CPU%<= (Scale down)	55%	55%	
Average Response Time:	151ms	25ms	
Throughput\sec:	16.6	16.6	
CPU Time in sec:	5.42	5.86	
No of Requests at server:	1.26K		
CPU%>= (Scale up)	80%		
CPU%<= (Scale down)	60%		
Average Response Time:	164ms		
Throughput\sec:	16.6		
CPU Time in sec:	5.36s		

Fig: Table displaying run on cloud for 10,000 samples – 10 minutes (Screen shots attached in zip file-“10,000Samples- 10 min-CPU%”)

Optimal Strategies Found:

The best found strategies are shown below:

Small Instance:

- CPU% >=75% Increase count by 1
- CPU% <=55% Decrease count by 1

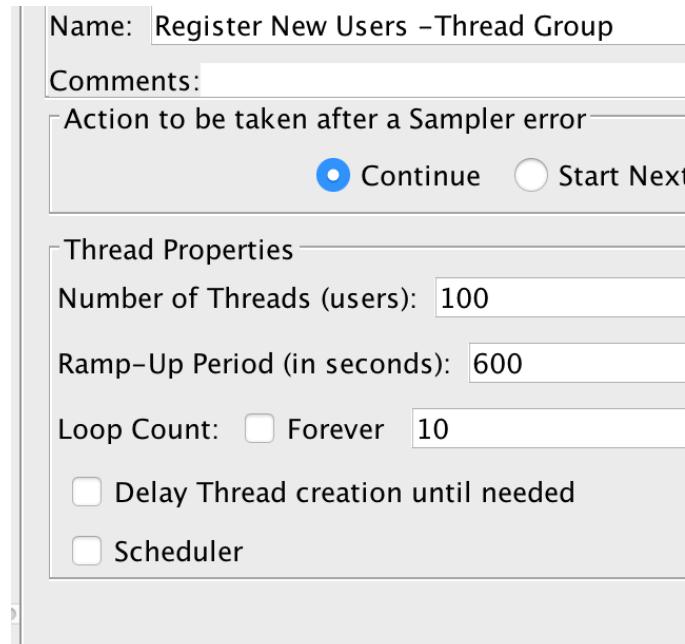


Fig: JMeter setting for Run

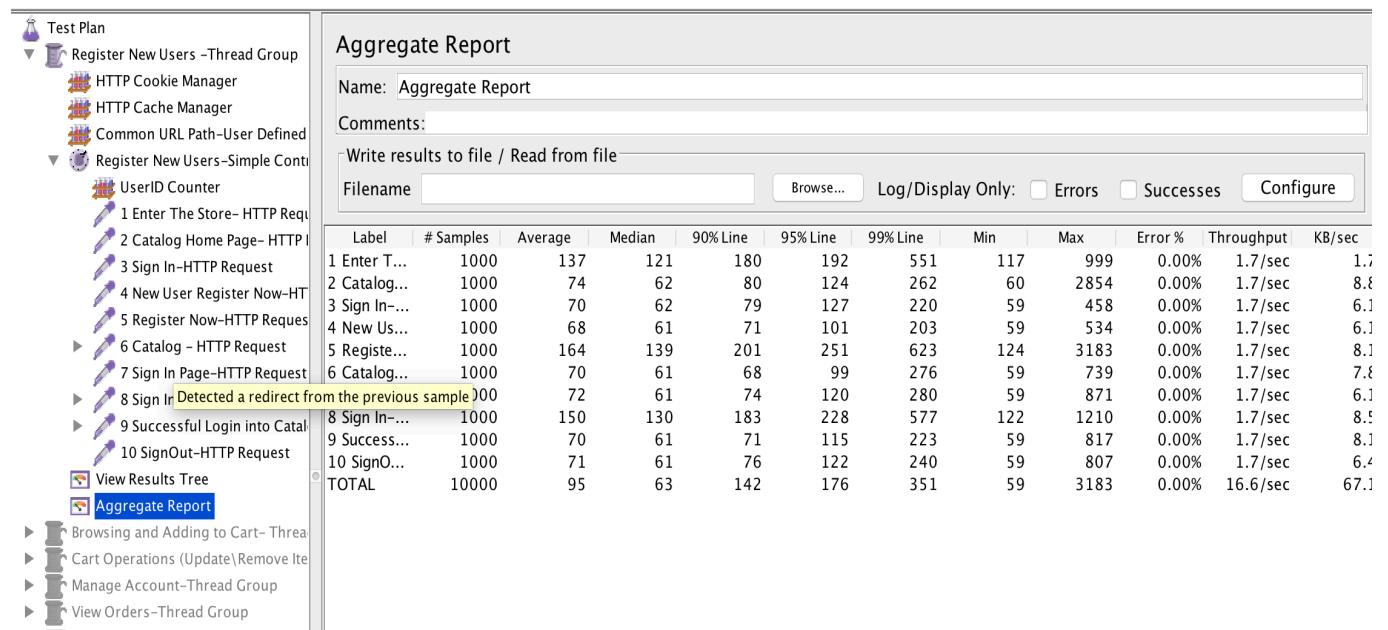


Fig: JMeter Results

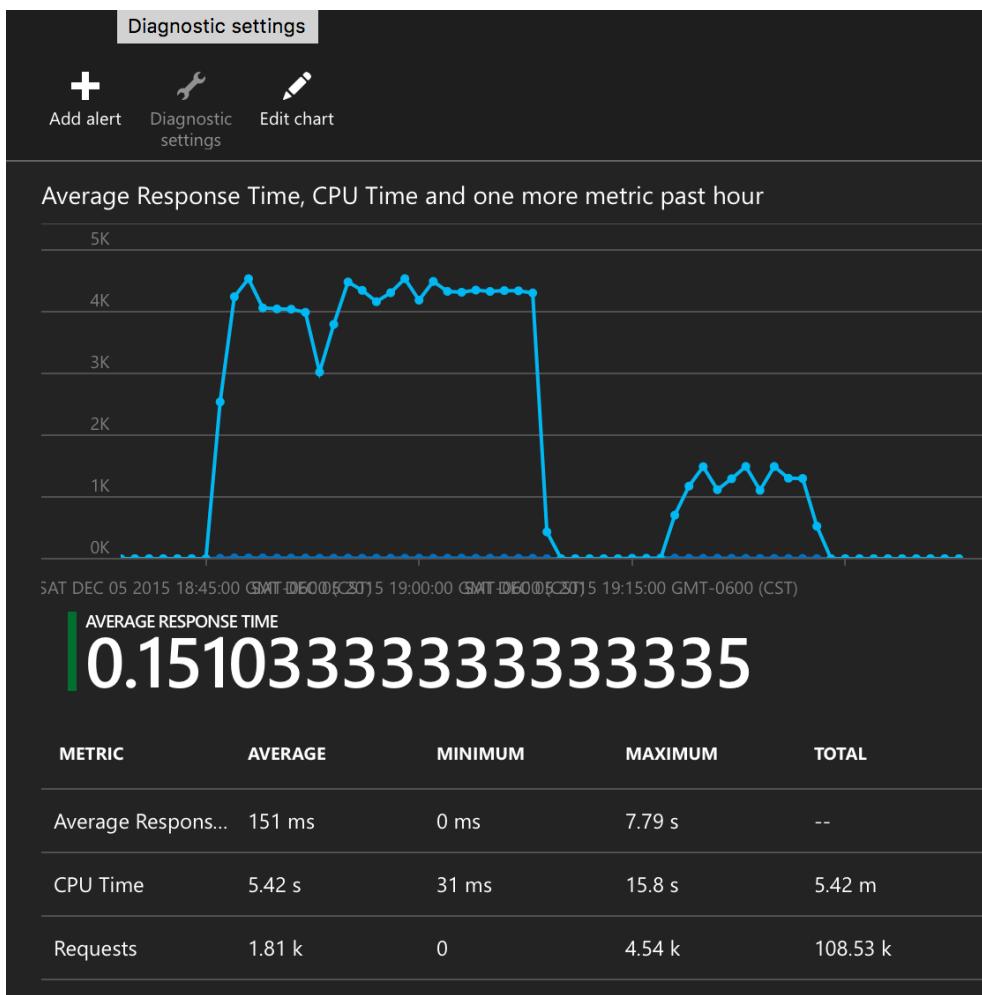


Fig: Metrics from MS Azure

Medium Instance:

Strategy:

