How to Deploy IBM OpenPower Cluster for Accelerated Databases

Version 1.0

INTRODUCTION

This document along with referenced links describes a comprehensive set of instructions, rules, and automation tools for building an OpenPOWER-based cluster tuned for Accelerated Databases. Examples of such accelerated databases include Kinetica's GPUdb.

Step 1 lists the hardware needed for this solution, including BOM. Step 2 designates the lab infrastructure configuration parameters needed to build solution. Step 3 is a high level description of the deployer node and initial preparation. Step 4 specifies a generic hardware build instructions including BOM contents for each building block and build rules (racking and network options). Step 5 describes the bare metal machine genesis processes used in Accelerated Database solutions. Step 6 is any desired post Genesis configuration(currently all within the automation). Step 7 is Accelerated Database operational manager or software orchestrator (not supported in first release). Finally, step 8 is for Kinetica's GPUdb specific instructions and documentation.

HIGH LEVEL DEPLOYMENT STEPS

	EACH STEP BELOW IS DESCRIBED IN MORE DETAIL BELOW
1	Acquire the hardware
2	Choose your configuration parameter for the solution
3	Prepare the deployer node
4	Rack and cable the hardware
5	Configure the cluster (Genesis)
6	Complete any post Genesis configurations
7	Install open source management software (not yet supported for this deployment kit)
8	Install the applicable Accelerated DB software (not automated in this deployment kit)

STEP 1: ACQUIRE THE HARDWARE

Go here for the Bill of Materials list of required parts:

Go here to contact an IBM representative for order/purchase assistance.

STEP 2: CHOOSE YOUR BASIC CONFIG PARAMETERS

To facilitate faster automated configuration of the overall solution, collect the following parameters before starting. This data will be edited into a config.yml file which will in turn be used to automatically configure and deploy the entire solution.

<table>
<tr><th>Parameter</th><th>Description</th><th>Example</th></tr>
<tr><td>Domain Name</td><td></td><td>Ibm.com</td></tr>
<tr><td>Upstream DNS Servers</td><td>While a DNS server is configured within the cluster, upstream DNS servers need to be defined for names tht cannot otherwise be resolved.</td><td>*4.4.4.4, 8.8.8.8 as default public upstream DNS servers</td></tr>
<tr><td>Deployment Node Host Name</td><td>What do you want to call your deployment node?</td><td>depnode</td></tr>
<tr><td>Management network IP address</td><td>Management for the cluster happens on its own internal network.</td><td>192.168.3.3.24</td></tr>
<tr><td>Data network IP address</td><td>Labeled interconnect in config.yml in example below</td><td>10.0.0.1/24</td></tr>
<tr><td>Management switch IP address</td><td>Labeled ipaddr-mgmt-switch in config.yml in example below</td><td>192.168.3.5</td></tr>
<tr><td>Data switch IP addresses</td><td>Labeled ipaddr-data-switch in config.yml in example below</td><td>9.3.3.178</td></tr>
<tr><td>Default login data</td><td>Both IDs and passwords</td><td>BMC network, OS Mgmt network</td></tr>
<tr><td>Data node hostnames and IPs addresses</td><td>Each node in the cluster needs a hostname and IP address for each of the management and data networks.</td><td>
<table>
<tr><th>Name</th><th>Management IP</th><th>Data IP</th></tr>
<tr><td>Min-1</td><td>192.168.3.102</td><td>10.0.0.2</td></tr>
<tr><td>Min-2</td><td>192.168.3.104</td><td>10.0.0.4</td></tr>
<tr><td>Min-3</td><td>192.168.3.106</td><td>10.0.0.6</td></tr>
<tr><td>Min-4</td><td>192.168.3.108</td><td>10.0.0.8</td></tr>
</table>
</td></tr>
</table>

Go here to see more options in the config.yml file.

