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VPCs, DLBs, VPNs and Connectivity:

A Deeper Dive

July 2020

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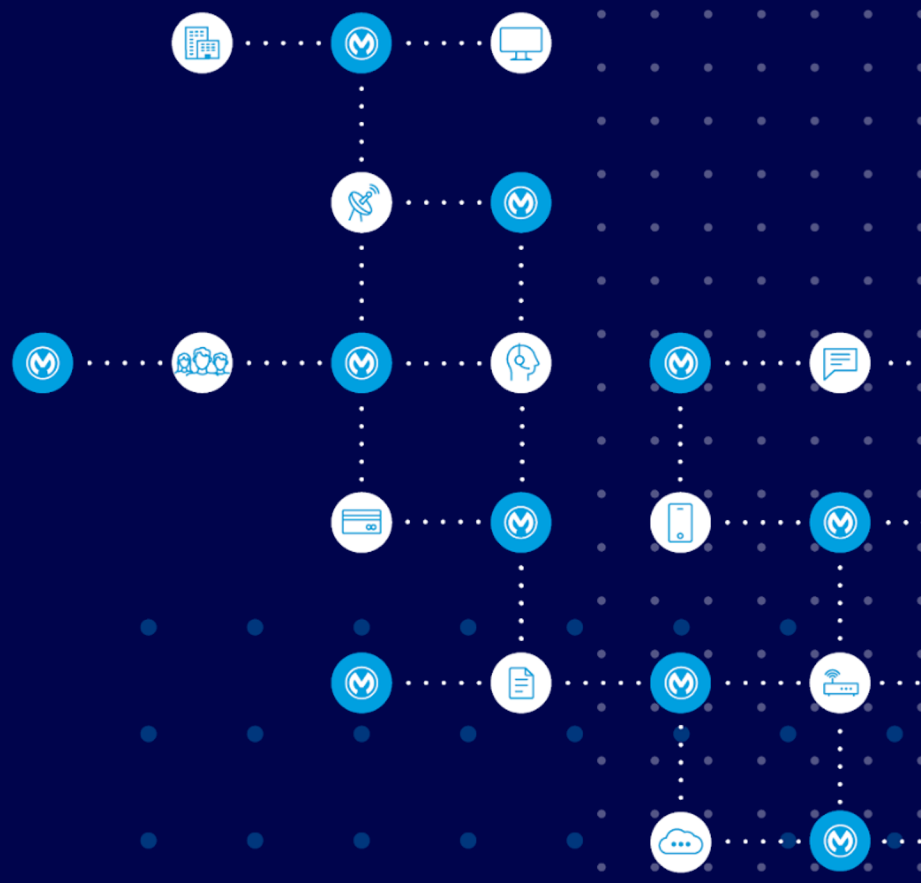

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Agenda

1. CloudHub Infrastructure overview.
2. VPC Overview
3. DLB Overview - Single DLB and Multiple DLBs
4. VPN Overview

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However, before we start talking about VPCs, DLBs and VPNs

Let’s step back a bit and talk about the overall layers within the CloudHub infrastructure and where VPCs, DLBs and VPNs actually fit in.

CloudHub Worker Security Perimeters

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4

*Each AMI is associated with a customer **security group***

8

*Anypoint Virtual Private Cloud (**VPC**) allows customers to create a virtual, **private, and isolated network segment***

10

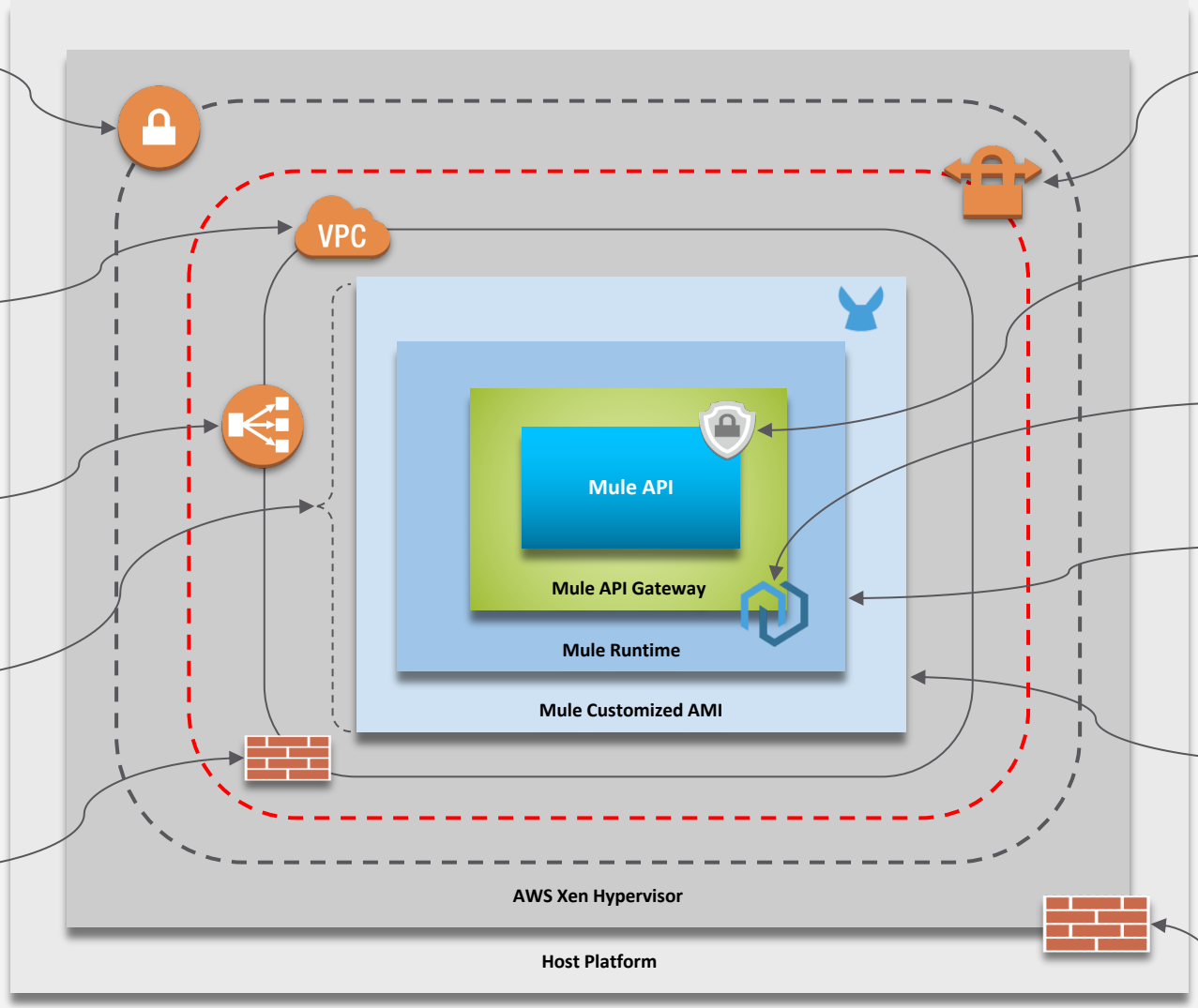
*A VPC can add one or more **dedicated load balancers** to further control access to resources*

1

*Each customer application in CloudHub is deployed to its own **dedicated virtual host**.*

9

*Each **VPC** has its own **firewall** to gate inbound access*



11

Anypoint VPN** can create a **secure connection** between your Anypoint Virtual Private Cloud (VPC) and your **on-premise network (intranet)

6

*A Mule application can employ a variety of **authentication** mechanisms (e.g., **mutual SSL, OAuth, JWT, ...**) for greater security*

7

*The Mule runtime has an **embedded API gateway** which can execute API policies to govern access to the API*

3

*The Mule **runtime** executes as an **unprivileged user** on the host and only **executes a single application***

2

- *Each CloudHub instance employs a heavily **customized and pruned AMI** devoid of all unnecessary packages and services. An Amazon Machine Image (AMI) is a special type of virtual appliance that is used to create a virtual machine within the Amazon Elastic Compute Cloud ("EC2"). It serves as the basic unit of deployment for services delivered using EC2.[1]*
- *Images are continually **scanned for known vulnerabilities** and applications are periodically redeployed to ensure they are executing on hosts with the latest, most up to date, OS and packages.*

5

*An **AWS firewall** is implemented in the **hypervisor** to gate network traffic*

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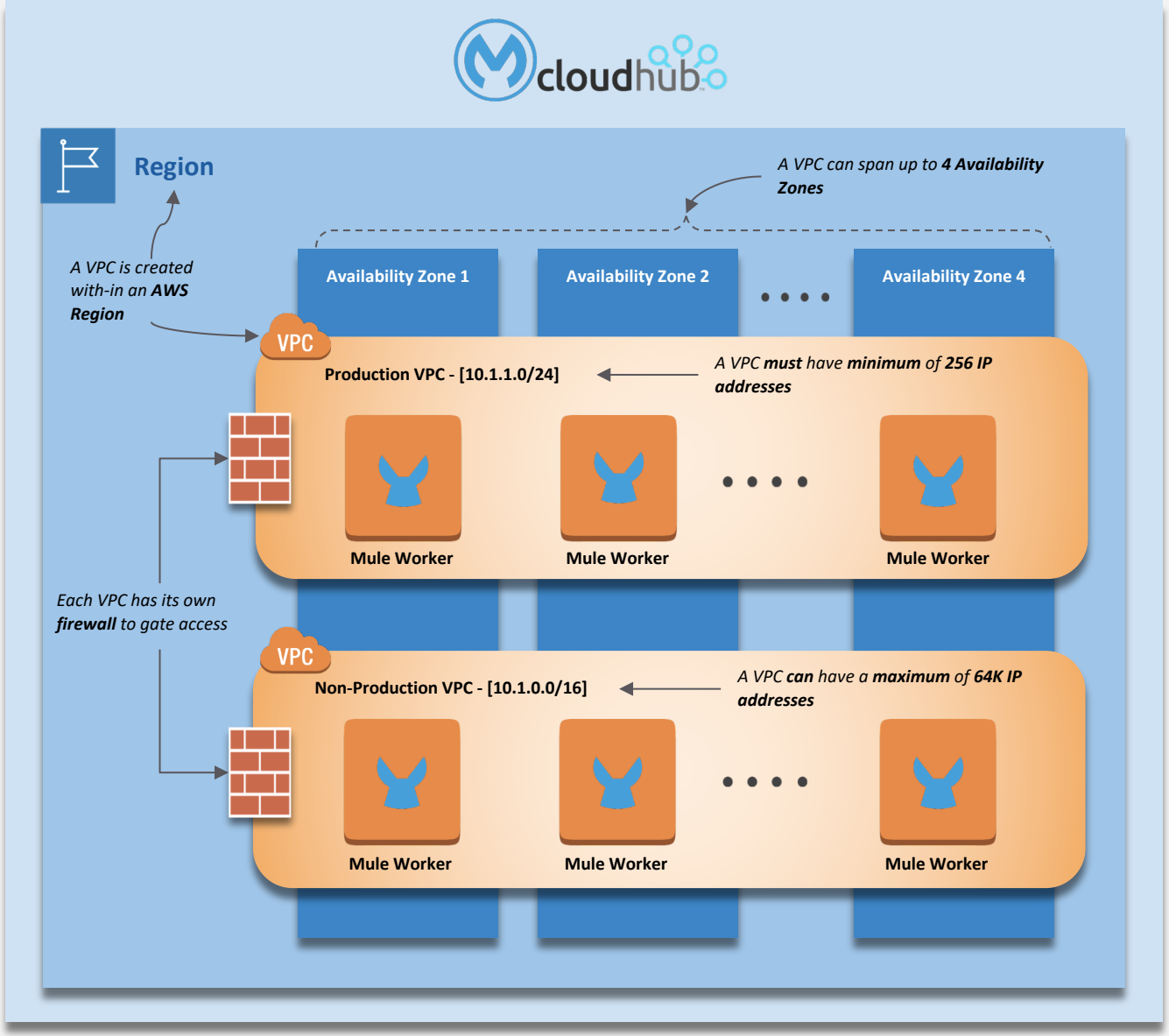
Virtual Private Clouds (VPCs)

Virtual Private Cloud (VPC)



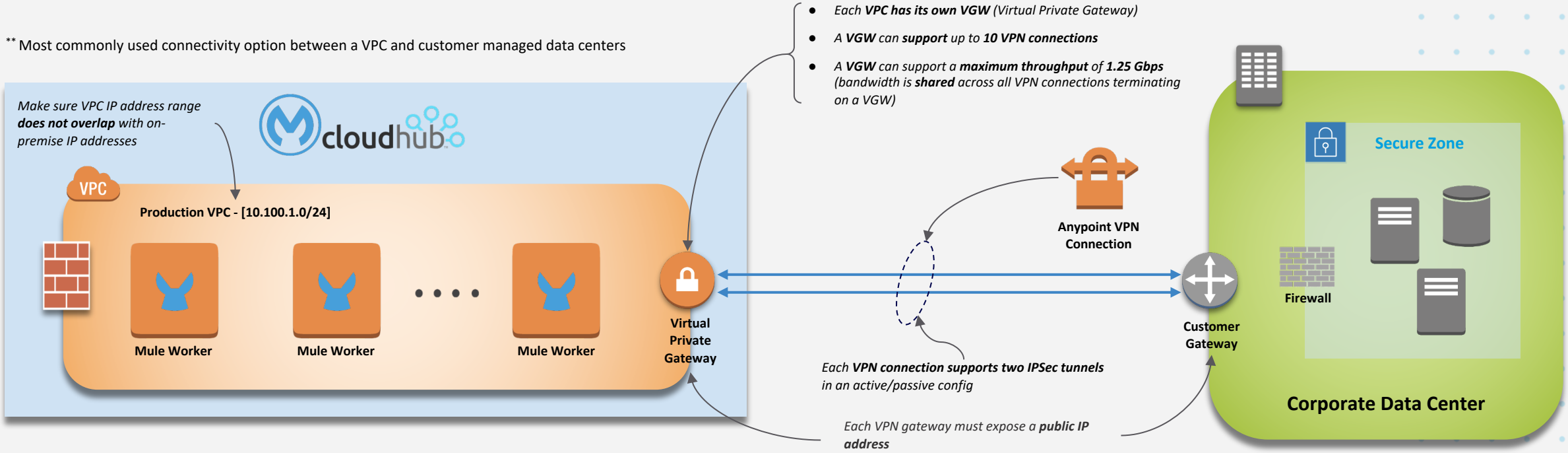
- A **logical segmentation** of your CloudHub worker IP network*
  - A **IPv4 IP** address is **32-bits long**
  - **Minimum segmentation**** of a VPC is a **24-bit subnet** (e.g., 10.1.1.0/24) for an availability of **256 IP addresses**.
  - **Maximum segmentation** of a VPC is a **16-bit subnet** (e.g., 10.1.0.0/16) for availability of **64K IP addresses**.
- A **private**, **fault-tolerant** and **secure network** for hosting your CloudHub workers.
  - Each VPC has its **own firewall** to gate access
  - A VPC can **span** across a maximum of **4 availability zones**
- Facilitates the **extension** of a corporate network and allows CloudHub workers to **access secure resources** behind a corporate firewall.

