
RedHat Virtualization - SAP HANA Appliance

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1. Executive Summary

At HyperScalers cloud enabled laboratory; we help customers design and perform proof of concept (PoC) on various cloud infrastructures; involving software and hardware platforms. The objective of this proof of concept is to install RedHat Virtualization and SAP HANA Express cloud solutions to evaluate appliance capabilities and evaluate their performance benchmarks.

Red Hat Virtualization is an enterprise-grade virtualization platform built on Red Hat Enterprise Linux (RHEL). Virtualization allows users to easily provision new virtual servers, workstations and provides more efficient use of physical server resources. With Red Hat Virtualization, you can manage your entire virtual infrastructure - including hosts, virtual machines, networks, storage and users - from a centralized graphical user interface or RESTful API.

SAP HANA is a complete database and application development platform. It combines an ACID-compliant database with high speed analytics, application services and flexible data-acquisition tools. The SAP HANA 2.0 express edition VM image is platform-independent; which can be installed to a Linux machine, provided it meets the storage and memory prerequisites. The SAP-HANA express installation is done in form of a VM for on-premise installation experience.

2. Introduction

SAP HANA is no longer just a powerful engine that combines transactional and analytical capabilities. It is also the platform on which customers will run their SAP enterprise applications, including SAP S/4HANA. Red Hat Enterprise Linux® for SAP Solutions is built on the same foundation as the world's leading enterprise Linux platform, Red Hat Enterprise Linux. Red Hat Enterprise Linux for SAP Solutions combines the reliability, scalability, and performance of Linux with technologies that meet the specific requirements of SAP applications, including those that run on SAP HANA. Standardizing entire SAP environment on Red Hat Enterprise Linux for SAP Solutions streamlines operations and reduces costs. The RedHat engineering and sales team collaborated with HyperScalers to qualify the SAP-HANA solution and come up with the demo appliance integrating their Virtualization suit; executing SAP-HANA HDB software.

At HyperScalers, we are solving Information Technology's core problem - the problem of complexity, simply through standardisation of best practices: Completeness and openness, and through economies of scale. The HyperScalers lab provides a facility for performing a Proof Of Concept of cloud computing based infrastructure solutions. It uses the scientific method to showcase the competencies of various appliances running within their own environment. The lab consists of hyperscale and conventional converged server storage and network infrastructure systems. The software vendors can utilize the existing hardware infrastructure to verify the performance and benchmark their appliances in the lab, before going to the customer.

The objectives of this PoC are:

1. Design and install multimode RedHat Virtualization suit on QCT hyperconverged architecture
2. Install SAP-HANA Express on RHEL and perform database performance benchmarking

3. Test Environment

The test environment consists of following hardware and software components:

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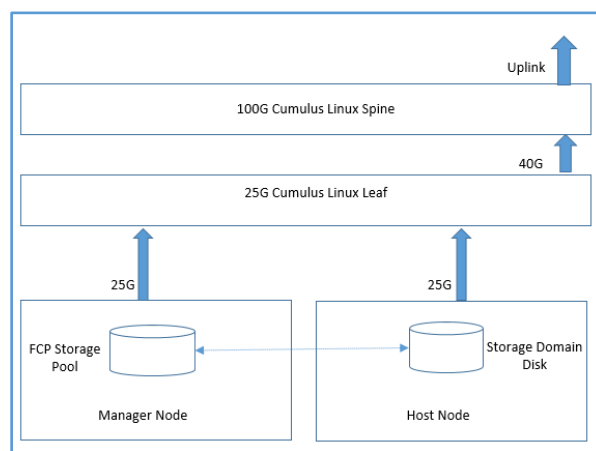
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Hardware	<p>Server Nodes</p> <ul style="list-style-type: none"> QuantaPlex T42S-2U (2 nodes) <ul style="list-style-type: none"> 2x Intel Xeon Gold 6130 @ 2.1 GHz 160GB RAM: 10 x 16GB @ 2133 MHz 240 GB Intel SATA SSD 2x1.9 TB HGST SAS SSD <p>Switches</p> <ul style="list-style-type: none"> QuantaMesh BMS T4048-IX2 as leaf switch QuantaMesh BMS T7032-IX1/IX1B as spine switch
Software	<ul style="list-style-type: none"> RedHat Virtualization 4.2 software suit SAP-HANA Express 2 SPS 03 Patch 6 Cumulus Linux ONOS v3.5.3 Oracle VirtualBox 6.0

4. Appliance architecture

The appliance architecture consists of hyperconverged QCT nodes in QuantaPlex T42S-2U chassis. These nodes are populated with Skylake Gold CPUs and 160GB DDR4 dimms. The storage consists of OS disk (SATA SSD) and 4 data drives (SAS SSD).