STEP 3: PREPARE THE DEPLOYER NODE

The deployer node is used to obtain the latest software and deployment tools from Github and populate the cluster. You can establish the deployer node as a temporary or permanent server. It can be any Power8 LC or x86 server with the following minimum characteristics:

- 2 cores and 32G RAM
- 3 Network Interface connections: IPMI, 10G (highspeed), 1G(Mgmt).
- Ubunutu 16.04 LTS before beginning with deployment.

If you do not already have Ubuntu, you can obtain it from the following:

- Power8-LC servers: https://www.ubuntu.com/download/server/power8
- For x86 servers: http://releases.ubuntu.com/16.04.1/

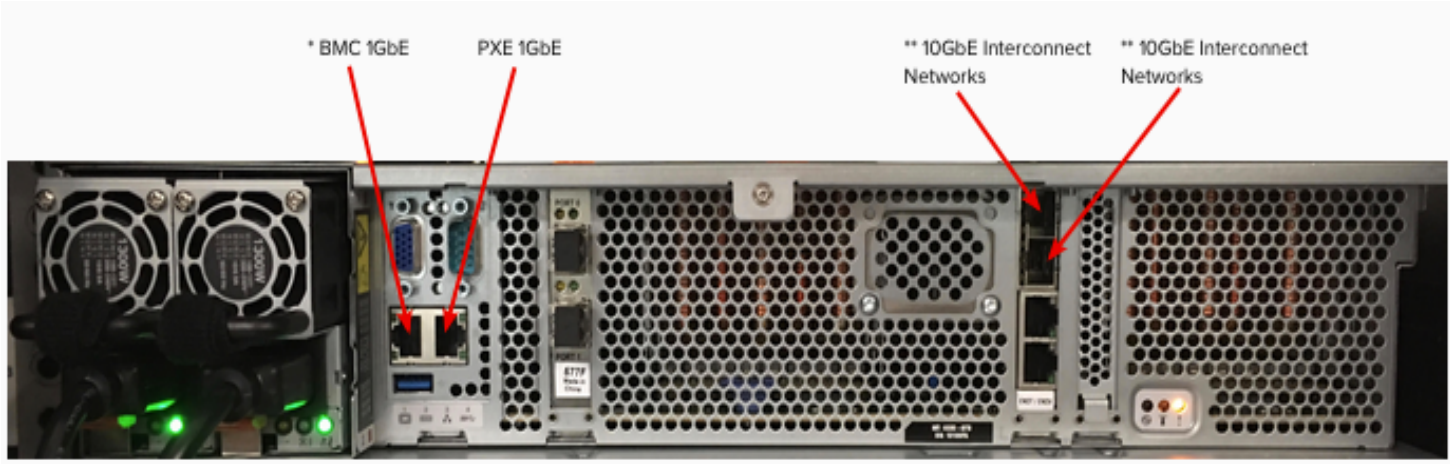
STEP 4: RACK AND CABLE THE CLUSTER

GPU-accelerated databases are best optimized with Power's unique high-speed NVLink bus between its CPU and NVIDIA GPUs, As a result, this design prescribes the IBM S822LC for HPC server (product ID: 8335-GTB) to enable the best possible database performance.

Go here to see it's specific configuration.

The Power server's network adapters should be configured as shown in the illustrations below for a system named MIN.

Back view:MIN



Note:

* While these servers are capable of sharing ports(multi-function port), automation requires the port to be set up as BMC data only.