* See **Appendix A** for more details on IP addressing
** **Not recommended** for Production and limited recommendation for non-production

Connecting to a Virtual Private Cloud (VPC)

- There are **3 primary methods** for connecting an Anypoint VPC to on-premises/customer managed data centers:
  - **VPC peering** to an AWS VPC within the same AWS region as the Anypoint VPC
  - AWS **Direct Connect**
  - Secured **VPN** Connection**

** Most commonly used connectivity option between a VPC and customer managed data centers



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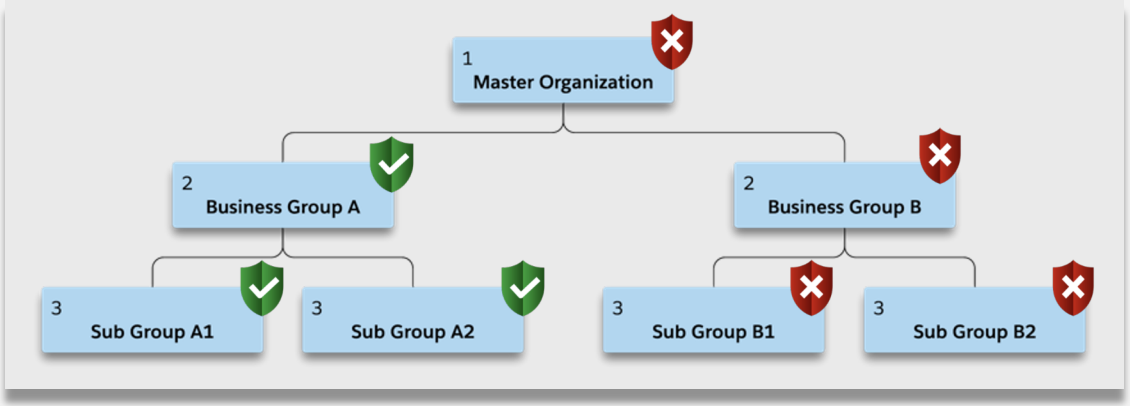
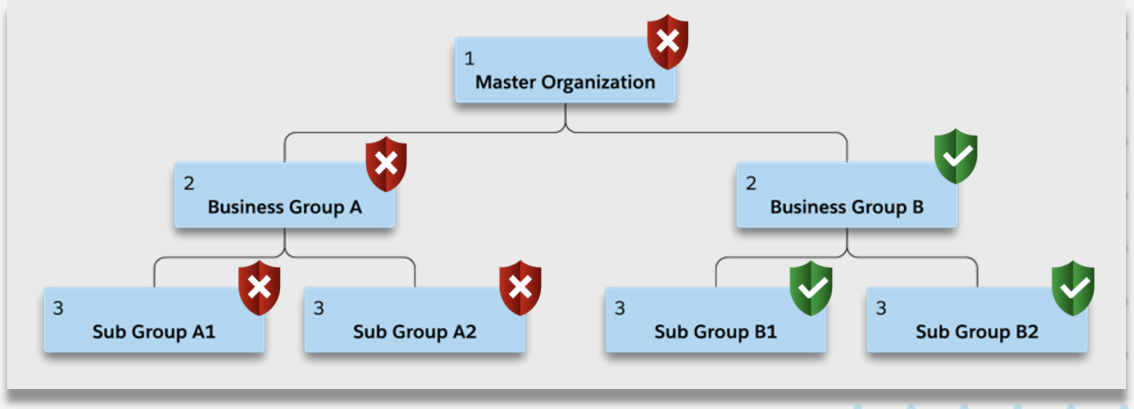
VPC Visibility and Shareability

- Anypoint **VPCs can** be created at any level of the Anypoint Organization structure but can **only** be **shared vertically down** the Anypoint Organization structure, **not up or across**

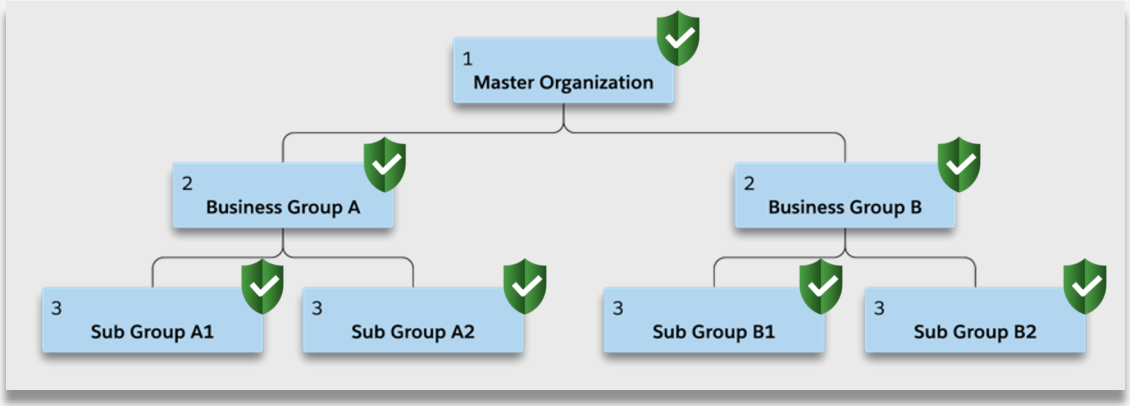
Example 1: VPC created in **Business Group A**



Example 2: VPC created in **Business Group B**



Example 3: VPC created in **Master Organization**[**]



** **Recommended**

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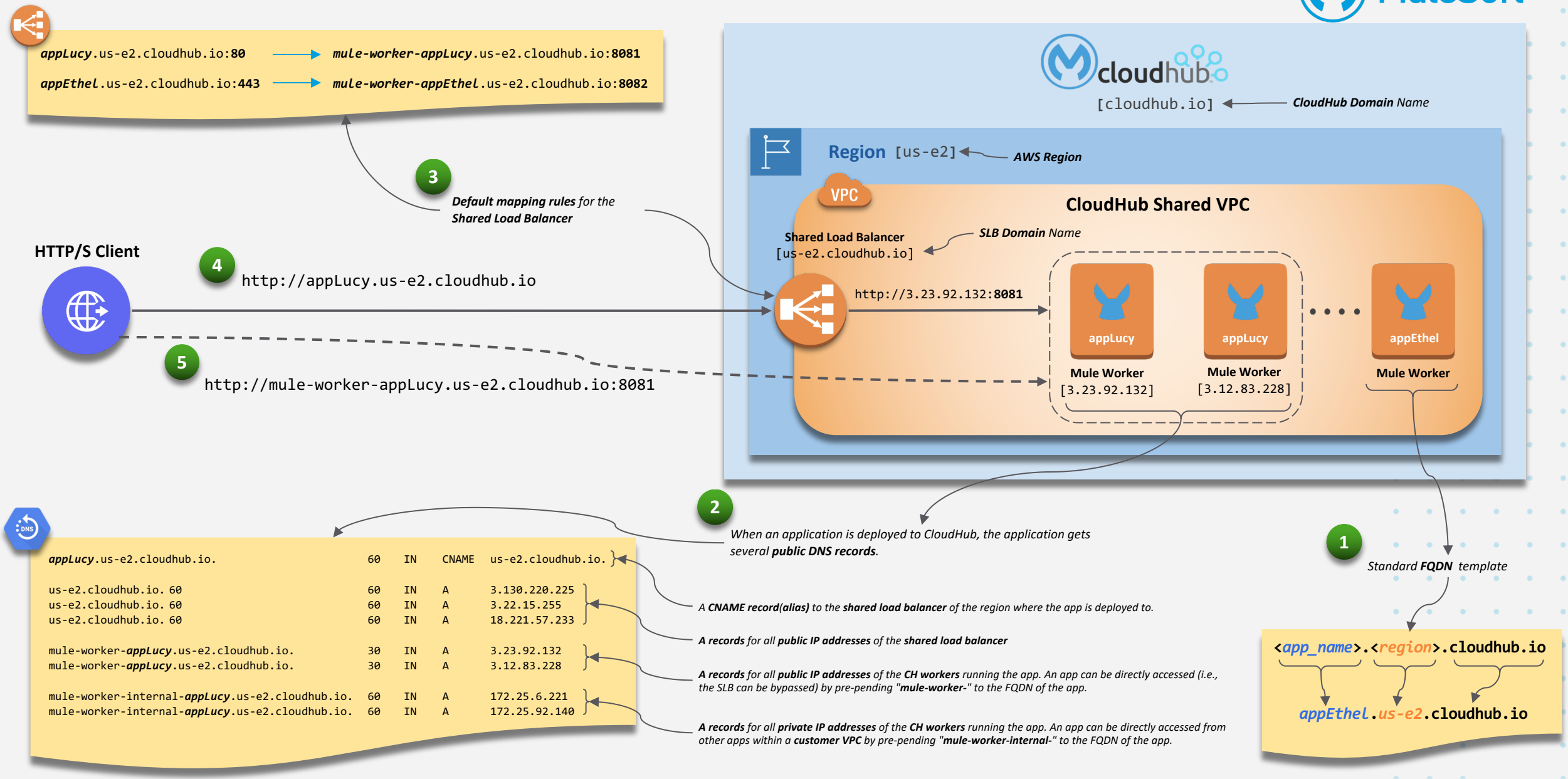
Dedicated Load Balancers (DLBs)

In order to understand DLBs, it is important to understand how load balancing works within the overall CloudHub Shared Environment

Shared CloudHub Load Balancer Architecture



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Now that we under Shared Load Balancers

Let’s move into Dedicated Load Balancers

Dedicated Load Balancers (DLB)

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- A DLB is an **optional** add-on **entitlement**
- A DLB typically has **higher throughput capabilities** than a Shared Load Balancer
- A DLB supports **custom SSL certificates** and two-way SSL (**Mutual SSL**)
- A DLB supports **proxy rules for mapping applications** to custom domains, so, for example, everything can be hosted under a single vanity domain
- A DLB is **deployed inside of a particular Anypoint VPC**
  - A VPC can have more than one DLB
  - A DLB **cannot** span multiple VPC
- A DLB is **comprised** of one or more **load balancer units** but can **be scaled**
  - A single **load balancer unit** is comprised of **two workers**
  - You can assign a **maximum to 4 load balancer units** to a DLB
  - A fully **maxed out DLB will have 8 workers**

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Using a Single DLB

- Provides **network isolation** of Mule applications within a VPC
- Governs which internal endpoints can be accessed via **customizable mapping rules**
- Supports **IP Whitelisting** to govern which networks can access the DLB
- Performs **load balancing of internal traffic** across workers within a VPC
- **Offloads TLS processing** by terminating TLS connections at the DLB

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Dedicated Load Balancer Architecture

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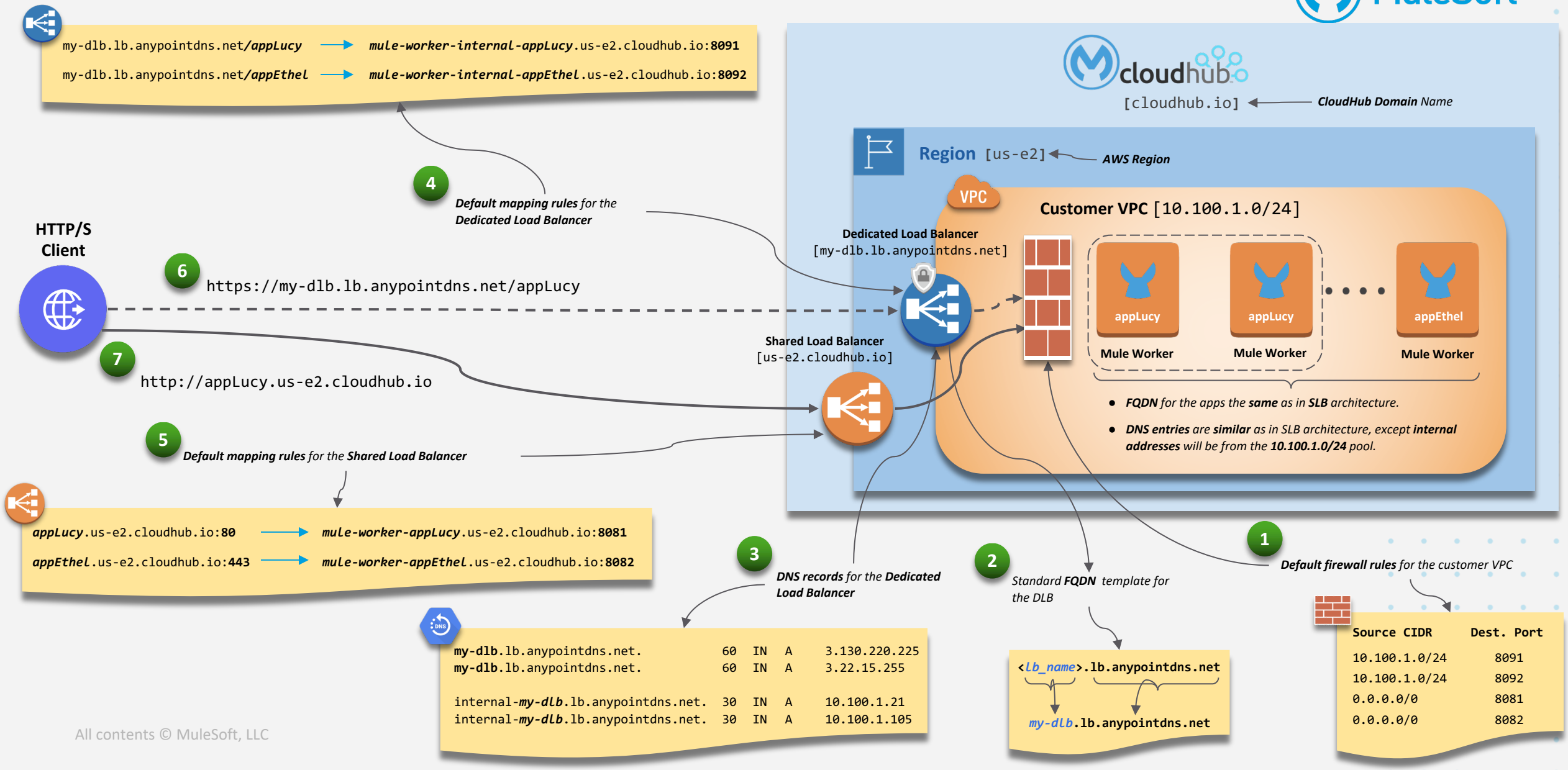

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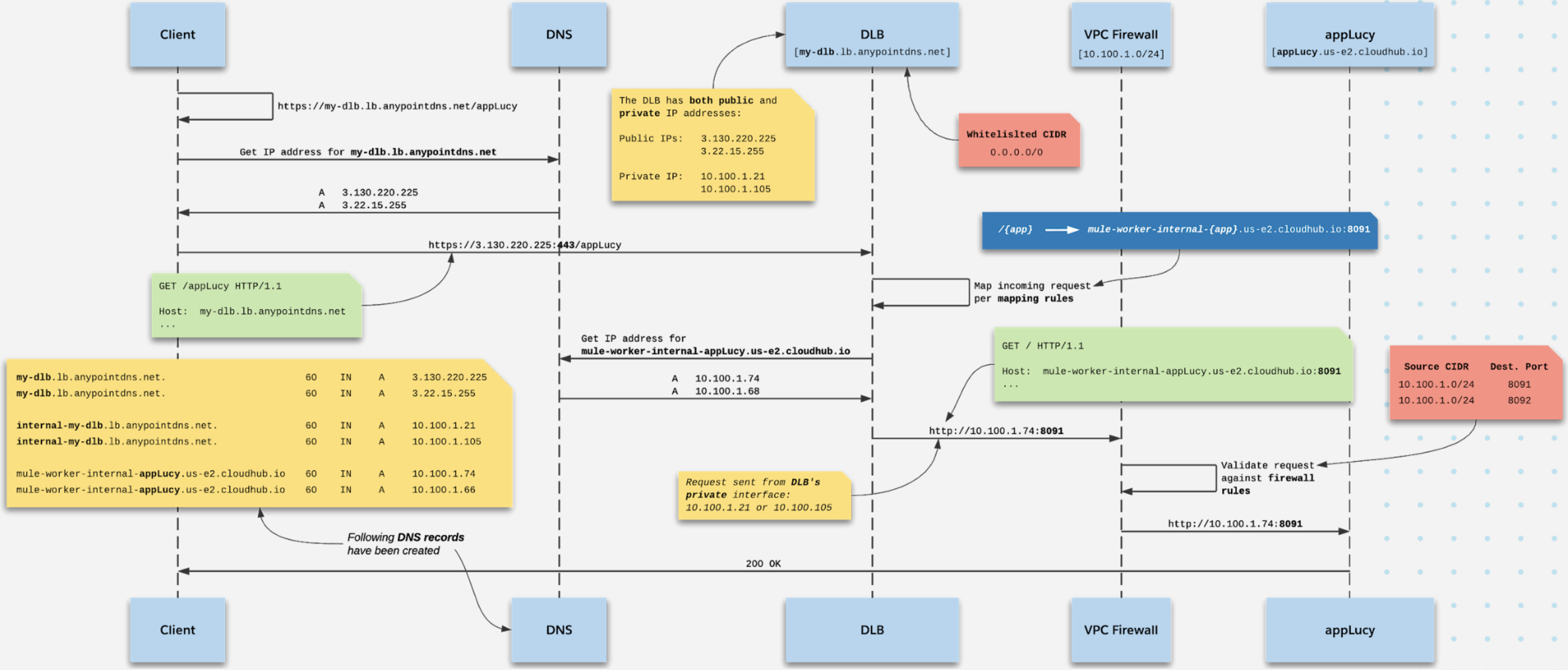
Sequence Diagram - Single DLB



