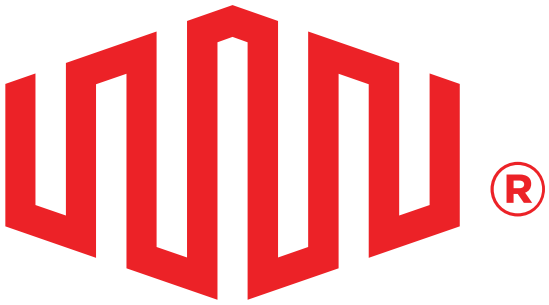
Equinix



Interconnection Benchmarking with OCI FastConnect & Equinix Fabric

Test Infrastructure - Configuration Details

Version: (1.0) **Date: (08/01/2022)**

Document History and Distribution

1. Revision History

Revision #	Revision Date	Description of Change	Author
0.1	01/01/2022	First Draft	R. Carrara
1.0	6/13/2022	Final draft for the Backup	P. Panchal

Contents

1. INTRODUCTION

The purpose of this document is to document the infrastructure used for performance testing. This is a companion document to the actual performance test results deliverable.

1.1 Objectives

To be transparent on the hardware, software, tools, and configuration details of the test environment used to benchmark data transfer times for Oracle Cloud Database backup activity.

1.2 Testing Strategy

Interconnection was provided using Oracle FastConnect via Equinix Fabric and direct Internet, both configured at 10Gbps.

A number of performance variables were introduced to simulate a wide range of real-world possibilities.

These variables were:

1) Latency

2) Packet Loss

3) MTU

4) Parallel Channels

5) Database Size

6) Oracle Cloud Region

1.3 Scope

Testing was performed from an Equinix Metal “Project” located in Silicon Valley to US West (San Jose) Oracle Cloud Region using three interconnection types:

i. Public internet

ii. Private Peering – Via Equinix Fabric VC

iii. Public Peering – Via Equinix Fabric VC

2. PHYSICAL INFRASTRUCTURE

2.1 Hardware

Equinix Metal is an automated, interconnected, low-latency bare metal-as-a-service offered and operated by Equinix. The test infrastructure was built out using Equinix Metal in Silicon Valley.

Server Name	*Equinix Metal Instance*	*CPU*	*Cores*	*Boot*	*Storage*	*Memory*	*Network*
VyOS Gateway	n2.xlarge.x86	2 x Intel Xeon Gold 5120	28 @ 2.20GHz	2 x 120 GB SSD	1 x 3.8 TB NVMe	384 GB RAM	4 x 10 Gbps
Linux Traffic Controller (tc)	n2.xlarge.x86	2 x Intel Xeon Gold 5120	28 @ 2.20GHz	2 x 120 GB SSD	1 x 3.8 TB NVMe	384 GB RAM	4 x 10 Gbps
OracleDB	m3.large.x86	1x AMD EPYC 7502P	32 @ 2.5Ghz	2 x 240 GB SSD	2 x 3.8 TB NVMe	256 GB RAM	2 x 25 Gbps

2.3 Software

Server Name	*OS*	*Kernel / Version*
VyOS Gateway	CentOS 8	4.19.106-amd64-vyos
Linux TC	CentOS 8	4.18.0-240.22.1.el8_3.x86_64
OracleDB	Oracle Linux Server 7.9	3.10.0-1160.24.1.el7.x86_64

2.4 Software Tools

Server Name	*OS*	*Kernel / Version*
VyOS Gateway	VyOS	1.2.5
Linux TC	Linux TC	tc utility, iproute2-5.9.0