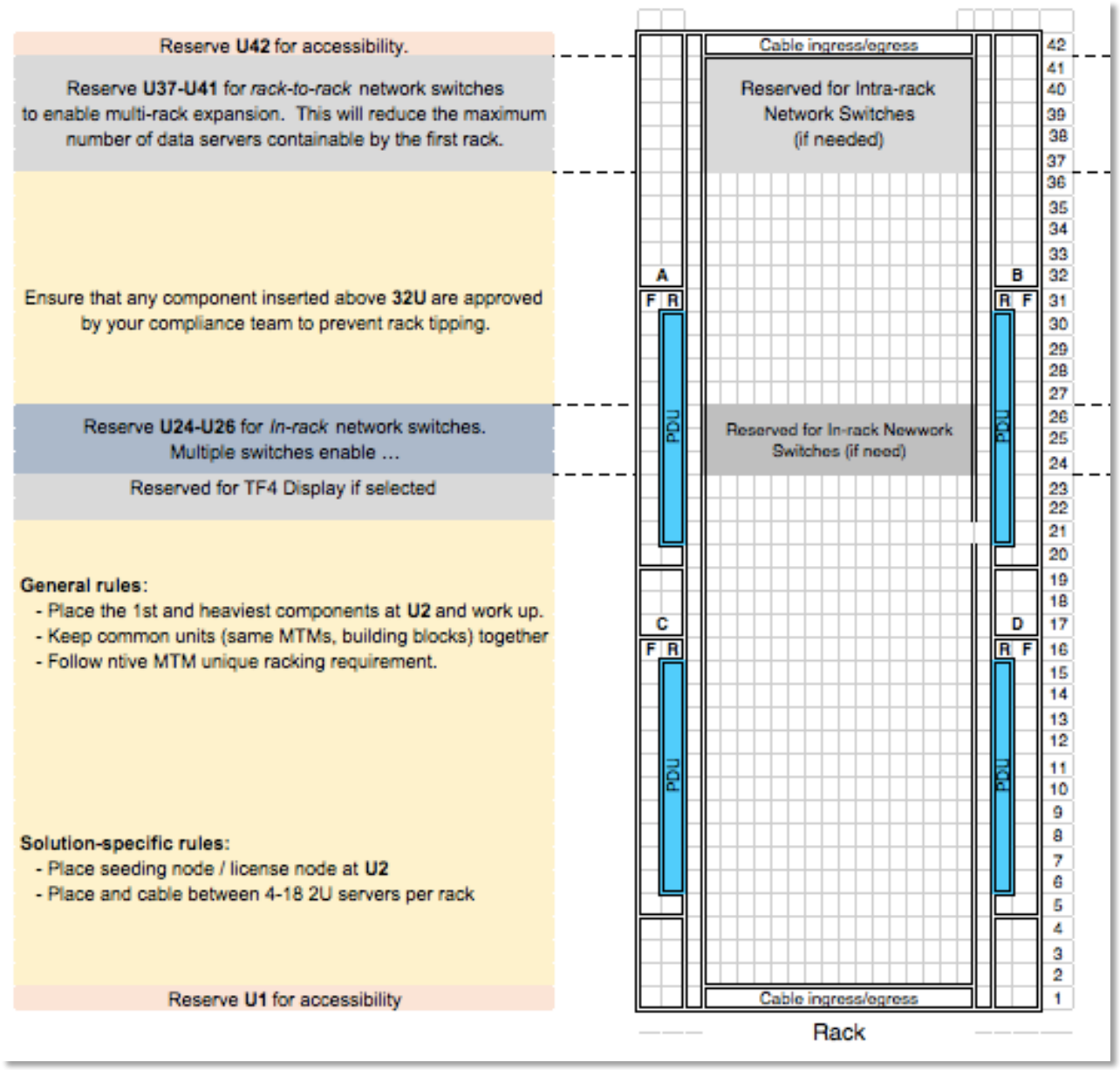
** If bonded networks are desired, two dual port adapters are required.

RACKING THE COMPONENTS

Instead of providing a long list of step-by-step instructions to build up the rack or servers and switches, this section specifes racking *rules* that specify both where to place the servers and switches and where to connect the cables.