The network backbone is provided by the Cumulus ONOS enabled BMS switches. These switches are configured in leaf/spine architecture. The server nodes connect to the leaf switch with redundant 25G data path. There are 2 25G ports coming out of each node and they are configured redundant at OS level. The leaf switch is connected to the spine at 40G uplink and spine effectively goes uplink to the router. The spine supports 100G datapath; but its auto negotiates to support 40G uplink from the leaf. The RedHat Virtualization is installed on minimum 2 nodes; manager and host nodes. These nodes are installed with RHEL 7.3 OS and are subscribed with the relevant packages to install RedHat Virtualization stack. The manager node provides management IDE and RESTAPI interface for managing the VMs and other virtualization features of appliance. The host node provides the compute resources (virtual CPU, RAM) to the management IDE. The SAS drives in host node are used as data storage domain; which gives stage virtualization to be used in management IDE. The manager node uses FCP (Fibre Channel Protocol) to access the storage disk.

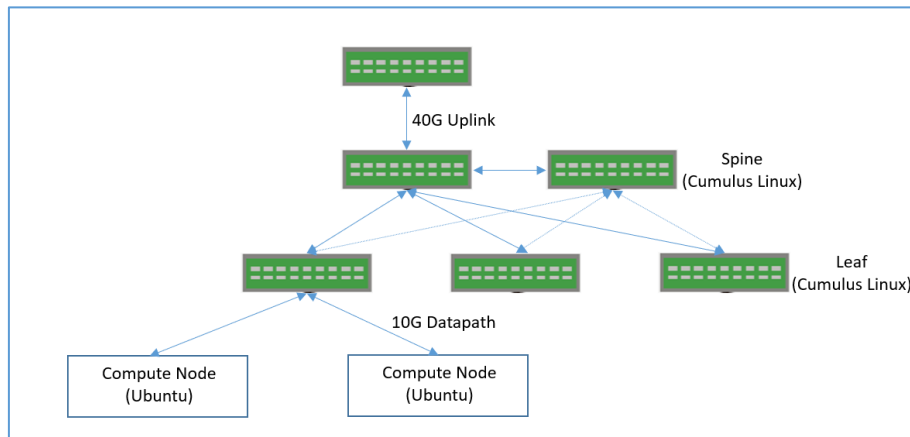
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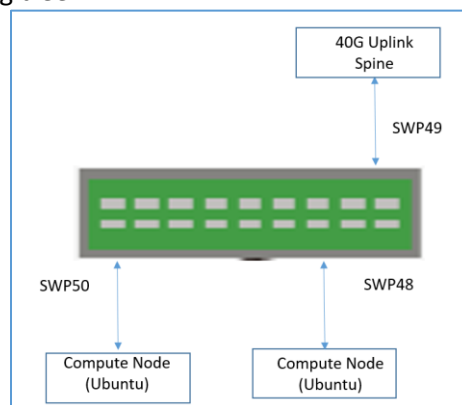
5. Appliance network infrastructure

The appliance is built upon Cumulus leaf-spine network infrastructure; the diagrams below describes the blocks involved in executing the network backbone.



The appliance connects spine switches to 40G uplink and 10G data path from leaf switches to the compute nodes. The 100G ports of spine switch are configured as 40G link speed for compatibility with uplink route. The Multi-Chassis Link Aggregation, or MLAG is configured to connect server ports to different switches and operate as if they are connected to a single, logical switch. This provides greater redundancy and greater system throughput. The QCT QuantaMesh BMS switches has a built-in baseboard management controller (BMC) that plays the role of monitoring the whole system. The BMC is an independent subsystem with its own processor and memory so that it can run well even if the switch system hangs or powers down.