2.5 Configurations

VyOS Gateway – VyOS Configuration

```
interfaces {
    bonding bond0 {
        address 136.144.55.221/31
        address 136.144.55.11/32
        description "Layer 3 bond"
        hash-policy layer2
        mode 802.3ad
        mtu 1500
    }
    dummy dum1 {
        address 145.40.90.164/32
    }
    ethernet eth0 {
        bond-group bond0
        duplex auto
        hw-id e4:43:4b:dd:e6:d0
        mtu 9000
        smp-affinity auto
        speed auto
    }
    ethernet eth1 {
        duplex auto
        hw-id e4:43:4b:dd:e6:d1
        mtu 9000
        smp-affinity auto
        speed auto
        vif 20 {
        }
        vif 1001 {
            address 10.100.0.1/30
            description "FC through Fabric to Oracle"
        }
        vif 1004 {
            address 10.100.0.9/30
            description "DC Remote VC"
        }
        vif 1005 {
            address 10.100.0.5/30
            description "PHX Remote VC"
        }
        vif 1010 {
            address 169.254.47.62/30
            address 145.40.90.165/32
            description "Public FC through Fabric to Oracle - SV"
        }
        vif 1014 {
            address 169.254.62.214/30
```

```
            address 145.40.90.167/32
            description "Public FC to DC"
        }
        vif 1015 {
            address 169.254.198.78/30
            address 145.40.90.166/32
            description "Public FC to PHX"
        }
    }
    ethernet eth2 {
        bond-group bond0
        duplex auto
        hw-id e4:43:4b:dd:e6:d2
        mtu 9000
        smp-affinity auto
        speed auto
    }
    ethernet eth3 {
        address 10.2.2.1/24
        duplex auto
        hw-id e4:43:4b:dd:e6:d3
        mtu 9000
        smp-affinity auto
        speed auto
    }
    loopback lo {
        address 10.5.5.1/32
    }
    vti vti0 {
        address 172.16.100.2/30
        description VPN_VTI0
    }
}
nat {
    destination {
        rule 200 {
            description "VPN D-NAT"
            destination {
                address 136.144.55.11
            }
            inbound-interface bond0
            translation {
                address 10.2.2.30
            }
        }
    }
    source {
        rule 100 {
            description "VPN Oracle S-NAT"
            outbound-interface bond0
            source {
                address 10.2.2.20
            }
            translation {
                address masquerade
```

```
            }
        }
        rule 105 {
            description "VPN Oracle S-NAT 10.4.4.0"
            outbound-interface bond0
            source {
                address 10.4.4.20
            }
            translation {
                address masquerade
            }
        }
        rule 120 {
            description "NAT for SV Public FC"
            outbound-interface eth1.1010
            source {
                address !169.254.47.60/30
            }
            translation {
                address 145.40.90.165
            }
        }
        rule 200 {
            description "VPN S-NAT"
            outbound-interface bond0
            source {
                address 10.2.2.30
            }
            translation {
                address 136.144.55.11
            }
        }
        rule 1014 {
            description "NAT for DC Public FC"
            outbound-interface eth1.1014
            source {
                address !169.254.62.212/30
            }
            translation {
                address 145.40.90.167
            }
        }
        rule 1015 {
            description "NAT for PHX Public FC"
            outbound-interface eth1.1015
            source {
                address !169.254.198.76/30
            }
            translation {
                address 145.40.90.166
            }
        }
    }
}
policy {
```

```
    prefix-list OCI-Prv {
        rule 10 {
            action permit
            prefix 10.2.2.0/24
        }
        rule 20 {
            action permit
            prefix 10.4.4.0/24
        }
    }
    prefix-list OCI-Pub {
        rule 10 {
            action permit
            prefix 136.144.55.11/32
        }
        rule 15 {
            action permit
            prefix 145.40.90.164/30
        }
    }
    prefix-list Static {
        rule 10 {
            action permit
            prefix 10.4.4.0/24
        }
    }
    route-map OCI-Prv {
        rule 10 {
            action permit
            match {
                ip {
                    address {
                        prefix-list OCI-Prv
                    }
                }
            }
        }
```

