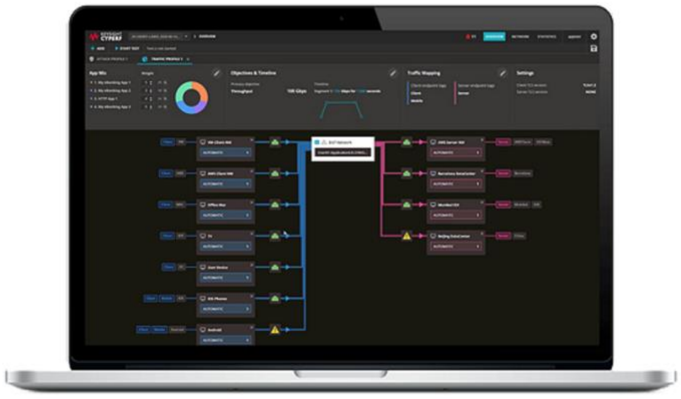
# CyPerf Test Drive

Testing That Replicates Your Network in Action



The focus of these labs is to provide users hands-on experience on how to use CyPerf for a few test scenarios that assess the performance and security efficacy of a cloud-deployed security control (in this case we will use a Web Application Firewall - WAF).

# CyPerf Test Drive

## Table of Contents

## Overview - The need for Hybrid, Distributed Network Testing

“If you can’t measure it, you can’t improve it.” This quote could not find better applicability than in today’s disaggregated hybrid networks, evolving applications, and service infrastructures. Digital transformation is the essence of these rapidly evolving ecosystems and key to competitiveness for most enterprises today. Success and agility in such environments depend on the ability to measure and analyze how distributed, disaggregated network infrastructures, applications, and services perform before going live, as well as during their production life cycle.

Digital business transformation and edge computing are bringing major unknowns to the performance, scalability, and threat protection of new, emerging network and security architectures. As an enterprise moving to more cost-effective and elastic off premises networking and storage, you face new challenges— are you delivering high-quality access to users, devices, and cloud services everywhere in your distributed, disaggregated networks? Is your cybersecurity infrastructure enough to limit exposure across your on- and off-prem networking? Are your security policies dynamically adjusting to your auto-scale events? Your perimeter-less, elastic, dynamic network requires a new testing paradigm.

Keysight CyPerf is the industry’s first cloud-native software test solution that recreates every aspect of a realistic workload across a variety of physical and cloud environments to deliver unprecedented insights into end user experience, security posture, and performance bottlenecks of distributed, hybrid networks.

CyPerf delivers new heights in realism that comes from simultaneously generating both legitimate traffic mixes and malicious activities across a complex network of proxies, software-defined wide area networking (SD-WAN), Secure Access Service Edge (SASE), VPN tunnels, Transport Layer Security (TLS) inspection, elastic load balancers, and web applications firewalls (WAF). Combined with the unique ability to interleave applications and attacks to model user behavior and security breaches, CyPerf enables a holistic approach in replicating distributed customer deployment environments faster and with more fidelity than other solutions

## Lab Introduction

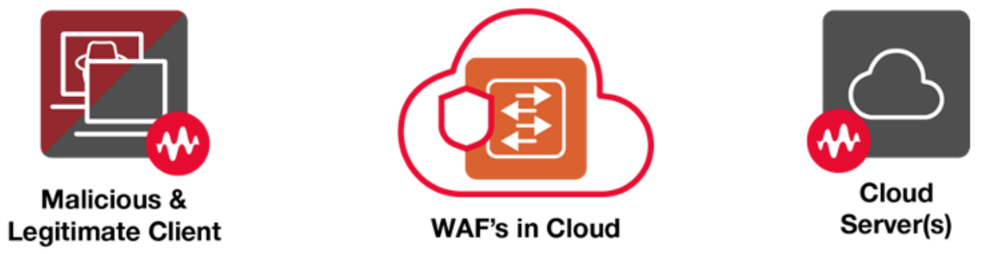
### *Overview*

For the following Labs we will be using a cloud-based setup with distributed, lightweight traffic agents which will generate realistic application and malicious traffic to assess the performance and security efficacy of a cloud-deployed Web Application Firewall - WAF (i.e. DUT, or device under test).

We have selected a cloud-deployed WAF for the device under test as a readily available security control however following a similar approach, an extremely large set of network devices or entire infrastructure can be tested.

The main two components of the Lab environment are:

1. The **test tool**: Keysight's CyPerf emulating the malicious and legitimate traffic clients as well as traffic servers (all deployed as cloud instances)
2. The **device under test (DUT)**: cloud-deployed WAF

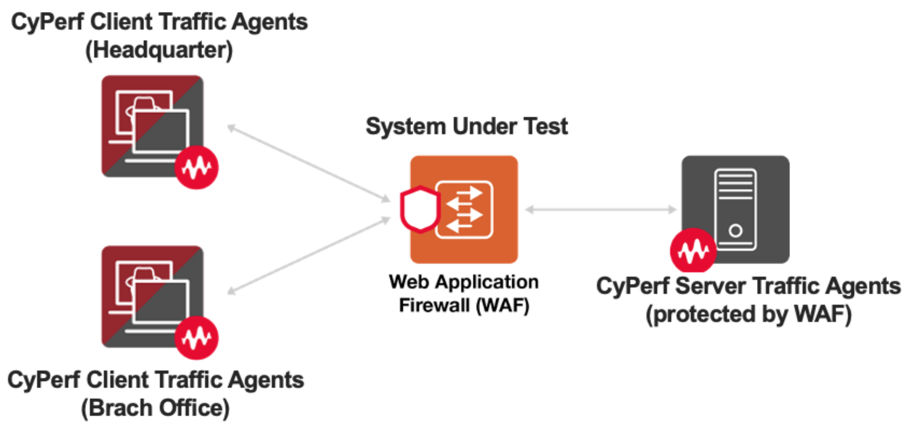


The main components of Keysight's CyPerf (test tool) are:

1. **Test Controller**: web-based UI for configuring and running tests, viewing real-time statistics and reviewing results
    - The CyPerf Controller will be deployed in the cloud and will be publicly available to users executing this lab as per <tba>
2. **Traffic Agents**: software agents generating test traffic
    - The CyPerf traffic agents (clients and servers) will be deployed in the cloud to generate legitimate and malicious traffic going through the cloud-deployed WAF (i.e. DUT).

## *Setup*

Below is the high-level diagram of the setup used in this lab:


CyPerf Client Traffic Agents (Headquarter)
System Under Test
Web Application Firewall (WAF)
CyPerf Server Traffic Agents (protected by WAF)
CyPerf Client Traffic Agents (Brach Office)

The setup for all the labs consists of the following:

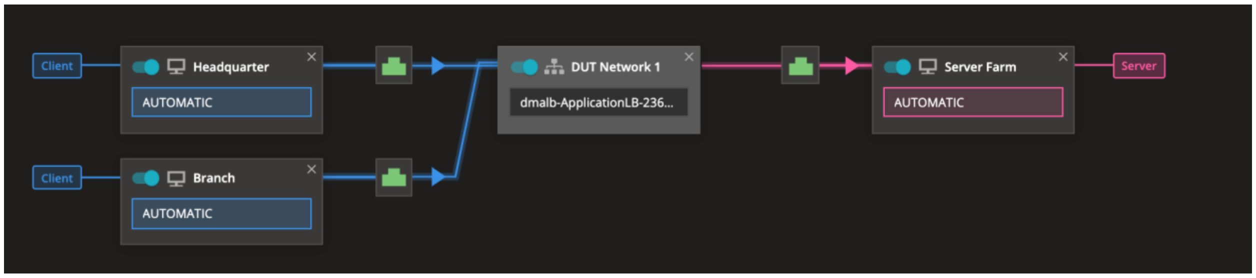
1. Traffic Agents:
    - **Clients**: Two CyPerf traffic agents acting as clients deployed in two different locations (in this particular setup, different availability zones) to model a distributed deployment. The two locations will be Headquarter and Branch Office.
    - **Servers**: One CyPerf traffic agent acting as server behind the cloud-based WAF.

**IMPORTANT** CyPerf traffic agents (clients and servers) can be virtually deployed in any Region/Zone, across a variety of public clouds (e.g., Microsoft Azure, Amazon Web Services, Google Cloud Platform) as well as on on-prem machines to emulate a large-scale distributed network to test the performance and security efficacy of such infrastructures. For more details, please refer to the product datasheet.

**CAUTION** In this particular Lab, due to cost related considerations, we have forcefully kept **one single server agent** in the group. Also due to the same considerations, although the cloud instances type used for the CyPerf traffic are capable of generating up to 10Gbps, we will limit the maximum throughput per test to 5Gbps.

CyPerf delivers elastically scaling traffic agents that can spawn and tear down dynamically during a test to validate auto-scale policies and enables customers to fine-tune the balance between user experience and security.

2. Device Under Test (DUT):
    - Cloud-based WAF: The configuration and the DUT will mostly consist of default parameters with a default security rule to block SQLi attacks



### *Resources and Prerequisites*

To run this lab users only need access to a common web browser. Everything will be run from a web interface.

All the resources for these labs can be found that the following location: https://github.com/Keysight/cyperf/tree/main/CyPerfTestDrive

This includes:

- Configuration files: each lab will start from a configuration file that is available at above location
- Step-by-step lab guiding document (this document)
- Intro video: a quick video that guides users on how to spin up and manage the test drive environment
- Cloud Formation templates
    - Using the Cloud Formation templates found at above location, users can deploy a similar setup with the one from this lab in their own cloud account.
- Terraform script: deploys the same environment as the above Cloud Formation templates, through a single, aggregated Terraform script

Looking for more resources? We offer a broad range of additional resources like deployment templates (for major public clouds), associated instructions and REST API wrappers at the following GitHub repository: https://github.com/Keysight/cyperf

## Lab 1: Setup Baselining – Max HTTPS performance

### *Overview*

As the very first step, we will baseline the maximum performance of the System Under Test (SUT) using HTTPS traffic.

For this scenario we will have the DUT configured with Load Balancing capabilities on as well as default WAF security rules to protect against SQLi attacks.

CyPerf will be configured with the following HTTP profile:

- HTTP GET - to fetch a 1MB page
- HTTP POST - to send a 500KB response

Also, as most traffic in today's networks is encrypted, we will be using TLS traffic, which the WAF device will need to decrypt, inspect and re-encrypt.

## *Objectives*

CyPerf provides a very large set of Key Performance indicators, however for this test we will focus on the following:

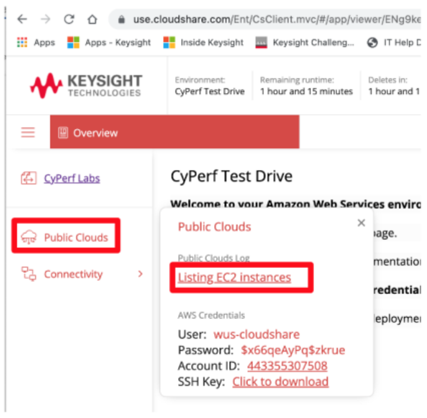
- Maximum throughput
- Latencies

For the test, we will import a configuration file that was already created beforehand to save time. Nevertheless, we will look at the most important parameters as per the step-by-step instructions below.

## *Step-by-Step Instructions*

Initially we will need to the connect to the CyPerf Controller, and for this we will need its IP address.

For this, in your CloudShare web page, please click on **Public Clouds** menu and then on **Listing EC2 instance**:



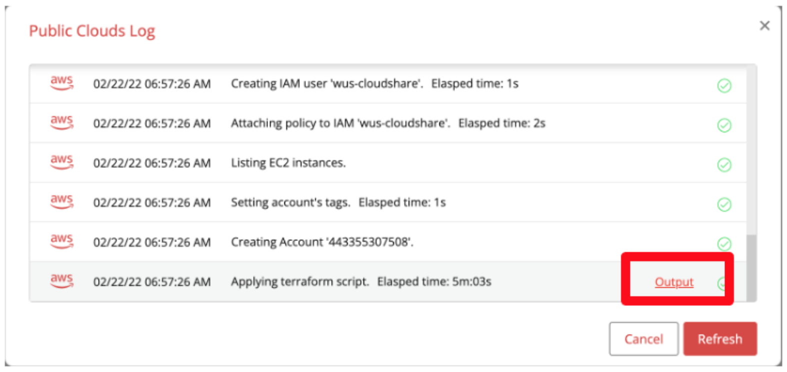
Environment: CyPerf Test Drive
Remaining runtime: 1 hour and 15 minutes
Deletes in: 1 hour and 1

CyPerf Test Drive

Welcome to your Amazon Web Services enviro

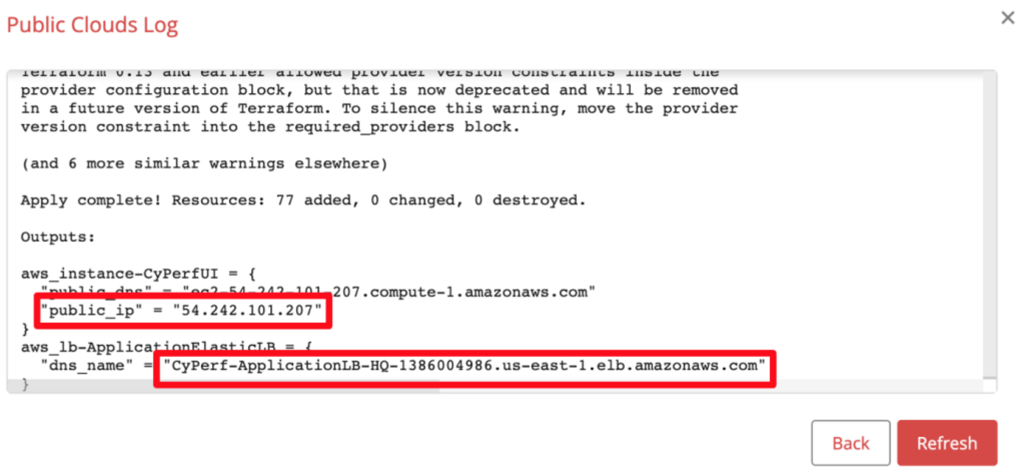
AWS Credentials
User: wus-cloudshare
Password: $x66qeAyPq$zkrue
Account ID: 443355307508
SSH Key: Click to download

In the new dialog, click on the **Output** link next to the *Applying terraform script* line:



```
aws 02/22/22 06:57:26 AM   Creating IAM user 'wus-cloudshare'.  Elasped time: 1s
aws 02/22/22 06:57:26 AM   Attaching policy to IAM 'wus-cloudshare'.  Elasped time: 2s
aws 02/22/22 06:57:26 AM   Listing EC2 instances.
aws 02/22/22 06:57:26 AM   Setting account's tags.  Elasped time: 1s
aws 02/22/22 06:57:26 AM   Creating Account '443355307508'.
aws 02/22/22 06:57:26 AM   Applying terraform script.  Elasped time: 5m:03s
```

Scroll all the way down through the Logs and at the bottom, the IP address of the CyPerf Controller (i.e., aws_instance-*CyPerfUI*) as well as the DNS name of the DUT (i.e., aws_lb-ApplicationElasticLB). Please copy both in a text file.



Public Clouds Log

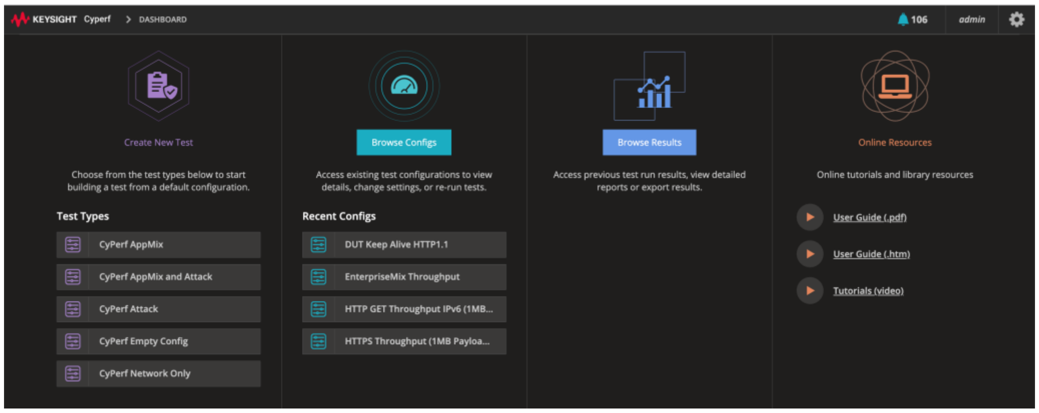
```
Terraform 0.13 and earlier allowed provider version constraints inside the
provider configuration block, but that is now deprecated and will be removed
in a future version of Terraform. To silence this warning, move the provider
version constraint into the required_providers block.

(and 6 more similar warnings elsewhere)

Apply complete! Resources: 77 added, 0 changed, 0 destroyed.

Outputs:

aws_instance-CyPerfUI = {
  "public_dns" = "ec2-54-242-101-207.compute-1.amazonaws.com"
  "public_ip" = "54.242.101.207"
}
aws_lb-ApplicationElasticLB = {
  "dns_name" = "CyPerf-ApplicationLB-HQ-1386004986.us-east-1.elb.amazonaws.com"
}
```

Next, we will log in to the CyPerf Controller and start configuring the tests:

1. Connect to the CyPerf Controller: open a Web Browser and type the IP address of the CyPerf Controller. Use the following credentials to log in:
   - UserName: admin
   - Password: CyPerf&Keysight#1

Congratulations! You have logged in for the first time in your own CyPerf instance.

Note: You will need to accept the TLS certificate of the Controller Web UI since this is a self-signed certificate.



KEYSIGHT Cyperf > DASHBOARD 106 admin

Create New Test

Choose from the test types below to start building a test from a default configuration.

Test Types

- CyPerf AppMix
- CyPerf AppMix and Attack
- CyPerf Attack
- CyPerf Empty Config
- CyPerf Network Only

Browse Configs

Access existing test configurations to view details, change settings, or re-run tests.

Recent Configs

- DUT Keep Alive HTTP1.1
- EnterpriseMix Throughput
- HTTP GET Throughput IPv6 (1MB...
- HTTPS Throughput (1MB Payloa...

Browse Results

Access previous test run results, view detailed reports or export results.

Online Resources

Online tutorials and library resources

- User Guide (.pdf)
- User Guide (.htm)
- Tutorials (video)

Next, let’s import the first configuration file. Before importing the configuration file, please make sure to download “CyPerf HTTPS.zip” file on your local machine from the following GitHub repo:

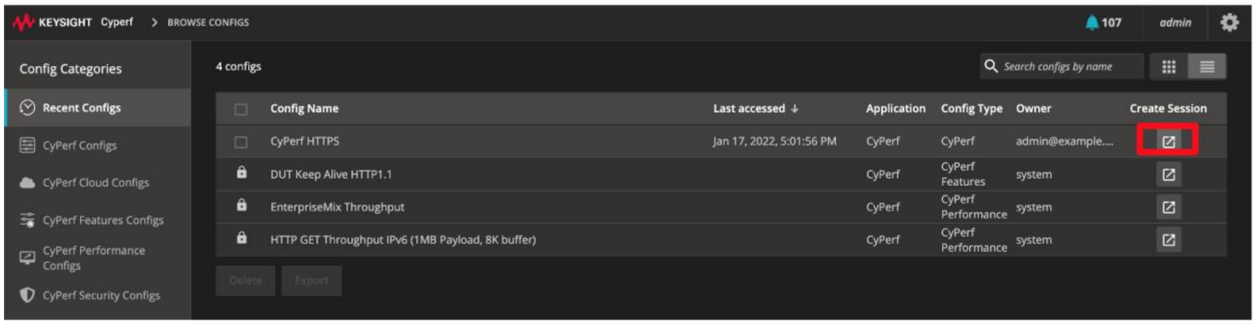
https://github.com/Keysight/cyperf/tree/main/CyPerfTestDrive/Configuration_Files

**IMPORTANT** CyPerf provides a list of canned configuration files optimized for various objectives and cloud environments which are a great starting point for such scenarios. These configs can be found under Browse Configs menu -> CyPerf Cloud Configs

2. In the CyPerf Controller's landing page, please navigate to **Browse Configs** and then click on the **Import** button on the lower left corner.