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Using Multiple DLBs

- Provides for even **greater network isolation** of Mule applications within a VPC
- Provides for a flexible governance and load balancing architecture
  - Use **one DLB** to **expose** and load balance **external facing APIs** (e.g., Experience APIs)
  - Use a **second DLB to hide internal APIs** (e.g., Process and System APIs) but still allow internal APIs to be load balanced.
  - Naming convention and patterns allow for dynamic routing and protection of internal APIs

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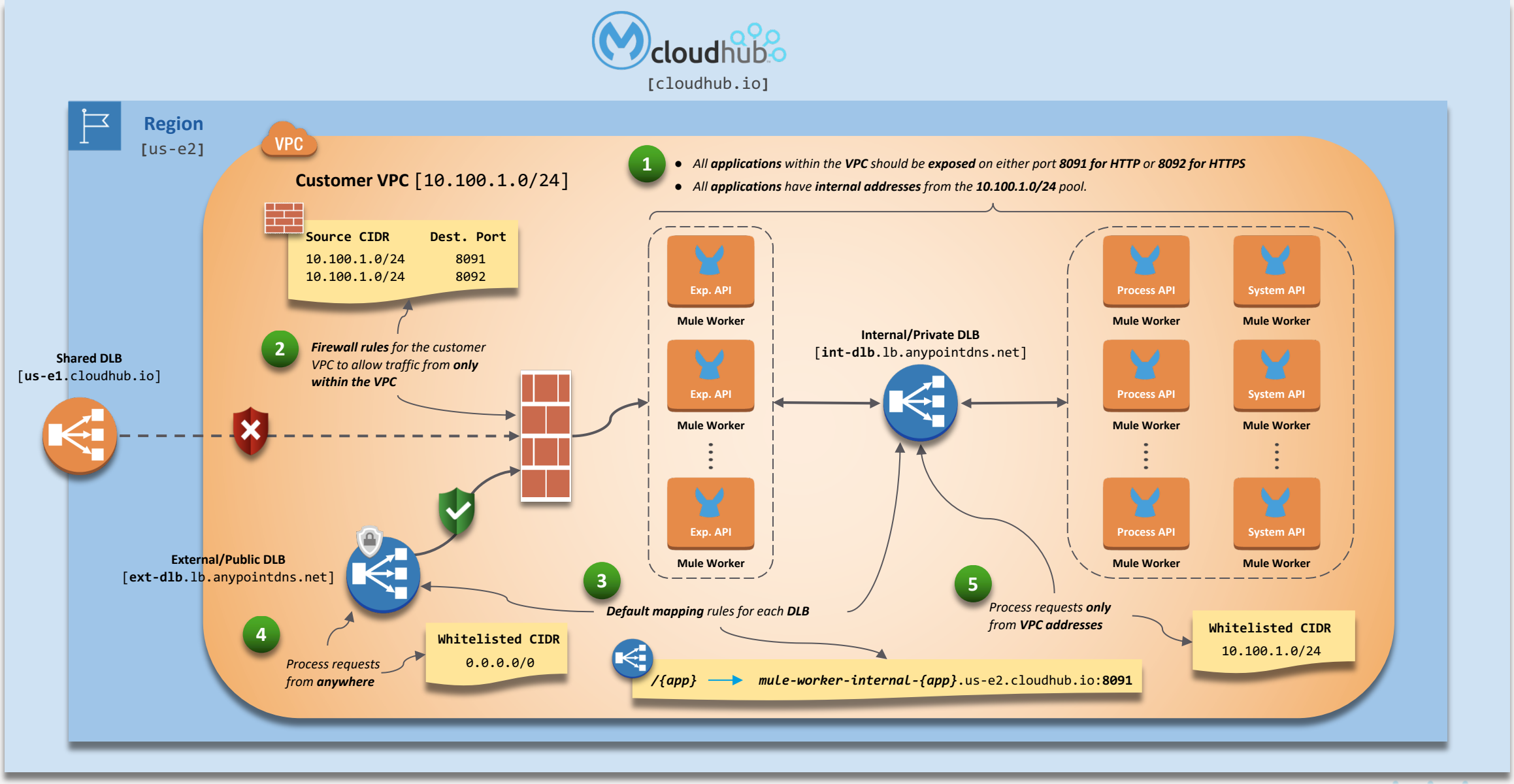
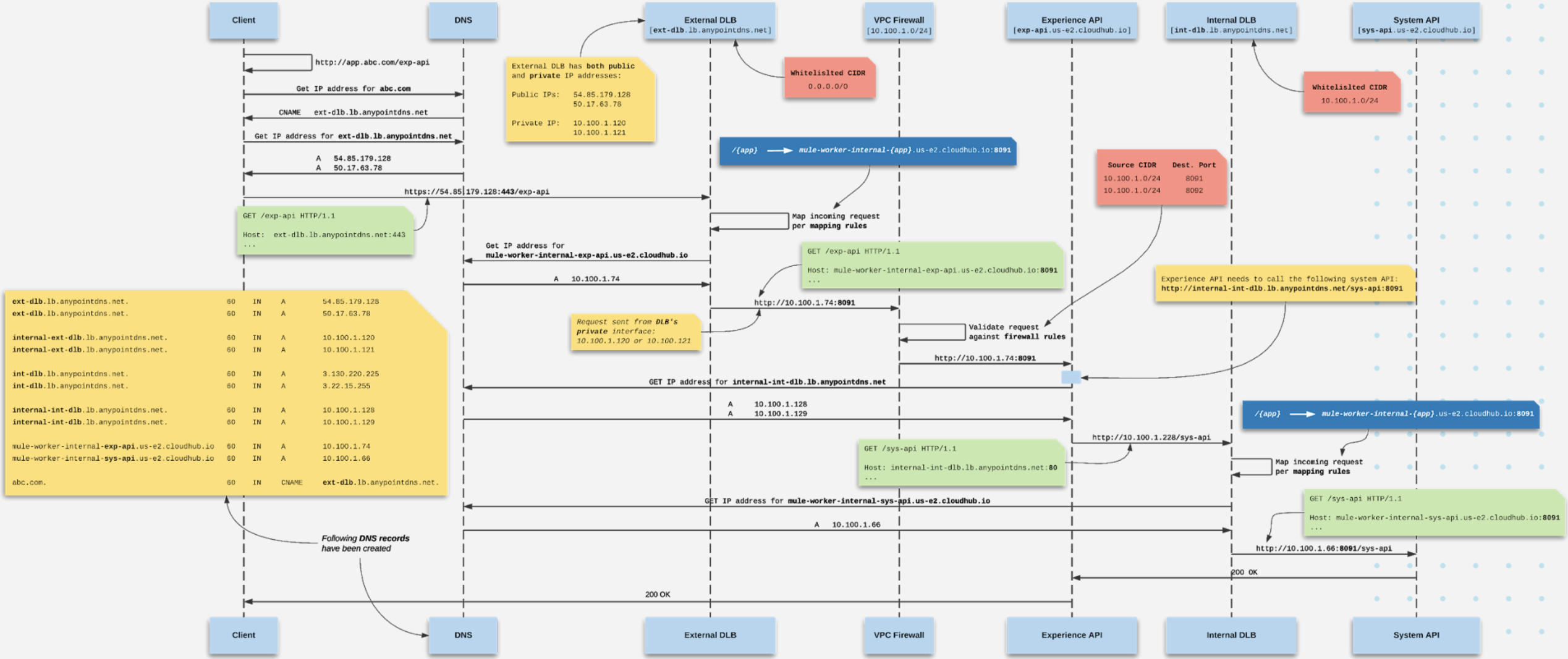
Multiple Dedicated Load Balancers Architecture



Sequence Diagram - Multiple DLBs



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Virtual Private Network (VPN)

Virtual Private Network (VPN)

- An Anypoint **VPN** provides a **secure, private connection** between your MuleSoft Virtual Private Cloud (VPC) and your on-premises network.
  - A VPN allows you to **extend your corporate network** to include your VPC
  - A VPN allows CloudHub workers and corporate systems to seamlessly communicate using **private IP addresses**
  - A VPN can only be associated to a single VPC
- A **Virtual Private Gateway** (VGW) **terminates** the VPN connection on the MuleSoft side
  - Each VPC has its own VGW
  - A VGW can support up to **10 VPN connections**
    - The number of VPNs you can create depends on the VPN entitlements available to your account.
  - A VGW can support a **maximum throughput of 1.25 Gbps**
    - **Bandwidth is shared** across all VPN connections terminating on a VGW
- Each VPN connection supports **two IPSec tunnels** in an *active/passive* config

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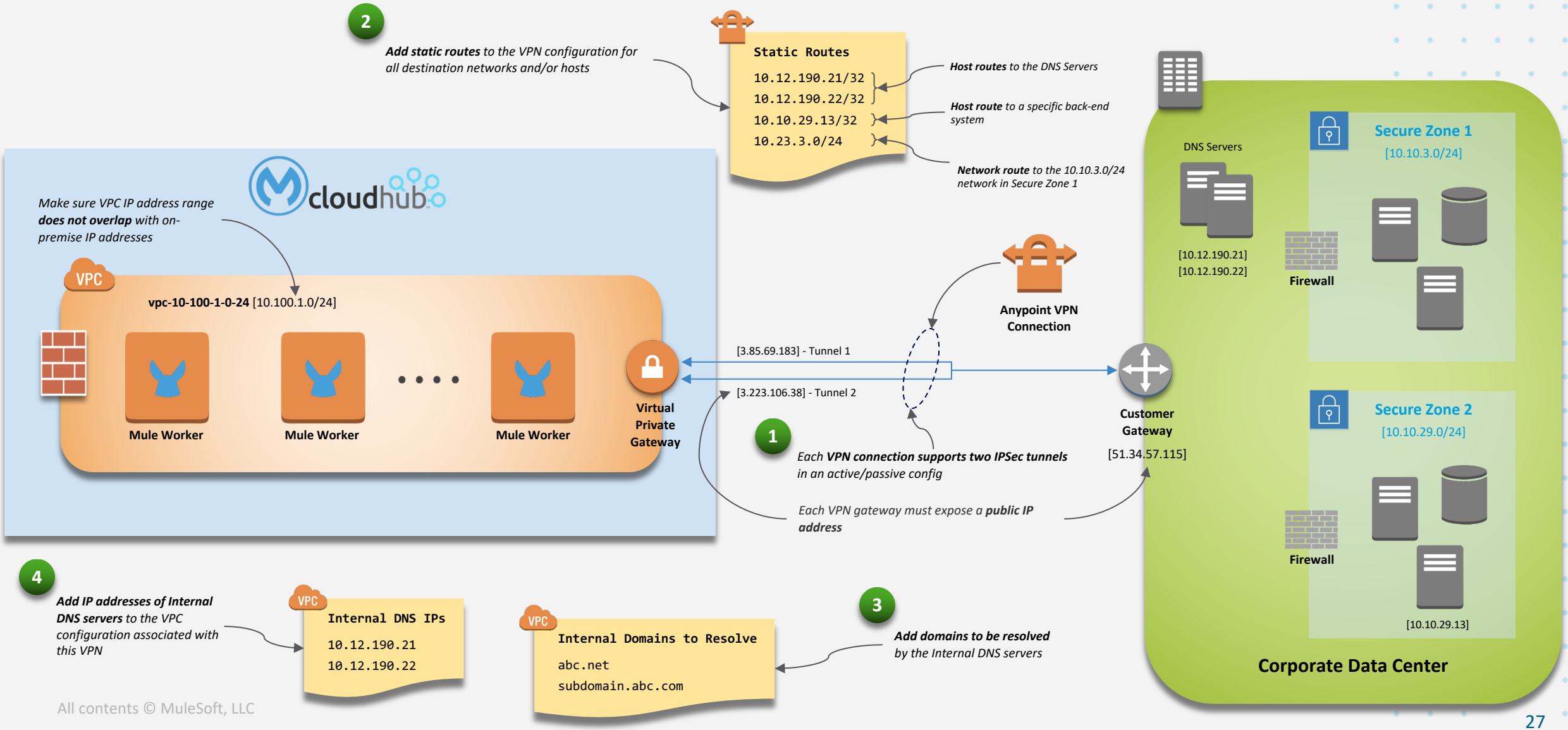
Anypoint VPN Architecture



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Provisioning Exercises

Provisioning a VPC, DLB and VPN

- The next few slides will walk you through the process of creating and configuring the following components:
  - VPC
  - DLB
  - VPN

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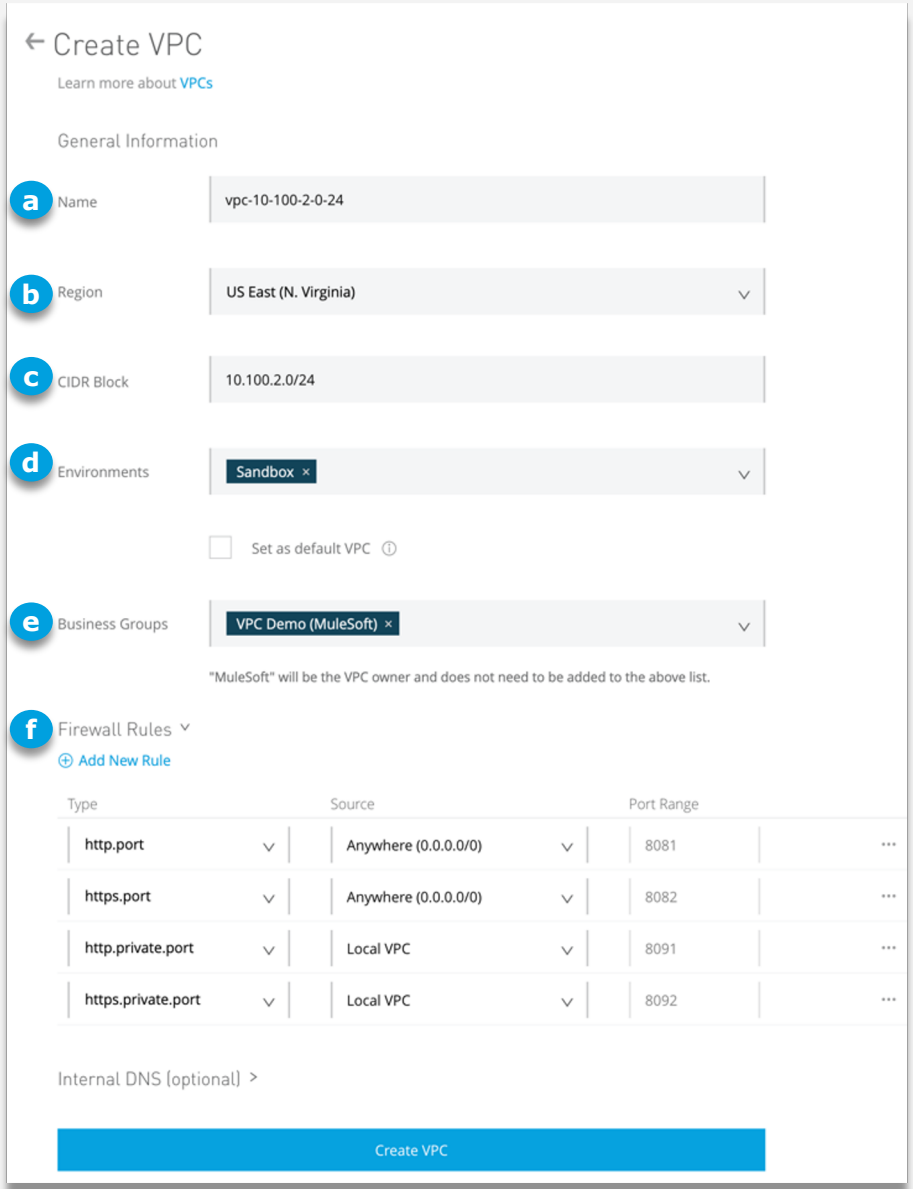
Exercise 1: Provisioning a VPC within the Anypoint Platform is Self-Service