The VLAN-aware mode in implements a configuration model for large-scale L2 environments, with one single instance of spanning tree.



The PoC connects two compute nodes with Ubuntu with uplink spine switch; through a traditional bridge interface using switch ports 48-50. The bridge configuration is deployed using Cumulus CLI:

```
cumulus@cumulus:~$ sudo brctl show
bridge name      bridge id        STP enabled  interfaces
bridge           8000.a81e84b4c455  yes         swp48
                                                         swp49
                                                         swp50
```

UP	swp48	bridge	10G	1500	Access/L2		
UP	swp49	bridge	40G	1500	Access/L2	cumulus	swp2
UP	swp50	bridge	40G	1500	Access/L2		
DN	swp51		100G	1500	NotConfigured		
DN	swp52		100G	1500	NotConfigured		
DN	swp53		100G	1500	NotConfigured		
DN	swp54		100G	1500	NotConfigured		
DN	swp55		100G	1500	NotConfigured		
DN	swp56		100G	1500	NotConfigured		
UP	bridge		N/A	1500	Bridge/L2		

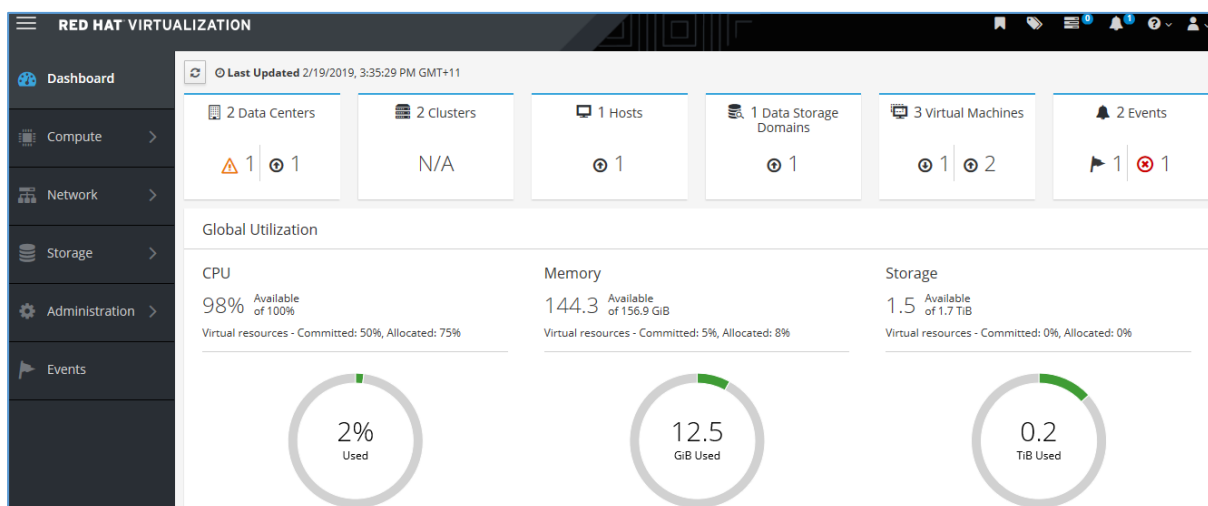
The traditional bridge interface enables laboratory dhcp to configure IP addresses to UBUNTU servers and virtual machines running on them.

6. RedHat virtualization

The virtualization manager is installed on a Red Hat Enterprise Linux 7 physical machine separate environment called as manager node. Red Hat Virtualization Host is a minimal operating system based on Red Hat Enterprise Linux, built for easy management, easy maintenance, and simple deployment. It is distributed as an ISO file from the Customer Portal and contains only the packages required for the machine to act as a host. The data domain contains all the data associated with virtual machines. The data domain uses Fibre Channel Protocol (FCP) for traffic between hosts and shared external storage. For this reason, SAN may occasionally be referred to as FCP storage.

6.1.1 Manager web IDE

After installing the virtualization packages; its management IDE is invoked through the IP address as configured. It provides a web administration portal where user can create and manage virtualization environment features like VM, storage etc.