- CPU% $\geq 85\%$ Increase count by 1
- CPU% $\leq 55\%$ Decrease count by 1

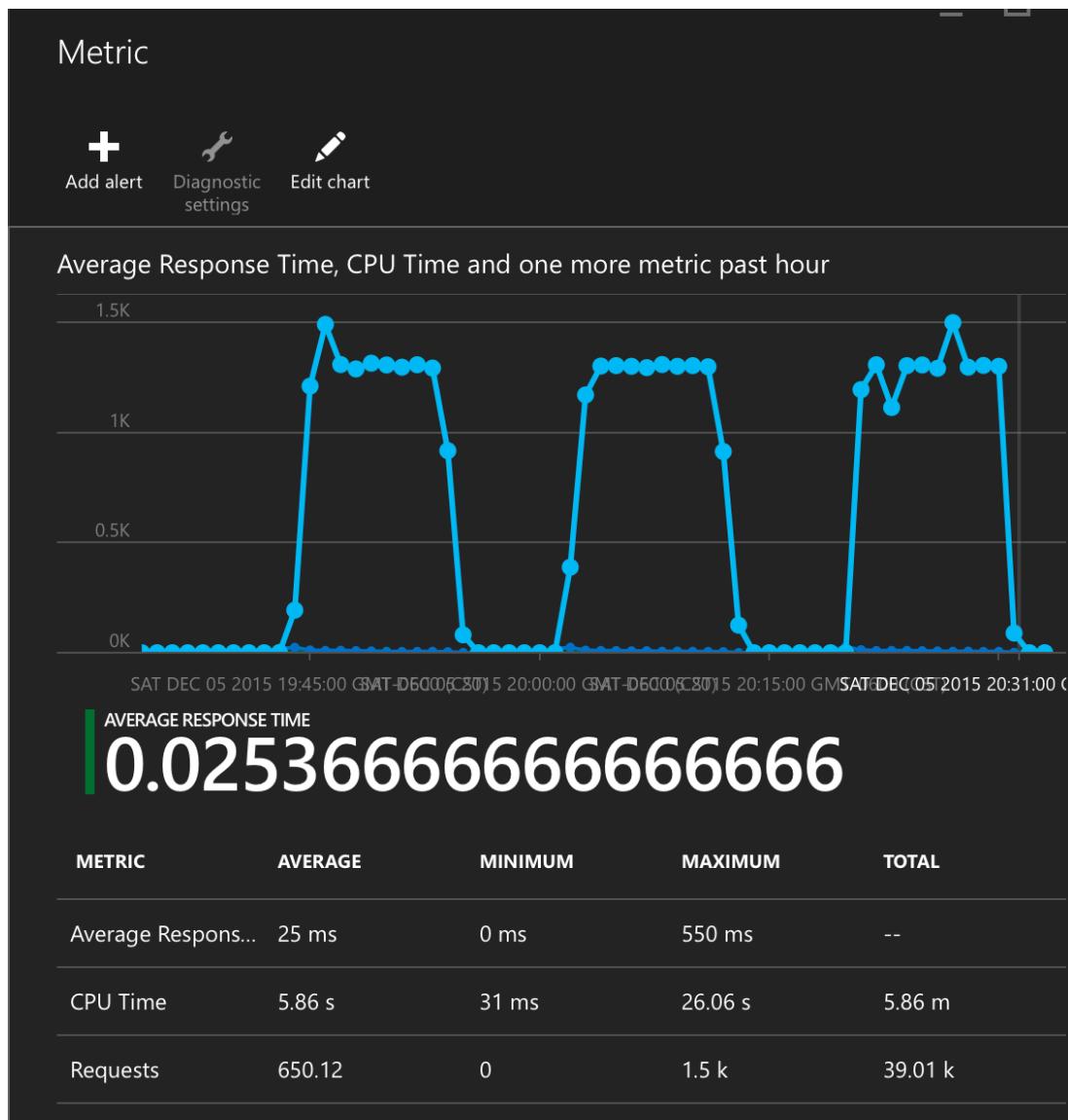


Fig: Metrics from MS Azure

Large Instance:

Strategy:

- CPU% $\geq 85\%$ Increase count by 1
- CPU% $\leq 65\%$ Decrease count by 1

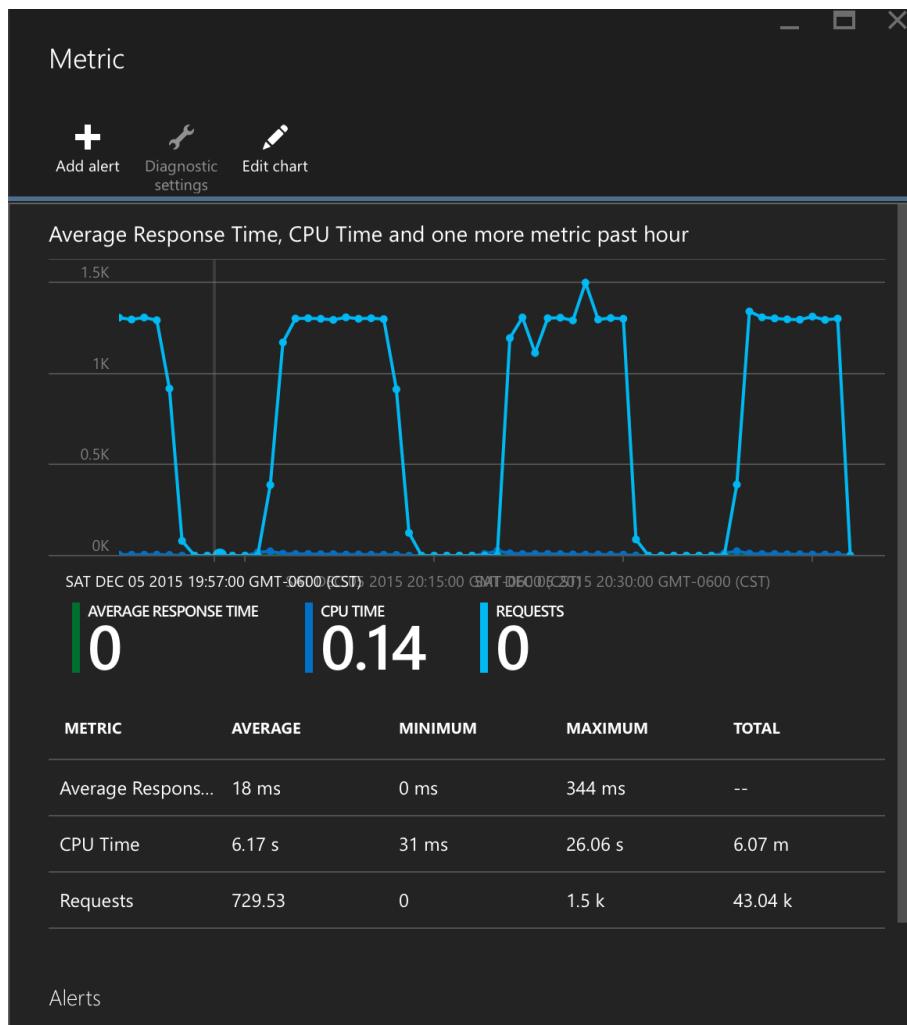


Fig: Metrics from MS Azure

Aggregate Report												
Name: Aggregate Report												
Comments:												
Write results to file / Read from file												
Label	# Samples	Average	Median	90% Line	95% Line	99% Line	Min	Max	Error %	Throughput	KB/sec	
Enter T...	1000	134	120	176	183	278	117	3179	0.00%	1.7/sec	1.7	
Catalog...	1000	67	61	65	105	135	59	1927	0.00%	1.7/sec	8.8	
Sign In...	1000	64	61	64	78	137	59	190	0.00%	1.7/sec	6.1	
New Us...	1000	63	61	64	68	118	59	522	0.00%	1.7/sec	6.1	
Registe...	1000	143	135	154	182	234	124	1897	0.00%	1.7/sec	8.1	
Catalog...	1000	62	61	63	65	106	59	145	0.00%	1.7/sec	7.7	
Sign In ...	1000	65	61	64	103	136	59	426	0.00%	1.7/sec	6.1	
Sign In...	1000	130	125	135	154	199	121	494	0.00%	1.7/sec	8.4	
Success...	1000	63	61	63	70	124	59	191	0.00%	1.7/sec	8.0	
D SignO...	1000	65	61	65	98	139	59	163	0.00%	1.7/sec	6.3	
OTAL	10000	85	62	134	142	188	59	3179	0.00%	16.6/sec	67.1	

Fig: JMeter Results

Observations:

1. Requests to the server are almost between the same ranges
2. Throughput is constant
3. Average Response time is below 1 second (observe last line)
4. The graph remains almost constant with less peaks
5. Max No of Instances=5, No of instances used: 2
6. No server errors encountered

Memory % Rules:

The next parameter tested are the memory % for various parts. As observed from the below table of values, for SMALL scale instances, the values of Avg response time, throughput and CPU time are almost similar. Hence, any one of the strategies can be adopted as a optimal strategy.

TABLE: 10,000 SAMPLES\10 Minutes Runs		
Metrics/Instances	SMALL	MEDIUM
Memory %>= (Scale up)	80%	85%
Memory %<= (Scale down)	45%	55%
No of Requests at server:	652	842
Average Response Time:	2.31	56ms
Throughput\sec:	16.6	16.6
CPU Time in sec:	4.36	3.12
No of Requests at server:	652	842
Memory %>= (Scale up)	80%	85%
Memory %<= (Scale down)	55%	50%
Average Response Time:	2.31	22ms
Throughput\sec:	16.6	16.6
CPU Time in sec:	3.17	3.01
No of Requests at server:	650	
Memory %>= (Scale up)	80%	
Memory %<= (Scale down)	60%	
Average Response Time:	2.31	
Throughput\sec:	16.6	
CPU Time in sec:	2.68	
No of Requests at server:	880	
Memory %>= (Scale up)	85%	
Memory %<= (Scale down)	55%	
Average Response Time:	2.31	
Throughput\sec:	16.6	
CPU Time in sec:	2.89	

Fig: Table displaying run on cloud for 10,000 samples – 10 minutes (Screen shots attached in zip file- “10,000Samples- 10 sec-Memory%”)

Optimal Strategy Found:

Small Instances: Almost all values give similar results, hence any one can be choose

Medium Instances:

- Memory % $\geq 85\%$ Increase count by 1
- Memory % $\leq 50\%$ Decrease count by 1

Transaction #2: Browsing & Adding to Cart

Local Machine Results:

The below graph shows the throughput noted on the jmeter run in the local system. There wasn't any out of memory or bound on this operation due to system constraints. Hence, the input for the cloud testing was maintained the same as

