

An Affordable Care Act Web Site **Load Testing Experience**

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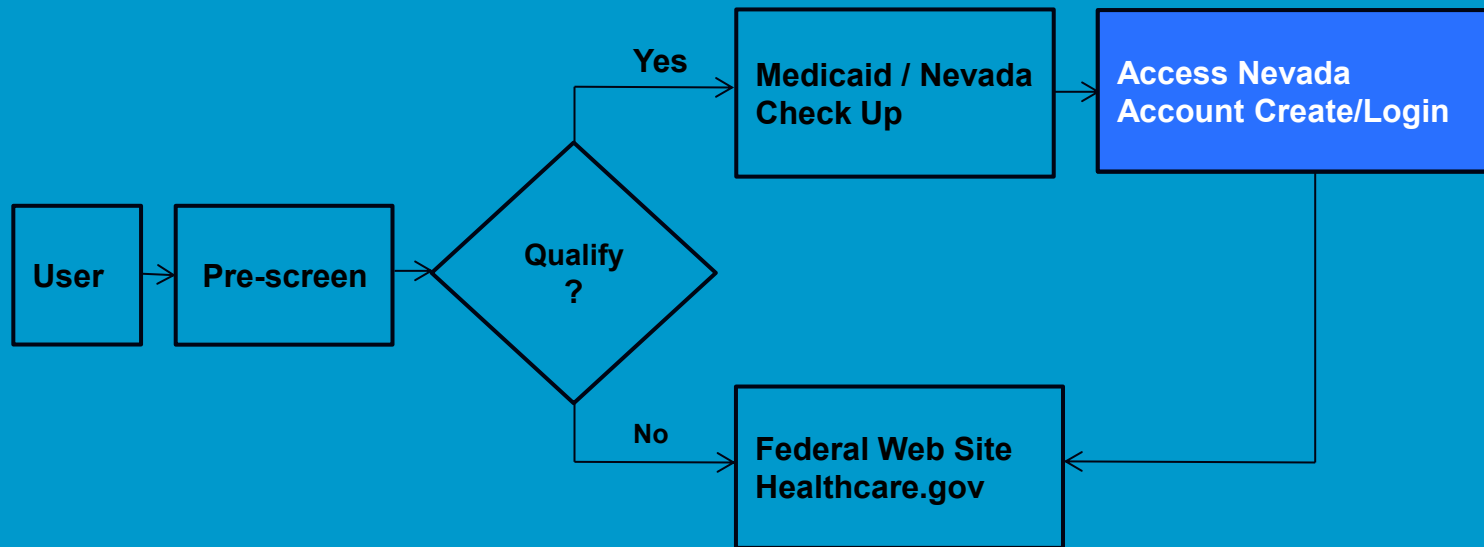
Affordable Care Act Web Site Problems

“Technical Glitches”