Creating a VPC

1. Login to Runtime Manager --> VPCs
2. Click **Create VPC**
   a. Name (give it a meaningful name)
   b. Select AWS Region
   c. Provide the CIDR Block for the VPC
   d. Select which Environment(s) is/are in the VPC
      - Default is all environments
   e. Select which Business Group(s) is/are in the VPC
      - Default is the master org
   f. Firewall Rules
      - 4 rules are set by default:
        - 2 rules to allow traffic from the Dedicated Load Balancer
        - 2 rules to allow traffic from the internet



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Exercise 2: Provisioning a DLB within the Anypoint Platform is Self-Service

Steps for creating a DLB

- Provision a VPC if one does not already exist - see Exercise 1
- Create at least one server SSL Certificate
- Provision a DLB
- Add certificates (server and/or client) to the DLB
- Create mapping rules

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Create an SSL Certificate – prerequisite for DLB

- Create an SSL Certificate **using the Certificate Authority** of your choice
- Or use ***openssl*** to generate a self signed certificate (not advised for Production use)

```
> openssl req -newkey rsa:2048 -nodes -keyout rickb-dlb1-private.pem -x509 -days 3000 -out rickb-dlb1-crt.pem
```

Where,

```
- req:      “command which creates and processes certificate requests in PKCS#10 format"
- newkey:   "creates a new certificate and a new private key"
- rsa:2048: "generates an RSA key 2048 bits in size"
- nodes:    “do not encrypt the private key”
- keyout:   “the file to write the newly created private key to”
- x509:     “output a self-signed certificate instead of a certificate request"
- days:     “the number of days to certify the certificate for”
- out:      “the output file to write the certificate to"
```

Output:

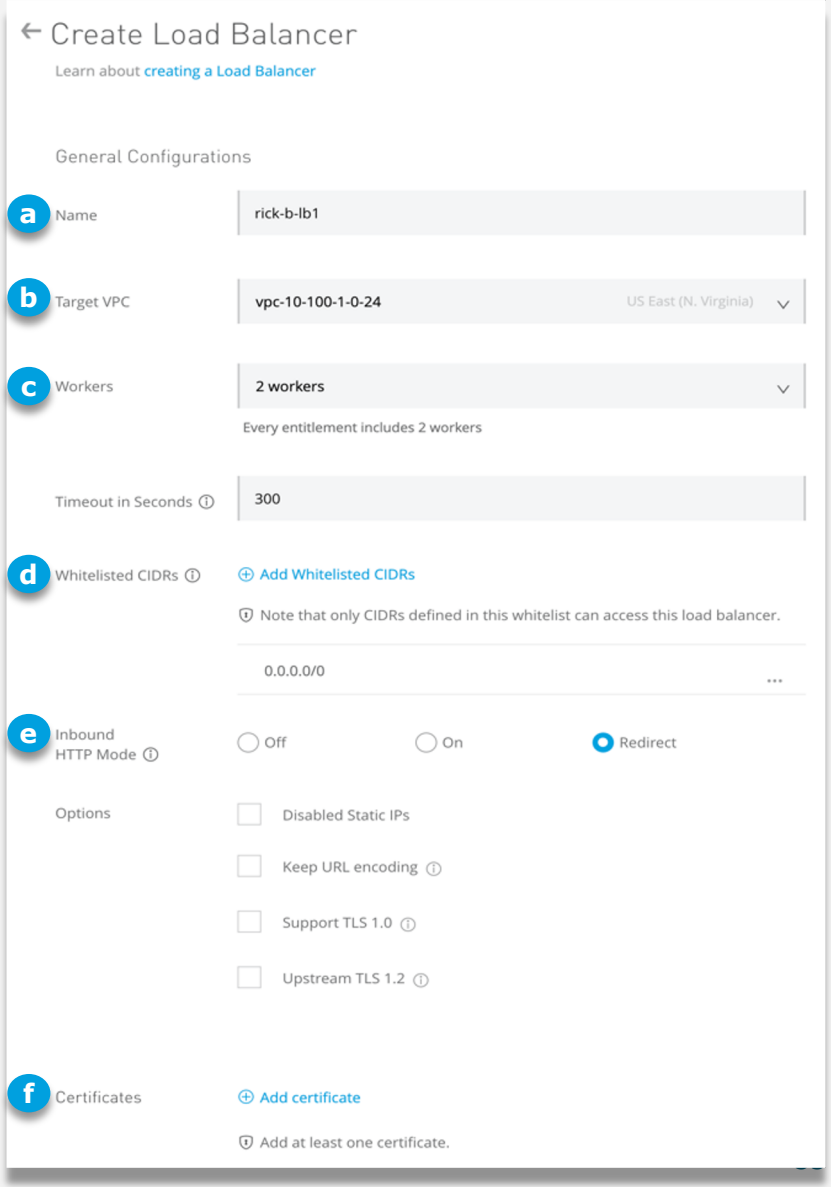
```
Generating a 2048 bit RSA private key
.....................................................................................................+++
writing new private key to 'rickb-dlb1-private.pem'
-----
You are about to be asked to enter information that will be incorporated into your certificate request.  What you are about to enter is what is called a Distinguished Name or a DN. There
are quite a few fields but you can leave some blank For some fields there will be a default value, if you enter '.', the field will be left blank.
-----
Country Name (2 letter code) []:US
State or Province Name (full name) []:Texas
Locality Name (eg, city) []:Frisco
Organization Name (eg, company) []:MuleSoft
Organizational Unit Name (eg, section) []:
Common Name (eg, fully qualified host name) []:*.rickbansal.com
Email Address []:rick.bansal@mulesoft.com

rickbansal@rickbansal-ltm2 ~ % ll *.pem
-rw-r--r--  1 rickbansal  staff  1285 Apr 12 19:10 rickb-dlb1-crt.pem
-rw-r--r--  1 rickbansal  staff  1704 Apr 12 19:10 rickb-dlb1-private.pem
```

All c

Creating a Dedicated Load Balancer

1. Login to Runtime Manager --> Load Balancer
2. Click **Create Load Balancer**
   a. Name (give it a meaningful name)
   b. Target VPC (must be an existing VPC)
   c. Number of Workers (min of 2/max of 8)
   d. Whitelisted CIDRs
      - This is a way to **control which requests are processed based on source IP** address
      - Default is that every source IP address is whitelisted
   e. Select how to handle HTTP requests (DLBs expect HTTPS requests)
      - Default is to drop the request (OFF)
   f. Add a **certificate****
      - **There must be at least one certificate associated with a DLB
      - Mapping rules are associated with a certificate



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Adding a Certificate to a Dedicated Load Balancer

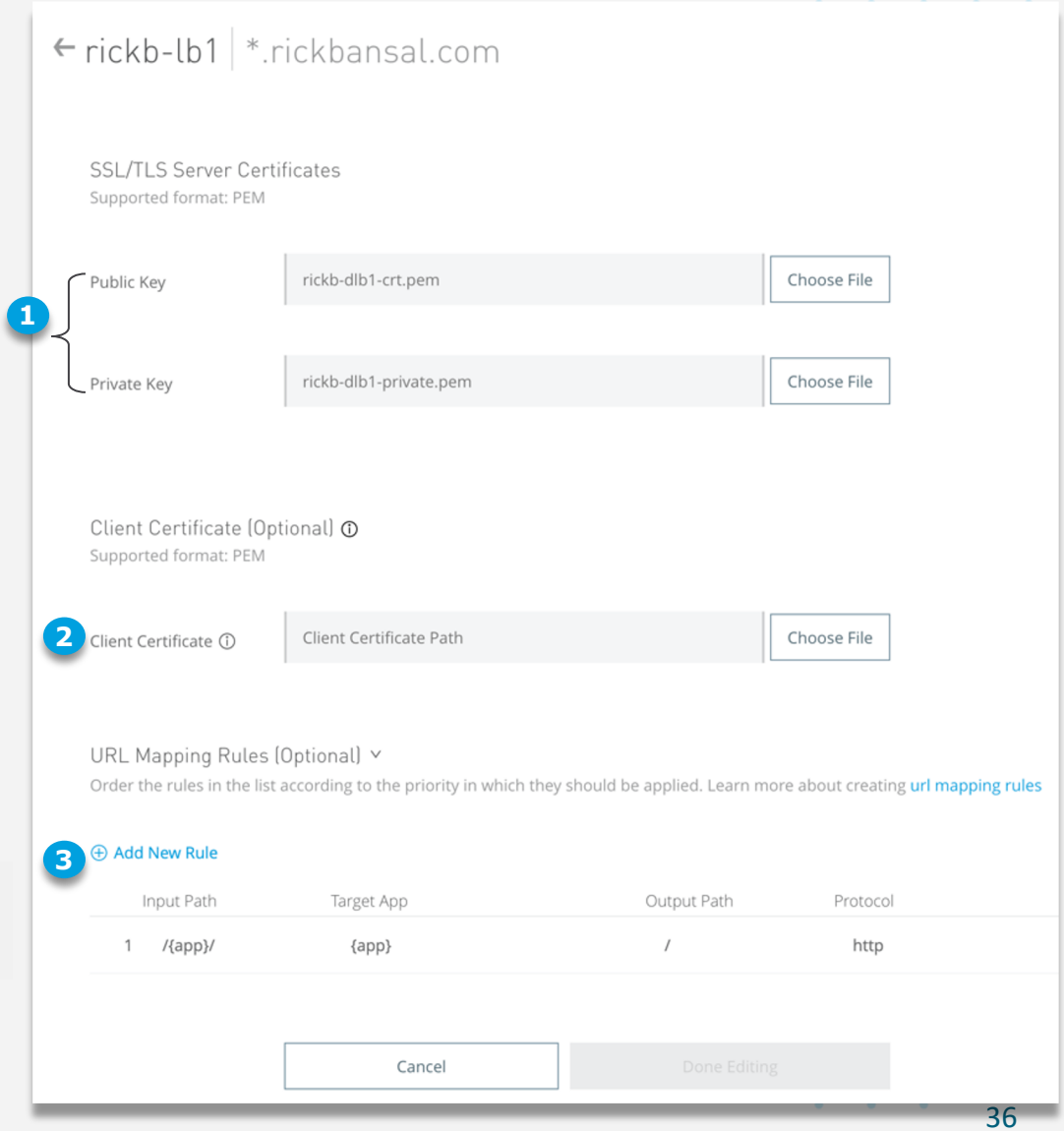
1. Upload your **private** and **public** keys
2. Upload any **client certificates** if 2-way Authentication is required
3. Add URL **Mapping Rules**
   - Default rule will provide the following mapping:

Input	Output
`<lb_name>.lb.anypointdns.net/{app}`	`mule-worker-internal-{app}.<region>.cloudhub.io:8091`

For example:

lb_name:	rickb-lb1
region:	us-e2
app:	appLucy

Input	Output
rickb-lb1.lb.anypointdns.net/appLucy	mule-worker-internal-appLucy.*us-e2*.cloudhub.io:8091



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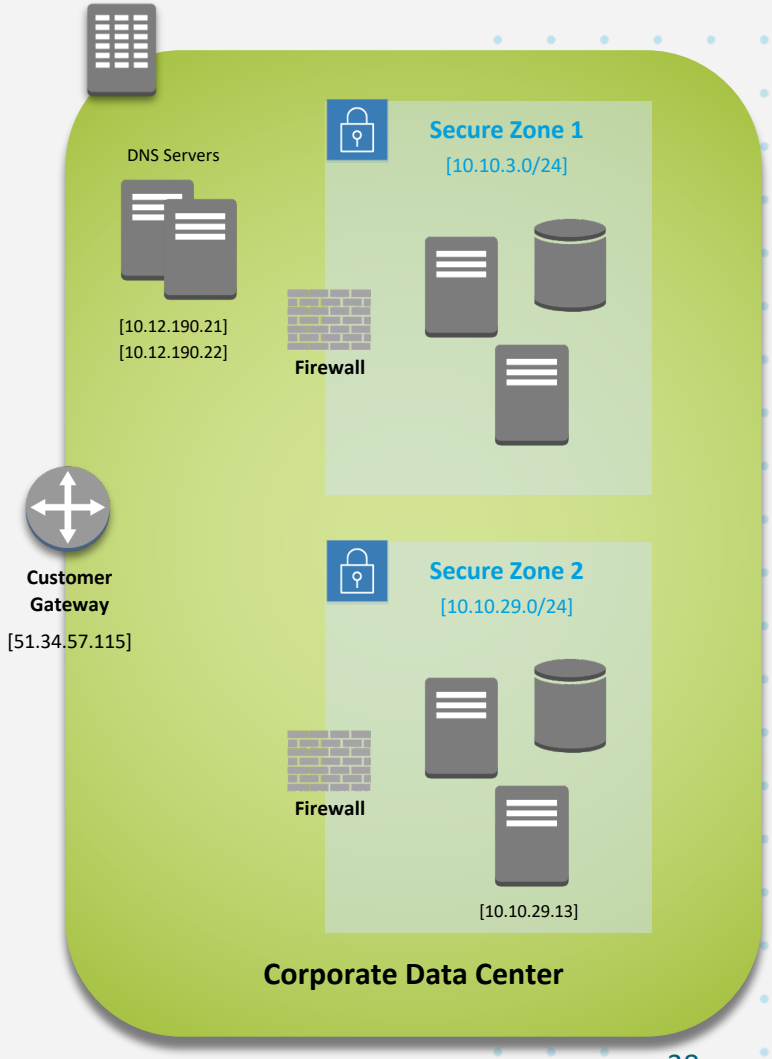
Exercise 3**: Provisioning a VPN within the Anypoint Platform is Self-Service

** Creating a VPN is an optional exercise as the demo will not validate the configuration of the VPN

Network Topology - **Before** Creating VPN

- Our task is to **securely connect Mule applications** running in CloudHub **to** systems hosted in ABC's **corporate data center**.