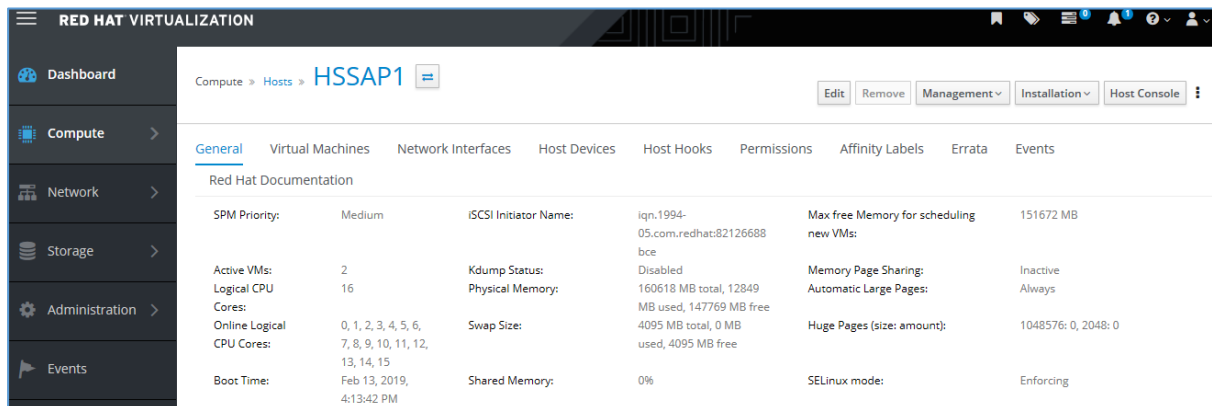


The screenshot above shows a datacentre configured above 2 clusters and 1 host machine. The host machine is configured using Cockpit software on host system. The cockpit plugin provides compatibility of RedHat Linux Virtualization host; so that it can be added as a compute host on the virtualization manager.

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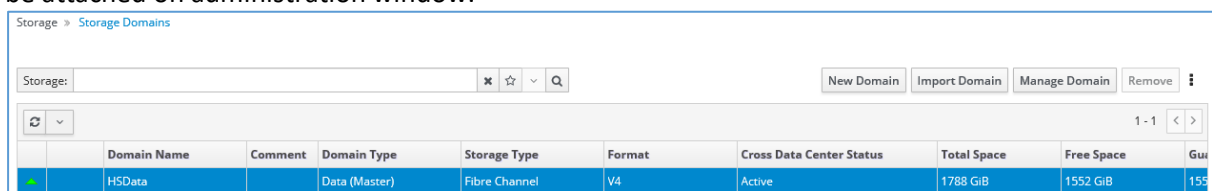
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Above screenshot shows host node attached to the management node through cockpit plugin. The interface enables management of host nodes from administration window.

6.1.2 Storage domain

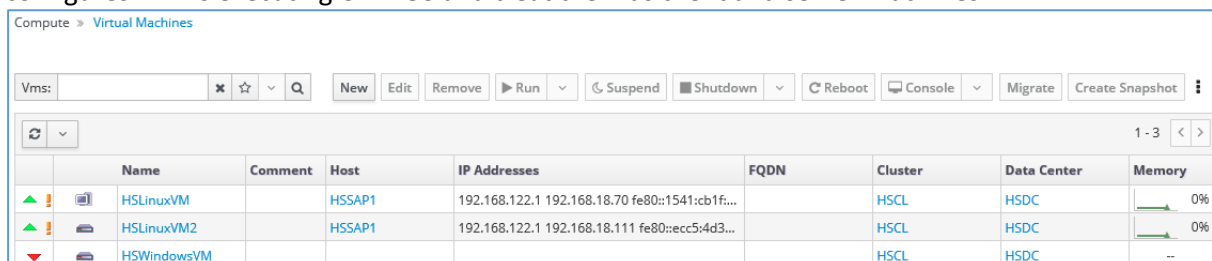
A storage domain is a collection of images that have a common storage interface. A storage domain contains complete images of templates and virtual machines (including snapshots), ISO files, and metadata about themselves. The appliance uses SAN disks on the host node for storage domain to be attached on administration window.