100 users * 10 iterations * 20 URL\iteration = 20,000 Samples ---- 10 Mins

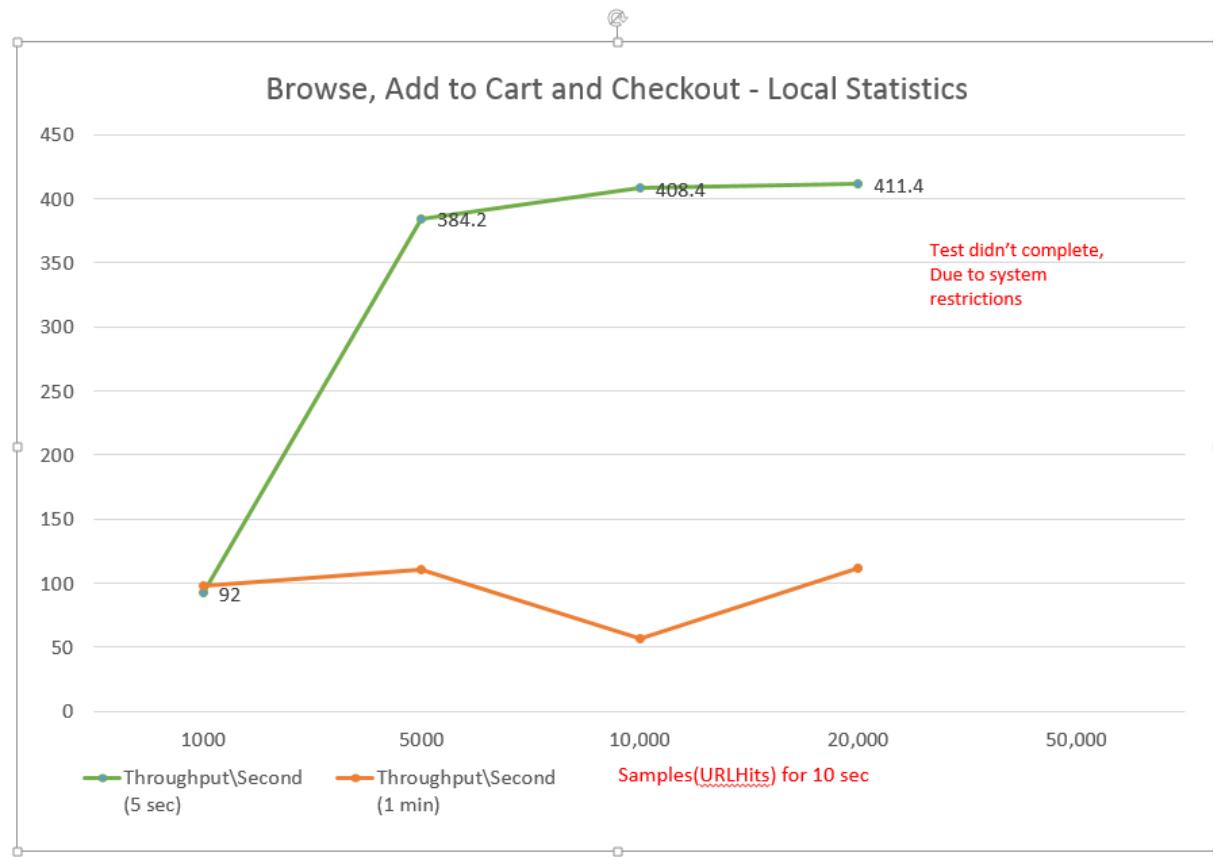


Fig: Graph plotted for throughput of local run

CPU % Results:**Cloud Results:****Input: 20,000 Samples, Ramp Up: 10 Minutes**

After understanding the application behavior, the second transaction was tested in the cloud with 20,000 samples on a ramp up period of 10 minutes. Various combinations of CPU% were taken on Small, Medium, Large instances scaling rules were tested and optimal strategies concluded.

TABLE: 20,000 SAMPLES\10 Minutes Runs

Metrics	SMALL	MEDIUM	LARGE
CPU %>= (Scale up)	75%	85%	90%
CPU %<= (Scale down)	60%	60%	60%
No of Requests at server:	902.77	1.33K	1.36K
Average Response Time:	3.24	1.14	2.36
Throughput\sec:	33.6	33.6	33.6
CPU Time in sec:	12.62	9.23	10.36
No of Requests at server:	1.31K	1.31K	
CPU %>= (Scale up)	80%	90%	
CPU %<= (Scale down)	60%	60%	
Average Response Time:	1.99s	1.21	
Throughput\sec:	33.6	33.6	
CPU Time in sec:	12.71	9.34	
No of Requests at server:	1.1K4		
CPU %>= (Scale up)	85%		
CPU %<= (Scale down)	60%		
Average Response Time:	11ms		
Throughput\sec:	33.6		
CPU Time in sec:	5.96		
No of Requests at server:	1.47K		
CPU %>= (Scale up)	80%		
CPU %<= (Scale down)	55%		
Average Response Time:	22ms		
Throughput\sec:	33.6		
CPU Time in sec:	8.46		

Fig: Table displaying run on cloud for 10,000 samples – 10 minutes (Screen shots attached in zip file- “10,000Samples- 10 sec-CPU%”)

Optimal Strategies Found:

The best found strategies are shown below:

Small Instance:

- CPU% $\geq 85\%$ Increase count by 1 (or) CPU% $\geq 80\%$ Increase count by 1
- CPU% $\leq 60\%$ Decrease count by 1 (or) CPU% $\geq 55\%$ Decrease count by 1