User Account Creation Failures

Nevada Health Link

<http://nevadahealthlink.com>



Overview

■ Account Creation

- Functional Flow
- User Interface

■ Load Testing Setup

- Web Pages Tested
- Test Script
- Testing Approach

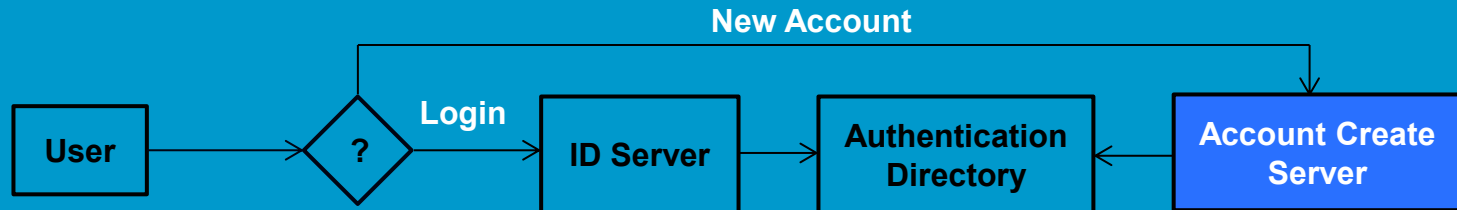
■ Tests Performed

- Development Environment
- Production Parallel Environment

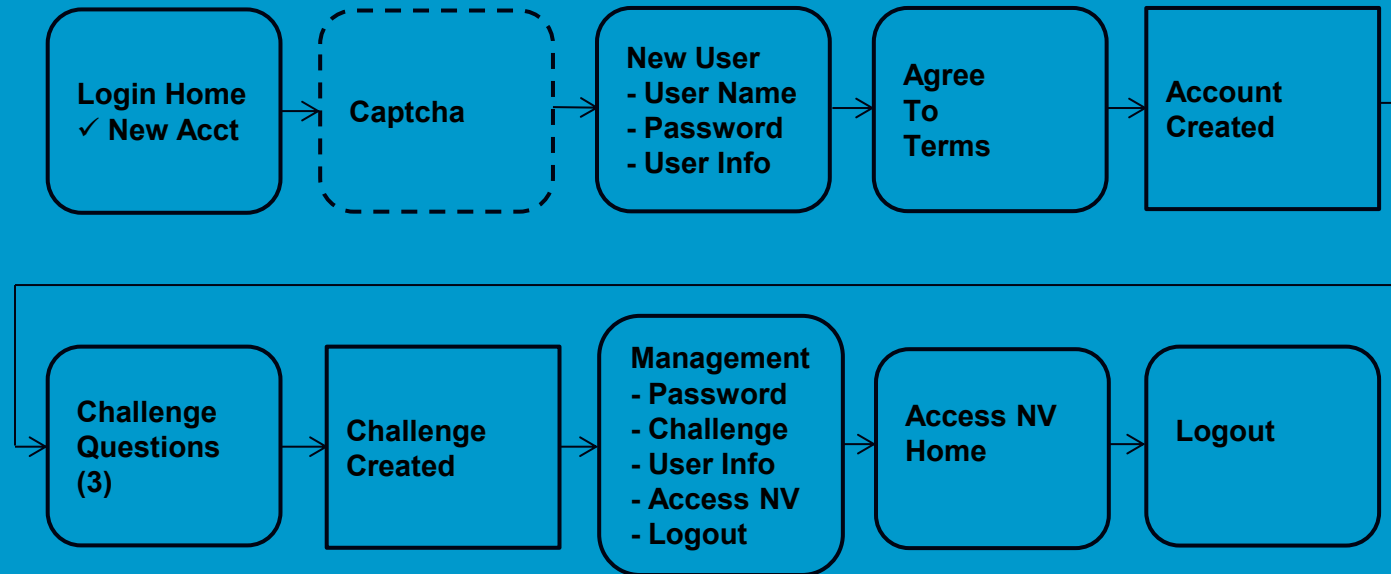
■ Lessons Learned

■ Summary

Account Create/Login Functional Components



Account Create/Login User Interface



Account Create Web Pages Tested

| | Name | Description |
|------------------------|-------------------------|--|
| Skip Captcha | 00_SkipCaptcha | Skip The Captcha Screen |
| | 10_NewUser_Form | User Account Creation Input Form |
| New User Check | 12_NewUser_InputCheck | User Account Input Edit Check During Entry (Five Instances) |
| | 20_NewUser_Agree | Agree To Terms Form |
| | 22_NewUser_Submit | Account Creation Submission |
| | 24_NewUser_Created | Account Creation Performed |
| | 30_Challenge_Setup | Challenge Question Setup Start |
| Challenge Check | 32_Challenge_Step | Challenge Question Setup Continue |
| | 40_Challenge_Form | Challenge Question Input Form |
| | 42_Challenge_InputCheck | Challenge Question Input Edit Check During Entry (Three Instances) |
| | 50_Challenge_Created | Challenge Question Answers Created |
| | 60_Management | Management Screen Presented |
| | 70_AccessNevada_Home | Access Nevada Home Page Retrieved |
| | 90_Logout | Logout Performed |

Jmeter Account Create Test Script

Skip Captcha

User Names

New User Check

Challenge Check

Uniform Random Timer

Aggregate Report

Name: Aggregate Report

Comments:

Write results to file / Read from file

Filename: ~/RunTable/AggregateReport.csv Log/Display Only: Errors Successes

| Label | # Samples | Average | Median | 90% Line | Min | Max | Error % | Throughput | KB/sec |
|-------|-----------|---------|--------|----------|-------------|--------------|---------|------------|--------|
| TOTAL | 0 | 0 | 0 | 0 | 92233720... | -92233720... | 0.00% | .0/hour | .0 |

Include group name in label? Save Table Header

Account Create Testing Approach

■ Traffic Generation

- Fix User Thread Count At Max Needed For All Traffic Levels Tested
- Reduce Mean Think Time To Increase Traffic From Test To Test
- Maintain A Consistent Request Mix Throughout
- Determine Traffic Timing Quality By Analyzing Time Between Request Statistics

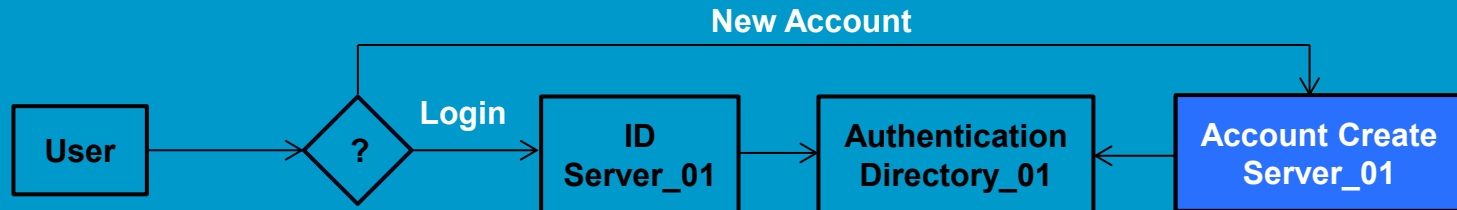
■ Results Analysis

- Create X-Y Plots Of Resource Consumption Levels As A Function Of Request Rate (Trans/Sec)