The HSDData is storage domain which resides physically in the host node; but its accessed from the management node through FCP protocol provided by virtualization suit. The administrator can assign storage to VMs from this pool and allocate ISO specific partitions as well.

6.1.3 Benchmarking the VMs

As part of benchmarking the performance of VM; HyperScalers's inhouse utility VMPMU is used. It configures 2 VMs executing CENTOS and treat them as client and server machines.



The VMPMU suit pings for all available VMs in the specified subnets and gather their storage and network performance numbers at runtime in stateless mode.

HyperScalers Pty Ltd Virtual Machine Performance Measurement Utility							
IAAS	OS	VM IP	PROCESSOR	FREQ MHz	CPU %	NET Mb/s	DISK SPEED MB/s
RedHat	Linux	192.168.18.111	Intel Xeon Processor	: In	kyla	480	678 MB/s
executes every 15 minutes.....							

The screenshot above shows CENTOS VM giving disk RW performance of 678MB/s and network throughput of 480Mb/s. The storager performance numbers are pretty good considering its executing on virtualized storage pool over FCP. The network path is executing within same subnet; hence the through put is god considering uplink speed to router is around 70Mb/s only. The leaf uses 25G uplink and VM traffic is working over layer2; since they are routing within same subnet and vlan. The same SAS SSD in a plain RHEL installation gives around 300MB/s RW performance; while in the appliance it's performing better due to virtualized environment.

7. SAP-HANA express

SAP HANA, express edition is a streamlined version of SAP HANA that can run on standalone server or VM. The express edition is free to use for in-memory databases up to 32GB of RAM. The objective of this PoC is to execute SAP-HANA express version on Redhat Virtualization platform and perform benchmarking tests. The tests involve creating HDB (Hana database) on the platforms and evaluate its performances.

7.1.1 Installing SAP-HANA express

The project uses virtual machine installation method for on SAP HANA 2.0, express edition on-premise installation. The server is installed with RHEL 7.3 OS and virtualbox as hypervisor. The VM image of SAP-HANA Express is downloaded after registering to the SAP website and it provides an OVA file; which is launched as VM on virtualbox. The OVA file is compatible with virtualbox only and it can't be imported as a VM in RedHat Virtualization. As a next version of this PoC; HyperScalers would enable binary installation of SAP-HANA on the SAP enable RHEL.

```
Configured timezone
=====
Local time: Fri 2018-12-21 02:02:19 AEDT
Universal time: Thu 2018-12-20 15:02:19 UTC
RTC time: Thu 2018-12-20 15:02:19
Time zone: Australia/Sydney (AEDT, +1100)
Network time on: no
NTP synchronized: no
RTC in local TZ: no

Welcome to SUSE Linux Enterprise Server for SAP Applications 12 SP2 (x86_64) -
Kernel 4.4.121-92.92-default (tty1).

SAP HANA, express edition 2.0 SPS03 server-plus-apps version
Host name : hxehost.localdomain
IP address : 10.0.0.130

hxehost login:
```