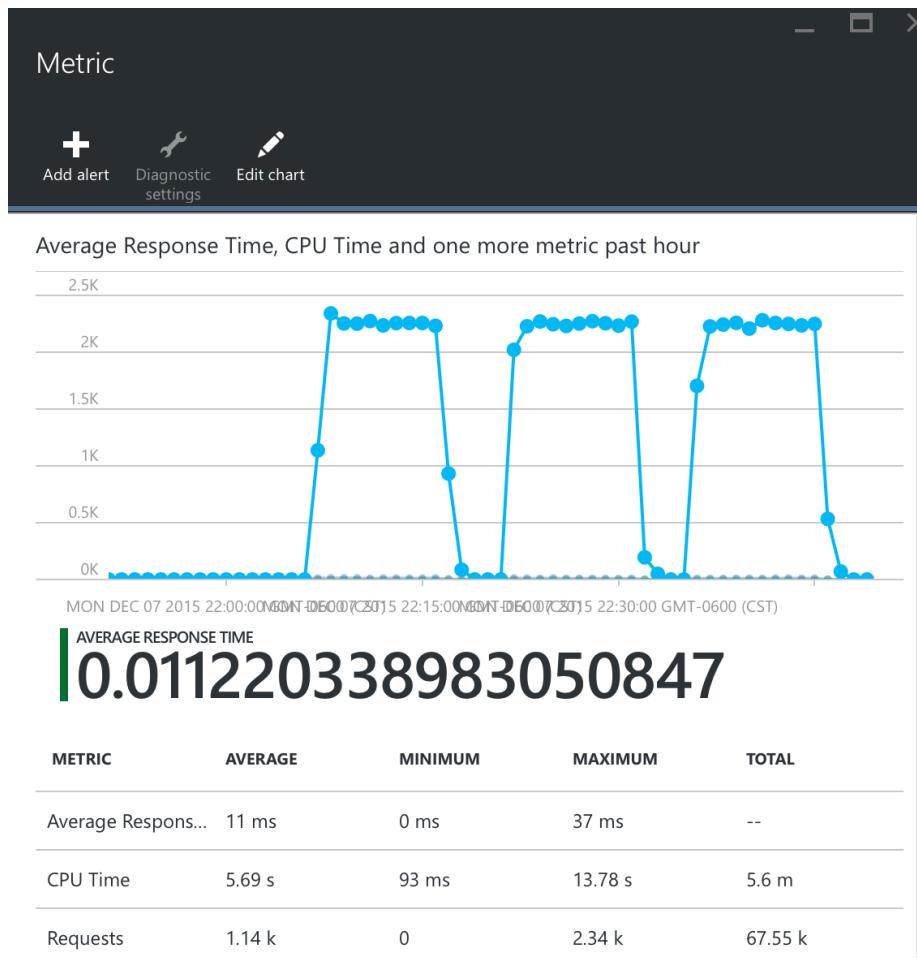


Fig: Metrics from MS Azure- Small Instance

Medium Instance:

Strategy:

- CPU% $\geq 85\%$ Increase count by 1
- CPU% $\leq 60\%$ Decrease count by 1

Large Instance:

Strategy:

- CPU% >=90% Increase count by 1
- CPU% <=60% Decrease count by 1

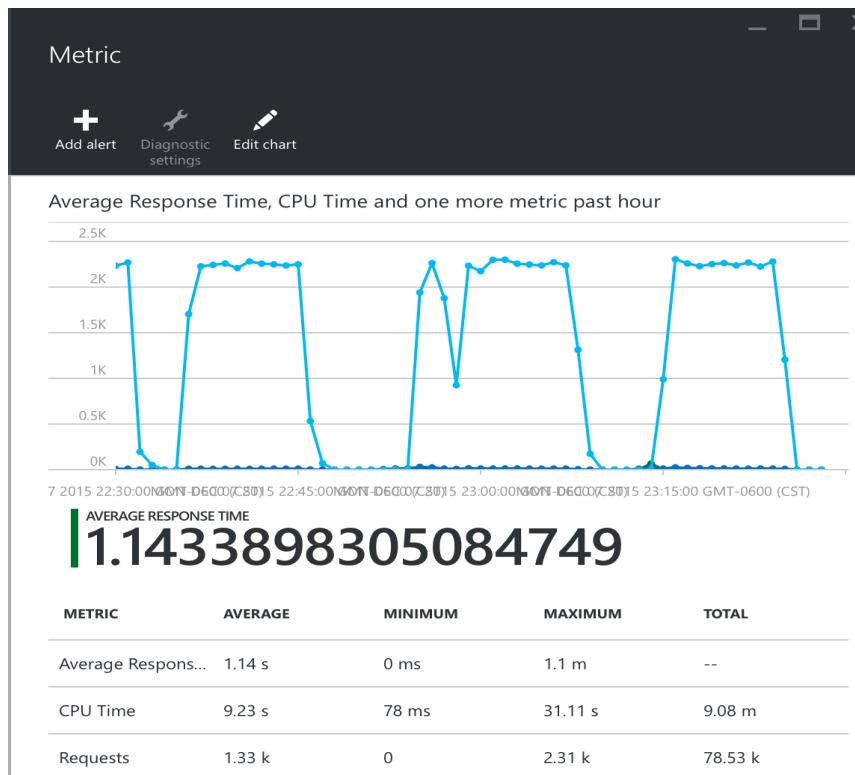


Fig: Metrics from MS Azure – Medium Scale

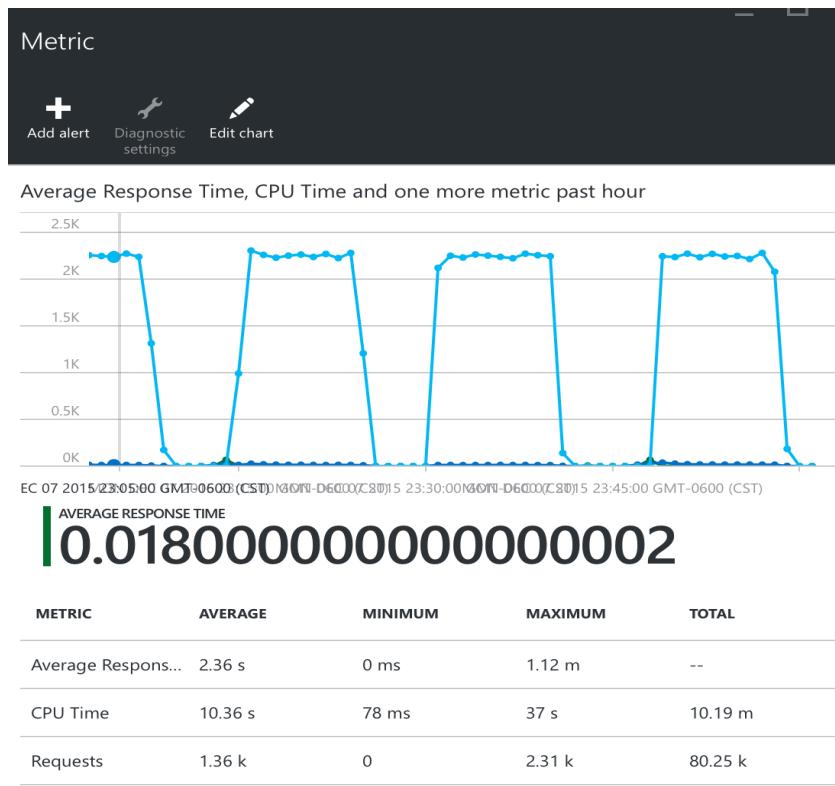


Fig: Metrics from MS Azure – Large Scale

Memory % Rules:

TABLE: 20,000 SAMPLES\10 Minutes Runs			
Metrics	SMALL	MEDIUM	LARGE
Memory %>= (Scale up)	80%	85%	90%
Memory %<= (Scale down)	60%	60%	60%
No of Requests at server:	678	775.36	748.32
Average Response Time:	8ms	1.55	6ms
Throughput\sec:	33.6	33.6	33.6
CPU Time in secs:	1.87	4.11	4.63
No of Requests at server:	810.54	1.16K	1.14K
Memory %>= (Scale up)	80%	90%	95%
Memory %<= (Scale down)	65%	55%	60%
Average Response Time:	11ms	1.55	8ms
Throughput\sec:	33.6	33.6	33.6
CPU Time in secs:	3.63	5.42	6.66
No of Requests at server:	1.21K	1.53K	1.17K

Memory %>= (Scale up)	85%	90%	95%
Memory %<= (Scale down)	45%	60%	55%
Average Response Time:	15ms	10ms	6ms
Throughput\sec:	33.6	33.6	33.6
CPU Time in secs:	4.85	6.37s	6.09

Fig: Table displaying run on cloud for 10,000 samples – 10 minutes (Screen shots attached in zip file- “10,000Samples- 10 sec-Memory%”)

Most Optimal Strategies found are:

Small Instance:

- Memory% >=80% Increase count by 1
- Memory % <=60% Decrease count by 1

Medium Instance:

- Memory % >=90% Increase count by 1
- Memory % <=60% Decrease count by 1

Large Instance:

- Memory % >=95% Increase count by 1
- Memory % <=55% Decrease count by 1

Observations:

1. We have chosen to keep the scale down memory value at a high threshold because the JPetStore application does not get overloaded easily. Also since this is not a shared cloud, multiple applications aren't hosted on the same cloud. Hence, once the instance is removed if half of the remaining work can be distributed among other instances, it is considered as an effective cost strategy.