Select the first configuration file (i.e., "CyPerf HTTPS.zip") from your local machine and complete the import step.

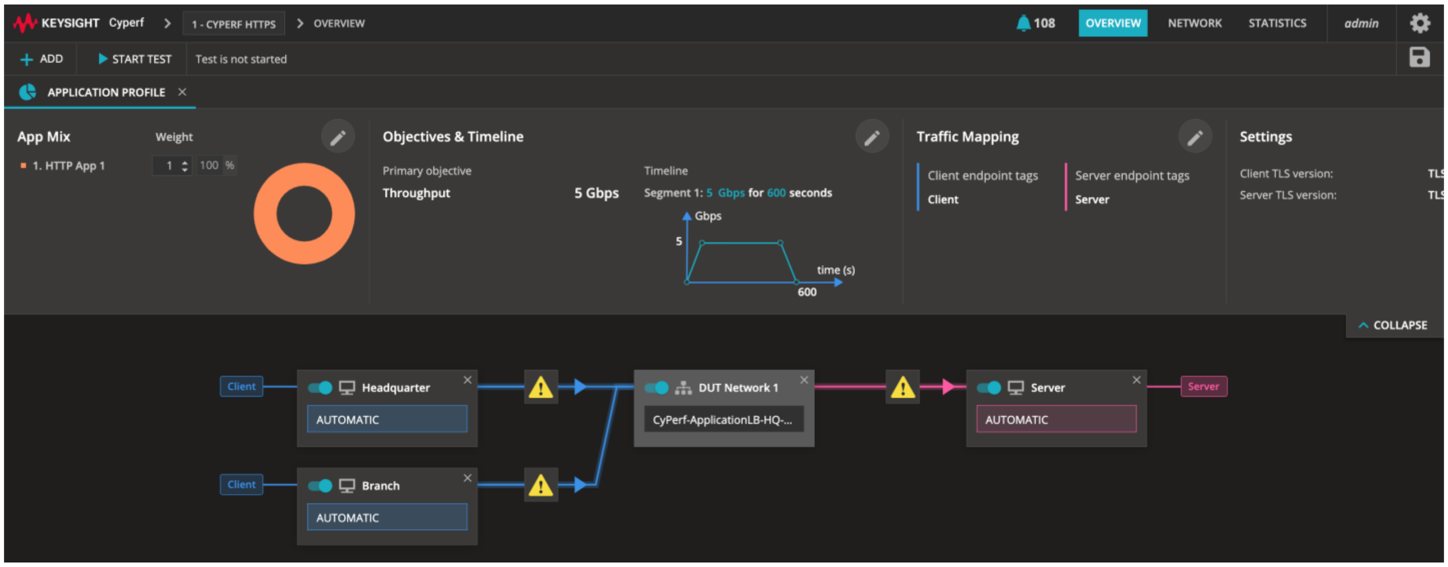
3. After the new config file is imported, please click on the "create session" icon, on the right side of the screen, on the same row with the new config:



4 configs

| Config Name | Last accessed ↓ | Application | Config Type | Owner | Create Session |
|---|---|---|---|---|---|
| CyPerf HTTPS | Jan 17, 2022, 5:01:56 PM | CyPerf | CyPerf | admin@example.... | ☑ |
| DUT Keep Alive HTTP1.1 | | CyPerf | CyPerf Features | system | ☑ |
| EnterpriseMix Throughput | | CyPerf | CyPerf Performance | system | ☑ |
| HTTP GET Throughput IPv6 (1MB Payload, 8K buffer) | | CyPerf | CyPerf Performance | system | ☑ |

4. The new config file will be loaded into a new CyPerf Session:



App Mix — Weight
1. HTTP App 1 — 1 — 100 %

Objectives & Timeline
Primary objective: Throughput — 5 Gbps
Timeline: Segment 1: 5 Gbps for 600 seconds
Gbps 5, time (s) 600

Traffic Mapping
Client endpoint tags: Client
Server endpoint tags: Server

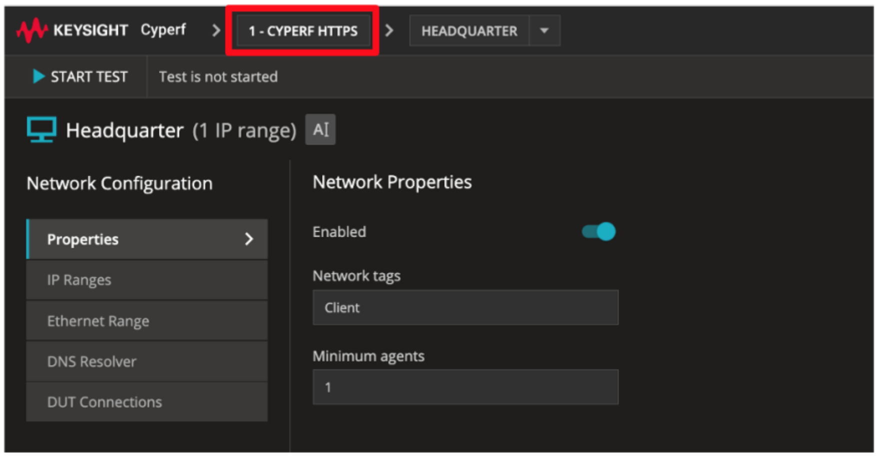
Settings
Client TLS version: TL
Server TLS version: TL

This is the CyPerf test overview page, where all the most important test parameters can be seen in a single pane of glass.

The bottom half of the page is an interactive representation of the logical topology used in this test. This topology reflects the setup that we described in the above "Lab Introduction" section. Upon clicking on any element in the topology, the menu with all the configurable parameters for the respective object will be showed.

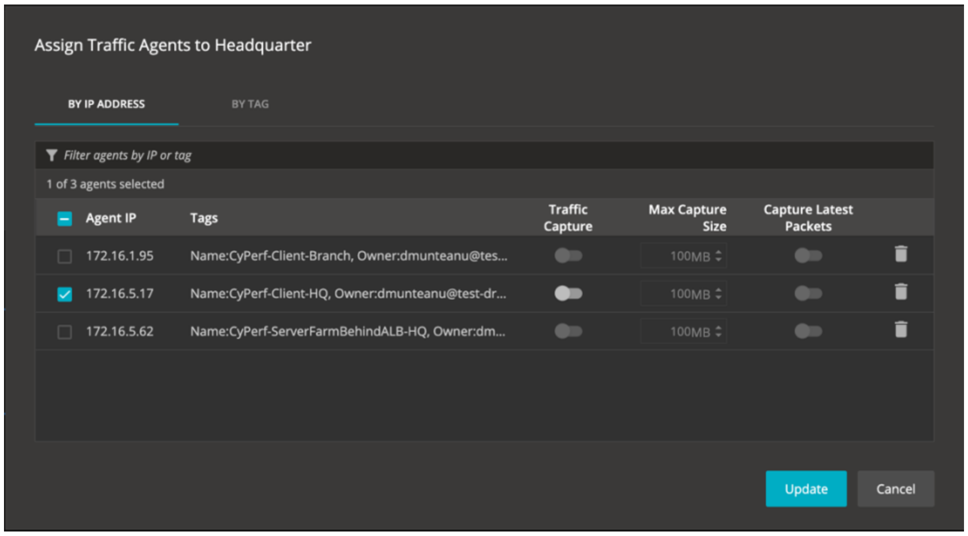
For example, if you click on the **Headquarter** network segment you can see all the network related parameters like configured IP addresses (in this case it is set on "*Automatic*" which means that the already assigned IP addresses will be used), DNS Resolvers etc.

You can click the "back" browser button or click on the **CyPerf HTTPS** button in the breadcrumb to navigated back to the test overview page:



5. First, let's assign the already deployed CyPerf Agents (which got automatically deployed when Applying the Terraform script in the CloudSahre webpage) to each of the Network Segments in our test configuration:
   a. Click on the "*yellow attention*" icon (⚠) corresponding to the **Headquarter** network segment.

   A new dialog will open with all the CyPerf traffic agents connected to your CyPerf Controller. For the **Headquarter** network segment, select the Agent that has the "*CyPerf-Client-HQ*" tag and click on the **Update** button:

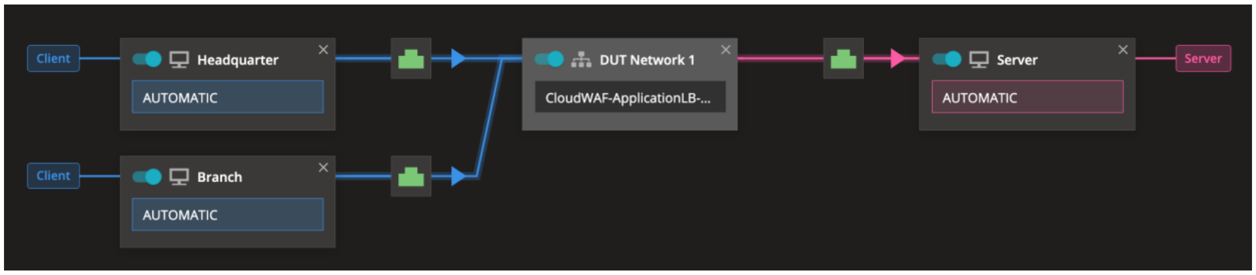

Assign Traffic Agents to Headquarter
BY IP ADDRESS
BY TAG
Filter agents by IP or tag
1 of 3 agents selected
Update
Cancel

| | Agent IP | Tags | Traffic Capture | Max Capture Size | Capture Latest Packets |
|---|---|---|---|---|---|
| ☐ | 172.16.1.95 | Name:CyPerf-Client-Branch, Owner:dmunteanu@tes... | | 100MB | |
| ✓ | 172.16.5.17 | Name:CyPerf-Client-HQ, Owner:dmunteanu@test-dr... | | 100MB | |
| ☐ | 172.16.5.62 | Name:CyPerf-ServerFarmBehindALB-HQ, Owner:dm... | | 100MB | |

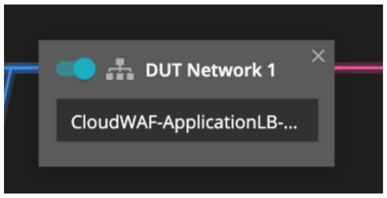
   Once the new CyPerf traffic agent is assigned, the "yellow attention" icon (⚠) will turn into a green port (🟩) which means that the **Headquarter** network segment has active CyPerf traffic agents assigned.

b. Next, repeat the above procedure and assign to the **Branch** network segment another CyPerf traffic agent with the tag "*CyPerf-Client-Branch*".
c. Lastly, for the **Server** network segment, assigned the last CyPerf traffic agent with the tag "*CyPerf-ServerFarmBehindALB*".

Now, that active CyPerf agents have been assigned, all three network segments should have a green port (🟩):

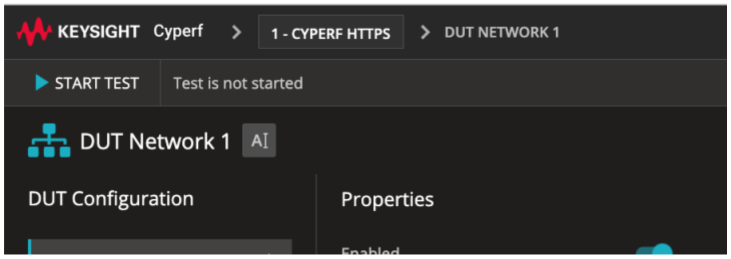


6. Next, let's configure the DUT address, which is basically the DNS Hostname that the DUT is listening for incoming requests, and which will be used by the CyPerf client traffic agents to send traffic to:
   a. Click on the **DUT Network** object in the middle of the topology diagram:



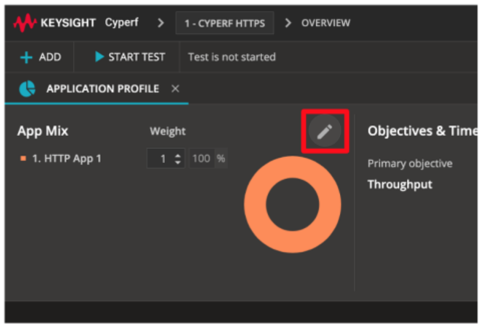
   b. In the new menu, paste the DUT public DNS that was obtained from the Public Cloud Logs (at the beginning of this lab) in the **Host** field.

7. Click on the **CyPerf HTTPS** button in the breadcrumb at the top of the page to go back to the test overview page:



Although the test is now ready to run, before starting it, let's have a look at the most important test parameters.

8. **Application Profile**: Click on the pencil icon ( ) in the Application Profile section:

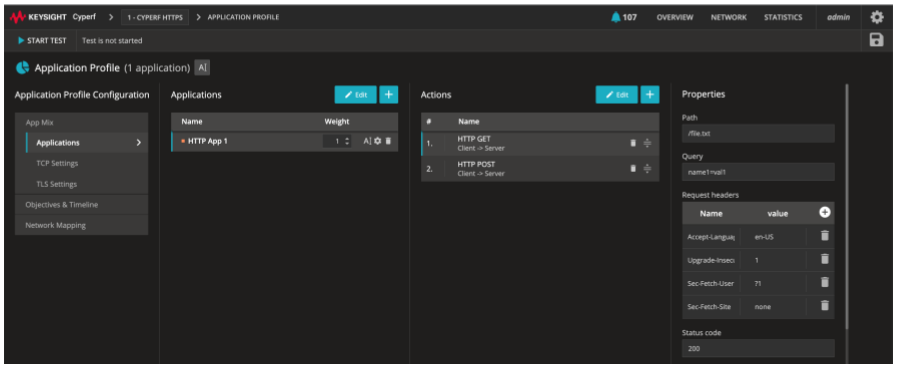


1. HTTP App 1 — Weight 1, 100 %

Primary objective: Throughput

The new menu will provide access to all the L4-7 configurations options, like:

a. *Type of traffic* is being sent from an L7 perspective:



| Name | Weight |
|---|---|
| HTTP App 1 | 1 |

| # | Name |
|---|---|
| 1. | HTTP GET<br>Client -> Server |
| 2. | HTTP POST<br>Client -> Server |

Path: /file.txt

Query: name1=val1

Request headers

| Name | value |
|---|---|
| Accept-Languag | en-US |
| Upgrade-Insec | 1 |
| Sec-Fetch-User | ?1 |
| Sec-Fetch-Site | none |

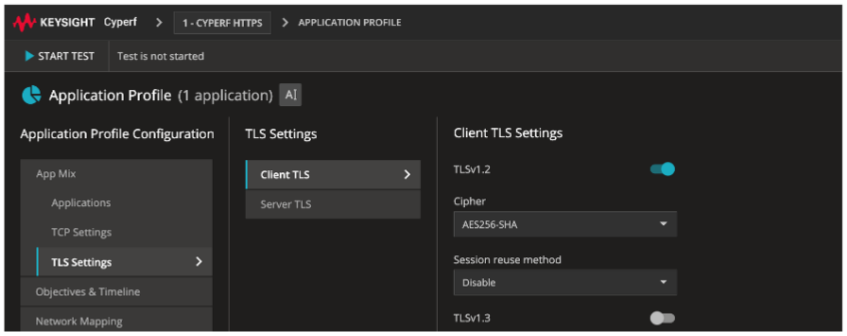
Status code: 200

In this test we are using a basic HTTP profile for bi-directional traffic with the following commands:

- HTTP GET - to fetch a 1MB page
- HTTP POST - to send a 500KB response

| IMPORTANT | CyPerf offers an unmatched flexibility for configuring and parametrizing the applications and the actions so that users can create their own unique profiles. In the next lab we will go in more details into what other apps are available into the application library. |
|---|---|

b. ***TLS Settings**:*



TLSv1.2: on

Cipher: AES256-SHA

Session reuse method: Disable

TLSv1.3: off

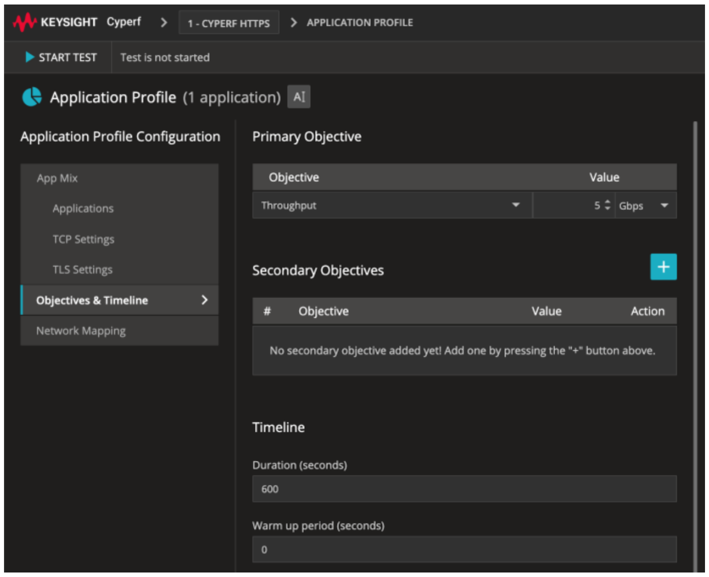
In this test we are also using a basic yet common TLS profile with the following commands:

- TLS 1.2
- RSA 2K key certificate
- RSA-AES256-SHA cipher

**IMPORTANT** Client and Server-side TLS parameters are configured independently, therefore CyPerf can be used to test a wide range of topologies/deployments including, but not limited to:

- **TLS Offload**: to test the DUT's ability to offload TLS connections facing the served clients, while the Server side is unencrypted.
- **TLS Man-in-the-Middle** (MiTM): to test the DUT's ability to decrypt, inspect (for malicious content, filtering etc) and re-encrypt TLS connections. In this case both client side and server side are TLS enabled.
- **TLS Pass-through**: in this scenario the client side and server side are also TLS enabled however, the DUT is not inspecting the encrypted content.

c. ***Objectives and Timeline****: this is where the test load objective and duration are configured:*



Test is not started

Primary Objective

| Objective | Value |
|---|---|
| Throughput | 5 Gbps |

| # | Objective | Value | Action |
|---|---|---|---|

No secondary objective added yet! Add one by pressing the "+" button above.

Timeline

Duration (seconds): 600

Warm up period (seconds): 0

**IMPORTANT** The Objectives and Timeline menu offers also the ability to configure secondary objectives enabling use cases where for example, a certain throughput level needs be achieved with a certain number of "Simulated Users".