These **suggested racking rules** focus on enabling:

- modularity per rack
- Consistency
- Expandability
- Ease of servicing, repurposing, shipping, and cooling


Reserve U42 for accessibility.
Reserve U37-U41 for rack-to-rack network switches to enable multi-rack expansion. This will reduce the maximum number of data servers containable by the first rack.
Ensure that any component inserted above 32U are approved by your compliance team to prevent rack tipping.
Reserve U24-U26 for In-rack network switches. Multiple switches enable …
Reserved for TF4 Display if selected
General rules:
- Place the 1st and heaviest components at U2 and work up.
- Keep common units (same MTMs, building blocks) together
- Follow ntive MTM unique racking requirement.
Solution-specific rules:
- Place seeding node / license node at U2
- Place and cable between 4-18 2U servers per rack
Reserve U1 for accessibility
Cable ingress/egress
Reserved for Intra-rack Network Switches (if needed)
Reserved for In-rack Newwork Switches (if need)
Cable ingress/egress
A
B
C
D
F R
R F
PDU
Rack

ADDITIONAL RACKING RULES

This version of the accelerated DB design supports in-server storage only. A future version will add support for external storage.

Place the intra-rack (leaf) network switches in **U24-U26** as follows:

- 10G/40G/IB data plane switch in **26U** (parts 8828-E36, 8831-NF2, or 7120-64C)
- Leave **U25** open. Reserve for later use of short-depth devices (see switch placement restriction above).
- 1G management plane switch in **24U**.

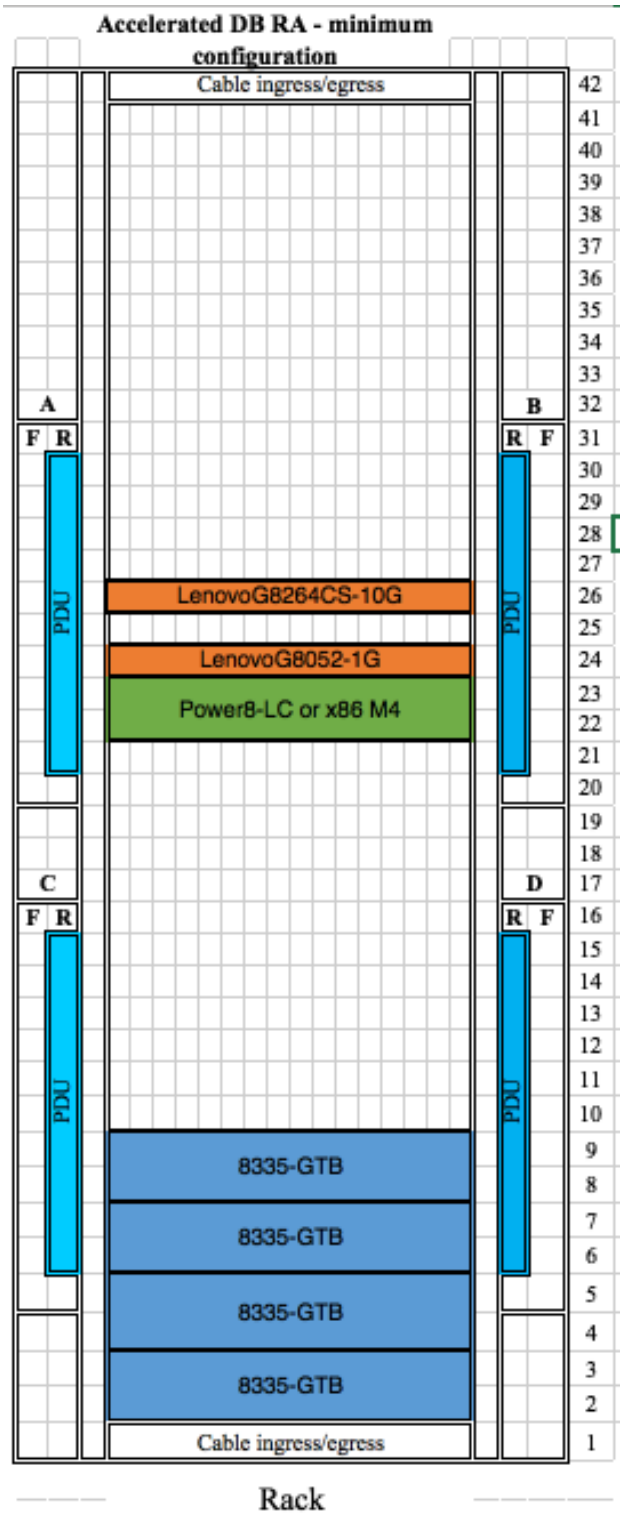
Place the inter-rack (spine) switches in slots **U37-U41** as follows:

- You can design the modular rack block as (every 2 racks if required). See the ***48x High Speed TOR Switch Option***.

No more racks can be ordered than what is needed to hold the servers.

If more than 4 PDUs are needed, place 3 horizontal PDUs in 40U and 41U. Spine switches take priority over additional PDUs. If 40U and 41U are occupied by Spine Switches, place horizontal PDUs in next available slots.

RESULTING EXAMPLE: MINIMUM FOUR 8335-GTB SYSTEM CLUSTER

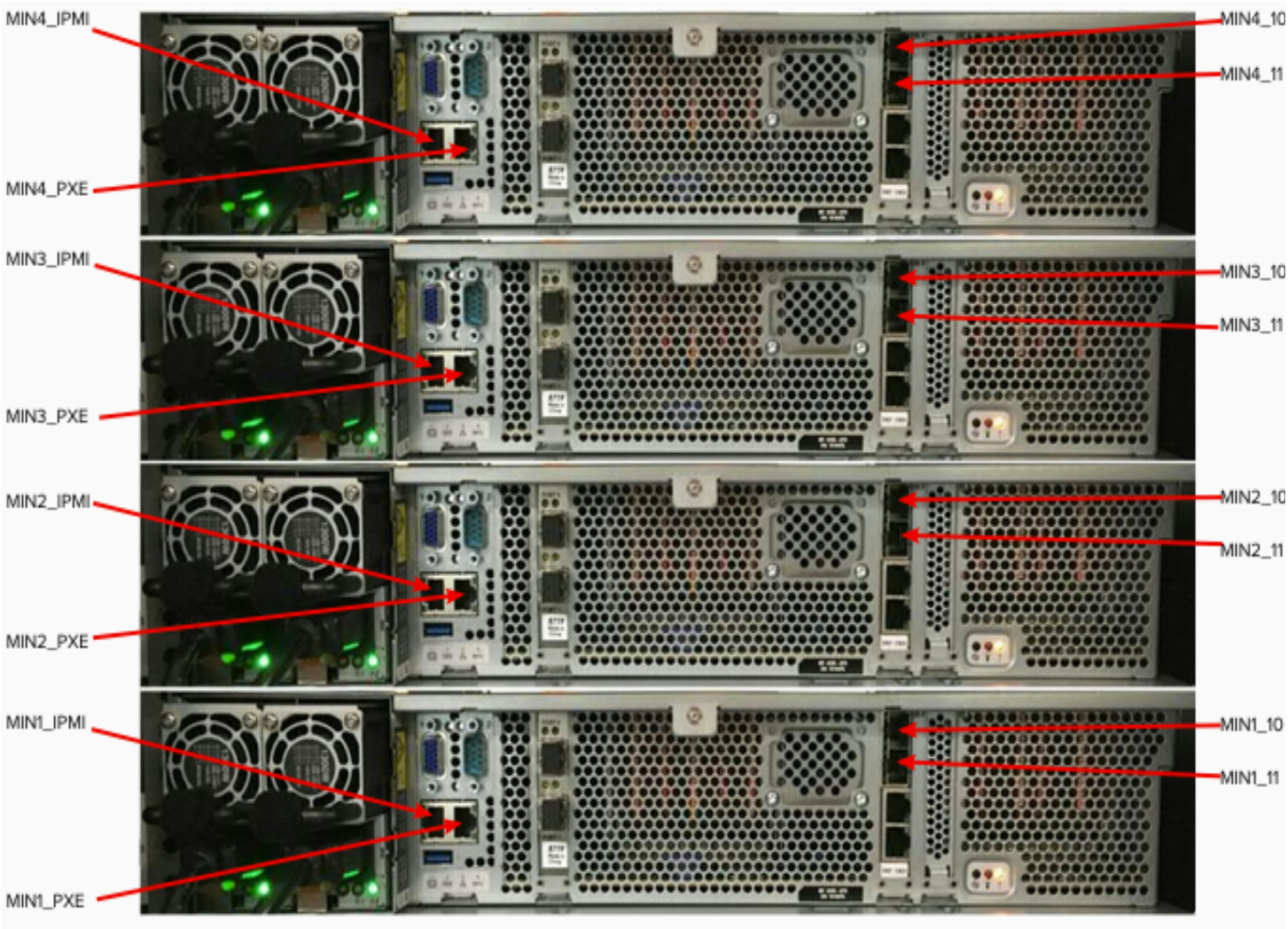


CABLE TOGETHER ALL COMPONENTS