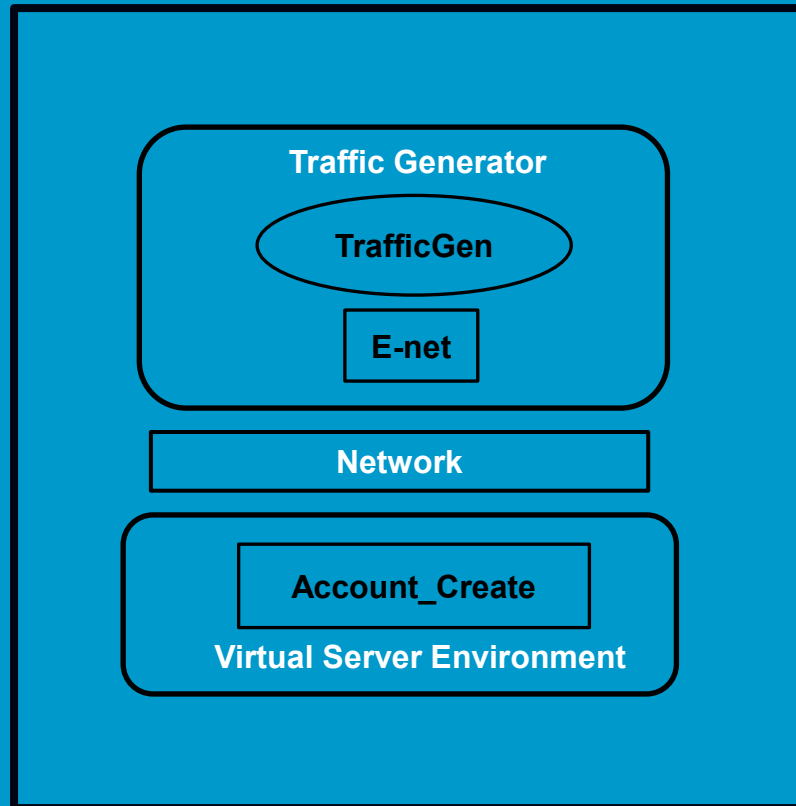
■ Capacity Statement

- Number Of Accounts Created / Hour

Development Testing Functional Components



Development Load Testing Topology

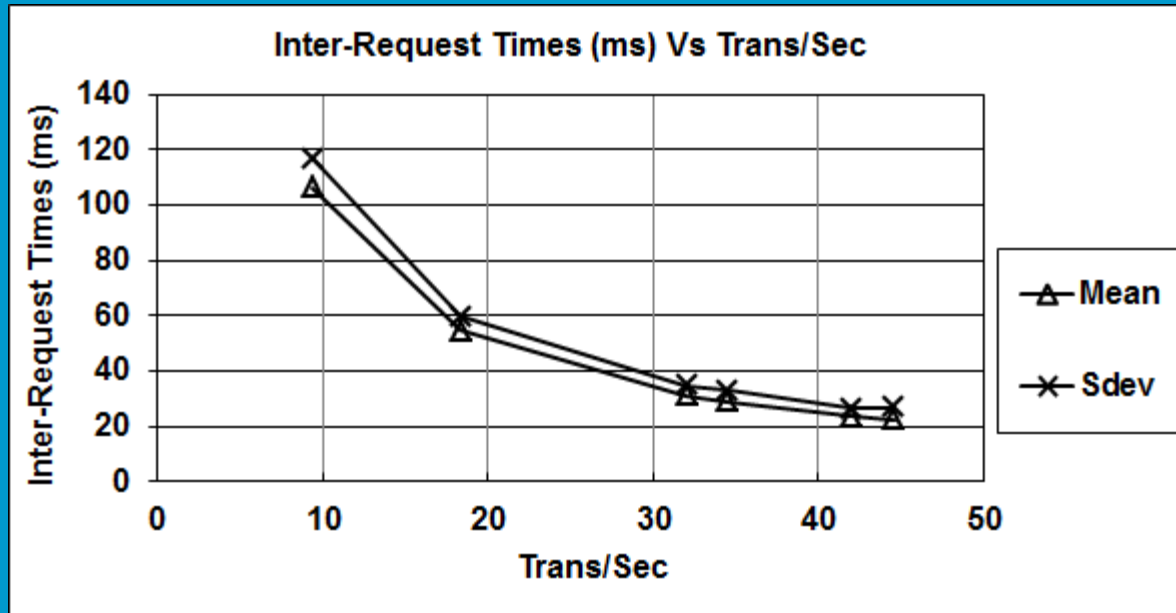


Load Generator Implementation

- 200 user threads
- 100 mbit/sec E-net connections
- 30 minute test runs
- Virtual server runs Linux O/S with resource consumption data collected

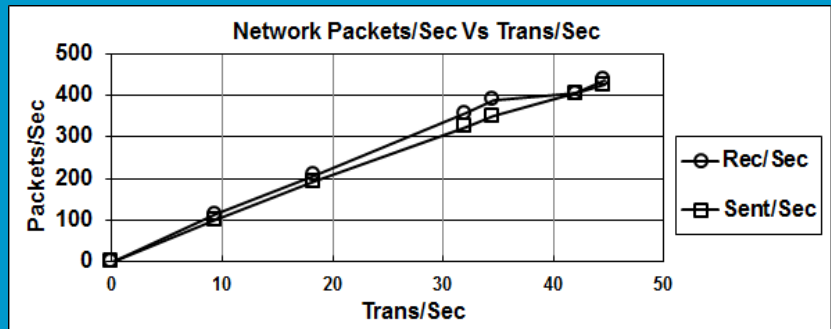
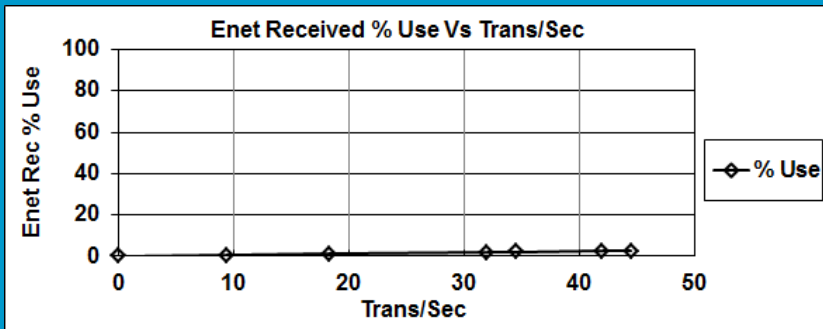
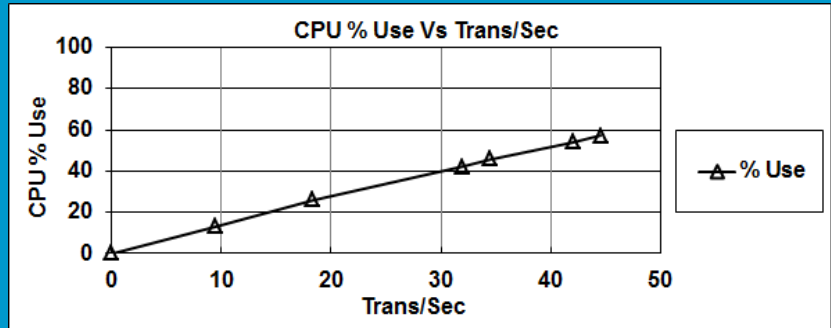
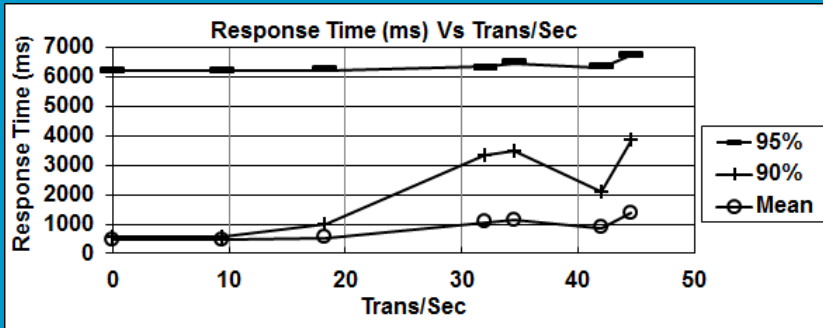
Development Tests Performed

Request Timing Quality



| Test Run | Load | | Inter-Request Times (ms) | | |
|----------|-------|-----------|--------------------------|--------|--------|
| | N | Trans/Sec | Mean | Sdev | % Diff |
| 1000 | 17220 | 9.40 | 106.35 | 116.97 | 10% |
| 1200 | 33250 | 18.32 | 54.59 | 59.89 | 10% |
| 1400 | 57849 | 32.01 | 31.24 | 34.96 | 12% |
| 1600 | 62450 | 34.55 | 28.94 | 33.20 | 15% |
| 1800 | 75864 | 42.03 | 23.79 | 26.54 | 12% |
| 2000 | 80432 | 44.56 | 22.44 | 26.77 | 19% |