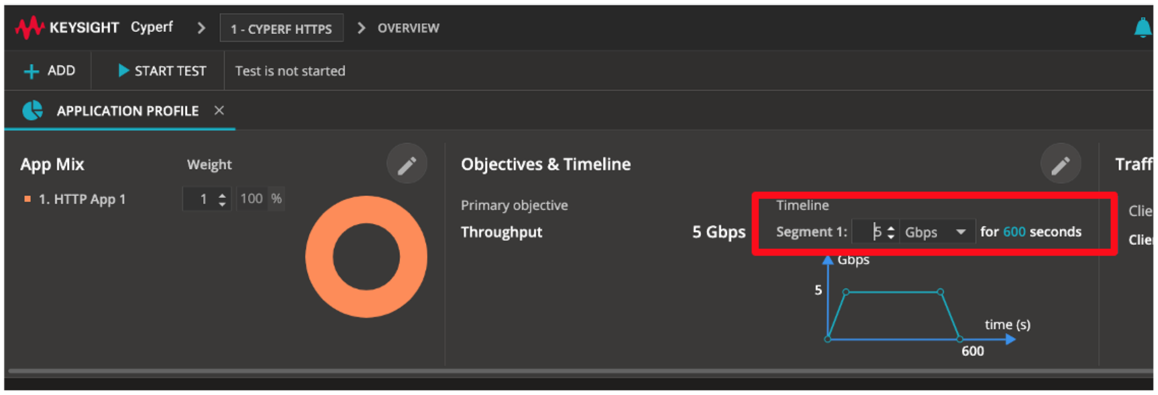
Now that the test has been updated with the details of the setup/agents assigned to your user, we can run the test and interpret the results.

**CAUTION**

AWS Elastic Load Balancers (ELB) are able to address a broad set of use cases and traffic load profiles however, when there is a sudden increase of traffic it is recommanded the that ELBs would be pre-warmed. The general recomandation is that "*the traffic increases at no more than 50 percent over a five-minute interval*".

For more information, please refer to: https://aws.amazon.com/articles/best-practices-in-evaluating-elastic-load-balancing/#pre-warming

Therefore, before running the first actual HTTPS performance baselining test, we will run an initial test just to pre-warm the ELB (as our traffic load will exceed 50% over a five-minute interval). In the test overview page, in the **Objectives and Timelines** section make sure that the value is set on 5Gbps:



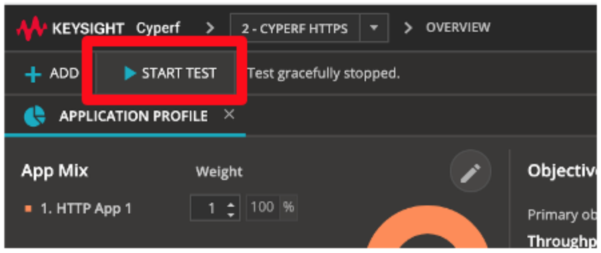
Test is not started

1. HTTP App 1 — 1 — 100 %

Primary objective: Throughput 5 Gbps

Timeline: Segment 1: 5 Gbps for 600 seconds

9. Click on the "Start Test" button in the upper left corner:

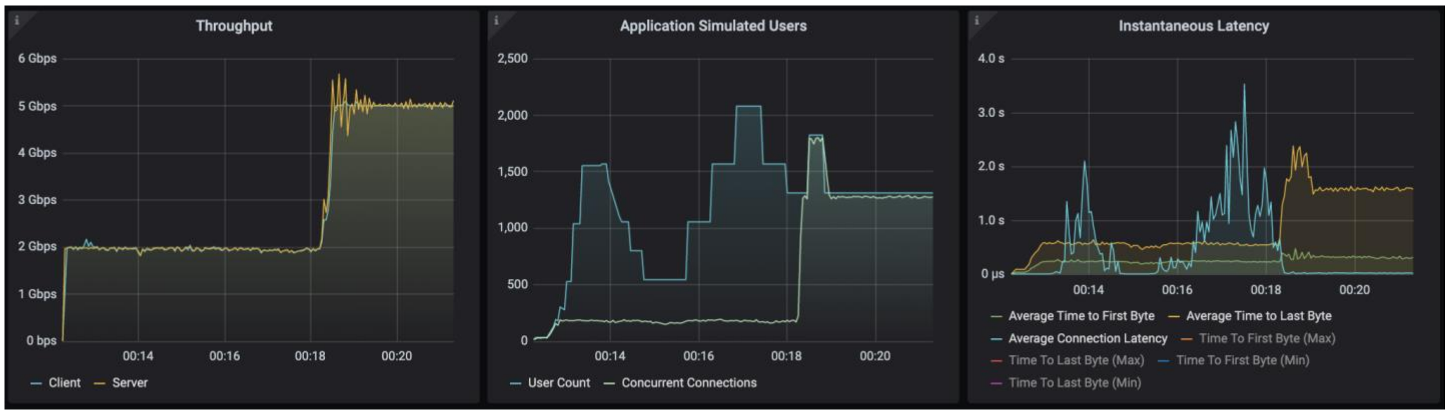


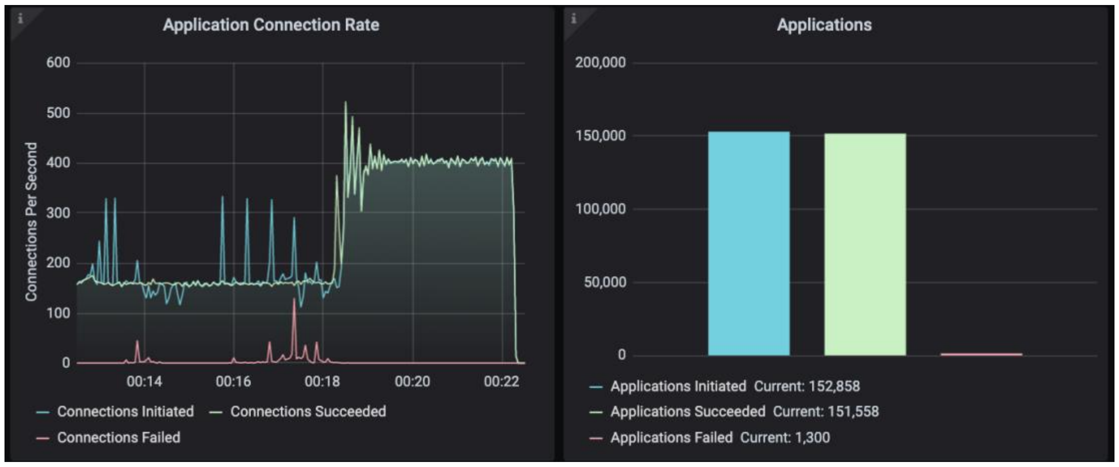
Test gracefully stopped.

1. HTTP App 1 — 1 — 100 %

The test traffic agents will get configured and in a few moments the traffic will start. The view will automatically switch to the "STATISTICS" dashboard.

For this initial warm-up test, we will notice that the 5Gbps of throughput will be achieved after a few good minutes into the test. Also, depending on a number of factors, it is possible that the test will report a number of Application Failures, Connection Failures and high Latency stats as the ELB is warming up.





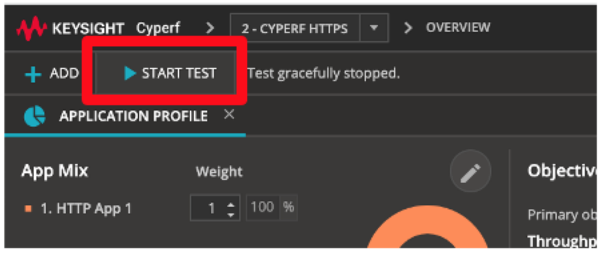
We will not analyze this initial warm-up test in great detail as it is not the scope of this document. However, users are welcomed to analyze different metrics to get an understanding of the infrastructure behavior when confronted with a spike in traffic, without a pre-warming up:

- Aside from the Application Failures, another obvious aspect is the huge spike in terms of the Connection Latency (the blue line of the Instantaneous Latency graph), especially in the first part of the test, when the configured objective of 5Gbps is not yet achieved.
- Another important metric is the Concurrent Connections levels, which is falling behind the Simulated Users since the CyPerf traffic agents are bringing up multiple Simulated Users in an attempt to reach the configured objective, however only few of the attempted connections are being successfully established.

After the test finishes, we will run another test, this time the test we want to analyze in detail, keeping the same traffic load to 5Gbps.

**IMPORTANT** The reason why we keep the same 5Gbps as the traffic load is due to cost reasons (as the traffic is distributed and crossing through a number of network and security controls)

10. Click on the “Start Test” button in the upper left corner:



Test gracefully stopped.

Again, the test traffic agents will get configured and in a few moments the traffic will start.

## *Result Analysis*

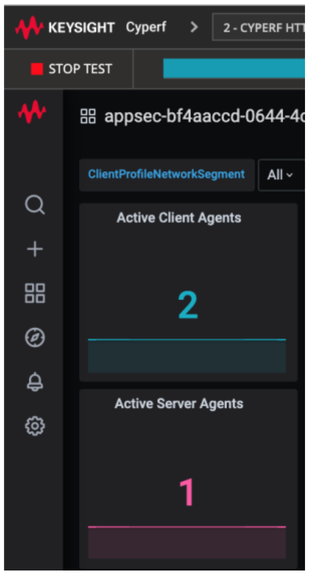
The maximum throughput performance test typically requires an iterative method in which the test is run multiple times, changing a number of test input parameters (which, due to time and cost constrains we would not be fully covering in this lab). The most important recommendation is that the DUT needs to be configured as close as possible as in the production environment to obtain meaningful results, instead of “datasheet”-like figures which are typically performed in an ideal scenario.

The importance of detailed and granular statistics is that it helps identify if the device has reached its saturation point and pin-point issues. Also interpreting the results in the correct manner will ensure that transient network, device or test tool behavior do not create a false negative condition, which is especially applicable for cloud environments.

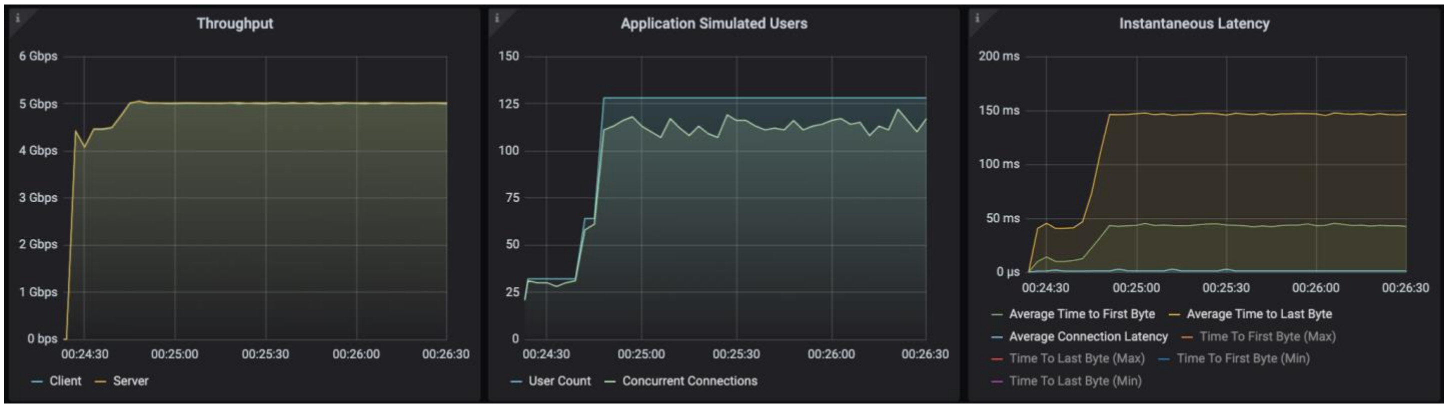
## *Real Time Statistics*

The graphs below provide a view of the real-time statistics for the test.  Real-time statistics provide instant access to key statistics that should be examined for failures at the TCP, TLS and HTTP protocol level.

The first thing that can be noticed is that in the test there are two clients and one server that are being active and participating into the test, which is per our configuration and expectations.



Next, in terms of **Throughput** the statistic indicates that the setup is able to easily reach the 5Gbps we have configured:

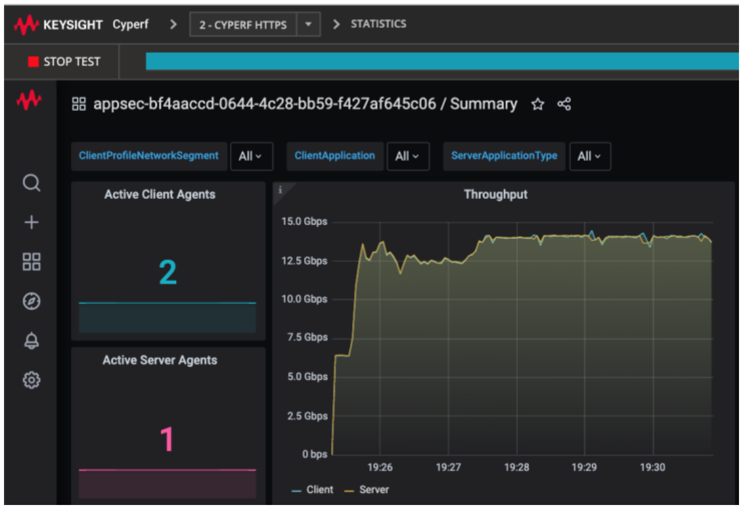


Also, per above graphs, we can see that the number of Concurrent Connections is closely following the number of Simulated Users which indicates that the infrastructure can easily cope with the generated traffic concurrency. Also, the Instantaneous Latency graphs are looking very good and stable values.

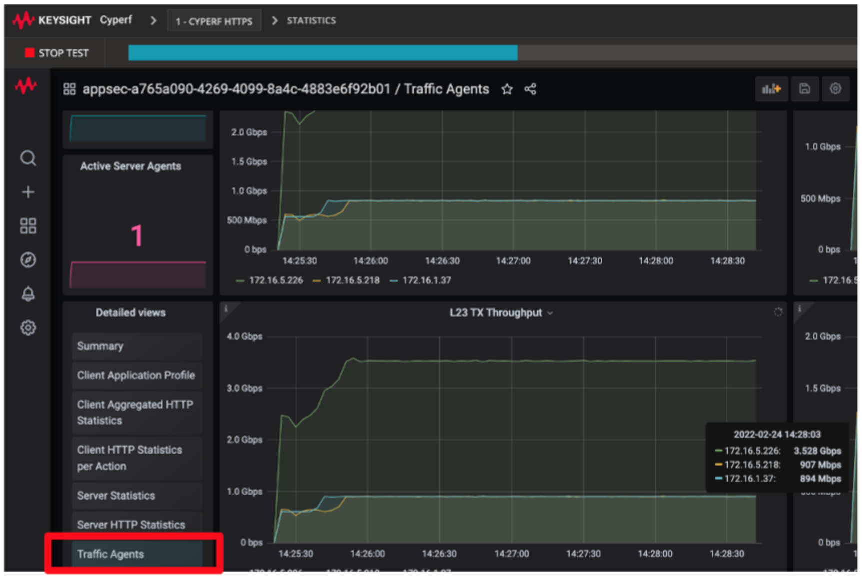
In the **Instantaneous Latency** view we can distinguish the following three important latency related metrics:

- Connection Latency: the average time it took for the TCP connection to establish
- Time to First Byte: the average time to receive the first data byte since the request was issued
- Time to Last Byte: the average time to receive the full data object/page since the request was issued

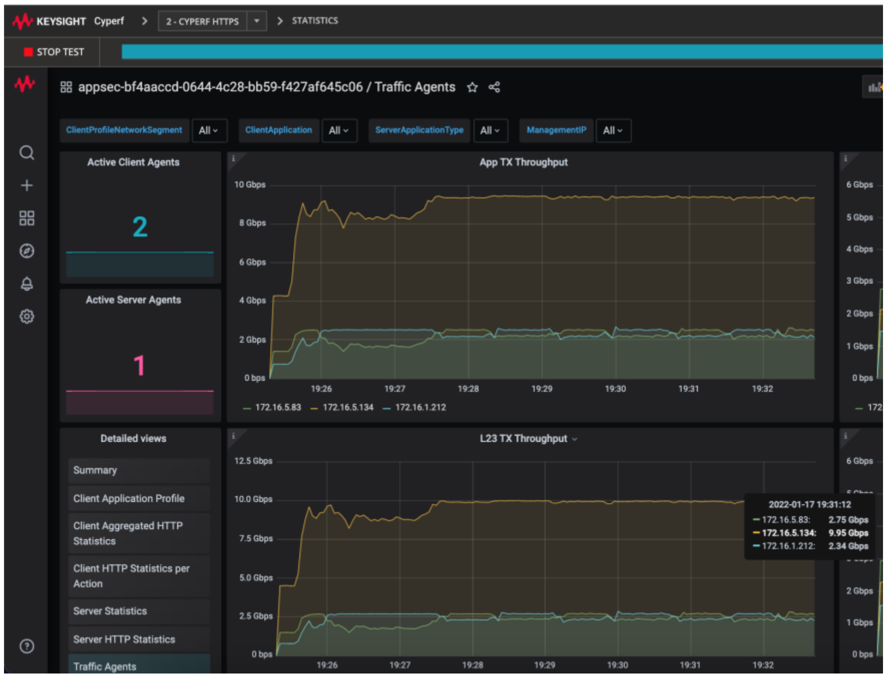
**Note**: Keep in mind that we restricted the load of this test to 5Gbps due to cost related reasons. If we would have properly warmed up the infrastructure and tried to push more traffic, the maximum performance obtained on this setup would have been around 14Gbps (below screenshot is after such a maximum performance test was ran):



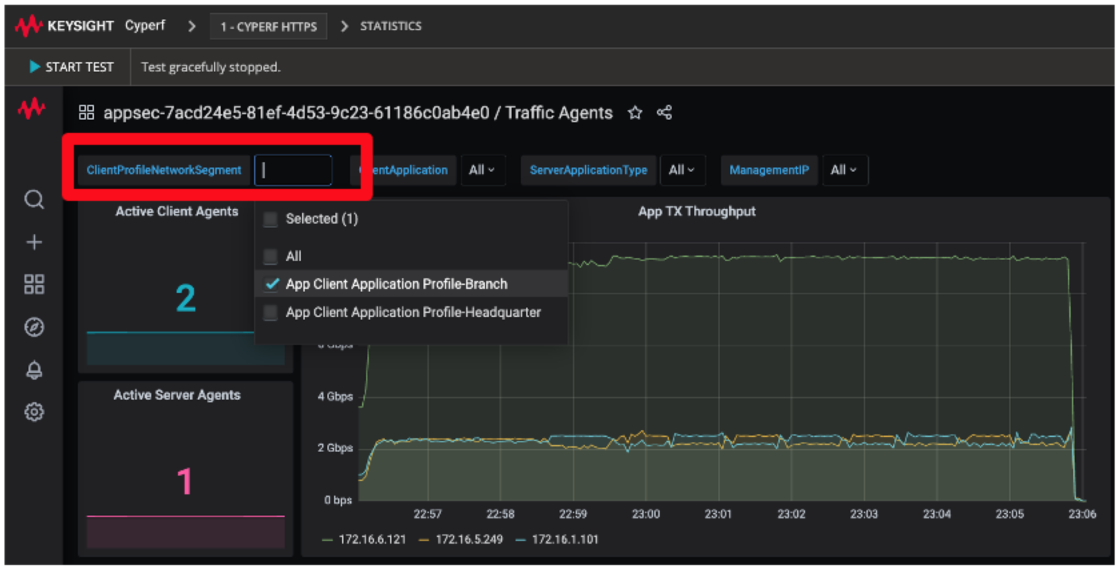
Next, for our current test, we can further look into more granular details and see how much traffic each agent is performing: if we look deeper and select from the **Detailed View** pane (in the lower left corner) the **Traffic Agents** dashboard we see that most of the traffic is generated by the server (i.e. 3.528Gbps) while the clients are fairly balanced (generating 907Mbps and 894Mbps respectively):