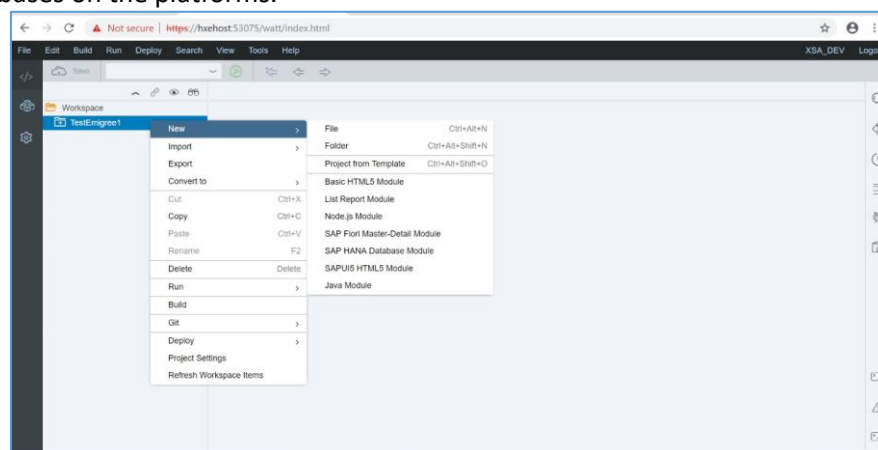
After installations; the hxehost (Hana Express Host) machine is powered on and it gives the SUSE prompt for host system. The host initializes all required applications to enable SAP HANA appliance; the status of applications needs to be verified as up and running before launching any database apps.


```
ksa-cockpit                STARTED      1/1      256 MB <unlimited>
> https://hxehost:51039
cockpit-persistence-svc   STARTED      1/1      1.00 GB <unlimited>
> https://hxehost:51041
cockpit-hdb-svc           STARTED      1/1      768 MB <unlimited>
> https://hxehost:51042
cockpit-xsa-svc           STARTED      1/1      768 MB <unlimited>
> https://hxehost:51048
cockpit-collection-svc   STARTED      1/1      768 MB <unlimited>
> https://hxehost:51040
cockpit-hdbui-svc         STARTED      1/1      128 MB <unlimited>
> https://hxehost:51044
cockpit-telemetry-svc     STARTED      1/1      768 MB <unlimited>
> https://hxehost:51049
cockpit-landscape-svc     STARTED      1/1      128 MB <unlimited>
> https://hxehost:51043
cockpit-web-app           STARTED      1/1      512 MB <unlimited>
> https://hxehost:51045
cockpit-adminui-svc       STARTED      1/1      128 MB <unlimited>
> https://hxehost:51046
cockpit-admin-web-app     STARTED      1/1      128 MB <unlimited>
> https://hxehost:51047

hxehost:hxeadn> xs apps | grep webide
webide                STARTED      1/1      512 MB <unlimited>
> https://hxehost:53075
hxehost:hxeadn> xs apps | grep cockpit-admin-web-app
cockpit-admin-web-app STARTED      1/1      128 MB <unlimited>
> https://hxehost:51047
```

7.1.2 Launching SAP-HANA web IDE and cockpit

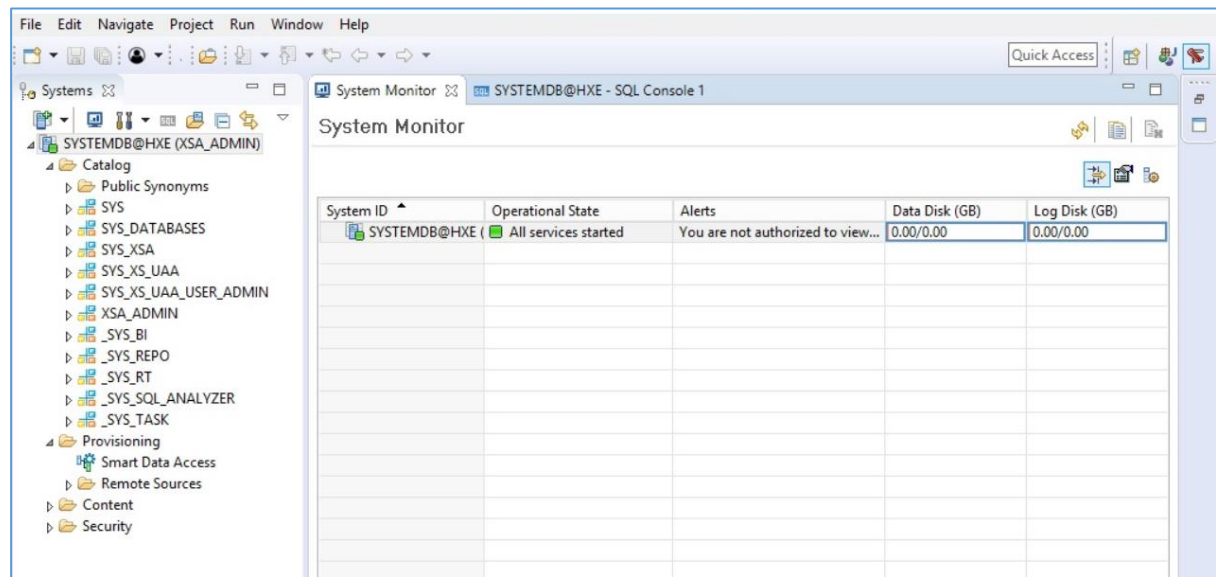
Once all the required apps are initialized; the SAP HANA web IDE and cockpit can be launched to verify the databases on the platforms.