VyOS Gateway – Bond0 Configuration

Bond0

```
Bonding Mode: IEEE 802.3ad Dynamic link aggregation
Transmit Hash Policy: layer2 (0)
MII Status: up
MII Polling Interval (ms): 250
Up Delay (ms): 0
Down Delay (ms): 0
```

```
802.3ad info
LACP rate: slow
Min links: 0
Aggregator selection policy (ad_select): stable

Slave Interface: eth2
MII Status: up
Speed: 10000 Mbps
Duplex: full
Link Failure Count: 0
Permanent HW addr: e4:43:4b:dd:e6:d2
Slave queue ID: 0
Aggregator ID: 1
Actor Churn State: none
Partner Churn State: none
Actor Churned Count: 0
Partner Churned Count: 0

Slave Interface: eth0
MII Status: up
Speed: 10000 Mbps
Duplex: full
Link Failure Count: 0
Permanent HW addr: e4:43:4b:dd:e6:d0
Slave queue ID: 0
Aggregator ID: 1
Actor Churn State: none
Partner Churn State: none
Actor Churned Count: 0
Partner Churned Count: 0
```

Linux TC – Bond0 & Bond1 Configuration

Bond0

```
Bonding Mode: IEEE 802.3ad Dynamic link aggregation
Transmit Hash Policy: layer2 (0)
MII Status: up
MII Polling Interval (ms): 100
Up Delay (ms): 200
Down Delay (ms): 200
Peer Notification Delay (ms): 0

802.3ad info
LACP rate: slow
Min links: 0
Aggregator selection policy (ad_select): stable
System priority: 65535
System MAC address: <Obfuscated>
Active Aggregator Info:
        Aggregator ID: 1
        Number of ports: 2
        Actor Key: 15
        Partner Key: 24
        Partner Mac Address: <Obfuscated>

Slave Interface: eno1
MII Status: up
Speed: 10000 Mbps
Duplex: full
Link Failure Count: 0
Permanent HW addr: e4:43:4b:de:10:00
Slave queue ID: 0
Aggregator ID: 1
Actor Churn State: none
Partner Churn State: none
Actor Churned Count: 0
Partner Churned Count: 0
details actor lacp pdu:
    system priority: 65535
    system mac address: <Obfuscated>
```

```
    port key: 15
    port priority: 255
    port number: 1
    port state: 61
details partner lacp pdu:
    system priority: 32768
    system mac address: <Obfuscated>
    oper key: 24
    port priority: 4096
    port number: 28
    port state: 61

Slave Interface: eno3
MII Status: up
Speed: 10000 Mbps
Duplex: full
Link Failure Count: 0
Permanent HW addr: e4:43:4b:de:10:02
Slave queue ID: 0
Aggregator ID: 1
Actor Churn State: none
Partner Churn State: none
Actor Churned Count: 0
Partner Churned Count: 0
details actor lacp pdu:
    system priority: 65535
    system mac address: <Obfuscated>
    port key: 15
    port priority: 255
    port number: 2
    port state: 61
details partner lacp pdu:
    system priority: 32768
    system mac address: <Obfuscated>
    oper key: 24
    port priority: 32768
```

```
    port number: 32796
    port state: 61
```

Bond1

```
Bonding Mode: IEEE 802.3ad Dynamic link aggregation
Transmit Hash Policy: layer2 (0)
MII Status: up
MII Polling Interval (ms): 100
Up Delay (ms): 200
Down Delay (ms): 200
Peer Notification Delay (ms): 0

802.3ad info
LACP rate: slow
Min links: 0
Aggregator selection policy (ad_select): stable
System priority: 65535
System MAC address: <Obfuscated>
Active Aggregator Info:
        Aggregator ID: 1
        Number of ports: 2
        Actor Key: 15
        Partner Key: 28
        Partner Mac Address: <Obfuscated>

Slave Interface: eno2
MII Status: up
Speed: 10000 Mbps
Duplex: full
Link Failure Count: 0
Permanent HW addr: <Obfuscated>
Slave queue ID: 0
Aggregator ID: 1
Actor Churn State: none
Partner Churn State: none
Actor Churned Count: 0
```

```
Partner Churned Count: 0
details actor lacp pdu:
    system priority: 65535
    system mac address: <Obfuscated>
    port key: 15
    port priority: 255
    port number: 1
    port state: 61
details partner lacp pdu:
    system priority: 32768
    system mac address: <Obfuscated>
    oper key: 28
    port priority: 32768
    port number: 32
    port state: 61

Slave Interface: eno4
MII Status: up
Speed: 10000 Mbps
Duplex: full
Link Failure Count: 0
Permanent HW addr: <Obfuscated>
Slave queue ID: 0
Aggregator ID: 1
Actor Churn State: none
Partner Churn State: none
Actor Churned Count: 0
Partner Churned Count: 0
details actor lacp pdu:
    system priority: 65535
    system mac address: <Obfuscated>
    port key: 15
    port priority: 255
    port number: 2
    port state: 61
details partner lacp pdu:
```

```
    system priority: 32768
    system mac address: <Obfuscated>
    oper key: 28
    port priority: 32768
    port number: 32800
    port state: 61
```