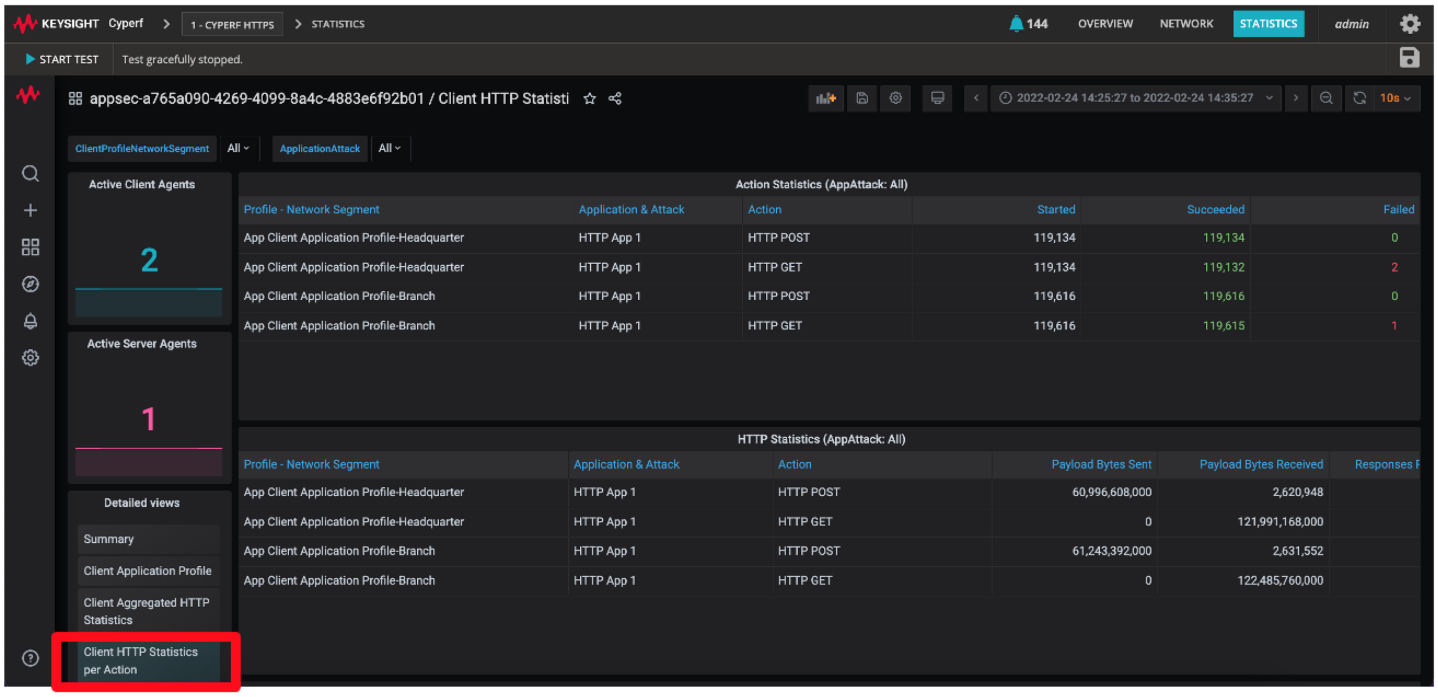
**Note**: when trying to push the maximum throughput the reason why we were getting up to 14Gbps (bi-directionally) was that the server agent could send traffic at up to 10Gbps (the Public Cloud provider is limiting the maximum bandwidth for this particular instance type to 10Gbps per direction). Also, the client agents could send traffic at 2.75Gbps and 2.34Gbps respectively for the max bandwidth test, as seen in below screenshot (taken for the maximum performance test):



A very useful functionality is the ability to apply filters for most of the stat views. For example, choosing only one network segment (in the upper left corner) would present only the stats for that respective segment which would help in pin-pointing issues with certain network segments (extremely useful when testing distributed environments):



The **Client HTTP Statistics per Action** dashboard from the **Detailed View** pane provides very granular stats about each action configured for all the applications in the test:



KEYSIGHT Cyperf
1 - CYPERF HTTPS
STATISTICS
144
OVERVIEW
NETWORK
STATISTICS
admin
START TEST
Test gracefully stopped.
appsec-a765a090-4269-4099-8a4c-4883e6f92b01 / Client HTTP Statisti
2022-02-24 14:25:27 to 2022-02-24 14:35:27
10s
ClientProfileNetworkSegment
All
ApplicationAttack
All
Active Client Agents
2
Active Server Agents
1
Detailed views
Summary
Client Application Profile
Client Aggregated HTTP Statistics
Client HTTP Statistics per Action

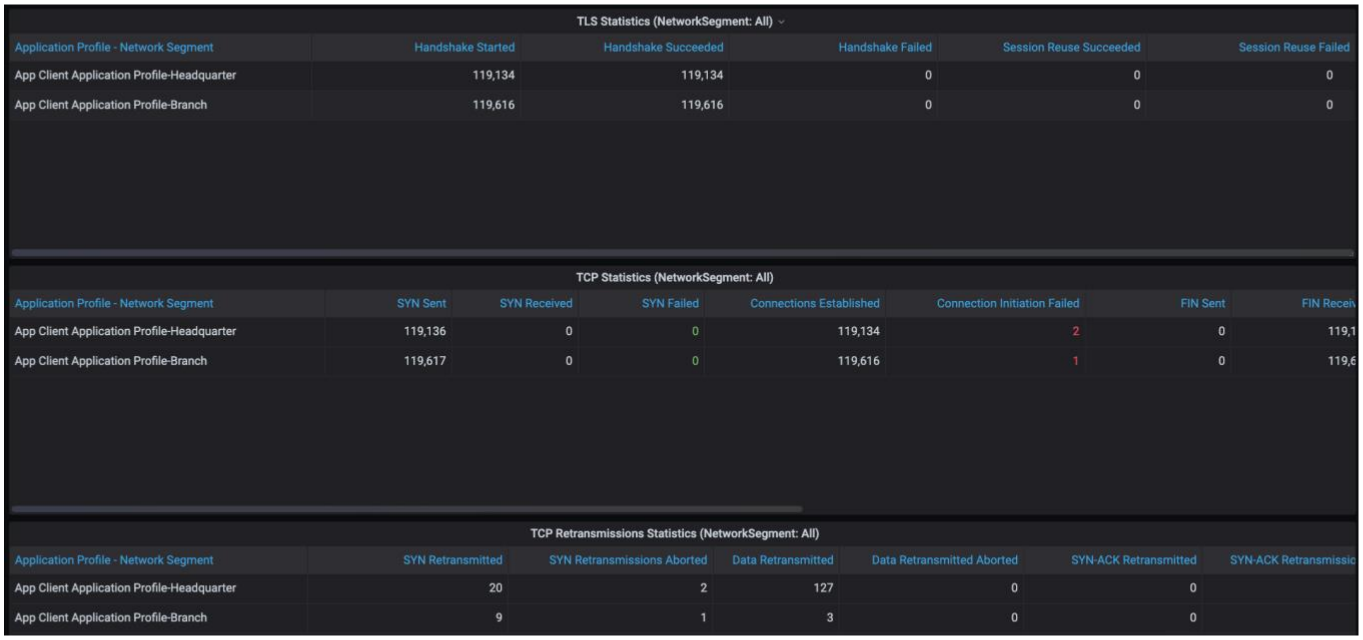
Action Statistics (AppAttack: All)

| Profile - Network Segment | Application & Attack | Action | Started | Succeeded | Failed |
|---|---|---|---|---|---|
| App Client Application Profile-Headquarter | HTTP App 1 | HTTP POST | 119,134 | 119,134 | 0 |
| App Client Application Profile-Headquarter | HTTP App 1 | HTTP GET | 119,134 | 119,132 | 2 |
| App Client Application Profile-Branch | HTTP App 1 | HTTP POST | 119,616 | 119,616 | 0 |
| App Client Application Profile-Branch | HTTP App 1 | HTTP GET | 119,616 | 119,615 | 1 |

HTTP Statistics (AppAttack: All)

| Profile - Network Segment | Application & Attack | Action | Payload Bytes Sent | Payload Bytes Received | Responses F |
|---|---|---|---|---|---|
| App Client Application Profile-Headquarter | HTTP App 1 | HTTP POST | 60,996,608,000 | 2,620,948 | |
| App Client Application Profile-Headquarter | HTTP App 1 | HTTP GET | 0 | 121,991,168,000 | |
| App Client Application Profile-Branch | HTTP App 1 | HTTP POST | 61,243,392,000 | 2,631,552 | |
| App Client Application Profile-Branch | HTTP App 1 | HTTP GET | 0 | 122,485,760,000 | |

From the **Detailed View** pane, the ***Client Application Profile*** view (scrolling down into the page) provides detailed TCP and TLS statistics to understand if there are TCP failures like retries or even rests as well as TLS Handshake stats.



TLS Statistics (NetworkSegment: All)

| Application Profile - Network Segment | Handshake Started | Handshake Succeeded | Handshake Failed | Session Reuse Succeeded | Session Reuse Failed |
|---|---|---|---|---|---|
| App Client Application Profile-Headquarter | 119,134 | 119,134 | 0 | 0 | 0 |
| App Client Application Profile-Branch | 119,616 | 119,616 | 0 | 0 | 0 |

TCP Statistics (NetworkSegment: All)

| Application Profile - Network Segment | SYN Sent | SYN Received | SYN Failed | Connections Established | Connection Initiation Failed | FIN Sent | FIN Receiv |
|---|---|---|---|---|---|---|---|
| App Client Application Profile-Headquarter | 119,136 | 0 | 0 | 119,134 | 2 | 0 | 119,1 |
| App Client Application Profile-Branch | 119,617 | 0 | 0 | 119,616 | 1 | 0 | 119,6 |

TCP Retransmissions Statistics (NetworkSegment: All)

| Application Profile - Network Segment | SYN Retransmitted | SYN Retransmissions Aborted | Data Retransmitted | Data Retransmitted Aborted | SYN-ACK Retransmitted | SYN-ACK Retransmissio |
|---|---|---|---|---|---|---|
| App Client Application Profile-Headquarter | 20 | 2 | 127 | 0 | 0 | |
| App Client Application Profile-Branch | 9 | 1 | 3 | 0 | 0 | |

## *Conclusions*

The purpose for this first test, was to baseline the maximum performance of the Device Under Test (DUT) using simple HTTPS traffic, which is what most vendors will publish in their datasheets. This is a recommended first step to run to build that baseline, with the important note that the test environment as well as the DUT config should be as close as possible to the production version.

## Lab 2: Realistic Enterprise traffic mix performance

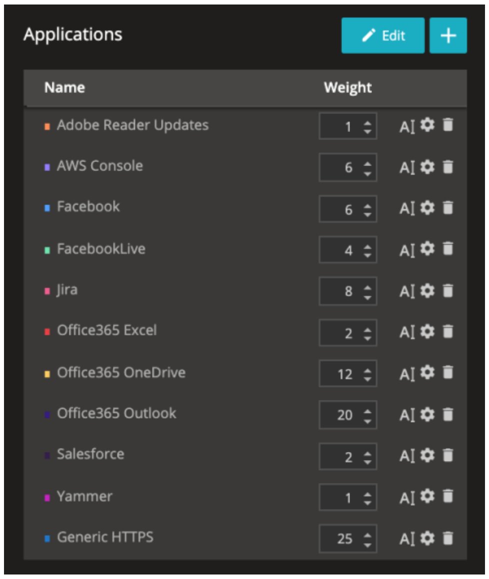
### *Overview*

For the second Lab, instead of generic HTTPS traffic, we will use a much more realistic traffic profile which resembles the typical applications traffic flows in an enterprise network.

Many Network Equipment Manufacturers publish the performance figures of their devices in "ideal scenarios" with either generic, large packet HTTP traffic or with application mixes that are geared so that those devices perform as good as possible.

Datasheets are a good starting point but since each environment is unique, it is paramount to test with an application traffic profile that resembles as close as possible the production environment. This will ensure that the test results will be as relevant as possible so that informed decisions can be made.

For this Lab, the emulated application traffic includes multiple Microsoft Office365 applications (like Outlook, OneDrive or Excel), Salesforce, Jira, Facebook, Yammer, AWS etc. The complete list of the application traffic and the associated weights is emphasized below:



| Name | Weight |
|---|---|
| Adobe Reader Updates | 1 |
| AWS Console | 6 |
| Facebook | 6 |
| FacebookLive | 4 |
| Jira | 8 |
| Office365 Excel | 2 |
| Office365 OneDrive | 12 |
| Office365 Outlook | 20 |
| Salesforce | 2 |
| Yammer | 1 |
| Generic HTTPS | 25 |

For this scenario we will have the SUT configured as per previous LAB, with Load Balancing capabilities on as well as default WAF security rules to protect against SQLi attacks.

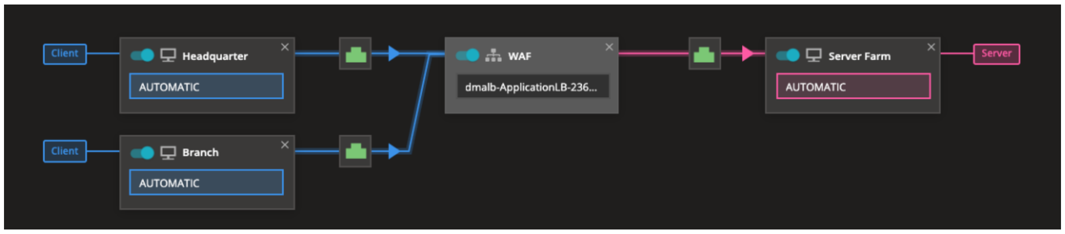
### *Objective*

Performance metrics to be characterized:

- Max throughput: as this is a realistic AppMix, we will focus on the overall achieved throughput, but other KPI are important as well like:
- Application Failures
- Application Latencies

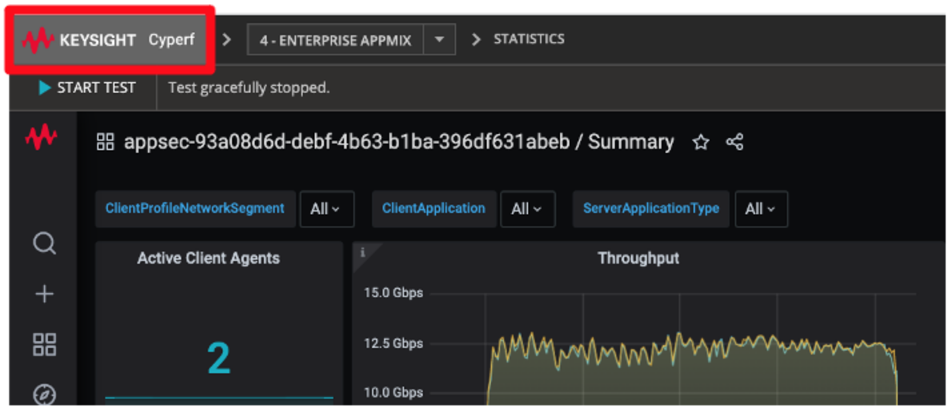
## *Setup*

The setup for this lab will be the same as the one described in the Introduction section:



## *Step-by-Step Instructions*

1. Once the previous test has been completed, navigate to CyPerf Controller's landing page by clicking on the "KEYSIGHT CyPerf" button in the upper left corner.

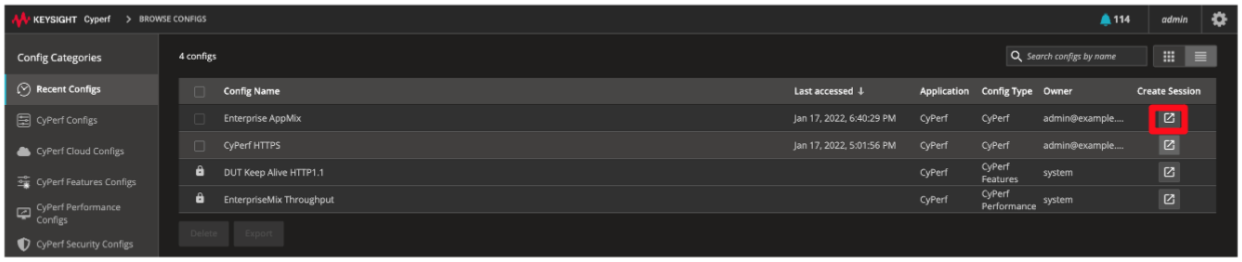


Test gracefully stopped.

appsec-93a08d6d-debf-4b63-b1ba-396df631abeb / Summary

To import the second configuration file, please first download "Enterprise AppMix.zip" file locally on your PC from the following GitHub repo: https://github.com/Keysight/cyperf/CyPerf/CyPerfTestDrive

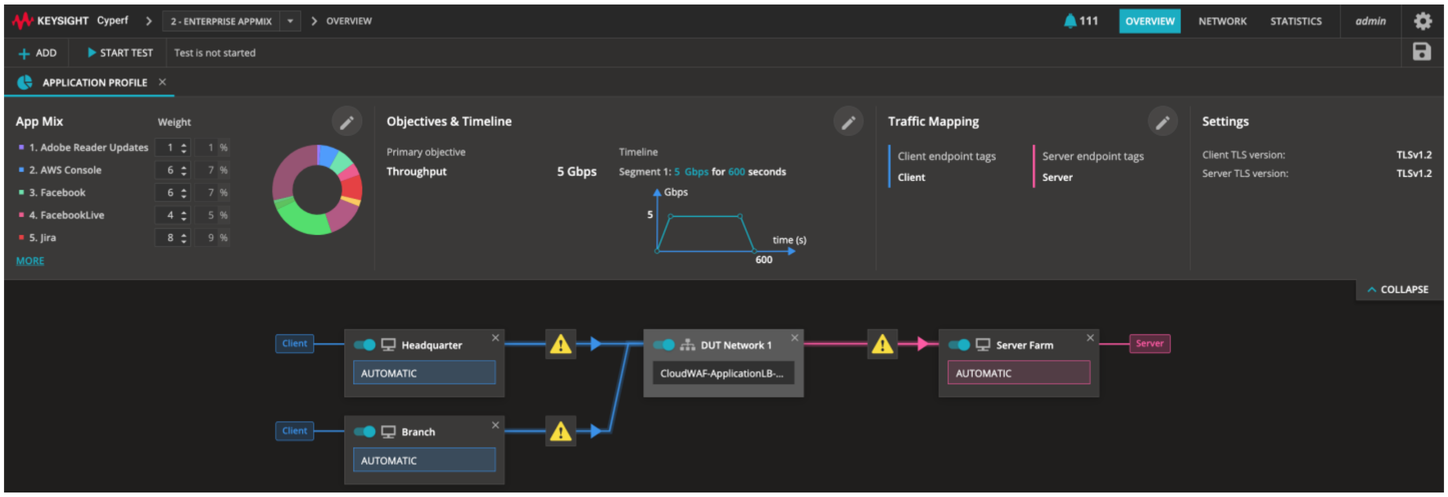
2. In the CyPerf Controller's landing page, please navigate to Browse Configs and then click on the import button on the lower left corner and select the just downloaded "Enterprise AppMix.zip" file.
3. After the new config file is imported, please click on the "create session button", on the right side of the screen, on the same row with the new config.