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Steps for creating a VPN

- Provision a VPC if one does not already exist - see Exercise 1
- Provision a VPN
- Configure the VPN based on the network topology shown in the previous slide
- Modify the VPC Configuration to accommodate DNS resolution of IP address of hosts on the intranet

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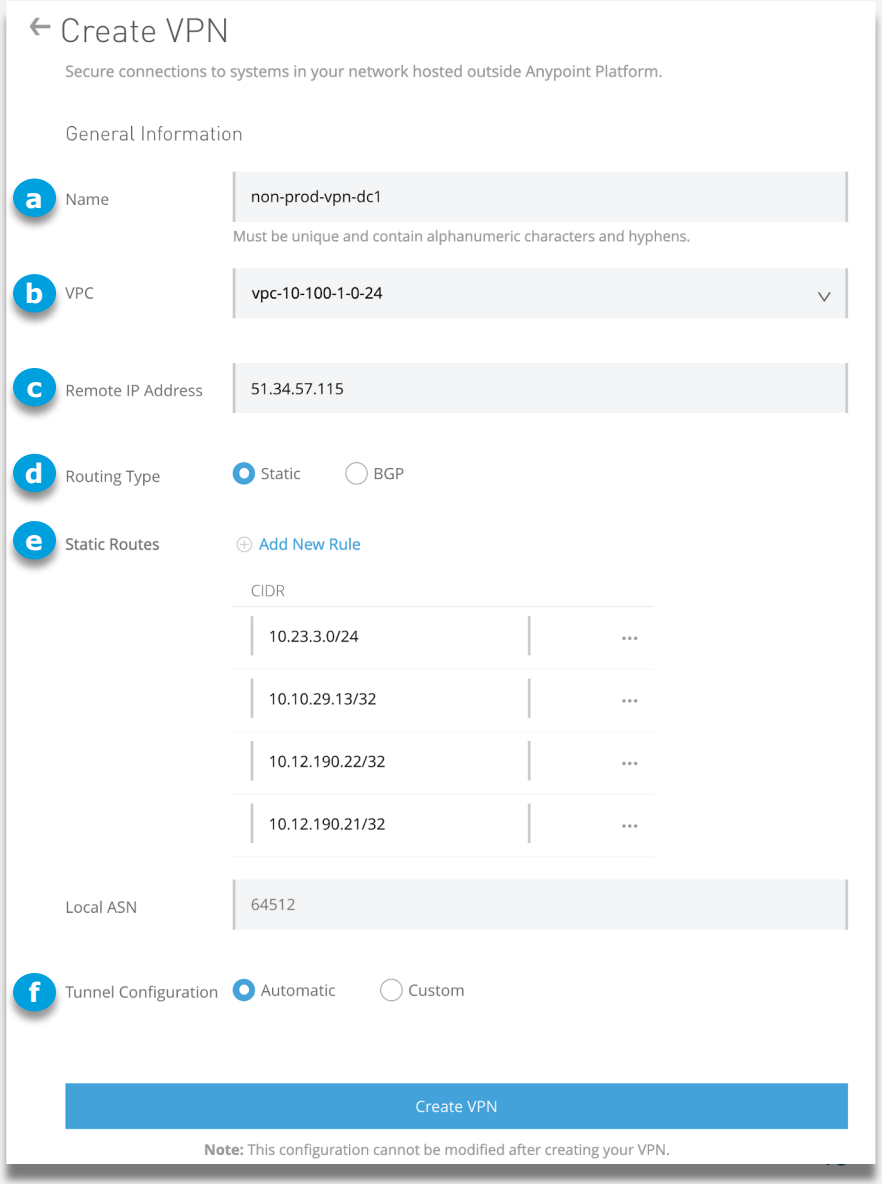
Creating a VPN

1. Login to Runtime Manager --> VPN
2. Click **Create VPN**
   a. Name (give it a meaningful name)
   b. Target VPC (must be an existing VPC)
   c. Remote IP Address is the IP address of the Customer GW
   d. Select ***Static*** Routing
   e. Add static routes - click **Add New Rule** for each new route
      - 10.23.3.0/24 - network route to the 10.23.3.0/24 subnet
      - 10.10.29.13/32 - host route to App Server 1
      - 10.12.190.22/32 - host route to DNS Server 1
      - 10.12.190.21/32 - host route to DNS Server 2
   f. Select ***Automatic*** Tunnel Configuration
      - Automatic tunnel configuration should work in most cases
3. Click **Create VPN**
   - It could take 10-15 minutes for the VPN to become "***Available***".



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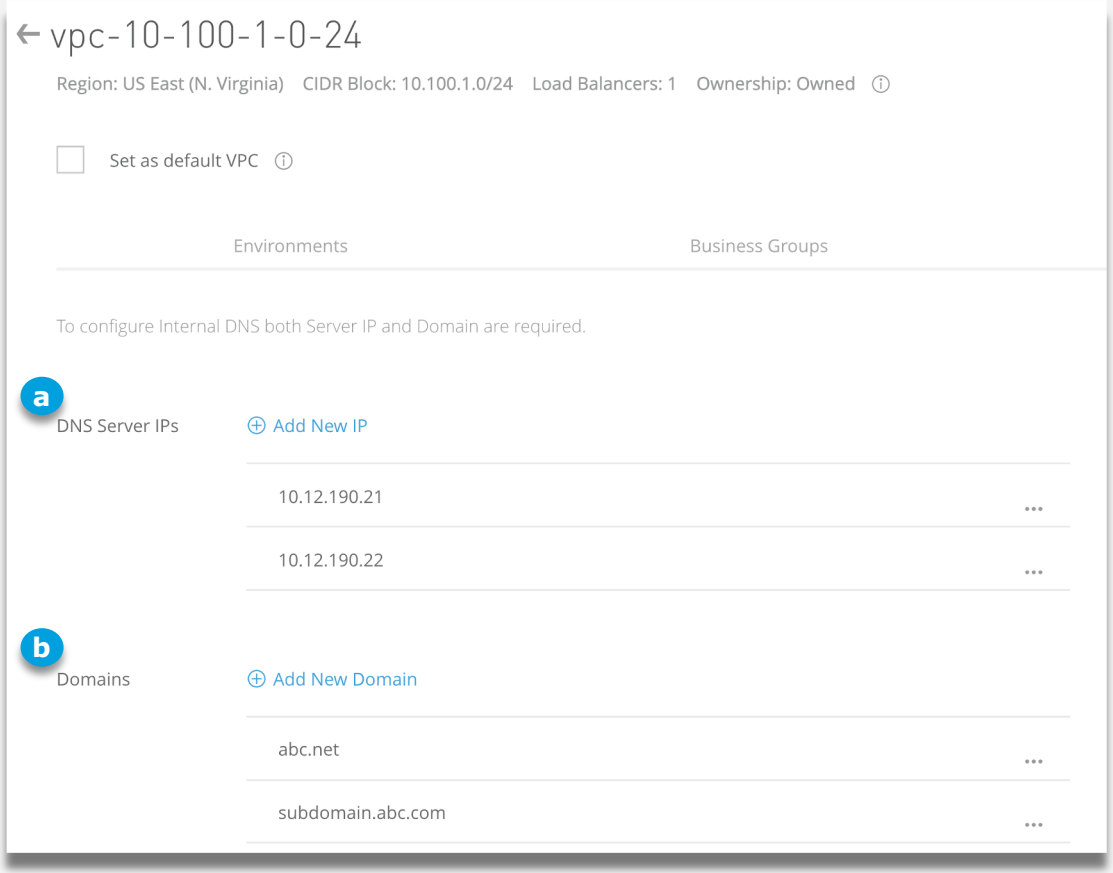
Modify the VPC for DNS*

1. Login to Runtime Manager --> VPCs
2. Click on **the VPC to modify**
3. Select **Internal DNS**
   a. Add DNS server(s) - click **Add New IP** for each server:
      - 10.12.190.21 - DNS server 1
      - 10.12.190.22 - DNS server 2
   b. Add domains to be resolved - click **Add New Domain** for each domain:
      - abc.net
      - subdomain.abc.com
4. Click **Apply Changes**



* May not be necessary for all VPN setups

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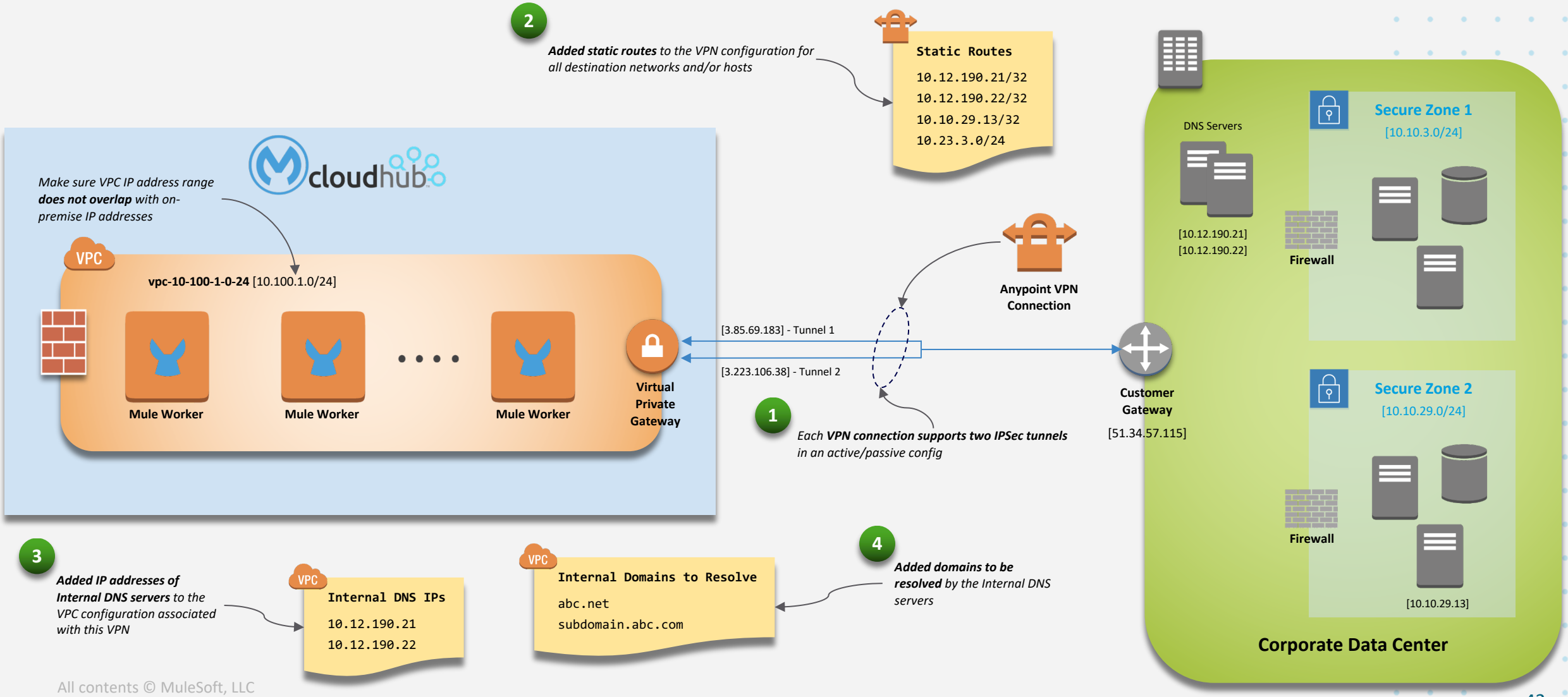
Network Topology - **After** Creating VPN



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Demo** - Validate Configuration of the VPC and the DLB

** The demo will not validate the configuration of the VPN created in Exercise 3

Bill-of-Material for the Demo

- Anypoint account
- DLB entitlement
- Customer VPC
- Shared CloudHub VPC
- Mule applications for testing
  - “rickb-net-tools-v2-1-1”**
  - “mule-runtime-keepalive-callback”**
- Postman

** See **Appendix B** for more details on the net-tools and keepAlive-callback services

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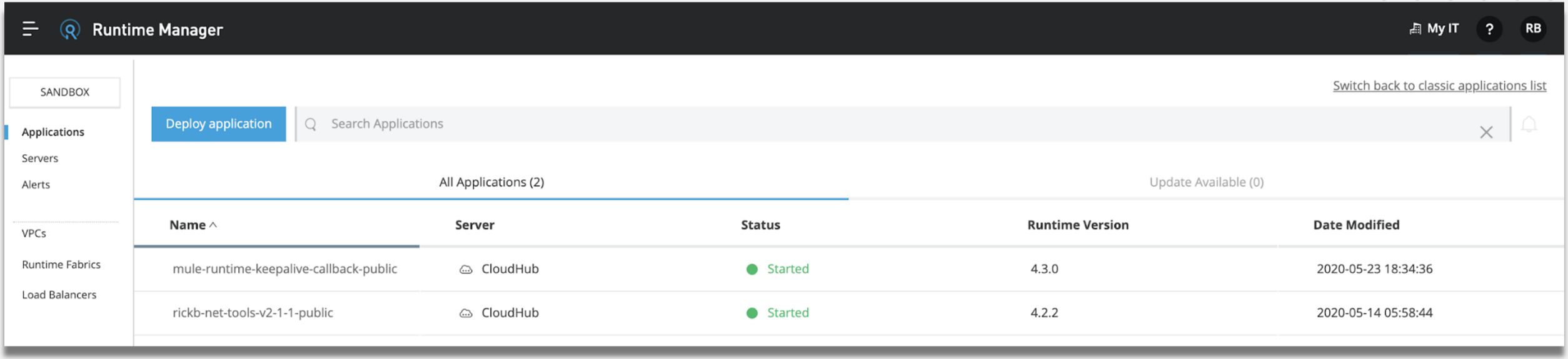
Applications in Business Group “My IT”

[Applications Within the **Public Shared VPC**]



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Applications in Business Group “VPC Demo”

[Applications Within a **Private VPC**]

Runtime Manager

VPC Demo ? RB

SANDBOX

Applications
Servers
Alerts

VPCs
Runtime Fabrics
Load Balancers

Switch back to classic applications list

Deploy application | Search Applications

All Applications (4) | Update Available (0)

Name	Server	Status	Runtime Version	Date Modified
mule-runtime-keepalive-callback-vpc-8081	CloudHub	Started	4.3.0	2020-05-21 18:43:55
mule-runtime-keepalive-callback-vpc-8091	CloudHub	Started	4.3.0	2020-05-21 17:47:09
rickb-net-tools-v2-1-1-vpc-8081	CloudHub	Started	4.3.0	2020-05-14 06:00:25
rickb-net-tools-v2-1-1-vpc-8091	CloudHub	Started	4.3.0	2020-05-14 08:34:57

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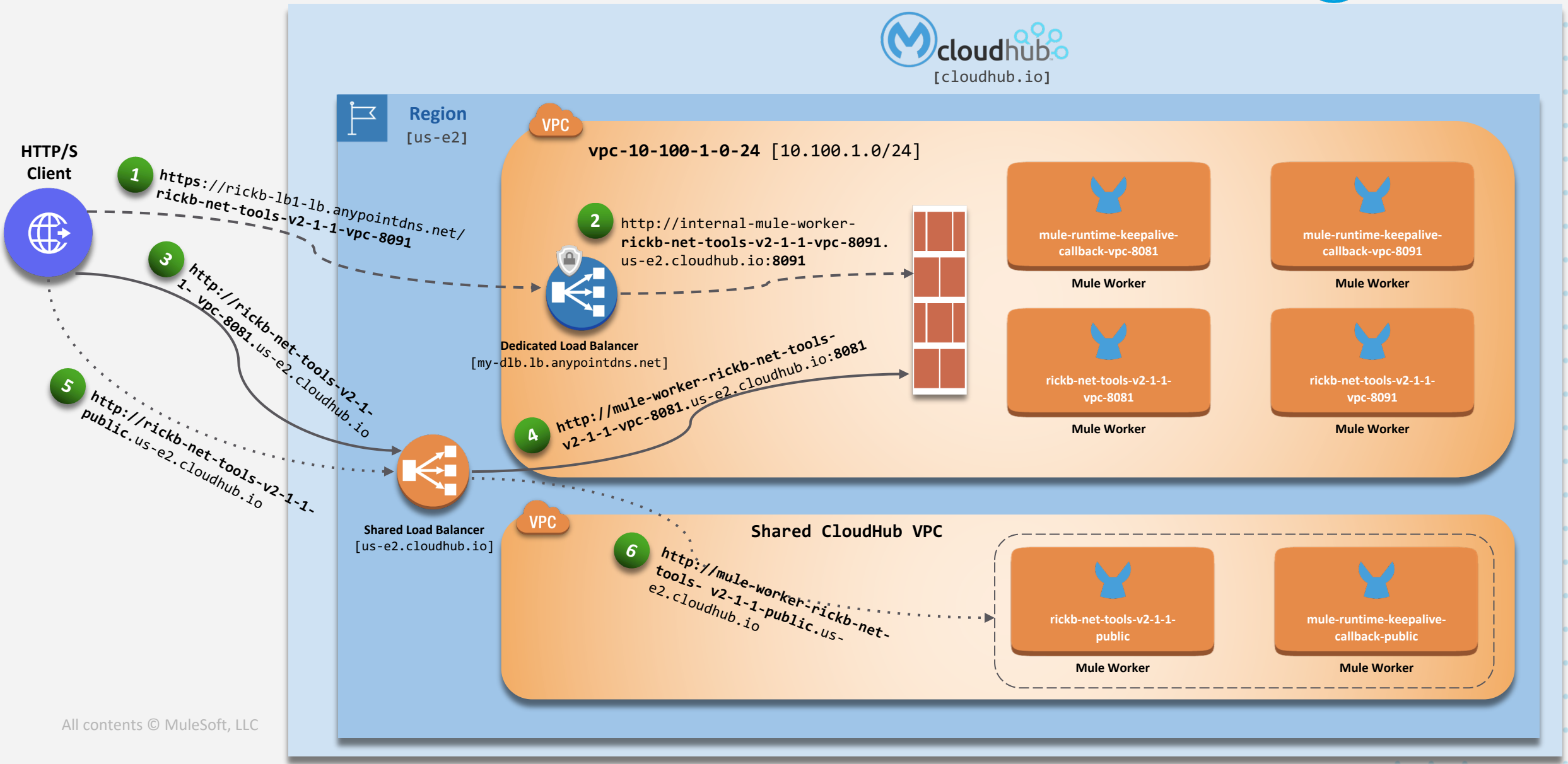
Demo Topology