MTU

```
eno1: mtu 1500
eno2: mtu 9000
eno3: mtu 1500
eno4: mtu 9000
bond0: mtu 1500
bond1: mtu 9000
bond1.1060@bond1: mtu 9000
bond1.1003@bond1: mtu 9000
```

OracleDB – Bond0

Bond0

```
Bonding Mode: IEEE 802.3ad Dynamic link aggregation
Transmit Hash Policy: layer2 (0)
MII Status: up
MII Polling Interval (ms): 100
Up Delay (ms): 200
Down Delay (ms): 200

802.3ad info
LACP rate: slow
Min links: 0
Aggregator selection policy (ad_select): stable
System priority: 65535
System MAC address: <Obfuscated>
```

```
Active Aggregator Info:
        Aggregator ID: 1
        Number of ports: 2
        Actor Key: 21
        Partner Key: 49
        Partner Mac Address: <Obfuscated>

Slave Interface: p3p1
MII Status: up
Speed: 25000 Mbps
Duplex: full
Link Failure Count: 0
Permanent HW addr: <Obfuscated>
Slave queue ID: 0
Aggregator ID: 1
Actor Churn State: none
Partner Churn State: none
Actor Churned Count: 0
Partner Churned Count: 0
details actor lacp pdu:
    system priority: 65535
    system mac address: <Obfuscated>
    port key: 21
    port priority: 255
    port number: 1
    port state: 61
details partner lacp pdu:
    system priority: 32768
    system mac address: <Obfuscated>
    oper key: 49
    port priority: 4096
    port number: 13
    port state: 61

Slave Interface: p3p2
MII Status: up
```

```
Speed: 25000 Mbps
Duplex: full
Link Failure Count: 0
Permanent HW addr: <Obfuscated>
Slave queue ID: 0
Aggregator ID: 1
Actor Churn State: none
Partner Churn State: none
Actor Churned Count: 0
Partner Churned Count: 0
details actor lacp pdu:
    system priority: 65535
    system mac address: <Obfuscated>
    port key: 21
    port priority: 255
    port number: 2
    port state: 61
details partner lacp pdu:
    system priority: 32768
    system mac address: <Obfuscated>
    oper key: 49
    port priority: 32768
    port number: 32781
    port state: 61
```

MTU

```
p3p1: mtu 9000
p3p2: mtu 9000
bond0: mtu 9000
bond0.1003@bond0: mtu 9000
bond0.1000@bond0: mtu 9000
bond0.1060@bond0: mtu 9000
```

2.6 Software Tools Configuration

In order to emulate RTT (Round-Trip Time) for tests, total latency was divided in two with each half applied on egress from the Linux TC system, bond1.1060 & bond1.1003.

Loss was applied in the direction of data transfer, from data source to data sink, based on which tests were performed, Backup or Recovery.

Real Internet latency to/from Oracle was negligible, approximately 1ms. Any possible Internet loss was not measurable. As such took the position of an assumed Internet baseline latency and loss over 0 and 0, respectively.

All tests were routed through the Linux TC box, including zero latency and zero loss tests.

Latency Values Used: All milliseconds (ms) – **0, 10, 20, 35, 50, 75, 100, 150**

Packet Loss % Values Used: 0.0%, 0.1% loss, 0.5% loss, 1% loss

Linux TC – Linux Traffic Control (TC) Configuration

Latency and loss parameters were applied using the variables of %1 and %2, respectively.
All scripts can be found in *the DB Creation, Oracle Cloud Backup Module Configuration and RMAN Backup to OCI* document.
 	