Development Testing Results Analysis



| TrafficGen | | | | | | |
|------------|-----------|--------------------|------|------|-------|----------|
| Test Run | Load | Response Time (ms) | | | Enet | Response |
| | Trans/Sec | Mean | 90% | 95% | % Use | % Error |
| 0 | 0.00 | 475 | 561 | 6206 | 0.00 | 0.00 |
| 1000 | 9.40 | 475 | 561 | 6206 | 0.56 | 0.00 |
| 1200 | 18.32 | 541 | 980 | 6216 | 1.09 | 0.00 |
| 1400 | 32.01 | 1072 | 3329 | 6335 | 1.90 | 0.01 |
| 1600 | 34.55 | 1121 | 3486 | 6468 | 2.05 | 0.00 |
| 1800 | 42.03 | 868 | 2092 | 6314 | 2.50 | 0.00 |
| 2000 | 44.56 | 1366 | 3827 | 6732 | 2.65 | 0.01 |

| Account Create Server | | |
|-----------------------|-------------|----------|
| CPU | Packets/Sec | |
| % Use | Rec/Sec | Sent/Sec |
| 0.00 | 0 | 0 |
| 13.00 | 114 | 101 |
| 26.00 | 208 | 193 |
| 42.00 | 357 | 324 |
| 46.00 | 389 | 350 |
| 54.00 | 405 | 405 |
| 57.00 | 437 | 424 |

| Comments |
|---------------------------|
| Base Latency |
| No Failures |
| " " |
| One Failed Account Create |
| No Failures |
| " " |
| One Failed Account Create |

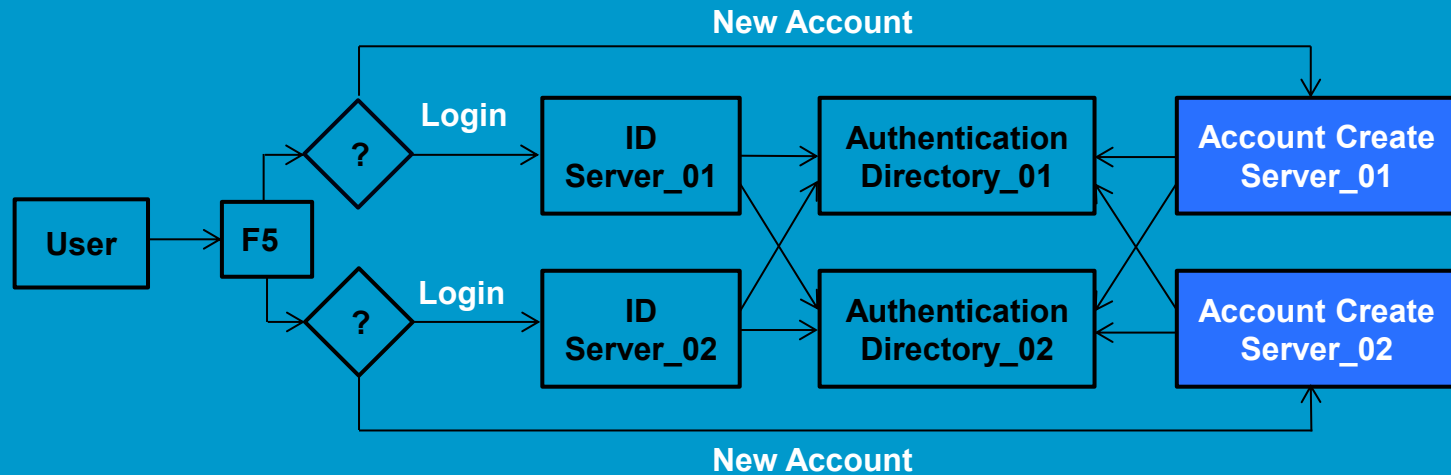
Development Testing Results From Test 1800

| Aggregate Statistics [RT(ms)-% Error-Bandwidth] - Dev_01_1800_AggregateReport | | | | | | | | | | | |
|---|--------------|-------|--------|------|------|------|------|-------------|-------|---------|--------|
| Event | n | tps | median | mean | sdev | p90 | p95 | min | max | % error | KB/sec |
| 00_SkipCaptcha | 200 | 1.96 | 138 | 236 | 299 | 475 | 753 | 88 | 2657 | 0.00 | 10.54 |
| 10_NewUser_Form | 4075 | 2.27 | 221 | 449 | 580 | 1167 | 1578 | 33 | 5755 | 0.00 | 16.75 |
| 12_NewUser_InputCheck | 20232 | 11.25 | 133 | 281 | 416 | 672 | 1028 | 23 | 6053 | 0.00 | 10.84 |
| 20_NewUser_Agree | 4024 | 2.26 | 605 | 1025 | 1132 | 2656 | 3420 | 59 | 7330 | 0.00 | 52.05 |
| 22_NewUser_Submit | 4017 | 2.26 | 216 | 417 | 530 | 1061 | 1478 | 36 | 5450 | 0.00 | 14.91 |
| 24_NewUser_Created | 4003 | 2.24 | 6645 | 6874 | 980 | 7518 | 7902 | 6054 | 23209 | 0.00 | 16.59 |
| 30_Challenge_Setup | 3976 | 2.25 | 98 | 220 | 354 | 525 | 859 | 17 | 4095 | 0.00 | 6.08 |
| 32_Challenge_Step | 3971 | 2.26 | 69 | 69 | 19 | 76 | 83 | 22 | 311 | 0.00 | 1.42 |
| 40_Challenge_Form | 3958 | 2.25 | 816 | 1267 | 1254 | 3067 | 3850 | 122 | 7961 | 0.00 | 51.81 |
| 42_Challenge_InputCheck | 11813 | 6.73 | 268 | 435 | 458 | 924 | 1283 | 138 | 5652 | 0.00 | 6.33 |
| 50_Challenge_Created | 3913 | 2.24 | 919 | 1301 | 1295 | 2323 | 3098 | 391 | 18132 | 0.00 | 15.61 |
| 60_Management | 3901 | 2.25 | 285 | 542 | 664 | 1358 | 1819 | 39 | 6380 | 0.00 | 20.57 |
| 70_AccessNevada_Home | 3897 | 2.24 | 932 | 1456 | 1490 | 3554 | 4609 | 92 | 9856 | 0.00 | 21.78 |
| 90_Logout | 3884 | 2.24 | 90 | 202 | 336 | 446 | 806 | 40 | 4461 | 0.00 | 19.85 |
| Total | 75864 | 42.03 | 245 | 868 | 1648 | 2092 | 6314 | 17 | 23209 | 0.00 | 249.58 |