4 configs

| Config Name | Last accessed ↓ | Application | Config Type | Owner | Create Session |
|---|---|---|---|---|---|
| Enterprise AppMix | Jan 17, 2022, 6:40:29 PM | CyPerf | CyPerf | admin@example.... | |
| CyPerf HTTPS | Jan 17, 2022, 5:01:56 PM | CyPerf | CyPerf | admin@example.... | |
| DUT Keep Alive HTTP1.1 | | CyPerf | CyPerf Features | system | |
| EnterpriseMix Throughput | | CyPerf | CyPerf Performance | system | |

4. The new config file will be loaded into a new CyPerf Session:



App Mix

| | Weight | |
|---|---|---|
| 1. Adobe Reader Updates | 1 | 1 % |
| 2. AWS Console | 6 | 7 % |
| 3. Facebook | 6 | 7 % |
| 4. FacebookLive | 4 | 5 % |
| 5. Jira | 8 | 9 % |

MORE

Objectives & Timeline

Primary objective: Throughput 5 Gbps

Timeline: Segment 1: 5 Gbps for 600 seconds

Traffic Mapping

Client endpoint tags: Client

Server endpoint tags: Server

Settings

Client TLS version: TLSv1.2

Server TLS version: TLSv1.2

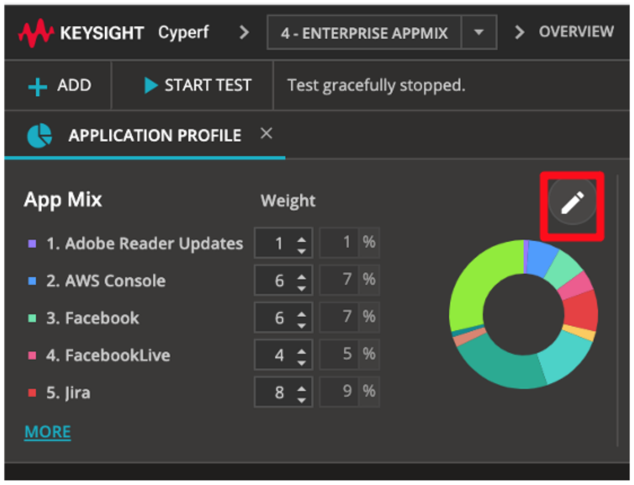
Before looking at the config in more details, we need to assign the CyPerf test traffic agents to the respective Network Segments, as we did in the previous labs:

Please repeat step #5, from the previous lab and make sure that the port icon turns green for all the three Network Segments.

Similarly, please repeat step #6 from the previous lab as well to configure the DUT address.

5. Now, in the CyPerf test overview page, we can see that the Application Profile component is a bit more advanced, having multiple applications instead of just HTTP as in the previous test. All the rest of the parameters are basically the same.
   Before running the test, let’s have a look at the new Application Profile.

6. Click on the “pencil” right above the pie chart graph from the “Application Profile” section.



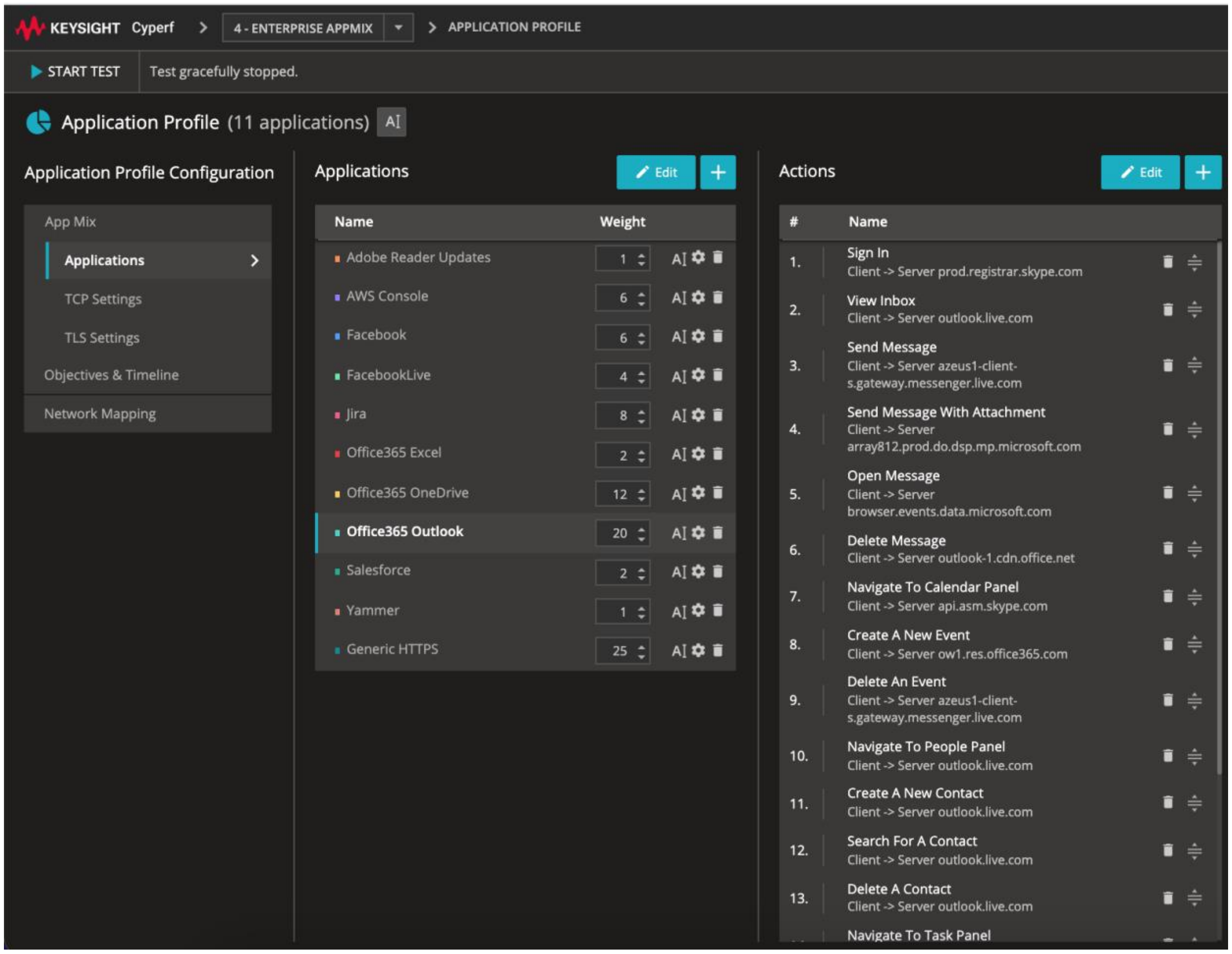
App Mix

| | Weight | |
|---|---|---|
| 1. Adobe Reader Updates | 1 | 1 % |
| 2. AWS Console | 6 | 7 % |
| 3. Facebook | 6 | 7 % |
| 4. FacebookLive | 4 | 5 % |
| 5. Jira | 8 | 9 % |

MORE

7. In the new menu, the entire AppMix composition with associated weights can be seen.

Clicking on any of the application will expose one level of detail deeper, showing all the actions comprising the respective application. For example, “Office365 Outlook” has the following list of granular apps.



Test gracefully stopped.

Application Profile (11 applications)

Applications

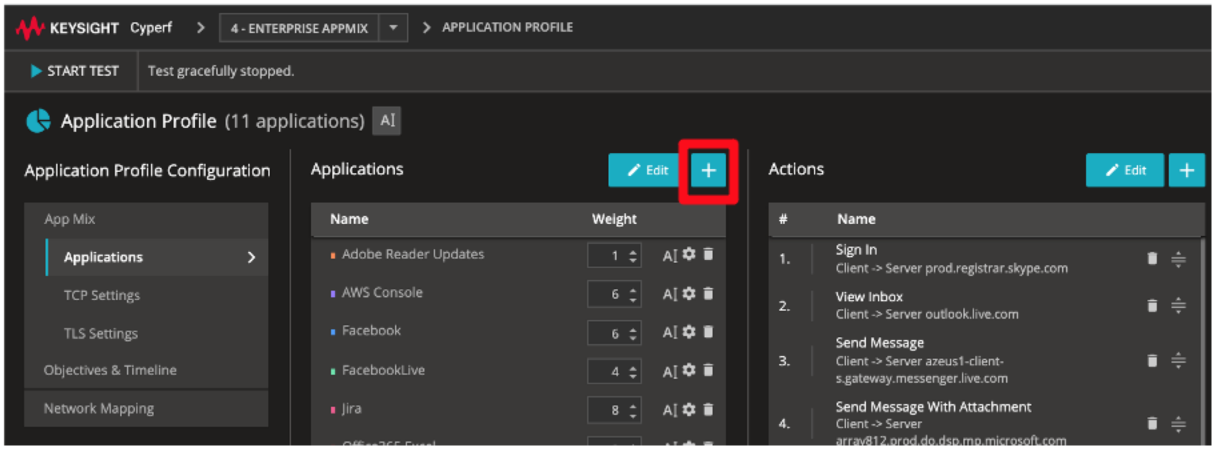
| Name | Weight |
|---|---|
| Adobe Reader Updates | 1 |
| AWS Console | 6 |
| Facebook | 6 |
| FacebookLive | 4 |
| Jira | 8 |
| Office365 Excel | 2 |
| Office365 OneDrive | 12 |
| Office365 Outlook | 20 |
| Salesforce | 2 |
| Yammer | 1 |
| Generic HTTPS | 25 |

Actions

| # | Name |
|---|---|
| 1. | Sign In<br>Client -> Server prod.registrar.skype.com |
| 2. | View Inbox<br>Client -> Server outlook.live.com |
| 3. | Send Message<br>Client -> Server azeus1-client-s.gateway.messenger.live.com |
| 4. | Send Message With Attachment<br>Client -> Server array812.prod.do.dsp.mp.microsoft.com |
| 5. | Open Message<br>Client -> Server browser.events.data.microsoft.com |
| 6. | Delete Message<br>Client -> Server outlook-1.cdn.office.net |
| 7. | Navigate To Calendar Panel<br>Client -> Server api.asm.skype.com |
| 8. | Create A New Event<br>Client -> Server ow1.res.office365.com |
| 9. | Delete An Event<br>Client -> Server azeus1-client-s.gateway.messenger.live.com |
| 10. | Navigate To People Panel<br>Client -> Server outlook.live.com |
| 11. | Create A New Contact<br>Client -> Server outlook.live.com |
| 12. | Search For A Contact<br>Client -> Server outlook.live.com |
| 13. | Delete A Contact<br>Client -> Server outlook.live.com |
|  | Navigate To Task Panel |

Tip: CyPerf offers users the ability to create their own customer Application mixes to resemble various traffic profiles from different network environments.:

- To add a new application from the library just click on the add button (+ icon):


KEYSIGHT Cyperf > 4 - ENTERPRISE APPMIX > APPLICATION PROFILE

START TEST Test gracefully stopped.

Application Profile (11 applications)

Application Profile Configuration: App Mix, Applications, TCP Settings, TLS Settings, Objectives & Timeline, Network Mapping

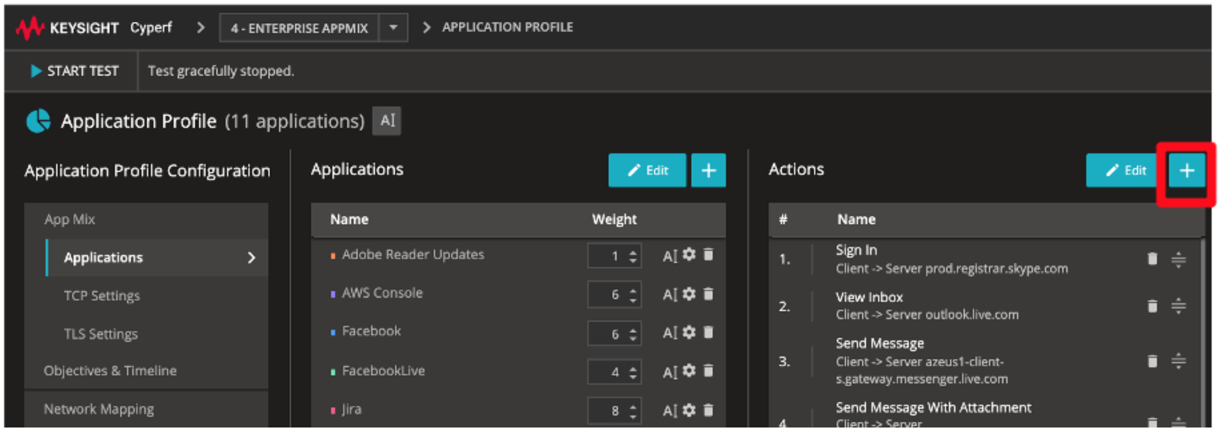
Applications

| Name | Weight |
|---|---|
| Adobe Reader Updates | 1 |
| AWS Console | 6 |
| Facebook | 6 |
| FacebookLive | 4 |
| Jira | 8 |

Actions

| # | Name |
|---|---|
| 1. | Sign In<br>Client -> Server prod.registrar.skype.com |
| 2. | View Inbox<br>Client -> Server outlook.live.com |
| 3. | Send Message<br>Client -> Server azeus1-client-s.gateway.messenger.live.com |
| 4. | Send Message With Attachment<br>Client -> Server array812.prod.do.dsp.mp.microsoft.com |

- To customize a specific application (for example build a custom email user action list), users can edit the application action list as well. To have access to all actions for a certain application just click on the add button (+ icon):


KEYSIGHT Cyperf > 4 - ENTERPRISE APPMIX > APPLICATION PROFILE

START TEST Test gracefully stopped.

Application Profile (11 applications)

Application Profile Configuration: App Mix, Applications, TCP Settings, TLS Settings, Objectives & Timeline, Network Mapping

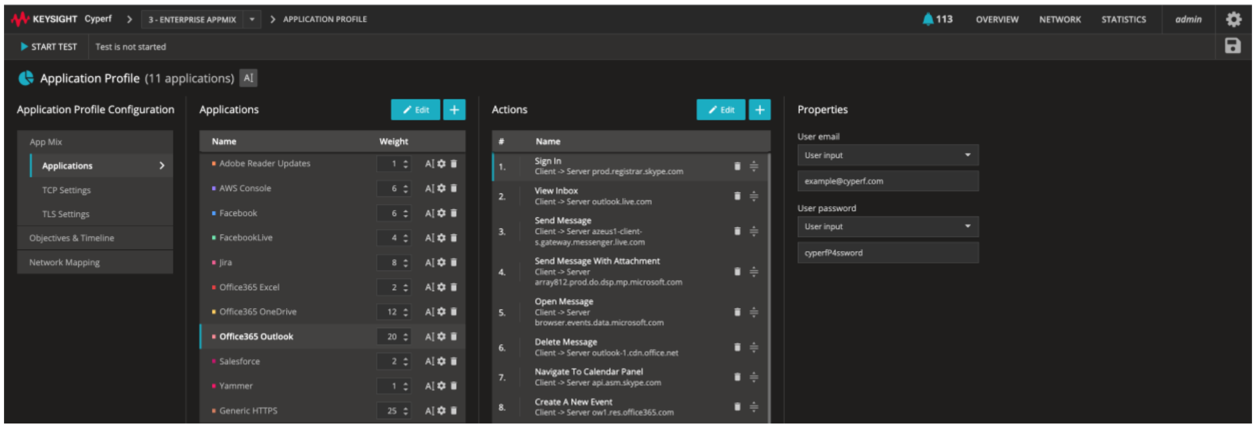
Applications

| Name | Weight |
|---|---|
| Adobe Reader Updates | 1 |
| AWS Console | 6 |
| Facebook | 6 |
| FacebookLive | 4 |
| Jira | 8 |

Actions

| # | Name |
|---|---|
| 1. | Sign In<br>Client -> Server prod.registrar.skype.com |
| 2. | View Inbox<br>Client -> Server outlook.live.com |
| 3. | Send Message<br>Client -> Server azeus1-client-s.gateway.messenger.live.com |
| 4. | Send Message With Attachment<br>Client -> Server |

- Last but not the least, application's actions can be customized as well. For example, an email login action can be configured with custom username and password values or even with playlists (lists of usernames & passwords that CyPerf can iterate through to simulate logging in from multiple users):


KEYSIGHT Cyperf > 3 - ENTERPRISE APPMIX > APPLICATION PROFILE · 113 · OVERVIEW · NETWORK · STATISTICS · admin

START TEST Test is not started

Application Profile (11 applications)

Application Profile Configuration: App Mix, Applications, TCP Settings, TLS Settings, Objectives & Timeline, Network Mapping

Applications

| Name | Weight |
|---|---|
| Adobe Reader Updates | 1 |
| AWS Console | 6 |
| Facebook | 6 |
| FacebookLive | 4 |
| Jira | 8 |
| Office365 Excel | 2 |
| Office365 OneDrive | 12 |
| Office365 Outlook | 20 |
| Salesforce | 2 |
| Yammer | 1 |
| Generic HTTPS | 25 |

Actions

| # | Name |
|---|---|
| 1. | Sign In<br>Client -> Server prod.registrar.skype.com |
| 2. | View Inbox<br>Client -> Server outlook.live.com |
| 3. | Send Message<br>Client -> Server azeus1-client-s.gateway.messenger.live.com |
| 4. | Send Message With Attachment<br>Client -> Server array812.prod.do.dsp.mp.microsoft.com |
| 5. | Open Message<br>Client -> Server browser.events.data.microsoft.com |
| 6. | Delete Message<br>Client -> Server outlook-1.cdn.office.net |
| 7. | Navigate To Calendar Panel<br>Client -> Server api.asm.skype.com |
| 8. | Create A New Event<br>Client -> Server ow1.res.office365.com |

Properties

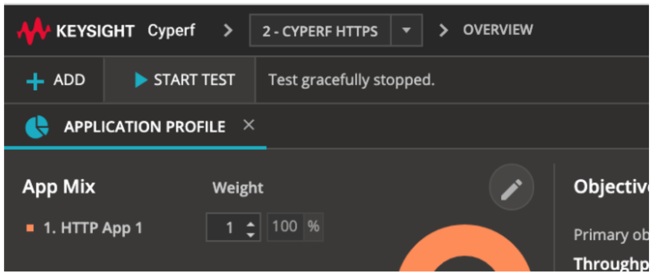
User email: User input — example@cyperf.com

User password: User input — cyperfP4ssword

8. In terms of Timeline and Objectives we will keep the same test load and duration as in the previous test due to the same reasons.

Now that the test has been updated with the details of the setup/agents assigned to your user, we can run the test and interpret the results.

9. Click on the “Start Test” button in the upper left corner:



Test gracefully stopped.

The test traffic agents will get configured and in a few moments the traffic will start. The view will automatically switch to the “STATISTICS” dashboard.