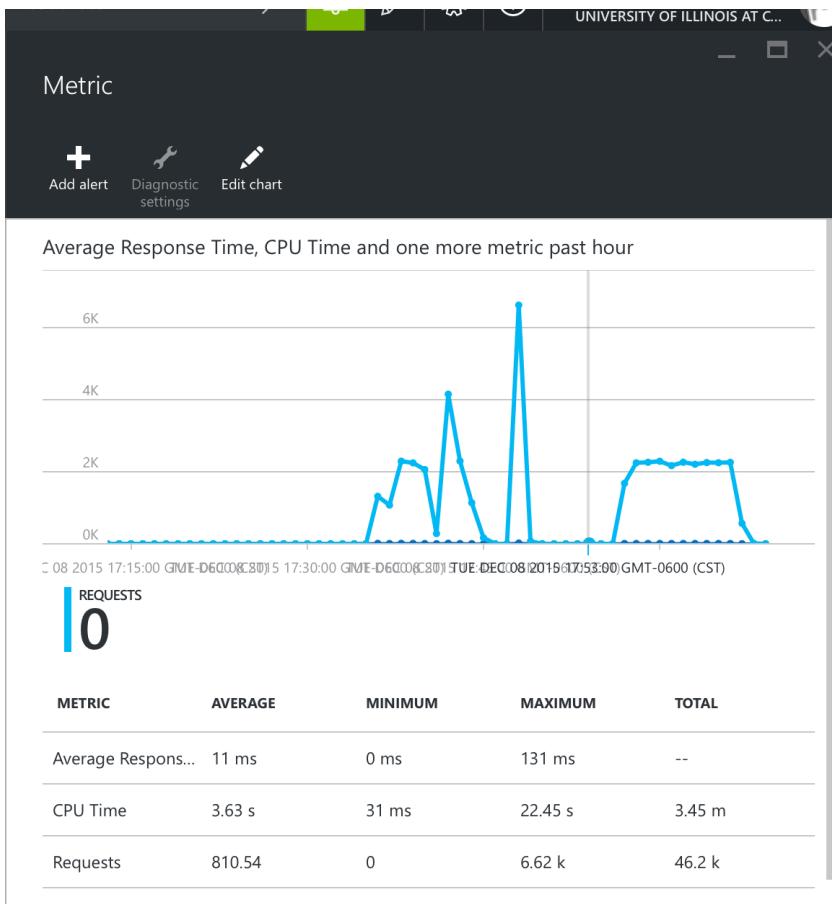


Fig: Metrics from MS Azure – Small Scale

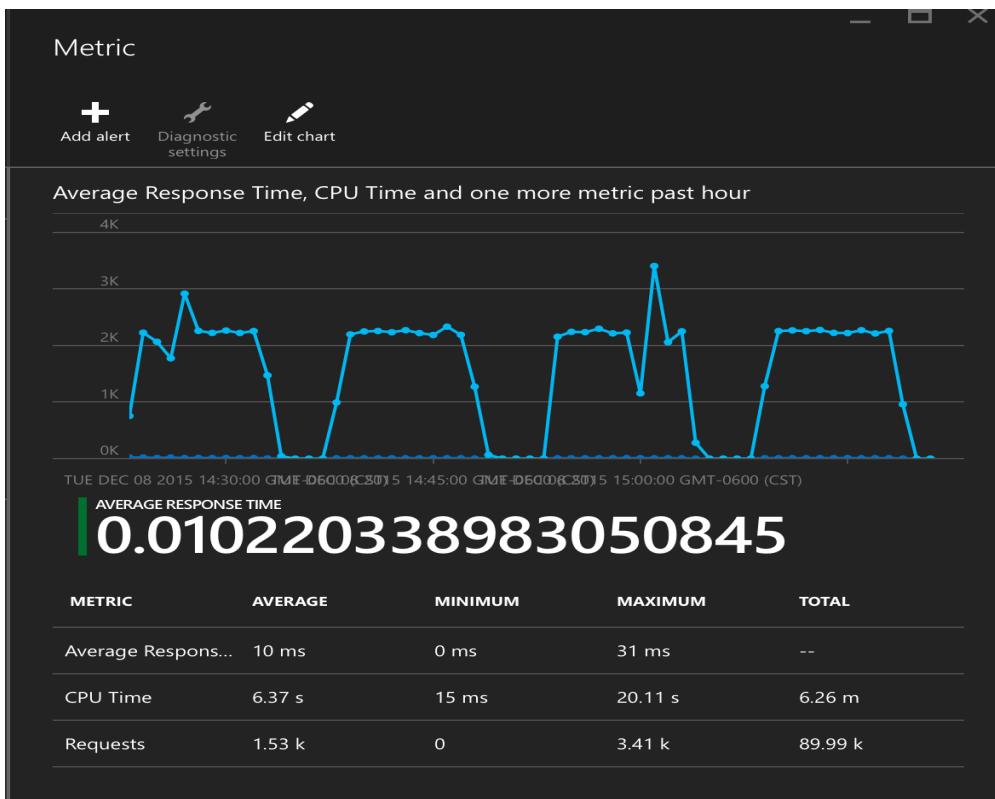


Fig: Metrics from MS Azure – Medium Scale

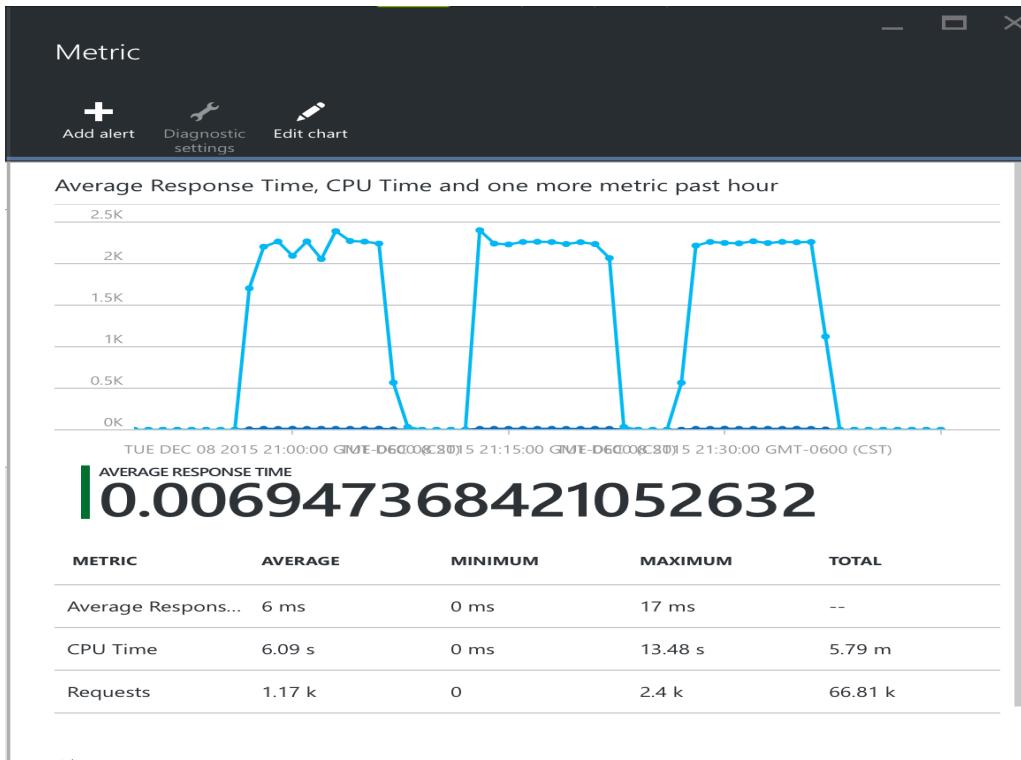


Fig: Metrics from MS Azure – Large Scale