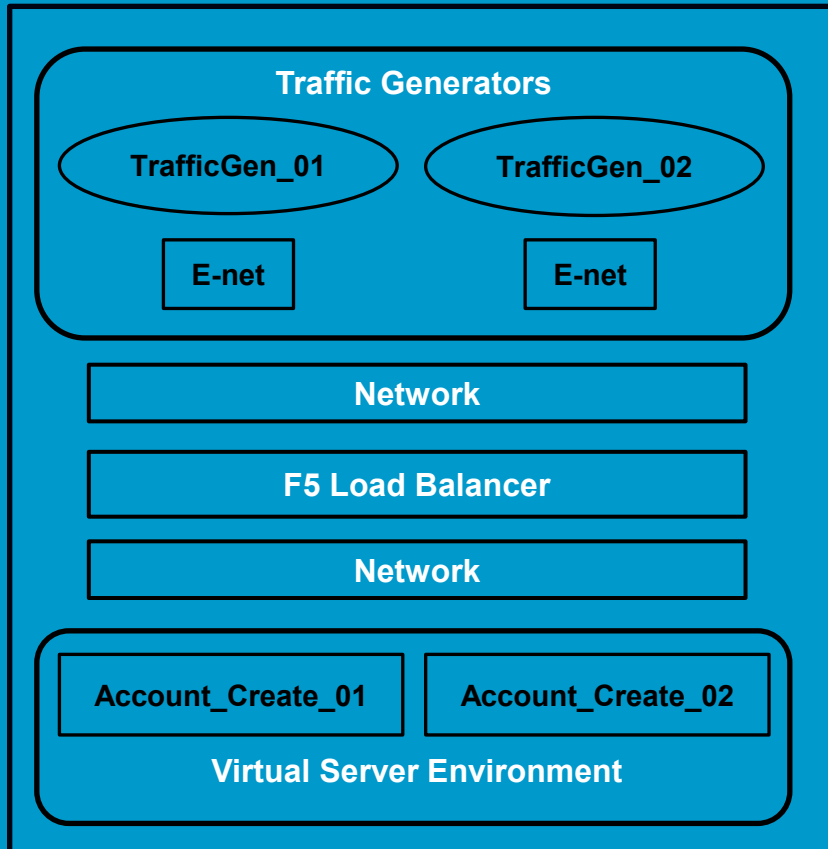
24_NewUser_Created = 5.27% Of Total Events (4003 / 75864)

Production Parallel Testing Functional Components

Load Balance Cluster



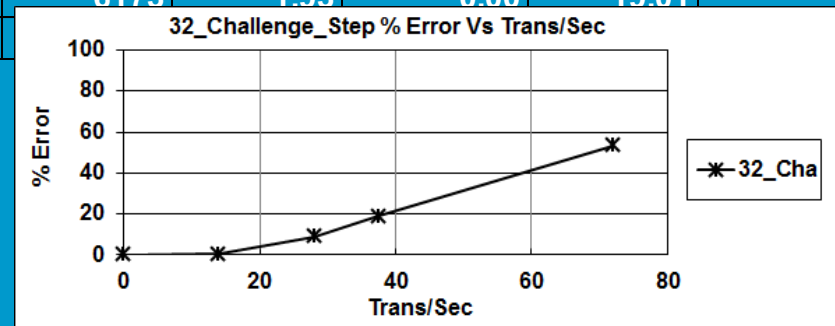
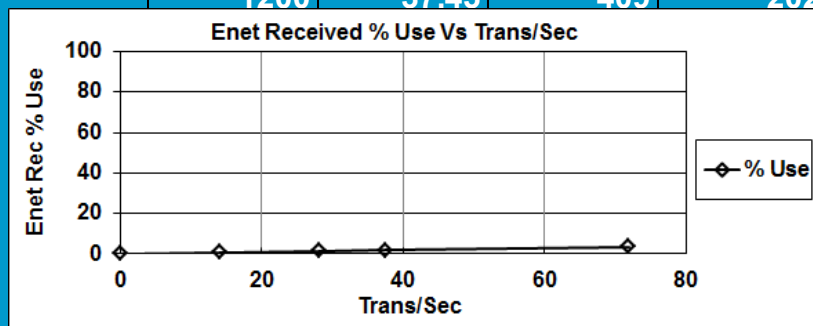
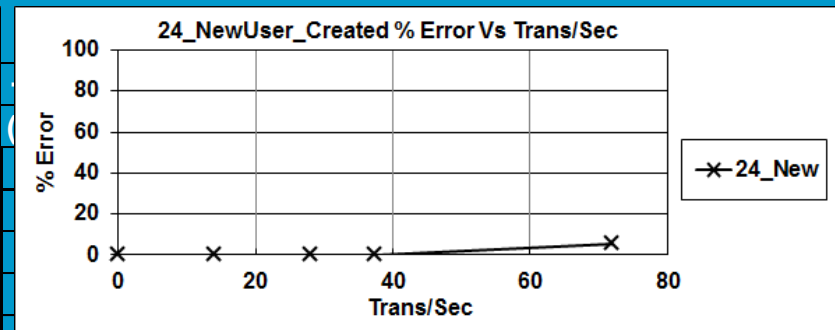
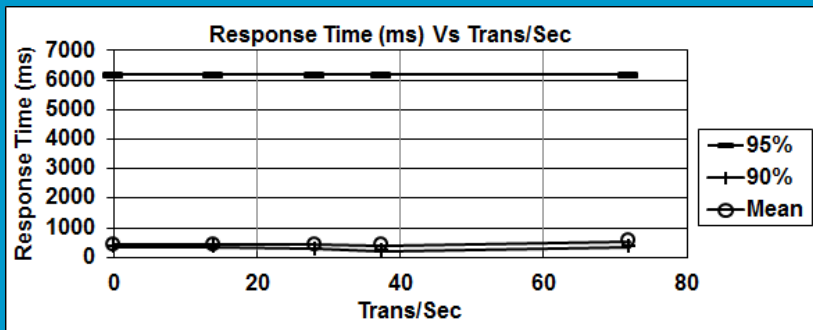
Production Parallel Load Testing Topology



Load Generator Implementation

- 300 user threads per generator
- 100 mbit/sec E-net connections
- 30 minute test runs
- Traffic generators time sink on NTP and their output files are merged
- Virtual servers run Linux O/S with resource consumption data collected