The IDE link can be found by doing grep into complete list of apps; before launching them on browser.

7.1.3 Launching SAP HANA eclipse and database experiments

SAP HANA Eclipse is an open-source IDE providing several tools in one program. Add-Ons like SAP HANA Database Studio, ABAP Development, BW Modelling Tools and many more. The project installs Eclipse Photon on Windows machine and attaches the SAP HANA Express appliance to it.



The eclipse dashboard provides methods to install and manage various projects like SQL, HTML etc.

7.1.4 Launching SAP HANA HDI module

The HDI manages database artefacts that allows multiple copies/versions of the same core objects to be used on the same HANA database at the same time. The exercise create a HANA Database module and builds the database table to be presented on the SAP Web IDE. The Web IDE provides the tab to create a HANA database module and the dashboard provides time consumed to create the modules.

```
Finalizing... ok Make succeeded (0 warnings): 1 files deployed (effective 1), 0 files undeployed (effective 0), 0 dependent
files redeployed Making... ok Starting make in the container "DB_1" with 1 files to deploy, 0 files to undeploy...
okDeploying to the container "DB_1"... ok (8s 95ms)No default-access-role handling needed; global role "DB_1::access_role"
will not be adaptedUnlocking the container "DB_1"...Unlocking the container "DB_1"... ok (0s 1ms)Deployment to container DB_1
done [Deployment ID: none].(19s 870ms)
9:26:26 AM (DIBuild) ***** End of /EmigreeHDI/db Build Log *****
9:26:26 AM (DIBuild) Build results link: https://hxehost:53075/che/builder/workspace0ywbxli16d908krx/download-all/02af1298-
22b1-4bda-8a22-7c2663d0bf05?arch=zip
9:26:26 AM (Builder) Build of /EmigreeHDI/db completed successfully.
```

The experiments completed HDB deployment in around 20 seconds. The next step creates a database templets and populates the information; finally the table in built and time consu,ed in recorded through IDE dashboard.

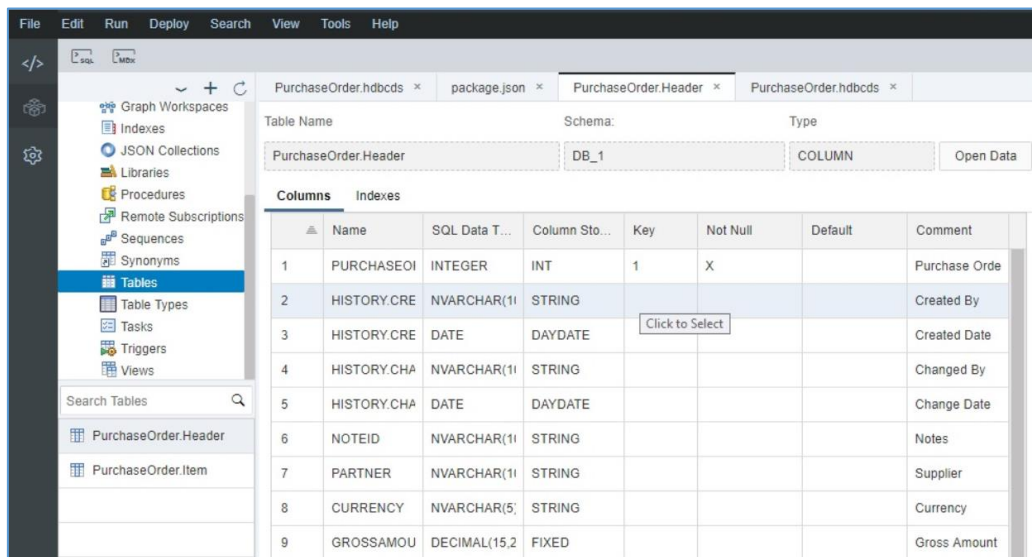
```
succeeded (0 warnings): 1 files deployed (effective 2), 0 files undeployed (effective 0), 0 dependent files redeployed
Making... ok Starting make in the container "DB_1" with 1 files to deploy, 0 files to undeploy... okDeploying to the
container "DB_1"... ok (49s 579ms)No default-access-role handling needed; global role "DB_1::access_role" will not be
adaptedUnlocking the container "DB_1"...Unlocking the container "DB_1"... ok (0s 24ms)Deployment to container DB_1 done
[Deployment ID: none].(55s 573ms)
9:40:12 AM (DIBuild) ***** End of /EmigreeHDI/db Build Log *****
9:40:12 AM (DIBuild) Build results link: https://hxehost:53075/che/builder/workspace0ywbxli16d908krx/download-all/d2a92246-
8bc3-43f2-a74f-1c8b27abf185?arch=zip
9:40:12 AM (Builder) Build of /EmigreeHDI/db completed successfully.
```