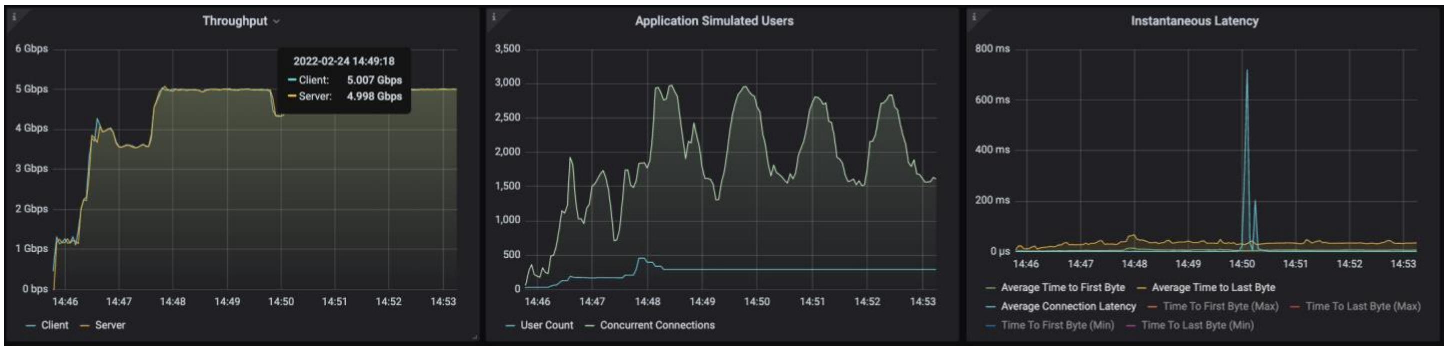
## *Real-Time Statistics*

The graph below provides a view of the real-time statistics for the test. Real-time statistics provide instant access to key statistics that should be examined for failures at the Application, HTTP and TCP/TLS protocol level.

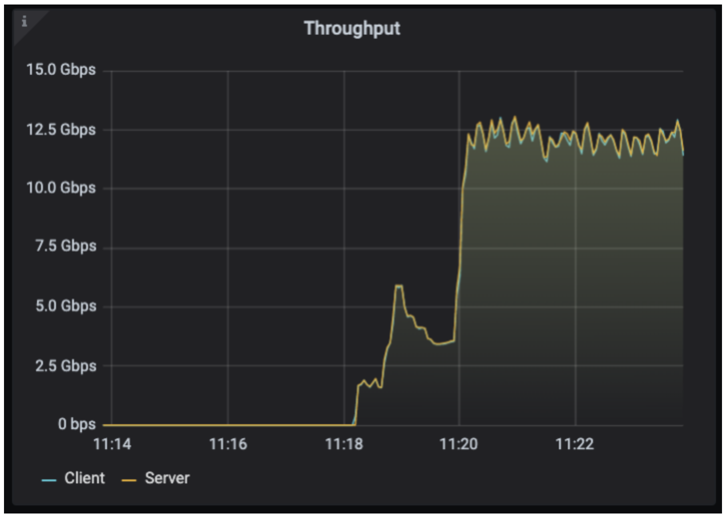
As the test is progressing, we will notice in the Summary dashboard that CyPerf is dynamically adapting the number of Simulated Users and generated Concurrent Connections to get to the best performance that the underlying setup will permit.

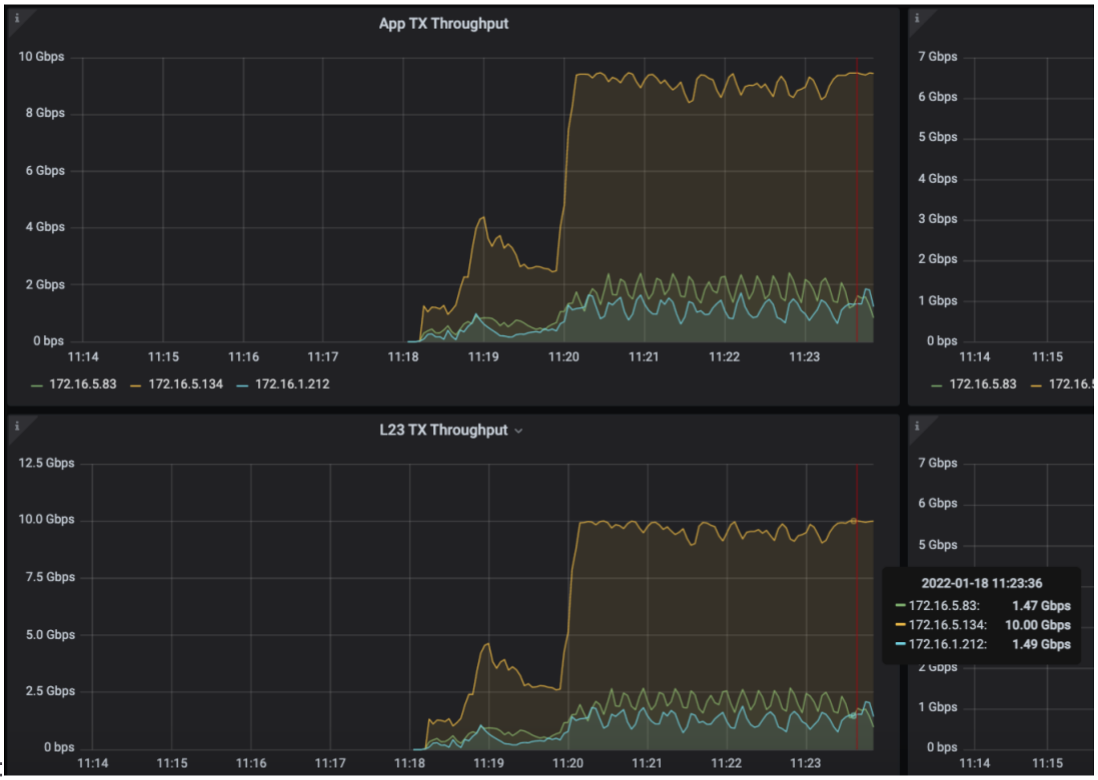
Note: CyPerf’s unique ability to dynamically adapt and find the best performance that the underlying infrastructure can handle by tweaking the number of users and concurrent connections is a proprietary goal-seeking mechanism allowing users to find that maximum performance much faster than using other test tools.

After a few minutes into the test (approx. 3-5 mins) we can see that the goal seeking mechanism stabilizes and the configured throughput is achieved (5Gbps):



**Note**: If we were to push the maximum throughput for this test as well, we would have obtained 12.5Gbps. Therefore, one important difference (for the max throughput test) that we would have seen compared to the previous Lab test is that the overall achieved throughput is lower (14Gbps vs 12.5Gbps). For such a maximum AppMix throughput test we would have noticed that the server agent is still capped at 10Gbps for the Tx traffic and the additional traffic is coming from the client agents that are generating upstream traffic, similar to a real environment. Below are two screenshots taken from such a maximum AppMix throughput test:



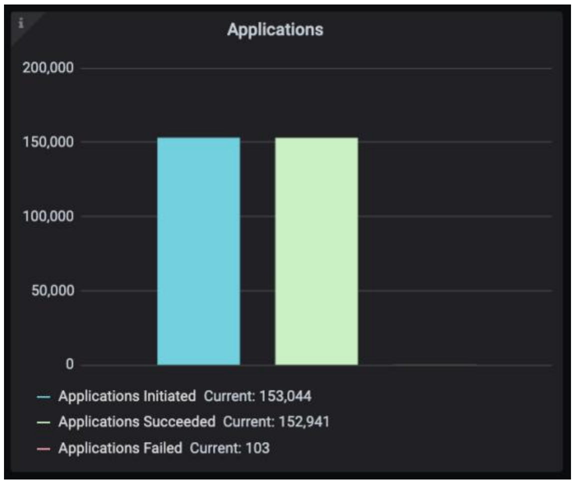


2022-01-18 11:23:36
172.16.5.83: 1.47 Gbps
172.16.5.134: 10.00 Gbps
172.16.1.212: 1.49 Gbps

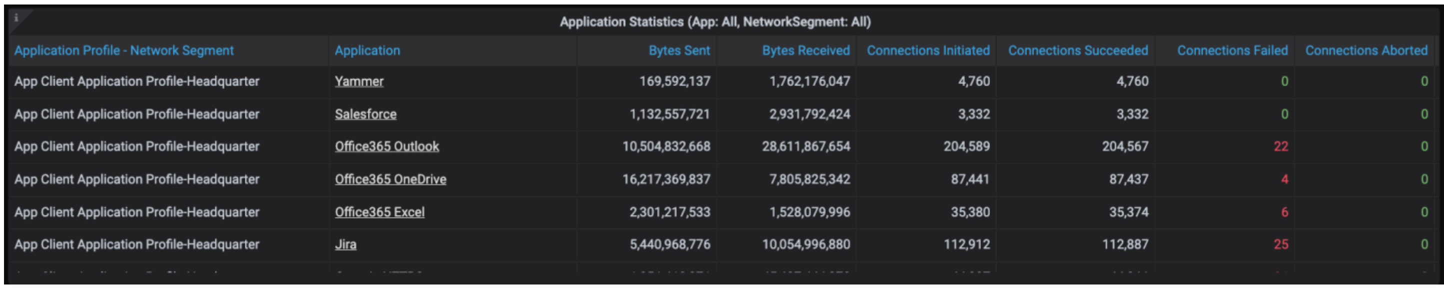
**IMPORTANT** In most test scenarios, a realistic application traffic mix is much more resource intensive on the DUT due to the lower average packet size and various application types (stressing the DUT's inspection engine). Nonetheless, this is the recommended and relevant approach to testing Network Devices, not the "ideal" datasheet test conditions approach.

Other important statistics to be inspected for the current test are described below.

Total Application Initiated/Successful and Failures:



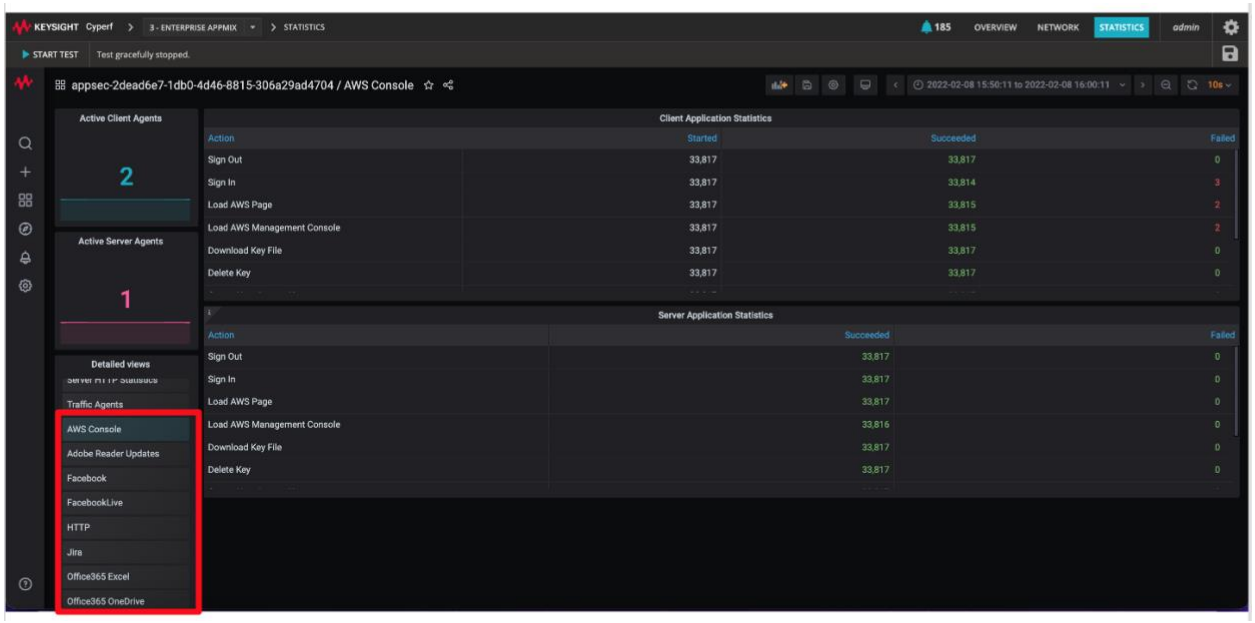
There are only 103 application failures out of over 150,000 initiated which, for most real-world requirements is an acceptable level. We can inspect further to understand which exact applications have observed failures (and even per location or Network Range) - we can see this in the **Client Application Profile** view (from the Detailed View pane) -> **Application Statistics** table:



Application Statistics (App: All, NetworkSegment: All)

| Application Profile - Network Segment | Application | Bytes Sent | Bytes Received | Connections Initiated | Connections Succeeded | Connections Failed | Connections Aborted |
|---|---|---|---|---|---|---|---|
| App Client Application Profile-Headquarter | Yammer | 169,592,137 | 1,762,176,047 | 4,760 | 4,760 | 0 | 0 |
| App Client Application Profile-Headquarter | Salesforce | 1,132,557,721 | 2,931,792,424 | 3,332 | 3,332 | 0 | 0 |
| App Client Application Profile-Headquarter | Office365 Outlook | 10,504,832,668 | 28,611,867,654 | 204,589 | 204,567 | 22 | 0 |
| App Client Application Profile-Headquarter | Office365 OneDrive | 16,217,369,837 | 7,805,825,342 | 87,441 | 87,437 | 4 | 0 |
| App Client Application Profile-Headquarter | Office365 Excel | 2,301,217,533 | 1,528,079,996 | 35,380 | 35,374 | 6 | 0 |
| App Client Application Profile-Headquarter | Jira | 5,440,968,776 | 10,054,996,880 | 112,912 | 112,887 | 25 | 0 |

For an even more granular stats, each application in the mix has its own view where stats for each of the action comprising the respective application is shown:



Test gracefully stopped.

appsec-2dead6e7-1db0-4d46-8815-306a29ad4704 / AWS Console

2022-02-08 15:50:11 to 2022-02-08 16:00:11 10s

Active Client Agents: 2

Active Server Agents: 1

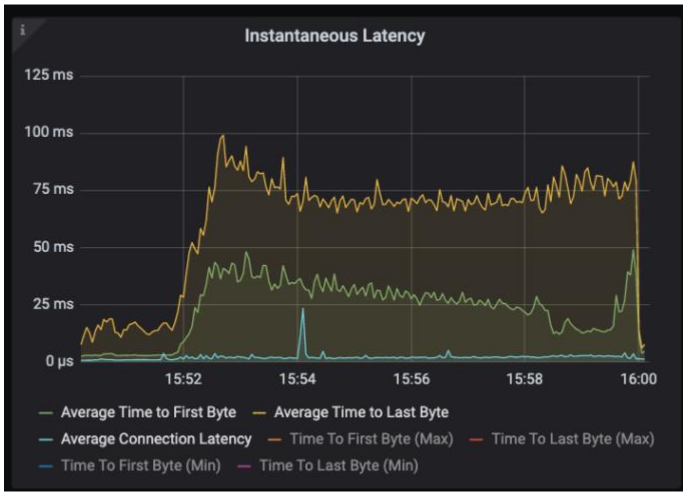
Client Application Statistics

| Action | Started | Succeeded | Failed |
|---|---|---|---|
| Sign Out | 33,817 | 33,817 | 0 |
| Sign In | 33,817 | 33,814 | 3 |
| Load AWS Page | 33,817 | 33,815 | 2 |
| Load AWS Management Console | 33,817 | 33,815 | 2 |
| Download Key File | 33,817 | 33,817 | 0 |
| Delete Key | 33,817 | 33,817 | 0 |

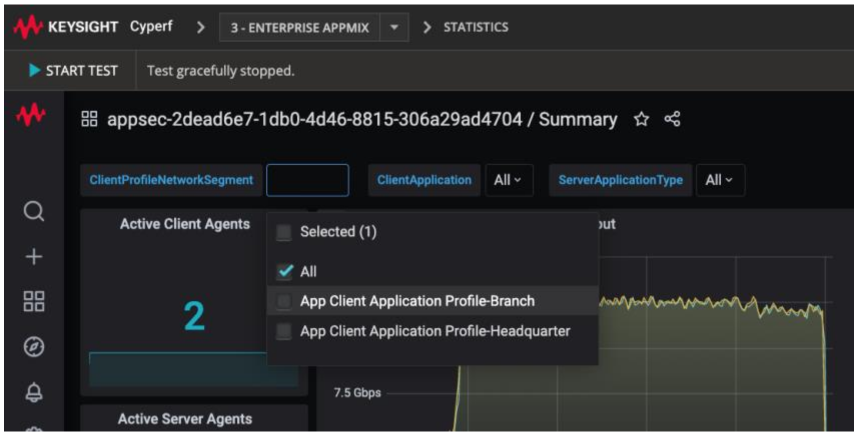
Server Application Statistics

| Action | Succeeded | Failed |
|---|---|---|
| Sign Out | 33,817 | 0 |
| Sign In | 33,817 | 0 |
| Load AWS Page | 33,817 | 0 |
| Load AWS Management Console | 33,816 | 0 |
| Download Key File | 33,817 | 0 |
| Delete Key | 33,817 | 0 |

Other important metrics to be analyzed are in the Instantaneous Latency graph from the **Summary** view:



As can be seen in the above graph the average latencies are fairly stable. Furthermore, we can also inspect the latencies that are experienced by each of the locations (or Network Segments) in the test by applying the relevant filter in the upper left corner on the Statistics screen (ClientProfileNetworkSegment)



## *Conclusions*

In this second test, we characterized the true performance of the Device Under Test (DUT) using a much more realistic application mix, which is not typically provided in the vendors' datasheets.

This is a very important test to run as it will uncover the true capabilities of various DUTs, and will help customers make informed, data-driven decisions.

## Lab 3: Realistic Security Efficacy

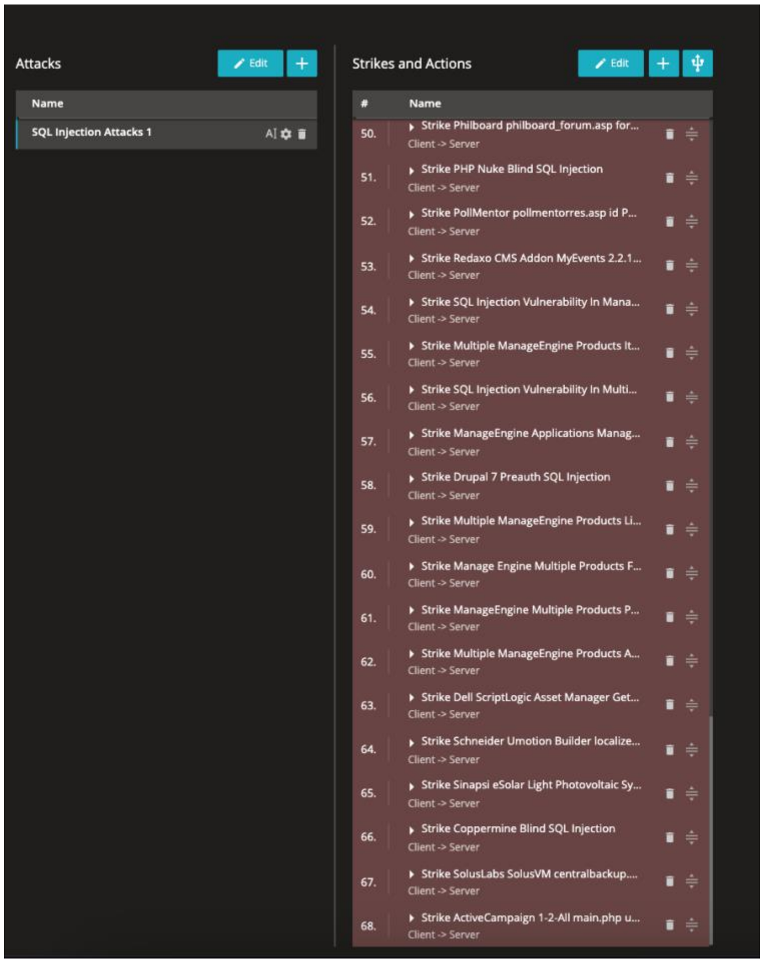
### *Overview*

In this Lab, we will go one step further and will evaluate the security efficacy of the Device Under Test (DUT).