Production Parallel Testing Load Balance Cluster Results Analysis



| TrafficGen_01 + TrafficGen02 | | | | | | | | |
|------------------------------|-------------------|--------------------|-----|------|---------------|------------------|--------------|---|
| Test Run | Load Trans/Sec | Response Time (ms) | | | Enet % Use | Response % Error | | Comments |
| | | Mean | 90% | 95% | | 24_New | 32_Challenge | |
| 0 | 0.00 | 426 | 355 | 6183 | 0.00 | 0.00 | 0.00 | Base Latency |
| 900 | 14.01 | 426 | 355 | 6183 | 0.79 | 0.00 | 0.49 | Errors - 32_Challenge_Step |
| 1000 | 28.06 | 413 | 274 | 6180 | 1.48 | 0.00 | 9.03 | " " |
| 1200 | 37.45 | 409 | 202 | 6173 | 1.93 | 0.00 | 19.01 | " " |
| 1400 | 71.97 | 532 | 346 | 6172 | 3.69 | 5.54 | 53.24 | Errors - 32_Challenge_Step and 24_NewUser_Created |

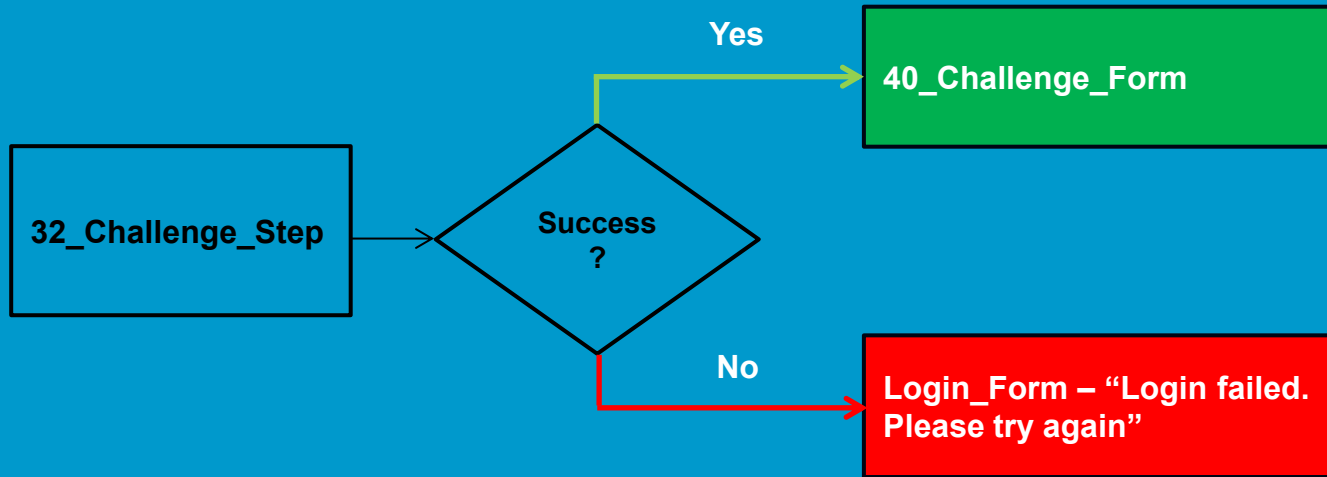
Production Parallel Testing

Load Balance Cluster Test 1200 Results

| Aggregate Statistics [RT(ms)-%Error-Bandwidth] - Production_Parallel_01_1200_AggregateReport | | | | | | | | | | | |
|--|--------------|--------------|--------|------|------|------|------|------|------|--------------|--------|
| Event | n | tps | median | mean | sdev | p90 | p95 | min | max | %error | KB/sec |
| 00_SkipCaptcha | 600 | 4.34 | 102 | 112 | 59 | 132 | 150 | 69 | 852 | 0.00 | 19.94 |
| 10_NewUser_Form | 3817 | 2.10 | 36 | 42 | 41 | 63 | 70 | 27 | 2169 | 0.00 | 17.22 |
| 12_NewUser_InputCheck | 18628 | 10.29 | 36 | 39 | 30 | 50 | 56 | 22 | 2143 | 0.00 | 7.84 |
| 20_NewUser_Agree | 3646 | 2.07 | 56 | 59 | 31 | 69 | 74 | 42 | 962 | 0.00 | 47.38 |
| 22_NewUser_Submit | 3637 | 2.10 | 43 | 46 | 39 | 55 | 60 | 31 | 2145 | 0.00 | 13.45 |
| 24_NewUser_Created | 3608 | 2.08 | 6202 | 6209 | 55 | 6240 | 6257 | 6152 | 7703 | 0.00 | 15.00 |
| 30_Challenge_Setup | 3571 | 2.08 | 12 | 14 | 9 | 20 | 24 | 7 | 351 | 0.00 | 5.72 |
| 32_Challenge_Step | 3551 | 2.08 | 65 | 239 | 714 | 80 | 3046 | 6 | 3111 | 19.01 | 4.51 |
| 40_Challenge_Form | 3520 | 2.08 | 91 | 84 | 47 | 116 | 137 | 7 | 1293 | 19.09 | 39.59 |
| 42_Challenge_InputCheck | 10363 | 6.13 | 150 | 130 | 59 | 175 | 182 | 9 | 1026 | 19.39 | 7.00 |
| 50_Challenge_Created | 3383 | 2.03 | 431 | 369 | 182 | 505 | 525 | 8 | 1279 | 19.72 | 12.04 |
| 60_Management | 3336 | 2.01 | 38 | 37 | 43 | 49 | 55 | 7 | 2119 | 19.84 | 15.44 |
| 70_AccessNevada_Home | 3297 | 1.99 | 53 | 54 | 48 | 73 | 86 | 7 | 1528 | 20.66 | 15.36 |
| 90_Logout | 3262 | 1.99 | 34 | 31 | 21 | 40 | 43 | 4 | 829 | 0.00 | 1.42 |
| Total | 68219 | 37.45 | 44 | 409 | 1384 | 202 | 6173 | 4 | 7703 | 7.87 | 192.51 |

32_Challenge_Step - 19.01% Error @ 37.45 tps Vs Development 0% Error @ 42.03 tps

32 Challenge Step Event Dispositions



Why A Login Form With “Login failed” ?

Why Is Development “Error Free” ?

32_Challenge_Step Event Functionality

Applies The Credentials Created In The 24_NewUser_Created Step To Perform A Private Path Login As A Setup For Challenge Question Completion.