To follow these cabling rules, simply cable the like labels on the servers to the applicable network switches. Shown here is the approach for a four server cluster configuration.

EXAMPLE: MINIMIM FOUR 8335-GTB SYSTEM CLUSTER NETWORKING

Rear server view with labels for four servers named MIN1, MIN2, MIN3, and MIN4…

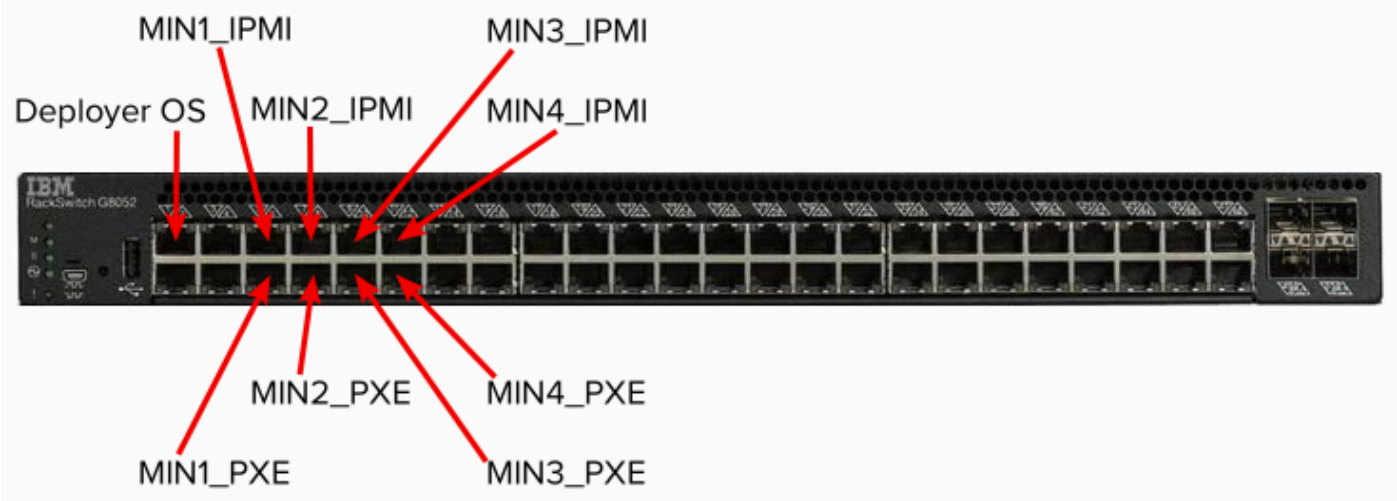


Network switch port view. The Labels on the ports shown on the network switch below correspond to the server labels above and also to what you would see in the config.yml and inventory.yml.