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net-tools Service API Console

API console | Network connectivity tools

API summary

- Resources
  - /uname
    - GET
  - /ifconfig
    - GET
  - /netstat
    - GET
  - /ipconfig
    - GET
  - /ping
    - GET
  - /socket
    - GET
  - /traceroute

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Network connectivity tools

Version: 2.0

Supported protocols: HTTP

API base URI

http://rickb-net-tools-v2-1-1-public.us-e2.cloudhub.io/api/

API resources HIDE

- /uname
- /ifconfig
- /netstat
- /ipconfig
- /ping
- /socket
- /traceroute
- /dns
- /curl
- /ciphertest
- /certest

Command	Description
uname	Print the following: machine hardware name, nodename, machine processor architecture name, OS release, OS name and OS version
ifconfig	Configures and/or displays the current configuration parameters for a network interface
netstat	Displays the contents of various network-related data structures
ipconfig	Prints to standard output the IP address for the first network service associated with the given interface. Note: Command may not be available on all host operating systems
ping	Sends ICMP ECHO_REQUEST packets to network host and displays round-trip times and packet loss statistics
socket	Creates a TCP socket to test connectivity to an IP:Port combination and displays if end point has a listener or not
traceroute	Attempts to trace the route an IP packet would follow to some internet host by launching UDP probe packets with a small ttl (time to live) then listening for an ICMP "time exceeded" reply from a gateway. Displays the route taken with all of the "hops" along the path and the time to reach each hop
dns	Resolves and displays the specified endpoint's IP using the hosts DNS servers
curl	Runs a standard ***curl*** from the Mule host to the specified resource
ciphertest	Checks available SSL cipher suites for a given endpoint and displays a list of the supported ciphers
certest	Runs an SSL connection to a given endpoint, pulls and displays the certificate found for the endpoint

Postman Calls to “keepAlive” Service

Shared Public VPC

Postman

POST keepAlive-direct

keepAlive-direct

POST http://mule-worker-mule-runtime-keepalive-callback-public.us-e2.cloudhub.io:8081/keepAlive

Send

Body — Status: 200 OK — Time: 392 ms — Size: 620 B


```
{
  "message": "keep alive received on local address: /172.25.68.127:8081",
  "headers": {
    "authorization": "Basic bXVsZTpNdWxlU29mdA==",
    "user-agent": "PostmanRuntime/7.24.1",
    "accept": "*/*",
    "cache-control": "no-cache",
    "postman-token": "99142fb8-1184-4a4d-abbd-f200741b5f16",
    "host": "mule-worker-mule-runtime-keepalive-callback-public.us-e2.cloudhub.io:8081",
    "accept-encoding": "gzip, deflate, br",
    "connection": "keep-alive",
    "content-length": "0"
  }
}
```


Postman

POST keepAlive

keepAlive

POST http://mule-runtime-keepalive-callback-public.us-e2.cloudhub.io/keepAlive

Send

Body — Status: 200 OK — Time: 481 ms — Size: 747 B


```
{
  "message": "keep alive received on local address: /172.25.68.127:8081",
  "headers": {
    "host": "mule-runtime-keepalive-callback-public.us-e2.cloudhub.io",
    "x-real-ip": "204.14.239.17",
    "content-length": "0",
    "accept": "*/*",
    "accept-encoding": "gzip, deflate, br",
    "authorization": "Basic bXVsZTpNdWxlU29mdA==",
    "cache-control": "no-cache",
    "postman-token": "45e53c24-e138-411e-90f0-1706df9d2ff7",
    "user-agent": "PostmanRuntime/7.24.1",
    "x-forwarded-for": "204.14.239.17",
    "x-forwarded-port": "80",
    "x-forwarded-proto": "http"
  }
}
```

Postman Calls to “rickb-net-tools” Service

Shared Public VPC

MuleSoft

Postman

New | Import | Runner | My Workspace | Invite | Sign In

GET ifconfig -a

No Environment

ifconfig -a

Comments 0 | Examples 0

GET http://rickb-net-tools-v2-1-1-public.us-e2.cloudhub.io/api/ifconfig?args=-a

Send | Save

Params | Authorization | Headers (8) | Body | Pre-request Script | Tests | Settings | Cookies | Code

Query Params

KEY	VALUE	DESCRIPTION
☑ args	-a	
Key	Value	Description

Bulk Edit

Body | Cookies | Headers (5) | Test Results | Status: 200 OK | Time: 488 ms | Size: 1.06 KB | Save Response

Pretty | Raw | Preview | Visualize | Text

```
eth0      Link encap:Ethernet  HWaddr 0A:F9:4A:B7:B4:44
          inet addr:172.25.150.140  Bcast:172.25.191.255  Mask:255.255.192.0
          inet6 addr: fe80::8f9:4aff:feb7:b444/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:9001  Metric:1
          RX packets:390794 errors:0 dropped:0 overruns:0 frame:0
          TX packets:363768 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:203688302 (194.2 MiB)  TX bytes:66211405 (63.1 MiB)

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:65536  Metric:1
          RX packets:497819 errors:0 dropped:0 overruns:0 frame:0
          TX packets:497819 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:30889901 (29.4 MiB)  TX bytes:30889901 (29.4 MiB)
```

Bootcamp

Postman

New | Import | Runner | My Workspace | Invite | Sign In

GET netstat -ant

No Environment

netstat -ant

Comments 0 | Examples 0

GET http://rickb-net-tools-v2-1-1-public.us-e2.cloudhub.io/api/netstat?args=-ant

Send | Save

Params | Authorization | Headers (8) | Body | Pre-request Script | Tests | Settings | Cookies | Code

Query Params

KEY	VALUE	DESCRIPTION
☑ args	-ant	
Key	Value	Description

Bulk Edit

Body | Cookies | Headers (5) | Test Results | Status: 200 OK | Time: 163 ms | Size: 3.34 KB | Save Response

Pretty | Raw | Preview | Visualize | Text

```
Active Internet connections (servers and established)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp        0      0 127.0.0.1:53            0.0.0.0:*               LISTEN
tcp        0      0 0.0.0.0:22              0.0.0.0:*               LISTEN
tcp        0      0 127.0.0.1:25            0.0.0.0:*               LISTEN
tcp        0      0 127.0.0.1:32000         0.0.0.0:*               LISTEN
tcp        0      0 0.0.0.0:7777            0.0.0.0:*               LISTEN
tcp        0      0 0.0.0.0:33355           0.0.0.0:*               LISTEN
tcp        0      0 0.0.0.0:9999            0.0.0.0:*               LISTEN
tcp        0      0 0.0.0.0:111             0.0.0.0:*               LISTEN
tcp        0      0 0.0.0.0:8081            0.0.0.0:*               LISTEN
tcp       88      0 172.25.60.242:9999      45.13.93.82:47716       CLOSE_WAIT
tcp        0      0 127.0.0.1:32000         127.0.0.1:31001         ESTABLISHED
tcp        0      0 172.25.60.242:9999      162.243.136.126:53616   CLOSE_WAIT
tcp        0      0 172.25.60.242:42350     52.87.72.105:443        ESTABLISHED
tcp        0      0 172.25.60.242:9999      60.191.52.254:53926     CLOSE_WAIT
tcp        0      0 172.25.60.242:9999      45.143.220.91:58324     CLOSE_WAIT
tcp        0      0 172.25.60.242:22        222.186.180.41:16786    ESTABLISHED
tcp        0      0 172.25.60.242:9999      162.243.145.54:41224    CLOSE_WAIT
tcp        0      0 172.25.60.242:9999      159.89.237.165:41140    CLOSE_WAIT
```

Bootcamp

Postman Calls to “rickb-net-tools” Service

Shared Public VPC

Postman

GET ping -host=mule-worker-mule-runtime-keepalive-callback.us-e1.cloudhub.io

GET http://rickb-net-tools-v2-1-1-public.us-e2.cloudhub.io/api/ping?host=mule-worker-mule-runtime-keepalive-callback-public.us-e2.cloudhub.io

KEY	VALUE	DESCRIPTION
host	mule-worker-mule-runtime-keepalive-callback-public.us-e2.clouc	

Status: 200 OK Time: 3.20 s Size: 938 B

```
PING mule-worker-mule-runtime-keepalive-callback-public.us-e2.cloudhub.io (18.218.16.201) 56(84) bytes of data.
64 bytes from ec2-18-218-16-201.us-east-2.compute.amazonaws.com (18.218.16.201): icmp_seq=1 ttl=254 time=0.350 ms
64 bytes from ec2-18-218-16-201.us-east-2.compute.amazonaws.com (18.218.16.201): icmp_seq=2 ttl=254 time=0.401 ms
64 bytes from ec2-18-218-16-201.us-east-2.compute.amazonaws.com (18.218.16.201): icmp_seq=3 ttl=254 time=0.394 ms
64 bytes from ec2-18-218-16-201.us-east-2.compute.amazonaws.com (18.218.16.201): icmp_seq=4 ttl=254 time=0.400 ms

--- mule-worker-mule-runtime-keepalive-callback-public.us-e2.cloudhub.io ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3036ms
rtt min/avg/max/mdev = 0.350/0.386/0.401/0.025 ms
```

Postman

GET ping -host=mule-worker-internal-mule-runtime-keepalive-callback.us-e1.cloudhub.io

GET http://rickb-net-tools-v2-1-1-public.us-e2.cloudhub.io/api/ping?host=mule-worker-internal-mule-runtime-keepalive-callback-public.us-e2.cloudhub.

KEY	VALUE	DESCRIPTION
host	mule-worker-internal-mule-runtime-keepalive-callback-public.us-e2.cloudhub.io	

Status: 200 OK Time: 3.26 s Size: 748 B

```
PING mule-worker-internal-mule-runtime-keepalive-callback-public.us-e2.cloudhub.io (172.25.68.127) 56(84) bytes of data.
64 bytes from 172.25.68.127: icmp_seq=1 ttl=255 time=0.360 ms
64 bytes from 172.25.68.127: icmp_seq=2 ttl=255 time=0.743 ms
64 bytes from 172.25.68.127: icmp_seq=3 ttl=255 time=0.424 ms
64 bytes from 172.25.68.127: icmp_seq=4 ttl=255 time=0.354 ms

--- mule-worker-internal-mule-runtime-keepalive-callback-public.us-e2.cloudhub.io ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3009ms
rtt min/avg/max/mdev = 0.354/0.470/0.743/0.160 ms
```

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Postman Calls to “rickb-net-tools” Service

Shared Public VPC

Postman

GET certest host = rickb-lb1.lb.anyp...

certest host = rickb-lb1.lb.anypointdns.net; port = 443

GET http://rickb-net-tools-v2-1-1-public.us-e2.cloudhub.io/api/certest?host=rickb-lb1.lb.anypointdns.net&port=443

Send

Params | Authorization | Headers (8) | Body | Pre-request Script | Tests | Settings

Query Params

KEY	VALUE	DESCRIPTION
host	rickb-lb1.lb.anypointdns.net	
port	443	

Body | Cookies | Headers (5) | Test Results — Status: 200 OK Time: 226 ms Size: 3 KB

```
CONNECTED(00000003)
---
Certificate chain
 0 s:/C=US/ST=Texas/L=Frisco/O=MuleSoft/CN=*.rickbansal.com/emailAddress=rick.bansal@mulesoft.com
   i:/C=US/ST=Texas/L=Frisco/O=MuleSoft/CN=*.rickbansal.com/emailAddress=rick.bansal@mulesoft.com
-----BEGIN CERTIFICATE-----
MIIDiDCCAnACCQDZvlAjtGC7JjANBgkqhkiG9w0BAQsFADCBhTELMAkGA1UEBhMC
VVMxDjAMBgNVBAgMBVRleGFzMQ8wDQYDVQQHDAZGcmlzY28xETAPBgNVBAoMCE11
bGVTb2Z0MRkwFwYDVQQDDBAqLnJpY2tiYW5zYWwuY29tMScwJQYJKoZIhvcNAQkB
FhhyaWNrLmJhbnNhbEBtdWxlc29mdC5jb20wHhcNMjAwNDEzMDAxMDAxWhcNMjgw
NjMwMDAxMDAxWjCBhTELMAkGA1UEBhMCVVMxDjAMBgNVBAgMBVRleGFzMQ8wDQYD
VQQHDAZGcmlzY28xETAPBgNVBAoMCE11bGVTb2Z0MRkwFwYDVQQDDBAqLnJpY2ti
YW5zYWwuY29tMScwJQYJKoZIhvcNAQkBFhhyaWNrLmJhbnNhbEBtdWxlc29mdC5j
b20wggEiMA0GCSqGSIb3DQEBAQUAA4IBDwAwggEKAoIBAQDFPIilibvoou5L6AmW
lfZbEnmLZW6itoI1eg14SOHmlKJ+axEEXI/YBbGkouIfUzrZtUWLpq248S5Q2wib
P/431WmOegoOVv3H3zcwAuzKrOse8veY6r0NYtK9eullYMCX5P+PebJ6bPxaKyO3
Exzr1PwN5QxfUxL2eBqBd9OkjsN59nyPPeDon6d1qKYkJC2HdoUhdkmfticVwjRR
fwGywPBQxxB1PqQct3sterE2FjVxuD0aZBwrDqWZnb9qgWz4LBuq12BytmcrRBOQ
tiUWp6QztI8JRTGz9D8K6Qc5O4MZnCU2v8RDFvLuU7DppxwOlTqHrOgqbbSmel4G
VOFLAgMBAAEwDQYJKoZIhvcNAQELBQADggEBAA9MAAUsGIpbBLFpeFtzjN9svXOd
9xUS2yjhZ+nFs95Ycb8RNU4/fpMTsv7GNIr7okW/4G56zUpU4LQcYUIqn9HkD0mV
```

Postman

GET ciphertest host = rickb-lb1.lb.a...

ciphertest host = rickb-lb1.lb.anypointdns.net; port = 443

GET http://rickb-net-tools-v2-1-1-public.us-e2.cloudhub.io/api/ciphertest?host=rickb-lb1.lb.anypointdns.net&port=443

Send

Params | Authorization | Headers (8) | Body | Pre-request Script | Tests | Settings

Query Params

KEY	VALUE	DESCRIPTION
host	rickb-lb1.lb.anypointdns.net	
port	443	

Body | Cookies | Headers (5) | Test Results — Status: 200 OK Time: 4.04 s Size: 2.79 KB

```
List of supported ciphers:

ECDHE-RSA-AES256-GCM-SHA384: YES
ECDHE-ECDSA-AES256-GCM-SHA384: NO
ECDHE-RSA-AES256-SHA384: YES
ECDHE-ECDSA-AES256-SHA384: NO
ECDHE-RSA-AES256-SHA: NO
ECDHE-ECDSA-AES256-SHA: NO
DH-DSS-AES256-GCM-SHA384: NO
DHE-DSS-AES256-GCM-SHA384: NO
DH-RSA-AES256-GCM-SHA384: NO
DHE-RSA-AES256-GCM-SHA384: YES
DHE-RSA-AES256-SHA256: NO
DHE-DSS-AES256-SHA256: NO
DH-RSA-AES256-SHA256: NO
DH-DSS-AES256-SHA256: NO
DHE-RSA-AES256-SHA: NO
DHE-DSS-AES256-SHA: NO
DH-RSA-AES256-SHA: NO
DH-DSS-AES256-SHA: NO
DHE-RSA-CAMELLIA256-SHA: NO
```

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Postman Calls to “rickb-net-tools” Service

Private VPC

Postman

New | Import | Runner | My Workspace | Invite | Sign In

POST keepAlive on 8091 | GET ping -host=host=mule-worker-i...