`tc qdisc add dev bond1.1003 root netem limit 187500 delay "$1"ms loss "$2"%"`
`tc qdisc add dev bond1.1060 root netem limit 187500 delay "$1"ms"`

2.7 Oracle DB Details

2.7.1 Versions

DB version: 19.3.0.0.0

OS Version: oracle linux:7:9

2.7.2 Oracle DB Creation

Database Creation in Silent mode :

```
[oracle@sv15-s3  ~]$ dbca -silent -createDatabase -templateName General_Purpose.dbc -gdbName TESTBMPOC -sid TESTBMPOC-sysPassword sys -systemPassword sys -emConfiguration NONE -datafileDestination /u01/app/oracle/oradata -storageType FS -characterSet AL32UTF8
Copying database files
1% complete
3% complete
```

```
35% complete
Creating and starting Oracle instance
37% complete
42% complete
47% complete
52% complete
53% complete
56% complete
58% complete
Registering database with Oracle Restart
64% complete
Completing Database Creation
68% complete
71% complete
75% complete
85% complete
96% complete
100% complete
Look at the log file
"/u01/app/oracle/cfgtoollogs/dbca/TESTBMPOC/TESTBMPOC.log" for
further details.
```

2.7.3 1TB Dataset Creation

Swingbench Commands to populate the 1TB of data in the Database

/home/oracle/swingbench/bin/oewizard -cl -create -cs //oracle-poc/EQXFC -u soe1 -p soe <pwd> -scale 450 -tc 32 -dba "sys as sysdba" -dbap <pwd> -ts SOE8 -df /oracle/app/oracle/oradata/EQXFC/soe08.dbf

2.7.4 OCI CLI Installation

Install, configure, and verify the OCI CLI, as outlined in https://docs.oracle.com/en-us/iaas/Content/API/SDKDocs/cliinstall.htm.

2.7.5 OCI Object Storage Bucket creation

Create an object Storage bucket and give it appropriate IAM permissions to the user configured in the above step by following https://docs.oracle.com/en-us/iaas/Content/Object/Tasks/managingbuckets.htm
It is important to note that the scripts are configured to use bucket name “BACKUP_EQXFC” hence it is recommended to use the same name. If the name is changed then the backup script will need to be adjusted accordingly.

2.7.6 OCI Connectivity

Configure RMAN to point to the Object Storage bucket created in the above step

```
java -jar oci_install.jar -host https://objectstorage.us-sanjose-1.oraclecloud.com \
  -pvtKeyFile <pvt Key File Location> \
  -pubFingerPrint <pub fingerprint for the key as shown in OCI console> \
  -uOCID ocid1.user.oc1<user ocid> \
  -tOCID ocid1.tenancy.oc1<tenancy ocid> \
  -cOCID ocid1.compartment.oc1<compartment ocid> \
  -configFile /oracle/app/oracle/product/19.0.0/dbhome_1/dbs/opcRMANTEST.ora \
  -walletDir /oracle/app/oracle/product/19.0.0/dbhome_1/dbs/wallet \
  -libDir /oracle/app/oracle/product/19.0.0/dbhome_1/lib \
  -bucket BACKUP_EQXFC
```

2.7.7 RMAN Configuration

OracleDB – RMAN Configuration

RMAN> show all;

using target database control file instead of recovery catalog

RMAN configuration parameters for database with db_unique_name RMANTEST are:

CONFIGURE RETENTION POLICY TO REDUNDANCY 1; # default

CONFIGURE BACKUP OPTIMIZATION OFF; # default

CONFIGURE DEFAULT DEVICE TYPE TO DISK; # default

CONFIGURE CONTROLFILE AUTOBACKUP OFF; # default

CONFIGURE CONTROLFILE AUTOBACKUP FORMAT FOR DEVICE TYPE SBT_TAPE TO '%F'; # default

CONFIGURE CONTROLFILE AUTOBACKUP FORMAT FOR DEVICE TYPE DISK TO '%F'; # default

CONFIGURE DEVICE TYPE 'SBT_TAPE' PARALLELISM 64 BACKUP TYPE TO BACKUPSET;