■ Development Environment

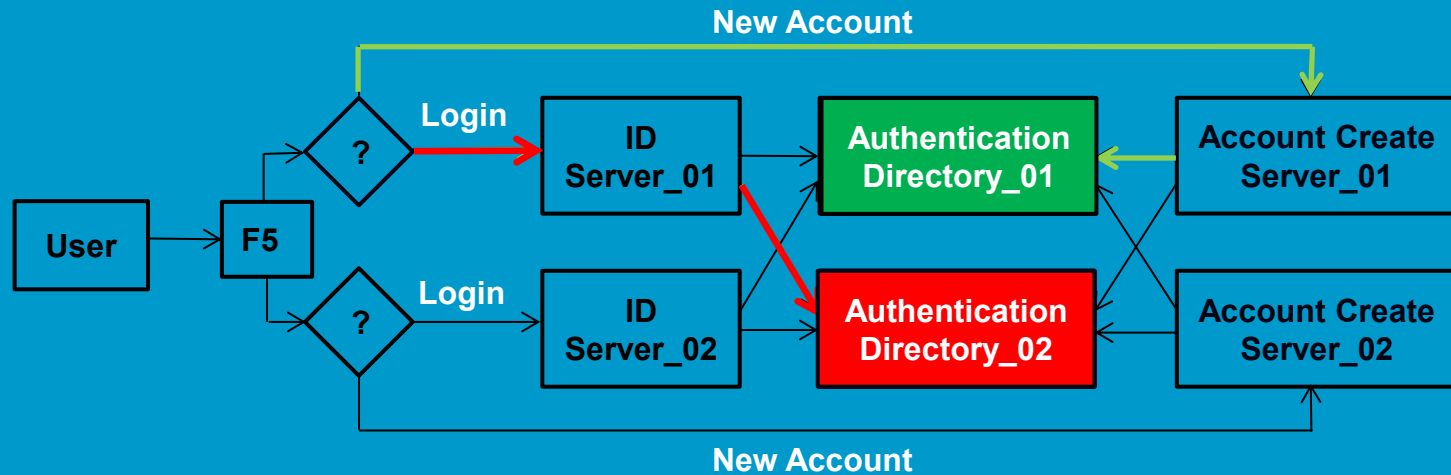
- Returns a 40_Challenge_Form

■ Load Balance Cluster Environment

- Sometimes It Succeeds (40_Challenge_Form)
- Sometimes It Fails (“Login failed. Please try again”)