No Environment

ping -host=host=mule-worker-internal-mule-runtime-keepalive-callback-vpc-8091.us-e1.cloudhub.io to net-tools on 8091 in VPC

Comments 0 | Examples 0

GET https://rickb-lb1.lb.anypointdns.net/rickb-net-tools-v2-1-1-vpc-8091/api/ping?host=mule-worker-internal-mule-runtime-keepalive-callback-vpc-809 | Send | Save

Params | Authorization | Headers (8) | Body | Pre-request Script | Tests | Settings | Cookies | Code

Query Params

KEY	VALUE	DESCRIPTION
host	mule-worker-internal-mule-runtime-keepalive-callback-vpc-8091.us-e1.cloudhub.io	
Key	Value	Description

Bulk Edit

Body | Cookies | Headers (8) | Test Results | Status: 200 OK | Time: 3.20 s | Size: 886 B | Save Response

Pretty | Raw | Preview | Visualize | Text

```
PING mule-worker-internal-mule-runtime-keepalive-callback-vpc-8091.us-e1.cloudhub.io (10.100.1.184) 56(84) bytes of data.
64 bytes from 10.100.1.184: icmp_seq=1 ttl=255 time=0.764 ms
64 bytes from 10.100.1.184: icmp_seq=2 ttl=255 time=0.951 ms
64 bytes from 10.100.1.184: icmp_seq=3 ttl=255 time=0.801 ms
64 bytes from 10.100.1.184: icmp_seq=4 ttl=255 time=0.855 ms

--- mule-worker-internal-mule-runtime-keepalive-callback-vpc-8091.us-e1.cloudhub.io ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3004ms
rtt min/avg/max/mdev = 0.764/0.842/0.951/0.078 ms
```

Bootcamp

Postman

New | Import | Runner | My Workspace | Invite | Sign In

GET ifconfig -a to net-tools on 8091...

No Environment

ifconfig -a to net-tools on 8091 in VPC

Comments 0 | Examples 0

GET https://rickb-lb1.lb.anypointdns.net/rickb-net-tools-v2-1-1-vpc-8091/api/ifconfig?args=-a | Send | Save

Params | Authorization | Headers (8) | Body | Pre-request Script | Tests | Settings | Cookies | Code

Query Params

KEY	VALUE	DESCRIPTION
args	-a	
Key	Value	Description

Bulk Edit

Body | Cookies | Headers (8) | Test Results | Status: 200 OK | Time: 661 ms | Size: 1.19 KB | Save Response

Pretty | Raw | Preview | Visualize | Text

```
eth0      Link encap:Ethernet  HWaddr 0E:10:81:A0:02:81
          inet addr:10.100.1.74  Bcast:10.100.1.127  Mask:255.255.255.192
          inet6 addr: fe80::c10:81ff:fea0:281/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:9001  Metric:1
          RX packets:424759 errors:0 dropped:0 overruns:0 frame:0
          TX packets:401135 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:210976922 (201.2 MiB)  TX bytes:73486937 (70.0 MiB)

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:65536  Metric:1
          RX packets:493413 errors:0 dropped:0 overruns:0 frame:0
          TX packets:493413 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:30616232 (29.1 MiB)  TX bytes:30616232 (29.1 MiB)
```

Bootcamp

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Postman Calls to “keepAlive” Service

Private VPC

Postman

New | Import | Runner | My Workspace | Invite | Sign In

POST keepAlive on 8091 | No Environment

keepAlive on 8091 | Comments 0 | Examples 0

POST https://rickb-lb1.lb.anypointdns.net/mule-runtime-keepalive-callback-vpc-8091/keepAlive | Send | Save

Params | Authorization | Headers (9) | Body | Pre-request Script | Tests | Settings | Cookies | Code

Query Params

KEY	VALUE	DESCRIPTION	Bulk Edit
Key	Value	Description	

Body | Cookies | Headers (8) | Test Results | Status: 200 OK | Time: 669 ms | Size: 829 B | Save Response

Pretty | Raw | Preview | Visualize | JSON


```
{
  "message": "keep alive received on local address: /10.100.1.184:8091",
  "headers": {
    "x-ssl-client-verify": "NONE",
    "host": "rickb-lb1.lb.anypointdns.net",
    "x-real-ip": "204.14.239.17",
    "x-forwarded-for": "204.14.239.17",
    "content-length": "0",
    "authorization": "Basic bXVsZTpNdWxlU29mdA==",
    "user-agent": "PostmanRuntime/7.24.1",
    "accept": "*/*",
    "cache-control": "no-cache",
    "postman-token": "6f21bab0-4777-4dee-8ac1-47c45f7d5abe",
    "accept-encoding": "gzip, deflate, br"
  }
}
```


Bootcamp

Postman

New | Import | Runner | My Workspace | Invite | Sign In

POST keepAlive on 8081 | No Environment

keepAlive on 8081 | Comments 0 | Examples 0

POST https://rickb-lb1.lb.anypointdns.net/mule-runtime-keepalive-callback-vpc-8081/keepAlive | Send | Save

Params | Authorization | Headers (9) | Body | Pre-request Script | Tests | Settings | Cookies | Code

Query Params

KEY	VALUE	DESCRIPTION	Bulk Edit
Key	Value	Description	

Body | Cookies | Headers (5) | Test Results | Status: 502 Bad Gateway | Time: 662 ms | Size: 322 B | Save Response

Pretty | Raw | Preview | Visualize | HTML


```
<html>

<head>
    <title>502 Bad Gateway</title>
</head>

<body>
    <center>
        <h1>502 Bad Gateway</h1>
    </center>
</body>

</html>
```


Bootcamp

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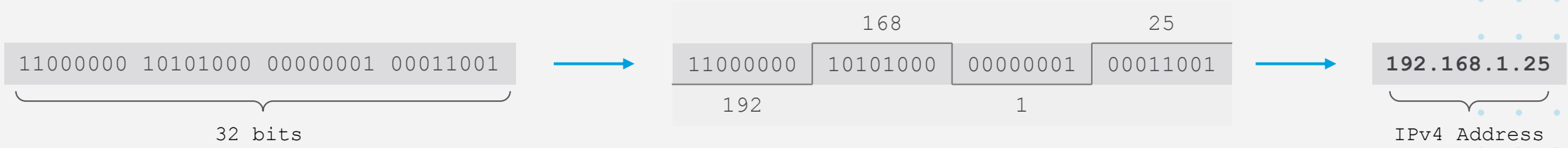
Appendix A: IP Addressing Details

IPv4 Addresses

- Every location or device on an **IP network** must be **uniquely addressable** by either an **IPv4 32-bit address** or an **IPv6 128-bit address**.
- While IPv6 is the newer version of the IP protocol, **IPv4** is still, by far, the **most implemented IP protocol on the internet**
- An IPv4 Network Address is a **32-bit binary number** represented as a **series of 4, base-10 octets, separated by a "."**
  - **Total** theoretical IPv4 **address space** is **2^{32}** addresses or **~4.3 x 10^9** addresses
  - For example, the diagram below **transforms** an IPv4 IP address **from** its **native** form **to** its common **decimal notation**:



- A unicast **IPv4 address** is comprised of **two logical components**: a **network** component and a **host** component.
- The bits that make up the **network** component of the address are **identified by a subnet mask** and remaining bits are part of the host component. Once assigned, the **network** portion is **static** but **host** portion remains **dynamic**.

	Network			Host
IP address:	11000000	10101000	00000001	xxxxxxxx
Subnet Mask:	11111111	11111111	11111111	00000000

Starting	Ending
192.168.1.0	192.168.1.255

256 total addresses

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IPv4 Addresses - cont'd

- In the early days of the Internet, **IPv4 addresses** were categorized into **five classes**:
  - **Class A, Class B, and Class C** addresses are the primary **unicast addresses**
  - **Class D** addresses are used for **multicasting** and **Class E** address are **reserved**
- The class defined the number of bits used for the network part and the number of bits used for the host part.

	Network	Host				Network	Host		
Class A:	00000000	00000000	00000000	00000000	→	01111111	11111111	11111111	11111111
	0.0.0.0					127.255.255.255			

	Network		Host			Network		Host	
Class B:	10000000	00000000	00000000	00000000	→	10111111	11111111	11111111	11111111
	128.0.0.0					191.255.255.255			

	Network			Host		Network			Host
Class C:	11000000	00000000	00000000	00000000	→	11011111	11111111	11111111	11111111
	192.0.0.0					223.255.255.255			

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Subnetting

- The idea of **subnetting** is to allow a user to **segment a network into smaller networks** for greater isolation.
- In the class based IPv4 address scheme, the user would create a new subnet by "**stealing**" **bits** from the **host portion** of the IP address, represented within the **subnet mask**:

	Network			Host
IP address:	11000000	10101000	00000001	10xxxxxx
Subnet Mask:	11111111	11111111	11111111	11000000

225.255.255.192

Stolen bits

	Network				Host
	11000000	10101000	00000001	10	xxxxxx

Starting IP	Ending IP
192.168.1.128	192.168.1.191

64 total addresses

- In this example, stealing the **2 most significant bits** of the host portion allows up to **4 subnets,** each w/**64 hosts**:

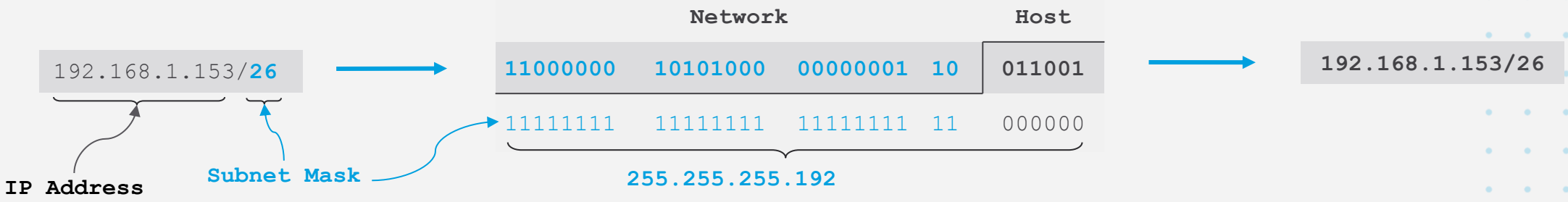
Network				Host
11000000	10101000	00000001	00	xxxxxx
11000000	10101000	00000001	01	xxxxxx
11000000	10101000	00000001	10	xxxxxx
11000000	10101000	00000001	11	xxxxxx

Network	Starting IP	Ending IP
192.168.1.0	192.168.1.0	192.168.1.63
192.168.1.64	192.168.1.64	192.168.1.127
192.168.1.128	192.168.1.128	192.168.1.191
192.168.1.192	192.168.1.192	192.168.1.255

All content

Subnets and CIDR Notation

- Because of the proliferation of devices on the Internet and the **limitations of the "Class" addresses for subnetting**, a new formatting scheme was **introduced** called **Classless Inter-Domain Routing (CIDR)**, pronounced "*cider*"
- **CIDR notation** expands upon the idea of subnetting by allowing the user to **add a subnet mask directly to the IP address specification**.
- The following example allows the user to create a **total** of **2^{26} subnets**, with **2^{6} hosts/subnet**:



- With **CIDR** notation**, subnets are of variable length.** The following example allows the user to create a **total** of **2^{12} subnets**, with **2^{20} hosts/subnet**:

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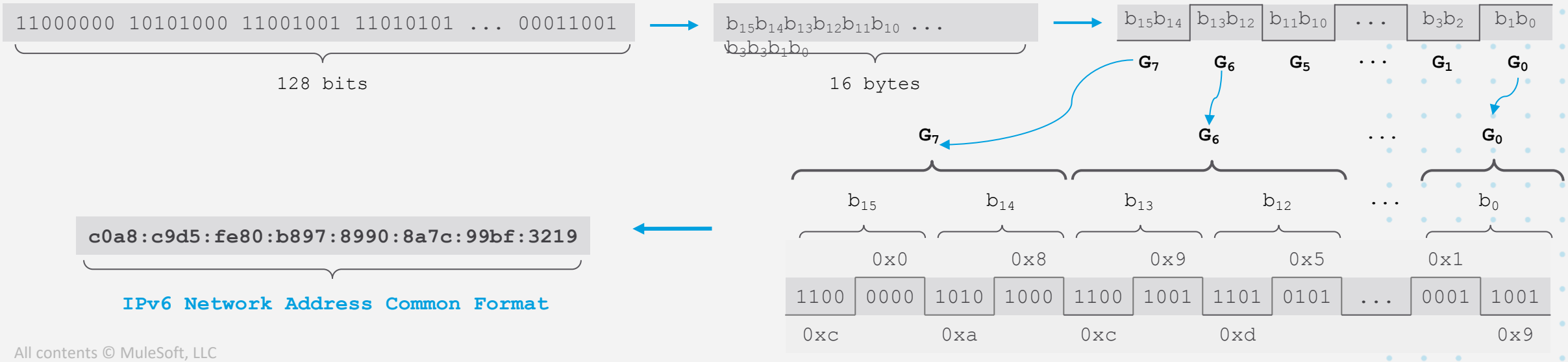
IPv6 Addresses

- Primary motivation for IPv6 was to **overcome the limited address space** of IPv4 as devices started to proliferate across the Internet.
- IPv6 and IPv4 are **not interoperable** protocols.
- IPv6 addresses are **128-bits long** providing a **total** theoretical **address space** of **2^{128}** addresses vs 2^{32} addresses for IPv4
  - **~3.4 x 10^{38} IPv6** addresses vs. **~4.3 x 10^{9} IPv4** addresses (fun fact: there are **~3.0 x 10^{23} stars** in the observable universe)
- An IPv6 Network Address is represented as **8 groups, of 4 hexadecimal digits, separated by a ":"**
  - For example, the diagram below **transforms** an IPv6 IP address from its **native** form **to** its **common notation**:



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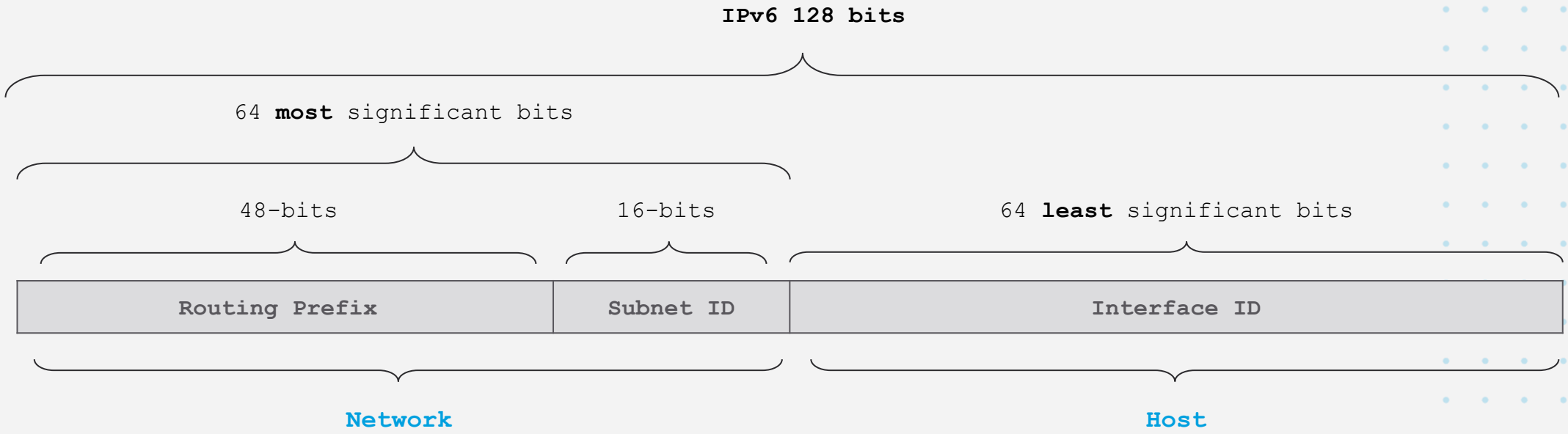
IPv6 Addresses - cont'd

- Similar to unicast IPv4 addresses, unicast **IPv6 addresses** are also comprised of **two logical components**: a **network** component and a **host** component
  - The **network** component is the **most significant 64-bits** and is further **decomposed** into the **routing prefix** and the **subnet id**
  - The **host** component is the **least significant 64-bits** and is referred to as the **interface id**



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Appendix B: net-tools service details

net-tools Service Authorization List

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studio-workspace-v750 - net-tools-v2.1.0/src/main/resources/beans.xml - Anypoint Studio

Package Explorer

- db-to-sfdc-sync-only-v1
- mule-runtime-keepalive-callback
- net-tools-v2.1.0
  - src/main/mule (Flows)
    - net-tools.xml
  - src/main/java
  - src/main/resources
    - beans.xml
    - config.yaml
    - log4j2.xml
    - api
    - web
    - web.css
    - web.js
  - src/test/java
  - src/test/resources
  - src/test/munit
  - JRE System Library [JRE [1.8.0_232]]
  - Mule Server 4.3.0 EE
  - Project Libraries
  - src
  - target
  - mule-artifact.json
  - README.md
  - pom.xml [Mule Server 4.3.0 EE]

net-tools | beans.xml

```xml
<beans xmlns="http://www.springframework.org/schema/beans"
  xmlns:context="http://www.springframework.org/schema/context"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:jdbc="http://www.springframework.org/schema/jdbc"
  xmlns:ss="http://www.springframework.org/schema/security"
  xsi:schemaLocation="http://www.springframework.org/schema/beans
    http://www.springframework.org/schema/beans/spring-beans-4.1.xsd
    http://www.springframework.org/schema/jdbc
    http://www.springframework.org/schema/jdbc/spring-jdbc-4.1.xsd
    http://www.springframework.org/schema/context
    http://www.springframework.org/schema/context/spring-context-4.1.xsd
    http://www.springframework.org/schema/security
    http://www.springframework.org/schema/security/spring-security-4.2.xsd">

  <ss:authentication-manager alias="authenticationManager">
    <ss:authentication-provider>
      <ss:user-service id="userService">
        <ss:user name="${user:mule}" password="${pass:MuleSoft}" authorities="ROLE_ADMIN" />
      </ss:user-service>
    </ss:authentication-provider>
  </ss:authentication-manager>
</beans>
```

Design Source

Mule Palette

net-tools-main

Listener → Basic security filter → APIkit Router

Open a Mule Configuration file or test t...ee the palette

Mule Properties | Problems | Console

Select a Mule message processor to edit its properties

beans.xml - net-tools-v2.1.0/src/main/resources

*Authorized **credentials list** for the Basic Security Filter are stored in* **`src/main/resources/beans.xml`**.

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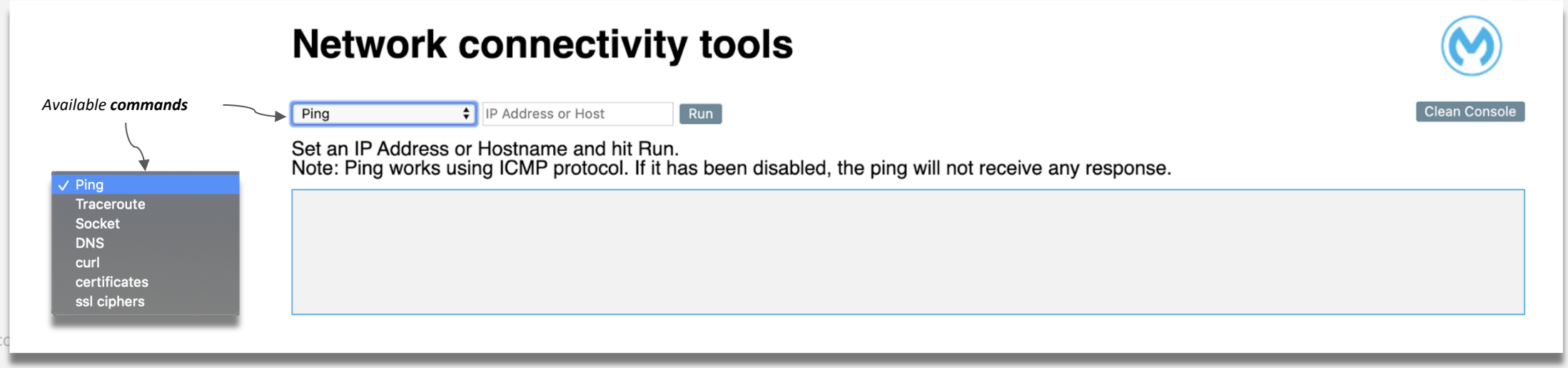
net-tools Service UI

- For convenience, the **net-tools service** has its own **UI**; however, the command list is limited to the options that were in the original net-tools service.
  - The **new options** that I added (`uname`, `ifconfig`, `netstat` and `ipconfig`) are **only available via APIs**
- The UI can be, generically, accessed via:
  - `http://<app-name>.<region>.cloudhub.io`
    - For example, `http://rickb-net-tools-v2-1-1-public.us-e2.cloudhub.io`
  - The UI uses the Basic Security Filter to protect access
    - Credentials are stored in the `beans.xml` file of the net-tools Studio project



net-tools Service API Console UI

API console | Network connectivity tools

API summary

- Resources
  - /uname
    - GET
  - /ifconfig
    - GET
  - /netstat
    - GET
  - /ipconfig
    - GET
  - /ping
    - GET
  - /socket
    - GET
  - /traceroute

Powered by MuleSoft

Network connectivity tools

Version: 2.0

Supported protocols: HTTP

API base URI

http://rickb-net-tools-v2-1-1-public.us-e2.cloudhub.io/api/

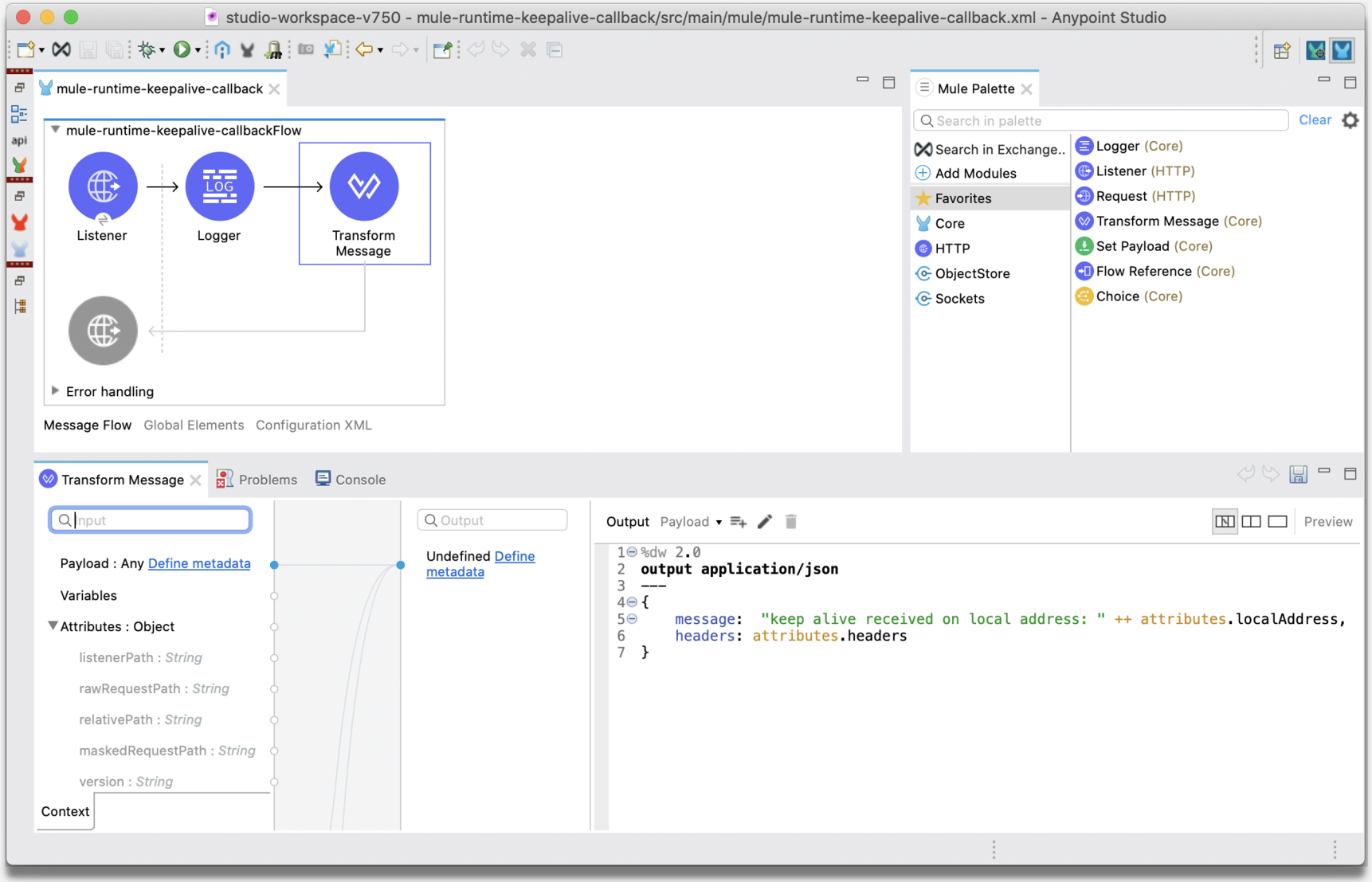
API resources HIDE

- /uname
- /ifconfig
- /netstat
- /ipconfig
- /ping
- /socket
- /traceroute
- /dns
- /curl
- /ciphertest
- /certest

Command	Description
uname	Print the following: machine hardware name, nodename, machine processor architecture name, OS release, OS name and OS version
ifconfig	Configures and/or displays the current configuration parameters for a network interface
netstat	Displays the contents of various network-related data structures
ipconfig	Prints to standard output the IP address for the first network service associated with the given interface. Note: Command may not be available on all host operating systems
ping	Sends ICMP ECHO_REQUEST packets to network host and displays round-trip times and packet loss statistics
socket	Creates a TCP socket to test connectivity to an IP:Port combination and displays if end point has a listener or not
traceroute	Attempts to trace the route an IP packet would follow to some internet host by launching UDP probe packets with a small ttl (time to live) then listening for an ICMP "time exceeded" reply from a gateway. Displays the route taken with all of the "hops" along the path and the time to reach each hop
dns	Resolves and displays the specified endpoint's IP using the hosts DNS servers
curl	Runs a standard ***curl*** from the Mule host to the specified resource
ciphertest	Checks available SSL cipher suites for a given endpoint and displays a list of the supported ciphers
certest	Runs an SSL connection to a given endpoint, pulls and displays the certificate found for the endpoint

All contents

keepAlive-callback Service Details



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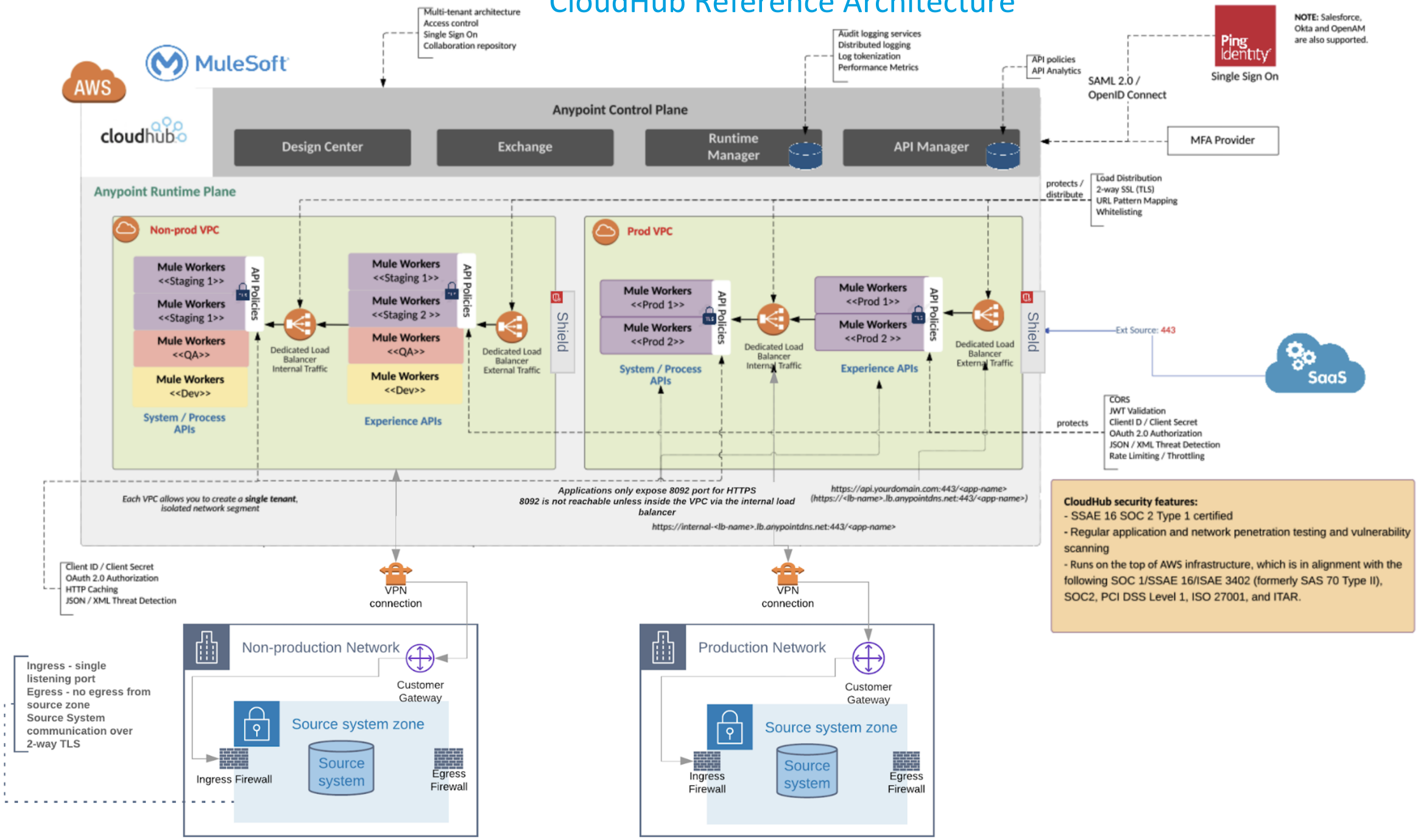
Appendix C: Misc

CloudHub Reference Architecture



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Thank you