In this example, 40GbE-to-4x10GbE fanout cables were used

Lenovo G8264CS - 10GbE data network switch cabling scheme below:

Lenovo G8052 - 1GbE management network switch cabling scheme below:



STEP 5: CONFIGURE THE CLUSTER (GENESIS)

This section covers the power on, initialization, configuration and installation of a cluster solution. This deployment kit provides an automated method to quickly and more predictably go from assembly to a tuned operational state of the cluster's infrastructure. We call it *hardware genesis*.

While genesis occurs once at the beginning of the cluster solution lifecycle, the open-sourced automation scripts are available and can be reused for maintenance and cluster expansion.

	GENESIS AUTOMATICALLY INITIALIZES & CONFIGURES THE HARDWARE BY…
A	Reading the config.YML files with edited environment-specific changes
B	Driving the BMCs to populate the IP addresses to the nodes
C	Detecting and populating relevant config data to the deployer node
D	Deploying needed firmware and operating system images to the server nodes
E	Configuring the network switches (VLANs, MLAG) – ***some manual steps required***
F	Configuring all server management and data nodes (network interfaces, GPU drivers,…)

At genesis completion, control of the cluster is transferred to the operational manager (or the software orchestrator) of choice, if supported. Throughout the cluster life cycle, persistent ansible playbooks provide runtime services to the operational manager.

Go here to see the genesis deployment README to learn more.

Go here to see the Accelerated Database README for procedure overview and deployment automation procedures. Deployment procedures include clone repository, update config.yml and two automation scripts (*install.sh* and *deploy.sh.*)

OBTAIN THE DEFAULT CONFIGURATION FILE

The genesis automation uses a config file to specify the target cluster configuration. The deployment tooling uses this YAML text file to specify the IP address locations of the managed

switches and the system nodes attached to the switches as well as other useful details for deployment process.

Go here to see the **generic** master copy of the latest version of the config file.

Go here for a copy of the OpenPOWER Accelerated Database Small Cluster config file.

TAILOR THE CONFIGURATION FILE FOR YOUR ENVIRONMENT

The *config.yml* file contains a lot of configuration information. To enable a cluster tailored to your environment, edit the YAML file with the configuration parameters you collected in Step 2, replacing the **RED** text with your data. The excerpt below focuses on the lines to edit.

Editable Portions of the Config.yml file

```
~ ~ ~ ~ ~ ~ ~ bunch of licencing comment and YAML ~ ~ ~ ~ ~
ipaddr-mgmt-network: 192.168.3.0/24      ← Should this be a red field?
ipaddr-mgmt-switch:
   rack1: 192.168.3.5                    ← Type your management switch IP address here.
ipaddr-data-switch:
   rack1: 9.3.3.178                      ← Type your data switch IP address here.
 ~ ~ ~ ~ ~ ~ ~ bunch of YAML and comments ~ ~ ~ ~ ~
networks:
   external:
      description: Organization site or external network
      addr: 9.3.3.0/24                   ← Type your XXX here.
      broadcast: 9.3.3.255               ← Type your XXX here.
      gateway: 9.3.3.1                   ← Type your XXX here.
      dns-nameservers: 9.3.1.200         ← Type your XXX here.
      dns-search: aus.stglabs.ibm.com
      method: static
      eth-port: eth10
   interconnect:
      description: Private 10G Data Network to Interconnect Cluster
      addr: 10.0.0.0/24
      broadcast: 10.0.0.255
      method: static
```

```
      eth-port: eth11
 ~ ~ ~ ~ ~ ~ ~ bunch of YAML and comments ~ ~ ~ ~ ~
node-templates:
   controller1:
      hostname: min                    ← Type your XXX here.
      userid-ipmi: ADMIN               ← Type your XXX here.
      password-ipmi: admin             ← Type your XXX here.
      cobbler-profile: ubuntu-16.04.1-server-ppc64el
 ~ ~ ~ ~ ~ ~ ~ bunch of YAML and comments ~ ~ ~ ~ ~
```

THE INVENTORY FILE

The Inventory file is a YAML text file that contains the entire inventory of the cluster taken during the Genesis process.