CONFIGURE DEVICE TYPE DISK PARALLELISM 1 BACKUP TYPE TO BACKUPSET; # default

CONFIGURE DATAFILE BACKUP COPIES FOR DEVICE TYPE SBT_TAPE TO 1; # default

CONFIGURE DATAFILE BACKUP COPIES FOR DEVICE TYPE DISK TO 1; # default

CONFIGURE ARCHIVELOG BACKUP COPIES FOR DEVICE TYPE SBT_TAPE TO 1; # default

CONFIGURE ARCHIVELOG BACKUP COPIES FOR DEVICE TYPE DISK TO 1; # default

CONFIGURE CHANNEL DEVICE TYPE 'SBT_TAPE' PARMS
'SBT_LIBRARY=/oracle/app/oracle/product/12.1.0.2/sbl_uat/lib/libopc.so,SBT_PARMS=(OPC_PFILE=/oracle/app/oracle/product/12.1.0.2/sbl_uat/dbs/opcRMANTEST.ora)';

CONFIGURE MAXSETSIZE TO UNLIMITED; # default

CONFIGURE ENCRYPTION FOR DATABASE OFF; # default

CONFIGURE ENCRYPTION ALGORITHM 'AES128'; # default

CONFIGURE COMPRESSION ALGORITHM 'BASIC' AS OF RELEASE 'DEFAULT' OPTIMIZE FOR LOAD TRUE ; # default

CONFIGURE RMAN OUTPUT TO KEEP FOR 7 DAYS; # default

CONFIGURE ARCHIVELOG DELETION POLICY TO NONE; # default

CONFIGURE SNAPSHOT CONTROLFILE NAME TO '/oracle/app/oracle/product/12.1.0.2/sbl_uat/dbs/snapcf_RMANTEST.f'; # default

RMAN>

To test the RMAN throughput to OCI, the following rman script can be used

To check what you can achieve on a single channel you can use this command:

```
 run {
       allocate channel t1 device type sbt parms='SBT_LIBRARY=/oracle/app/oracle/product/12.1.0.2/sbl_uat/lib/libopc.so
```

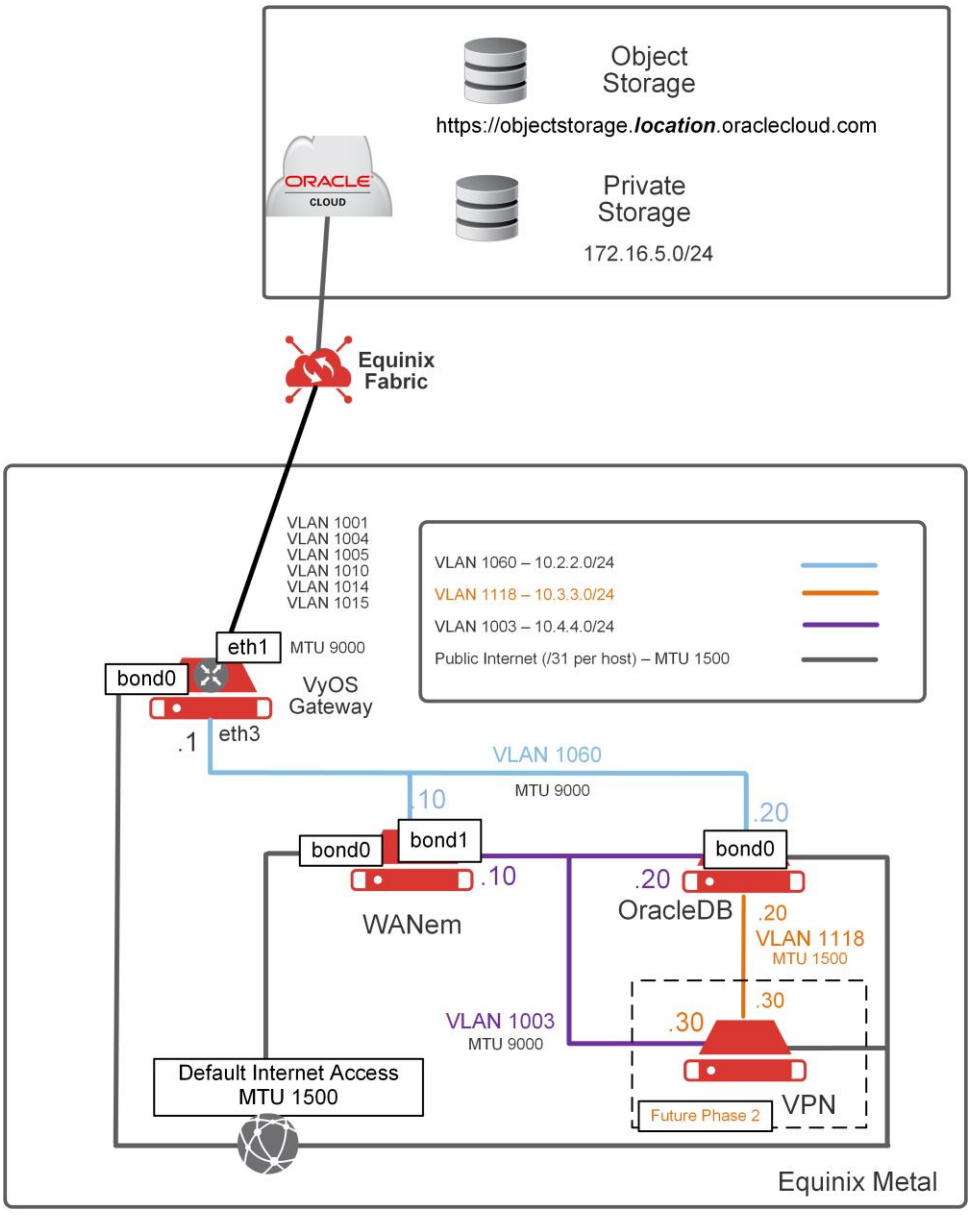
```
ENV=(OPC_PFILE=/oracle/app/oracle/product/12.1.0.2/sbl_uat/dbs/opcRMANTEST.ora)';
        send channel t1 'NETTEST backup 1024M' ;


    }
```