First, we will keep the previously used realistic traffic profile, so that all security attacks are happening while legitimate traffic is present as well. This is similar to what is observed in production networks as security attack never happen alone or in isolation.

The really challenging part for the security devices is to accurately identify (and block as needed) the malicious traffic while not impacting the legitimate traffic therefore offering a seamless user experience.

Therefore, along with the previously used Enterprise application traffic mix, we will be added a security profile that will consists of 68 selected SQLi attacks.



| Name |
|---|
| SQL Injection Attacks 1 |

| # | Name |
|---|---|
| 50. | Strike Philboard philboard_forum.asp for... Client -> Server |
| 51. | Strike PHP Nuke Blind SQL Injection Client -> Server |
| 52. | Strike PollMentor pollmentorres.asp id P... Client -> Server |
| 53. | Strike Redaxo CMS Addon MyEvents 2.2.1... Client -> Server |
| 54. | Strike SQL Injection Vulnerability In Mana... Client -> Server |
| 55. | Strike Multiple ManageEngine Products It... Client -> Server |
| 56. | Strike SQL Injection Vulnerability In Multi... Client -> Server |
| 57. | Strike ManageEngine Applications Manag... Client -> Server |
| 58. | Strike Drupal 7 Preauth SQL Injection Client -> Server |
| 59. | Strike Multiple ManageEngine Products Li... Client -> Server |
| 60. | Strike Manage Engine Multiple Products F... Client -> Server |
| 61. | Strike ManageEngine Multiple Products P... Client -> Server |
| 62. | Strike Multiple ManageEngine Products A... Client -> Server |
| 63. | Strike Dell ScriptLogic Asset Manager Get... Client -> Server |
| 64. | Strike Schneider Umotion Builder localize... Client -> Server |
| 65. | Strike Sinapsi eSolar Light Photovoltaic Sy... Client -> Server |
| 66. | Strike Coppermine Blind SQL Injection Client -> Server |
| 67. | Strike SolusLabs SolusVM centralbackup.... Client -> Server |
| 68. | Strike ActiveCampaign 1-2-All main.php u... Client -> Server |

For this scenario we will have the SUT configured as per previous LAB, with Load Balancing capabilities on as well as default WAF security rules to protect against SQLi attacks.

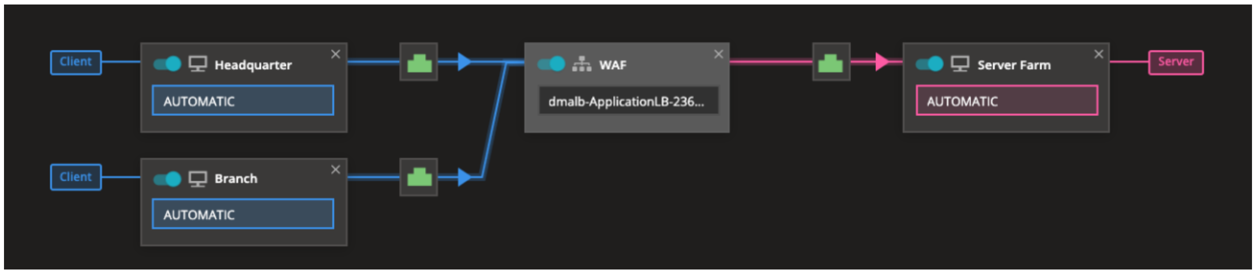
### *Objective*

Performance metrics required:

- Legitimate traffic KPIs: throughput, latencies, application failures etc.
- Security Efficacy: percentage of blocked security strikes

### *Setup*

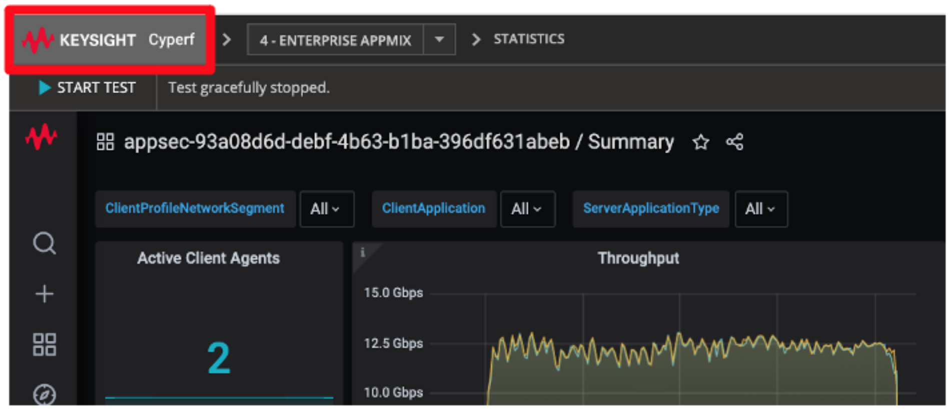
The setup for this lab will be the same as the one described in the Introduction section:



The DUT will be configured as in the previous tests, with Load Balancing enabled as well as the default SQLi security rules set on blocks. All the other security rules are set on allowed to make sure we are characterizing the security efficacy of the default SQLi security rules (all generated security attacks will be SQLi attacks).

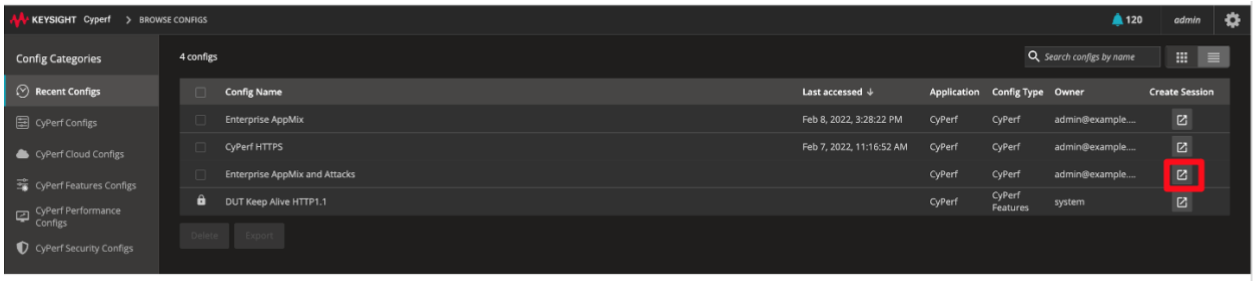
### *Step-by-Step Instructions*

1. Once the previous test has been completed, navigate to CyPerf Controller's landing page by clicking on the "KEYSIGHT CyPerf" button in the upper left corner.



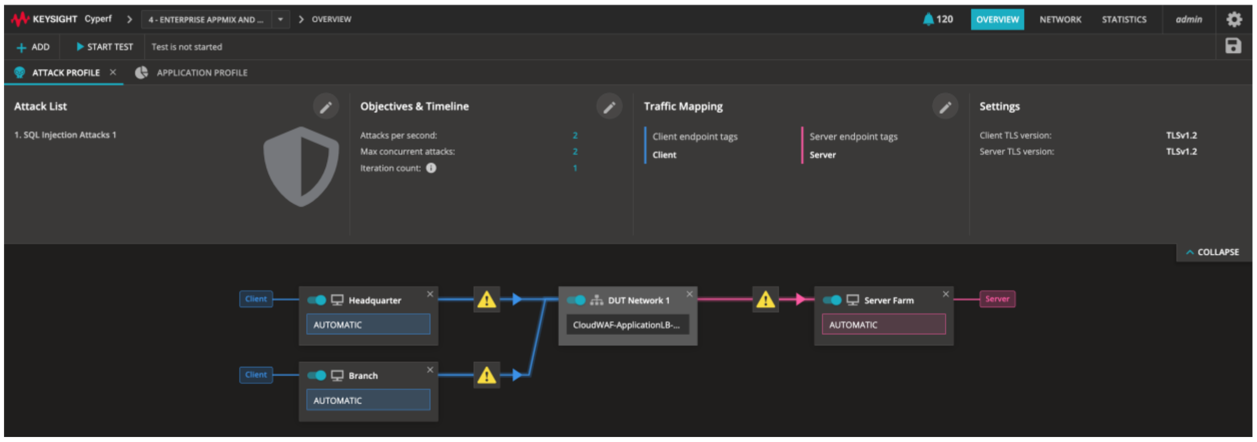
To import the third configuration file, please first download "Enterprise AppMix and Attacks.zip" file locally on your PC from the following GitHub repo: https://github.com/Keysight/cyperf/CyPerf/CyPerfTestDrive

2. In the CyPerf Controller's landing page, please navigate to Browse Configs and then click on the import button on the lower left corner and select the just downloaded "Enterprise AppMix and Attacks.zip" file.
3. After the new config file is imported, please click on the "create session button", on the right side of the screen, on the same row with the new config.



| Config Name | Last accessed ↓ | Application | Config Type | Owner | Create Session |
|---|---|---|---|---|---|
| Enterprise AppMix | Feb 8, 2022, 3:28:22 PM | CyPerf | CyPerf | admin@example.... | |
| CyPerf HTTPS | Feb 7, 2022, 11:16:52 AM | CyPerf | CyPerf | admin@example.... | |
| Enterprise AppMix and Attacks | | CyPerf | CyPerf | admin@example.... | |
| DUT Keep Alive HTTP1.1 | | CyPerf | CyPerf Features | system | |

4. The new config file will be loaded into a new CyPerf Session:



Attack List
1. SQL Injection Attacks 1

Objectives & Timeline
Attacks per second: 2
Max concurrent attacks: 2
Iteration count: 1

Traffic Mapping
Client endpoint tags: Client
Server endpoint tags: Server

Settings
Client TLS version: TLSv1.2
Server TLS version: TLSv1.2

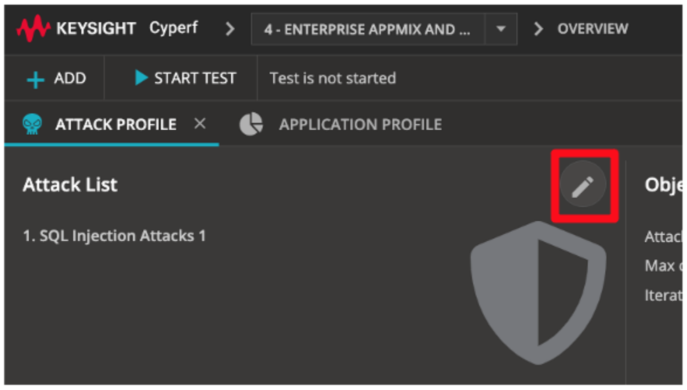
Before looking at the config in more details, we need to assign the CyPerf test traffic agents to the respective Network Segments, as we did in the first lab.

Please repeat step #5, from the first lab and make sure that the port icon turns green for all the three Network Segments.

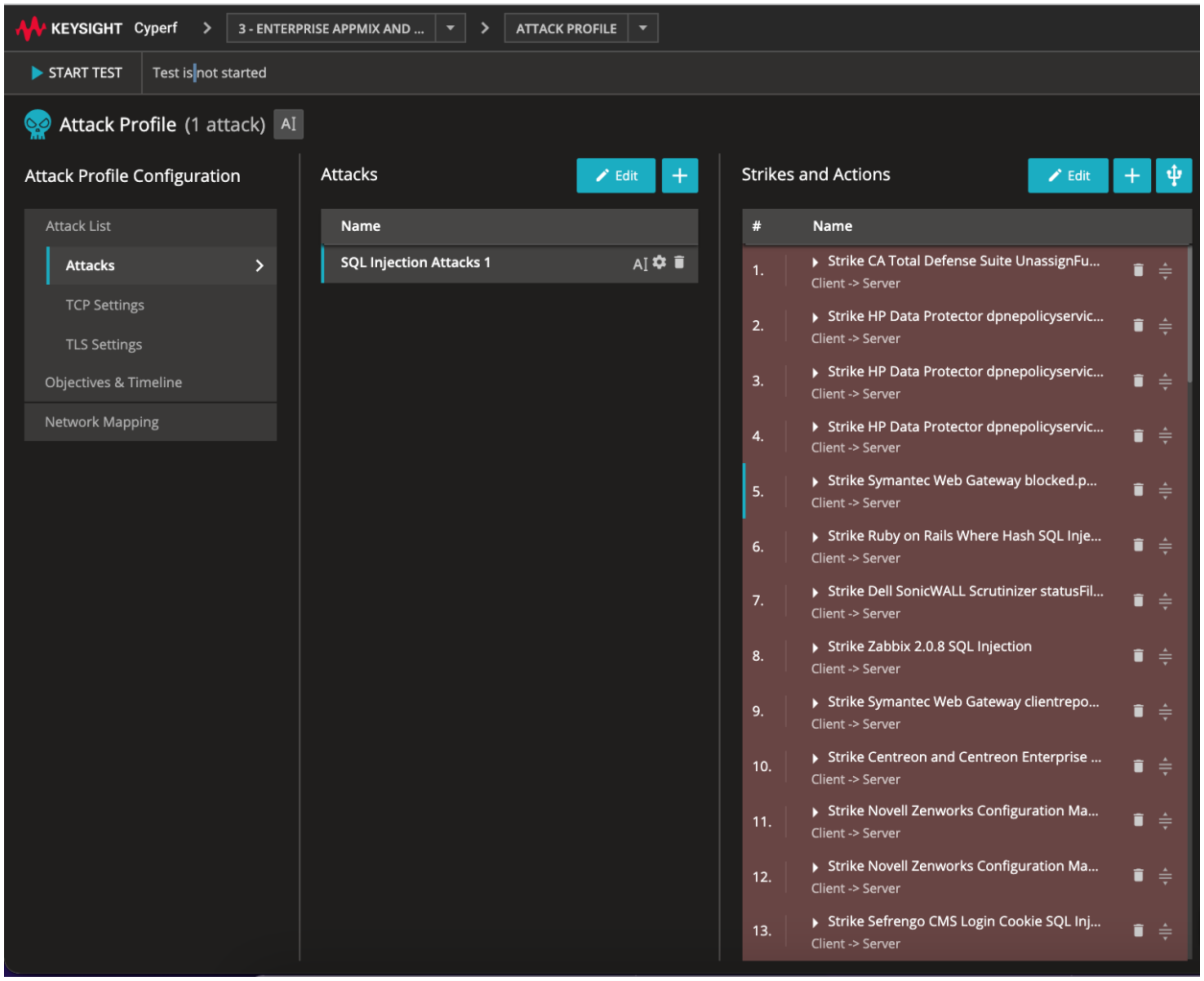
Similarly, please repeat step #6 from the previous lab as well to configure the DUT address.

5. Now, in the CyPerf test overview page, we can see that along with the Application Profile there is a second profile – Attack Profile.
   Before running the test, let's have a look at the new Attack Profile

6. Click on the "pencil" right above the shield graph from the "Attack Profile" section.



7. In the new menu, the Attack list be seen which has one attack with 68 individual SQLi Strikes. Clicking on any of the "SQL Injection Attack" will expose all the 68 individual SQLi Strikes:

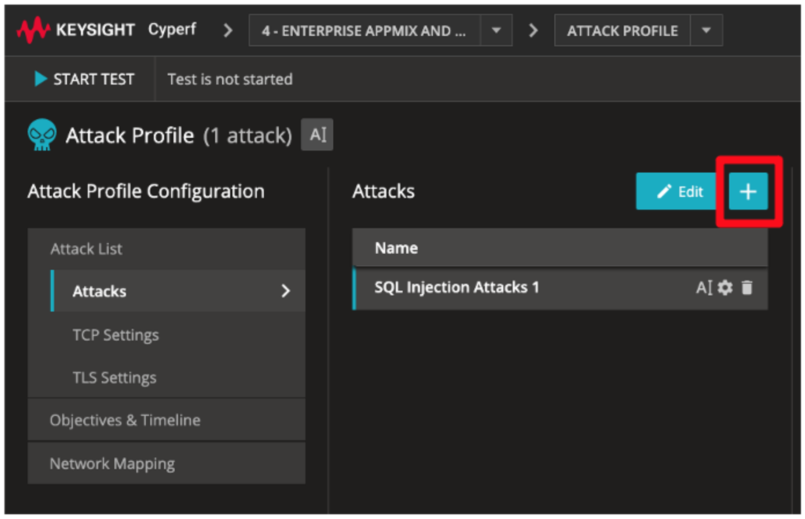


| Name |
|---|
| SQL Injection Attacks 1 |

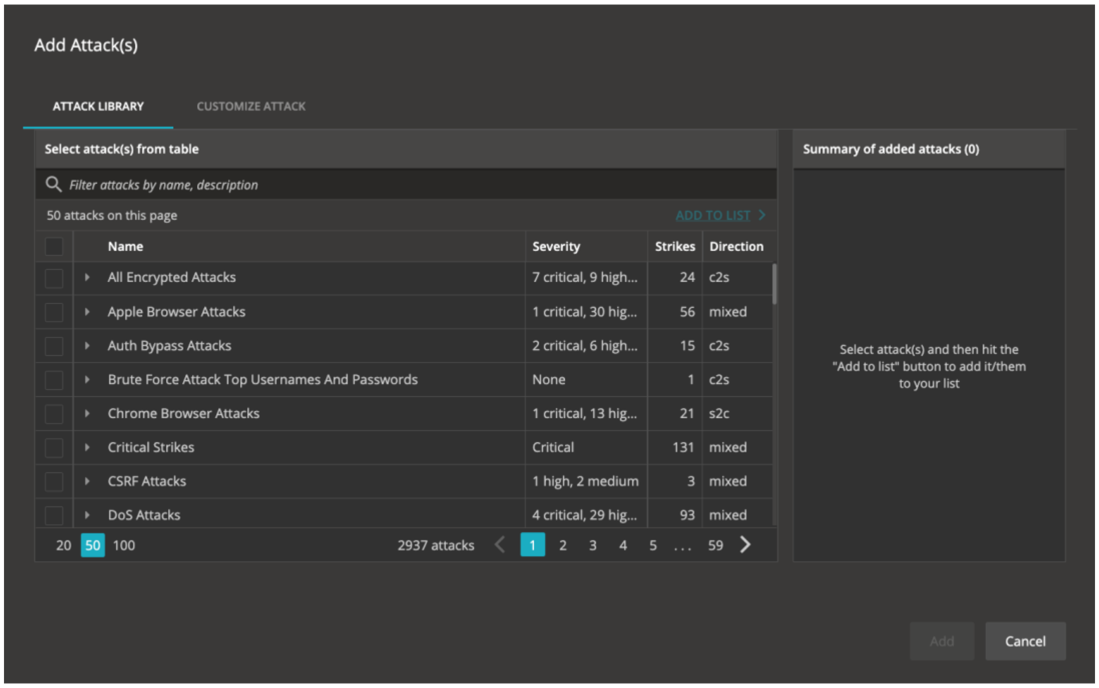
| # | Name |
|---|---|
| 1. | Strike CA Total Defense Suite UnassignFu... Client -> Server |
| 2. | Strike HP Data Protector dpnepolicyservic... Client -> Server |
| 3. | Strike HP Data Protector dpnepolicyservic... Client -> Server |
| 4. | Strike HP Data Protector dpnepolicyservic... Client -> Server |
| 5. | Strike Symantec Web Gateway blocked.p... Client -> Server |
| 6. | Strike Ruby on Rails Where Hash SQL Inje... Client -> Server |
| 7. | Strike Dell SonicWALL Scrutinizer statusFil... Client -> Server |
| 8. | Strike Zabbix 2.0.8 SQL Injection Client -> Server |
| 9. | Strike Symantec Web Gateway clientrepo... Client -> Server |
| 10. | Strike Centreon and Centreon Enterprise ... Client -> Server |
| 11. | Strike Novell Zenworks Configuration Ma... Client -> Server |
| 12. | Strike Novell Zenworks Configuration Ma... Client -> Server |
| 13. | Strike Sefrengo CMS Login Cookie SQL Inj... Client -> Server |