The HDB deployment with sample data table took around 60 sec for complete deployment.

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The screenshot shows a database IDE window with a menu bar (File, Edit, Run, Deploy, Search, View, Tools, Help) and a toolbar. On the left is a sidebar with a tree view containing categories like Graph Workspaces, Indexes, JSON Collections, Libraries, Procedures, Remote Subscriptions, Sequences, Synonyms, Tables (selected), Table Types, Tasks, Triggers, and Views. Below the tree is a 'Search Tables' input field. The main area displays the 'PurchaseOrder.Header' table structure. At the top, it shows 'Table Name: PurchaseOrder.Header', 'Schema: DB_1', and 'Type: COLUMN' with an 'Open Data' button. Below this is a 'Columns' tab with a table listing the columns. The table has 9 rows and 8 columns: Name, SQL Data Type, Column Storage, Key, Not Null, Default, and Comment. The columns are: 1. PURCHASEOI (INTEGER, INT, Key=1, Not Null=X, Comment='Purchase Order'), 2. HISTORY.CRE (NVARCHAR(1), STRING, Comment='Created By'), 3. HISTORY.CRE (DATE, DAYDATE, Comment='Created Date'), 4. HISTORY.CHA (NVARCHAR(1), STRING, Comment='Changed By'), 5. HISTORY.CHA (DATE, DAYDATE, Comment='Change Date'), 6. NOTEID (NVARCHAR(1), STRING, Comment='Notes'), 7. PARTNER (NVARCHAR(1), STRING, Comment='Supplier'), 8. CURRENCY (NVARCHAR(5), STRING, Comment='Currency'), 9. GROSSAMOU (DECIMAL(15,2), FIXED, Comment='Gross Amount').

	Name	SQL Data T...	Column Sto...	Key	Not Null	Default	Comment
1	PURCHASEOI	INTEGER	INT	1	X		Purchase Order
2	HISTORY.CRE	NVARCHAR(1)	STRING				Created By
3	HISTORY.CRE	DATE	DAYDATE				Created Date
4	HISTORY.CHA	NVARCHAR(1)	STRING				Changed By
5	HISTORY.CHA	DATE	DAYDATE				Change Date
6	NOTEID	NVARCHAR(1)	STRING				Notes
7	PARTNER	NVARCHAR(1)	STRING				Supplier
8	CURRENCY	NVARCHAR(5)	STRING				Currency
9	GROSSAMOU	DECIMAL(15,2)	FIXED				Gross Amount

The database table is loaded on the database explorer on IDE window and entered entries can be verified on the dashboard. The example above creates a purchase order record and the entries can be entered and verified on the IDE window.

8. Appliance accessibility

The appliance can be accessible to the customers using WAP DDNS "http://hyperscalers.asuscomm.com/". Depending on the customer requirements; the administrator can open a port accessible via DDNS VPN.

9. Conclusion

The appliance shows that RedHat Virtualization solution can be efficiently designed as appliance on QCT open racks. The performance on a hyperconverged architecture is benchmarked would be improved with better CPU cores and storage drives. The virtualization suit utilized as IaaS for the appliance efficiently and it hosts a self-managing web interface; it's a convenient interface to create a virtualized compute, network and storage environment. The RedHat RHEL provides efficient environment to evaluate SAP-HANA express solution. The database applications were evaluated on the appliance and their performance were benchmarked. As a next step; SAP-HANA would be installed in binary mode on RHEL and evaluated on non-virtualized environment.