Go here for the **generic** master copy of the latest inventory file.

The file consists of the network switches and server nodes. The Switches data structure indicates the types of switches (Management, Spine, or Leaf), their IP addresses, and associated login credentials. The following is a sample inventory data structure specifying the attributes of the management and leaf switches.

```
switches:
   mgmt:
   - hostname: mgmtswitch1
     ipv4-addr: 192.168.3.5
     rack-id: rack1
     userid: admin                    ← Type your XXX here????
     password: mspassword             ← Type your XXX here????
   leaf:
   - hostname: leafswitch1
     ipv4-addr: 192.168.3.6
     rack-id: rack1
     userid: joeleaf
     password: joeleafpassword
```

The server Nodes data structure specifies the type of node controller, its network properties, and its system architectural information (ppc64 vs x86). A snippet of such an inventory data structure follows below.

```
    Controller1:
    - hostname: min-1
      userid-ipmi: ADMIN
      password-ipmi: admin
      port-ipmi: 15
      port-pxe: 16
      port-eth10: 21
      port-eth11: 22
      mac-ipmi: 70:e2:84:14:0a:10
      ipv4-ipmi: 192.168.3.107
      rack-id: rack1
      template: controller2
      architecture: ppc64
      chassis-part-number: 8335-GTB
      chassis-serial-number: 1004C9A
      mac-pxe: 70:e2:84:14:0a:12
      ipv4-pxe: 192.168.3.108
      external-addr: 9.3.3.5
      interconnect-addr: 10.0.0.4
reference-architecture:
    gpudb_nvidia_playbook:
      description: playbook for installing nvidia for gpudb
      cuda_deb: /tmp/cuda-repo-ubuntu1604-8-0-local_8.0.35-1_ppc64el.deb
      driver_level: nvidia-361
      dkms_deb: /tmp/dkms_2.2.0.3-2ubuntu14_all.deb
```

After Genesis is complete, the inventory.yml is located on the deployment node in */var/oprc.*

STEP 6: COMPLETE ANY POST GENESIS CONFIGURATIONS

For this solution, there are a couple of procedures that need to be completed post-Genesis. These have been automated within deploy.sh referenced in Accelerated Database README and decribed in STEP 5.

COMPLETE NETWORKING CONFIG

Performed during the deploy.sh.

Each node will have a 10G nework interface for cluster interconnect and external connection.

INSTALL NVIDIA DRIVER

Performed during the deploy.sh.

For GPUdb only the Nvidia driver is installed, but full CUDA is available locally on the deployment node in the *~/accelerated-db/playbooks/packages* directory.

STEP 7: INSTALL OPEN SOURCE MANAGEMENT SOFTWARE

This deployment kit does not yet auto-deploy open source management tooling for this cluster. *A future version of this kit will add this feature*. Installing your own management tooling will need to be performed independent of this deployment kit.

STEP 8: INSTALL THE APPLICATION SOFTWARE

Since today's GPU-accelerated Database tools are proprietary today, this deployment kit does not automatically deploy them. *We will add more pointers to those solutions as they support this configuration.*

GPUDB

Kinetica, Inc. is the commercial provider of GPUDB. Go to their site or contact them to get help deplying their database onto this cluster.

Go here to Kinetica's website.

Go here to see Kinetica's overview and architecture.

Go here to see Kinetica's installation instructions.

Go here to see how to run Kinetica once installed.

APPENDIX

REFERENCE LINKS

Go here for 8335-GTB system Redbook(technical overview)

Go here for further 8335-GTB reference material via IBM Knowledge Center.

Go here for Accelerated-db GitHub repository(currently IBM internal only)

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