2.7.8 Scripting details for Backups

The backup script can be found under https://github.com/equinix/cloud-interconnection-benchmarking-backup scripts folder

3. LOGICAL

3.1 Network and Hosts



3.2 Hosts, Interfaces and IP Addressing

VyOS Gateway Network Interfaces	
bond0 -	136.144.55.221/31
eth3 -	10.2.2.1/24
eth1.1001 -	10.100.0.1/30 (SV Local VC)
eth1.1004 -	10.100.0.9/30 (DC Remote VC)
eth1.1005 -	10.100.0.5/30 (PHX Remote VC)
Public FC VC to Oracle SV	
eth1.1010 -	169.254.62.214/30
	145.40.90.167/32
Public FC VC to Oracle DC	
eth1.1014 -	169.254.62.214/30
	145.40.90.167/32
Public FC VC to Oracle PHX	
eth1.1015 -	169.254.62.214/30
	145.40.90.166/32
Source NAT –	136.144.55.11
DGW –	136.144.55.220

VyOS Gateway - n2.xlarge

eth0 + eth2 (bond0) = Internet
eth1 = 10G Fabric connection
eth3 = Internal test environment

WANem - n2.xlarge

eno1 + eno3 (bond0) = Internet
eno2 + eno4 (bond1) = Internal test environment

OracleDB - m3.large

eno1 + eno3 (bond0) = Internet
eno2 + eno4 (bond1) = Internal test environment

VyOS VPN - TBD

WANem Network Interfaces	
bond0 -	139.178.68.123/31
bond1.1060 -	10.2.2.10/24
bond1.1003 -	10.4.4.10/24
DGW -	139.178.68.122

VyOS VPN Network Interfaces	
bond0 -	TBD/31
TBD -	10.4.4.30/24
TBD -	10.3.3.30/24
vti0 -	172.16.200.1
DGW -	TBD

Oracle DB Network Interfaces	
bond0 -	145.40.90.227/31
bond0.1060 -	10.2.2.20/24
bond0.1003 -	10.4.4.20/24
bond0.1118 -	10.3.3.20/24
DGW –	145.40.90.226