32_Challenge_Step Failure In Load Balance Cluster

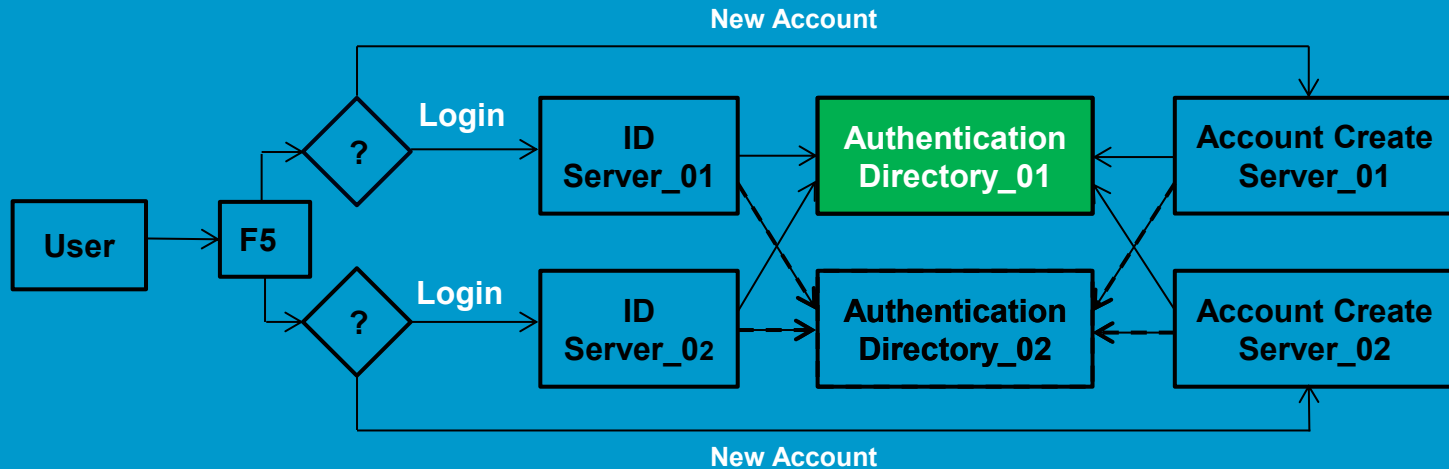
Load Balance Cluster



- 24_NewUser_Created
- 32_Challenge_Step

Production Parallel Testing Functional Components

Failover Configuration



Production Parallel Testing

Failover Configuration Test 0200 Results

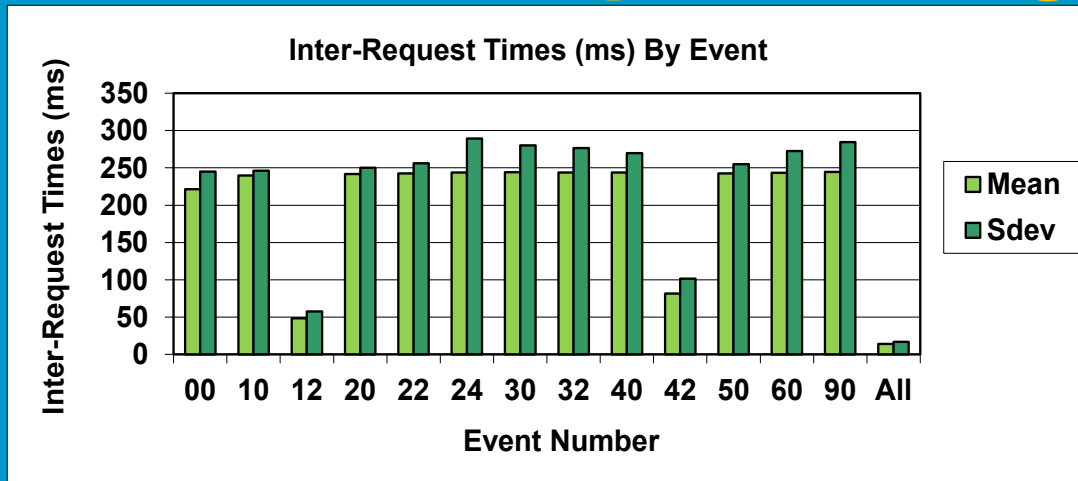
| Aggregate Statistics [RT(ms)-%Error-Bandwidth] - Production_Parallel_01_0200_AggregateReport | | | | | | | | | | | |
|--|-------------|--------------|--------|------|------|------|------|------|------|--------|--------|
| Event | n | tps | median | mean | sdev | p90 | p95 | min | max | %error | KB/sec |
| 00_SkipCaptcha | 600 | 4.52 | 153 | 172 | 74 | 237 | 287 | 95 | 929 | 0.00 | 25.83 |
| 10_NewUser_Form | 7537 | 4.17 | 84 | 111 | 98 | 189 | 251 | 37 | 1610 | 0.00 | 32.14 |
| 12_NewUser_InputCheck | 37196 | 20.62 | 45 | 60 | 69 | 103 | 135 | 20 | 3104 | 0.00 | 20.65 |
| 20_NewUser_Agree | 7348 | 4.14 | 144 | 207 | 183 | 413 | 537 | 59 | 2831 | 0.00 | 95.47 |
| 22_NewUser_Submit | 7309 | 4.12 | 75 | 102 | 100 | 180 | 233 | 36 | 3071 | 0.00 | 27.38 |
| 24_NewUser_Created | 7275 | 4.09 | 6248 | 6273 | 110 | 6372 | 6441 | 6065 | 7513 | 0.00 | 30.42 |
| 30_Challenge_Setup | 7220 | 4.10 | 47 | 68 | 100 | 121 | 157 | 16 | 3032 | 0.00 | 15.00 |
| 32_Challenge_Step | 7193 | 4.11 | 65 | 70 | 74 | 74 | 80 | 18 | 3098 | 0.00 | 4.23 |
| 40_Challenge_Form | 7162 | 4.10 | 310 | 373 | 225 | 607 | 765 | 133 | 3309 | 0.00 | 100.08 |
| 42_Challenge_InputCheck | 21307 | 12.27 | 193 | 216 | 101 | 297 | 349 | 138 | 3232 | 0.00 | 11.94 |
| 50_Challenge_Created | 7040 | 4.12 | 528 | 565 | 145 | 724 | 811 | 359 | 2200 | 0.00 | 28.73 |
| 60_Management | 7006 | 4.11 | 85 | 114 | 100 | 204 | 264 | 38 | 3065 | 0.00 | 37.64 |
| 90_Logout | 6965 | 4.09 | 67 | 79 | 56 | 113 | 136 | 44 | 2303 | 0.00 | 38.26 |
| Total | 131158 | 72.34 | 93 | 493 | 1411 | 520 | 6189 | 16 | 7513 | 0.00 | 429.56 |

Failover - 0 % Error @ 72.34 tps

Load Balance - 19.01% Error @ 37.45 tps and 53.24 % Error @ 71.97 tps

14,724 Users Created / Hour (4.09 User Creates / Sec x 3600 Sec / Hour)

Failover Test 0200 Request Timing Quality



| Inter-Request Times (ms) - Production_Parallel_01_0200_AggregateReport | | | | | |
|--|--------|-----------|--------------------------|--------|--------|
| Event | Load | | Inter-Request Times (ms) | | |
| | N | Trans/Sec | Mean | Sdev | % Diff |
| 00_SkipCaptcha | 599 | 4.51 | 221.24 | 245.07 | 11% |
| 10_NewUser_Form | 7536 | 4.17 | 239.93 | 246.18 | 3% |
| 12_NewUser_InputCheck | 37195 | 20.62 | 48.49 | 57.42 | 18% |
| 20_NewUser_Agree | 7347 | 4.13 | 241.84 | 250.30 | 3% |
| 22_NewUser_Submit | 7308 | 4.12 | 242.52 | 256.27 | 6% |
| 24_NewUser_Created | 7274 | 4.09 | 243.76 | 289.20 | 19% |
| 30_Challenge_Setup | 7219 | 4.10 | 244.03 | 280.04 | 15% |
| 32_Challenge_Step | 7192 | 4.10 | 243.61 | 276.48 | 13% |
| 40_Challenge_Form | 7161 | 4.10 | 243.83 | 269.78 | 11% |
| 42_Challenge_InputCheck | 21306 | 12.27 | 81.52 | 101.45 | 24% |
| 50_Challenge_Created | 7039 | 4.12 | 242.66 | 254.86 | 5% |
| 60_Management | 7005 | 4.11 | 243.26 | 272.40 | 12% |
| 90_Logout | 6964 | 4.09 | 244.41 | 284.52 | 16% |
| All | 131157 | 72.34 | 13.82 | 16.85 | 22% |

Lessons Learned

- 1. Load Testing Can Uncover Problems That Are Easily Fixed Before The Go Live Date.**
- 2. Multiple Load Generators Help Isolate The Source Of The Problem.**
- 3. Recording The Event Sequence With The Load Tool Provides Insights Not Obvious When Invoking The Service With A Browser.**
 - a) The 32_Challenge_Step Login And Associated Parameters Are Clearly Spelled Out In The Recorded Script's HTTP Request.**

32 Challenge Step HTTP Request

32_Challenge_Step

User Credentials

The screenshot displays the Apache JMeter interface for configuring an HTTP Request. The left sidebar shows a test plan tree with the step '32_Challenge_Step' selected. The main panel shows the following configuration:

- Name:** 32_Challenge_Step
- Web Server:** Server Name or IP: \${Server_id}, Port Number: \${Port2}
- HTTP Request:** Implementation: Java, Protocol [http]: \${Proto}, Method: POST, Content encoding: [\${Encode1}]
- Path:** [/\${SPath32}]
- Parameters:** A table of parameters to be sent with the request.

| Name: | Value | Encode? | Include Equals? |
|---------------|--------------|-------------------------------------|-------------------------------------|
| option | credential | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| target | \$(Target) | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| Ecom_User_ID | \$(UserName) | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| Ecom_Password | \$(Password) | <input type="checkbox"/> | <input checked="" type="checkbox"/> |

Additional options include 'Send Files With the Request' and 'Proxy Server' settings.

Summary

This Experience Illustrates That “Technical Glitches” In Web Applications Can Sometimes Be Mitigated Through Load Testing Or Even Just Recording The Key Events With The Load Tool.

If More Of This Work Had Been Done Some Of These Underperforming Affordable Care Act Web Sites May Have Been Spared A Measure Of The User Frustration So Highly Publicized.

QUESTIONS

? ? ?

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