Tip: CyPerf offers users the ability to add into the test those attacks that are more relevant for the type of DUT they are testing and obviously the production environment as well:

- To add a new attack from the library just click on the add button (+ icon):

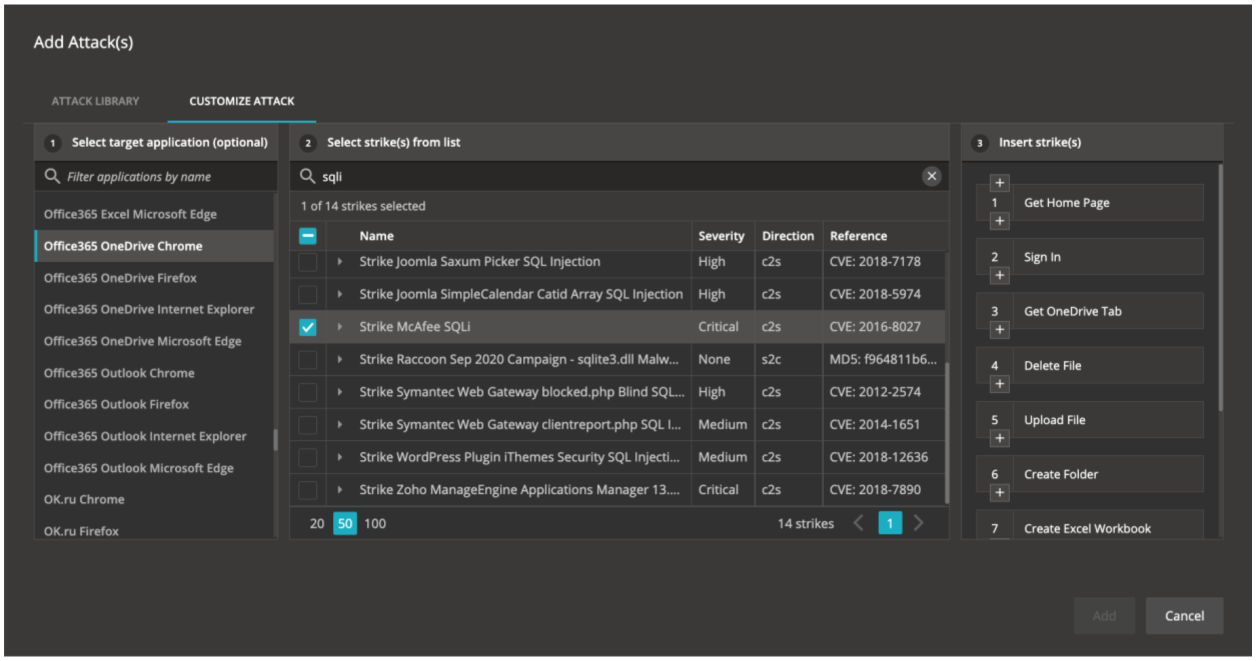


- The attack library comprises a comprehensive list of attacks containing multiple strikes, grouped based on certain categories, as well as individual strikes


Add Attack(s)
ATTACK LIBRARY
CUSTOMIZE ATTACK
Select attack(s) from table
Filter attacks by name, description
50 attacks on this page
ADD TO LIST
Summary of added attacks (0)
Select attack(s) and then hit the "Add to list" button to add it/them to your list
20 50 100
2937 attacks
1 2 3 4 5 ... 59
Add
Cancel

| Name | Severity | Strikes | Direction |
|---|---|---|---|
| All Encrypted Attacks | 7 critical, 9 high... | 24 | c2s |
| Apple Browser Attacks | 1 critical, 30 hig... | 56 | mixed |
| Auth Bypass Attacks | 2 critical, 6 high... | 15 | c2s |
| Brute Force Attack Top Usernames And Passwords | None | 1 | c2s |
| Chrome Browser Attacks | 1 critical, 13 hig... | 21 | s2c |
| Critical Strikes | Critical | 131 | mixed |
| CSRF Attacks | 1 high, 2 medium | 3 | mixed |
| DoS Attacks | 4 critical, 29 hig... | 93 | mixed |

Tip: Users can also create custom attacks by combining legitimate application actions with malicious strikes allowing an unprecedented level of realism. This can be done either manually by adding desired application acting to an attack or through the Customize Attack pane in the Add Attack dialog:


Add Attack(s)

ATTACK LIBRARY | CUSTOMIZE ATTACK

1 Select target application (optional)

Filter applications by name

- Office365 Excel Microsoft Edge
- Office365 OneDrive Chrome
- Office365 OneDrive Firefox
- Office365 OneDrive Internet Explorer
- Office365 OneDrive Microsoft Edge
- Office365 Outlook Chrome
- Office365 Outlook Firefox
- Office365 Outlook Internet Explorer
- Office365 Outlook Microsoft Edge
- OK.ru Chrome
- OK.ru Firefox

2 Select strike(s) from list

sqli

1 of 14 strikes selected

| | Name | Severity | Direction | Reference |
|---|---|---|---|---|
| | Strike Joomla Saxum Picker SQL Injection | High | c2s | CVE: 2018-7178 |
| | Strike Joomla SimpleCalendar Catid Array SQL Injection | High | c2s | CVE: 2018-5974 |
| ✓ | Strike McAfee SQLi | Critical | c2s | CVE: 2016-8027 |
| | Strike Raccoon Sep 2020 Campaign - sqlite3.dll Malw... | None | s2c | MD5: f964811b6... |
| | Strike Symantec Web Gateway blocked.php Blind SQL... | High | c2s | CVE: 2012-2574 |
| | Strike Symantec Web Gateway clientreport.php SQL I... | Medium | c2s | CVE: 2014-1651 |
| | Strike WordPress Plugin iThemes Security SQL Injecti... | Medium | c2s | CVE: 2018-12636 |
| | Strike Zoho ManageEngine Applications Manager 13.... | Critical | c2s | CVE: 2018-7890 |

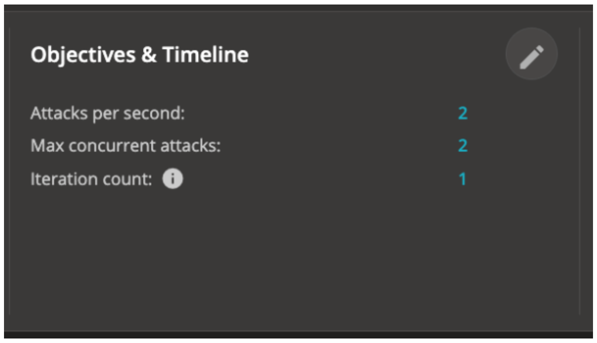
20 50 100 — 14 strikes — 1

3 Insert strike(s)

1. Get Home Page
2. Sign In
3. Get OneDrive Tab
4. Delete File
5. Upload File
6. Create Folder
7. Create Excel Workbook

Add | Cancel

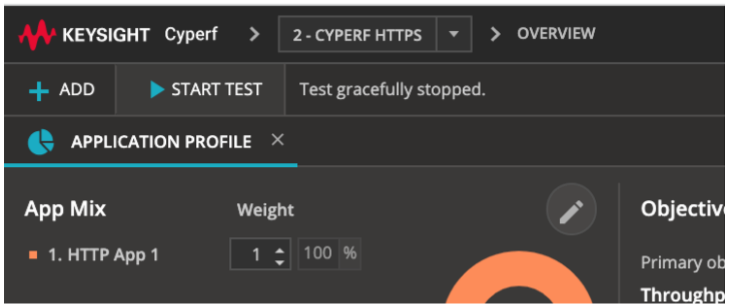
8. The Objective and Timeline of the Attack Profile is configured to 2 attacks per second and 2 maximum concurrent attacks and iterating only once through the attack list:


Objectives & Timeline

Attacks per second: 2
Max concurrent attacks: 2
Iteration count: 1

All the other test parameters are kept the same as in the previous lab.
Now that the test has been updated with the details of the setup/agents assigned to your user, we can run the test and interpret the results.

9. Click on the “Start Test” button in the upper left corner:



Test gracefully stopped.

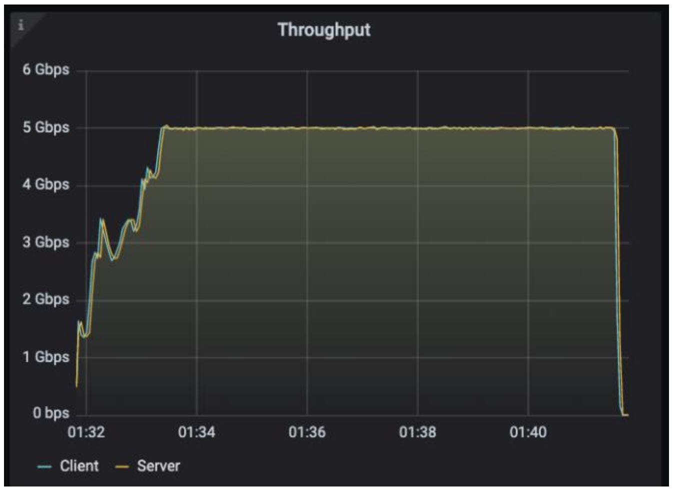
App Mix — Weight

1. HTTP App 1 — 1 — 100 %

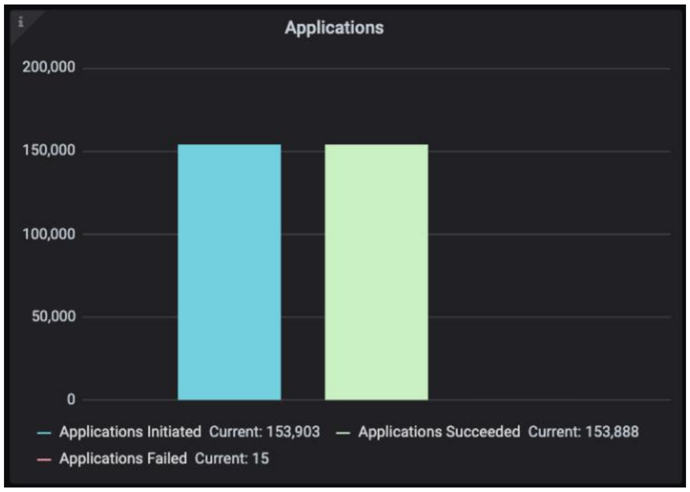
The test traffic agents will get configured and in a few moments the traffic will start. The view will automatically switch to the “STATISTICS” dashboard.

### *Real-Time Statistics*

First, in terms of application traffic we see a similar behavior to the previous test and after a few minutes into the test (approx. 3-5 mins) we can see that the goal seeking mechanism stabilizes. The resulting throughput is achieved as well:



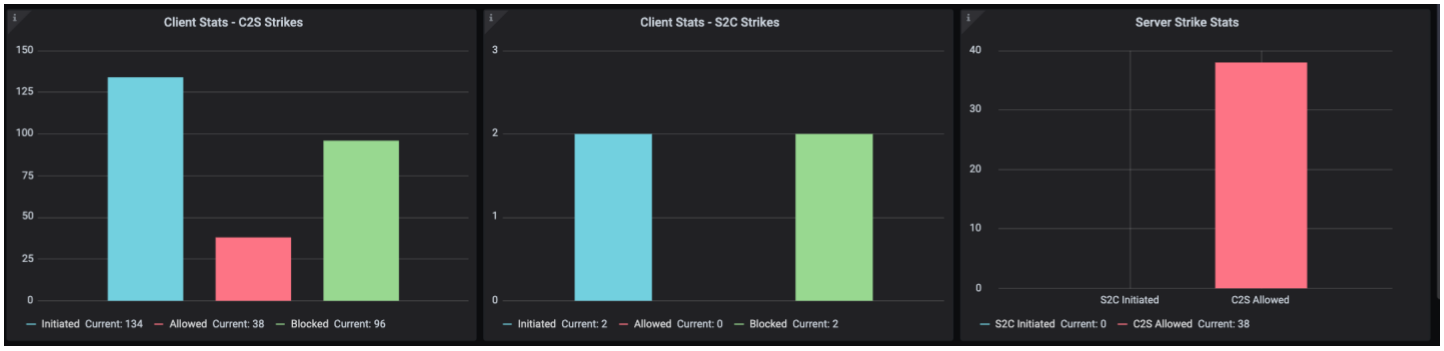
One important thing to check is if/how many application failures we have for this test. In the “Applications” graphs we see that only 3 application iterations failed out of over 150,000:



Therefore, on the legitimate traffic front we can conclude that the behavior is similar to the previous test, hence at this level of traffic, there is no significant impact when it comes to application traffic.

**IMPORTANT** In general, adding or enabling more policies, features and functionalities on Network Security devices would lead to an impact to the maximum performance the device can handle. Therefore, it is very important, when characterizing the performance of any DUT to make sure that its configuration reflets the production needs and requirements.

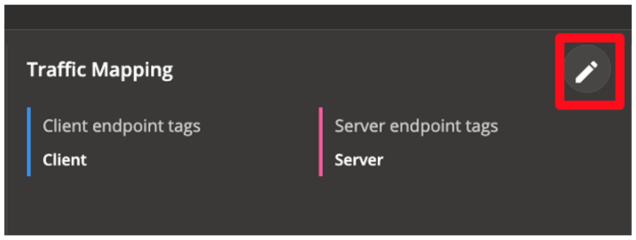
Next, let's see what is the security efficacy of the default SQLi security rules relative to the SQLi attack samples we selected. From the Summary dashboard, we see that out of the total 136 strikes (134 client to server and 2 server to client), there are 38 which have been allowed:



The reason why there have been a total of 136 strikes executed is that the same strike list (of 68 strikes) was executed from both client locations (or Network Segments).

Therefore, it seems that the security efficacy of the WAF for default SQLi security rules (tested against the selected SQLi attack samples) **is approx. 72%.**

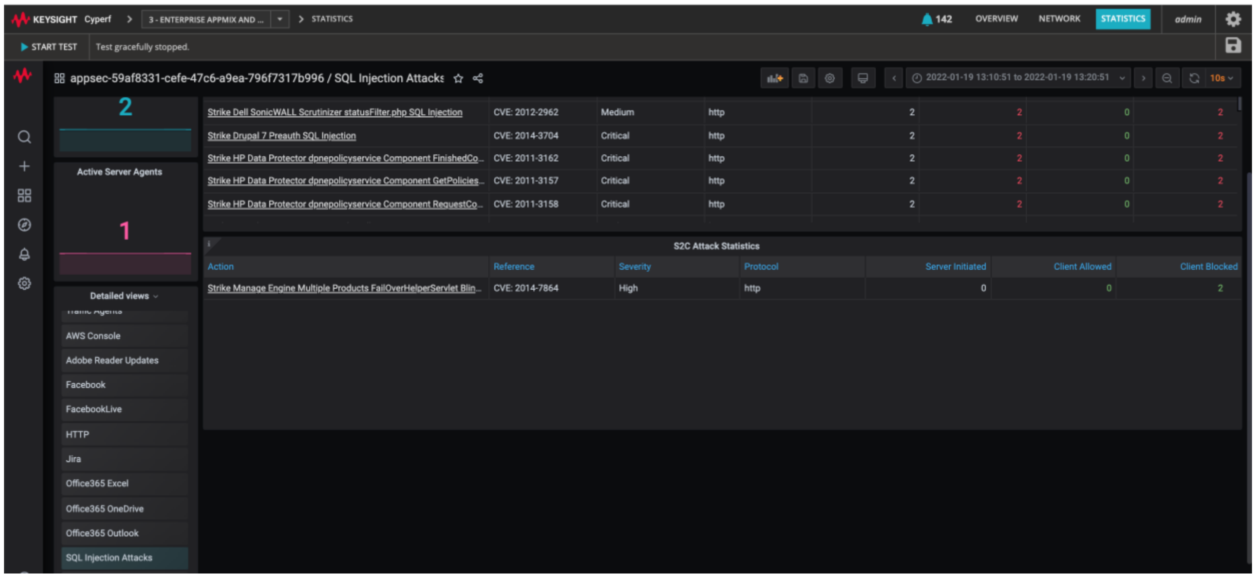
**IMPORTANT** Using the advanced traffic mapping functionality (accessible via the pencil icon " ✎ " from the **Traffic Mapping** section in the test overview page), users can configure the security profile to be executed only from one location (e.g., Branch) to emulate complex scenarios where different locations are generating different traffic patterns (same traffic mapping feature can be granularly applied to each legitimate application as well). More details on how to configure traffic mapping and Network Segments tags also available in the CyPerf's User Guide.


Traffic Mapping

| Client endpoint tags | Server endpoint tags |
|---|---|
| Client | Server |

Furthermore, users can also check what exact security strike have been allowed and which blocked for an even better visibility into the associated risks relative to the production environment.

In the “SQL Injection Attacks” detailed view, each of the security strikes are individually presented with their allowed/block status:



Test gracefully stopped.

appsec-59af8331-cefe-47c6-a9ea-796f7317b996 / SQL Injection Attacks

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Strike Dell SonicWALL Scrutinizer statusFilter.php SQL Injection | CVE: 2012-2962 | Medium | http | 2 | 2 | 0 | 2 |
| Strike Drupal 7 Preauth SQL Injection | CVE: 2014-3704 | Critical | http | 2 | 2 | 0 | 2 |
| Strike HP Data Protector dpnepolicyservice Component FinishedCo... | CVE: 2011-3162 | Critical | http | 2 | 2 | 0 | 2 |
| Strike HP Data Protector dpnepolicyservice Component GetPolicies... | CVE: 2011-3157 | Critical | http | 2 | 2 | 0 | 2 |
| Strike HP Data Protector dpnepolicyservice Component RequestCo... | CVE: 2011-3158 | Critical | http | 2 | 2 | 0 | 2 |

S2C Attack Statistics

| Action | Reference | Severity | Protocol | Server Initiated | Client Allowed | Client Blocked |
|---|---|---|---|---|---|---|
| Strike Manage Engine Multiple Products FailOverHelperServlet Blin... | CVE: 2014-7864 | High | http | 0 | 0 | 2 |

For example, the “Drupal 7 Preauth SQL Injection” strike which in our test is allowed, can have assigned a different security risk level based on the real production environment characteristics (e.g., if Drupal is being used or not and what version).

## Conclusions

In this third and last test, we characterized the true performance of the System Under Test (SUT) using malicious traffic in conjunction with a realistic application mix. First, we evaluated the impact on the legitimate traffic and then we saw that is the SUT security efficacy of the default SQLi security rules relative to the SQLi attack samples we selected.