

# How to Depoly IBM OpenPower Cluster for Accelerated Databases

Version 1.0

## INTRODUCTION

This document along with referenced links describes a comprehensive of instructions, rules, and automation tools for building an OpenPOWER-based cluster tuned for Accelerated Databases. Examples of such accelerated databased 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 lever description of deployer node and initial preparation. Step 4 specifies a generic hardware build instruction including: BOM contents for each building block, build rule (racking and network options). Step 5 described the bare metal machine genesis processes used in Accelerated Database solutions. Step 6 is any post Genesis configurations desired(currently all within the automation). Step 7 is Accerated 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	<a href="#">Acquire the hardware</a>
2	<a href="#">Choose your configuration parameter for the solution</a>
3	<a href="#">Prepare the deployer node</a>
4	<a href="#">Rack and cable the hardware</a>
5	<a href="#">Configure the cluster (Genesis)</a>
6	<a href="#">Complete any post Genesis configurations</a>
7	<a href="#">Install open source management software</a> (not yet supported for this deployment kit)
8	<a href="#">Install the applicable Accelerated DB software</a> (not automated in this deployment kit)

## STEP 1: ACQUIRE THE HARDWARE

Go [here](#) for the Bill of Materials list of required parts:

If you do not already have the needed parts, go [here](#) to contact an IBM representative to help you.

## STEP 2: CHOOSE YOUR BASIC CONFIG PARAMETERS

To facilitate faster automated configuration of the overall solution, collect together the following parameters before you start. This data will be edited into a config file which will in turn be used to automatically tune the infrastructure and add other needed software.

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

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 use 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).
- Ubuntu 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/>

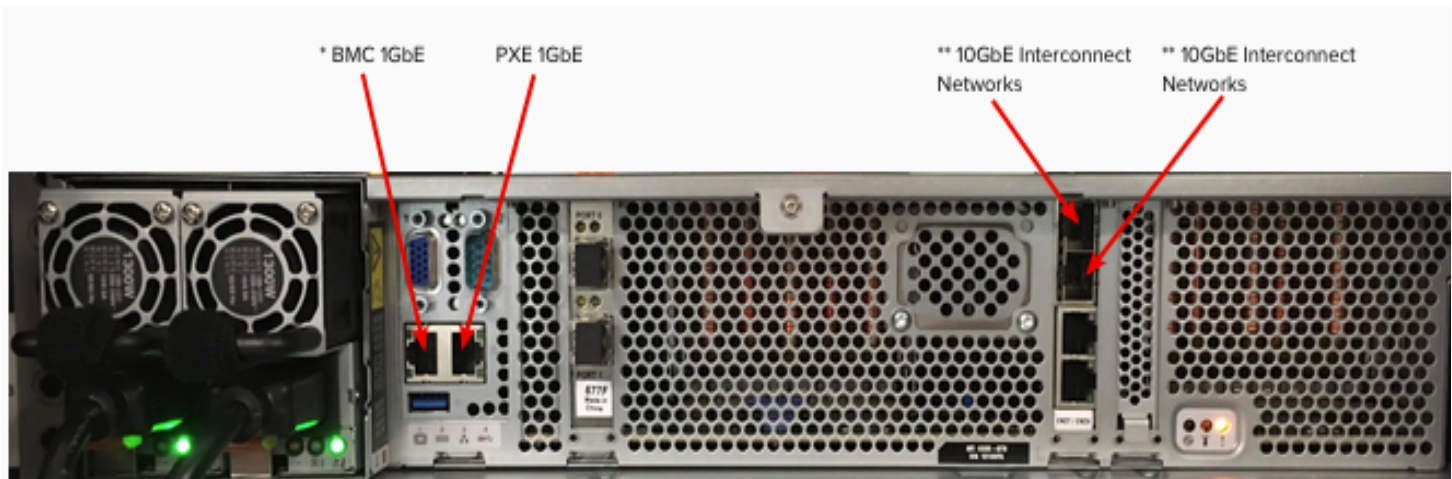
## STEP 4: RACK AND CABLE THE CLUSTER

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 database performance.

Go [here](#) to see its specific configuration.

Your Power servers network adapters should be configured as shown in the illustrations below.

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 specifies 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:

- modulation 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

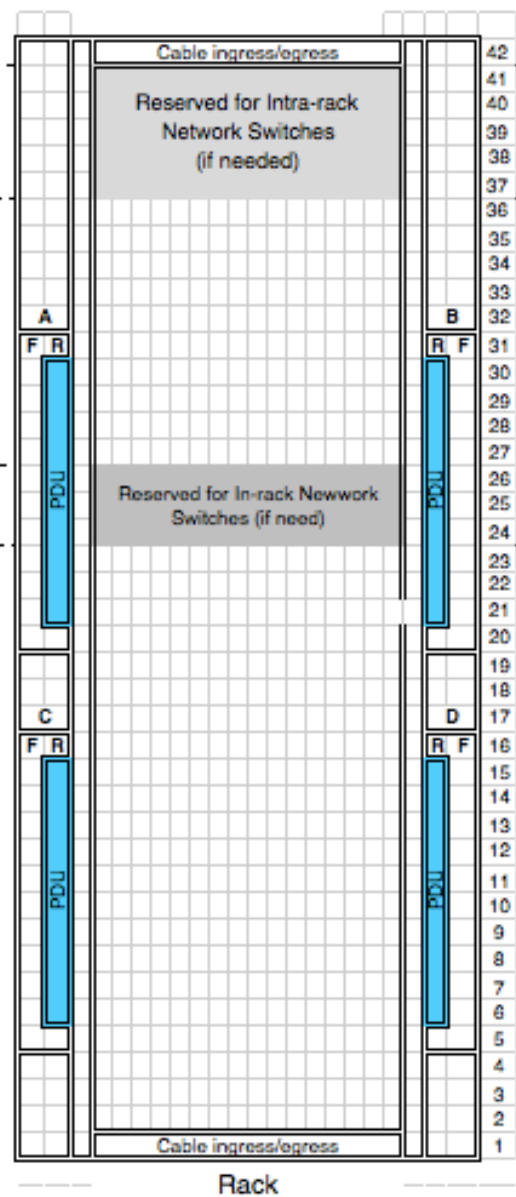
**General rules:**

- Place the 1st and heaviest components at U2 and work up.
- Keep common units (same MTMs, building blocks) together
- Follow native 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



## 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**.

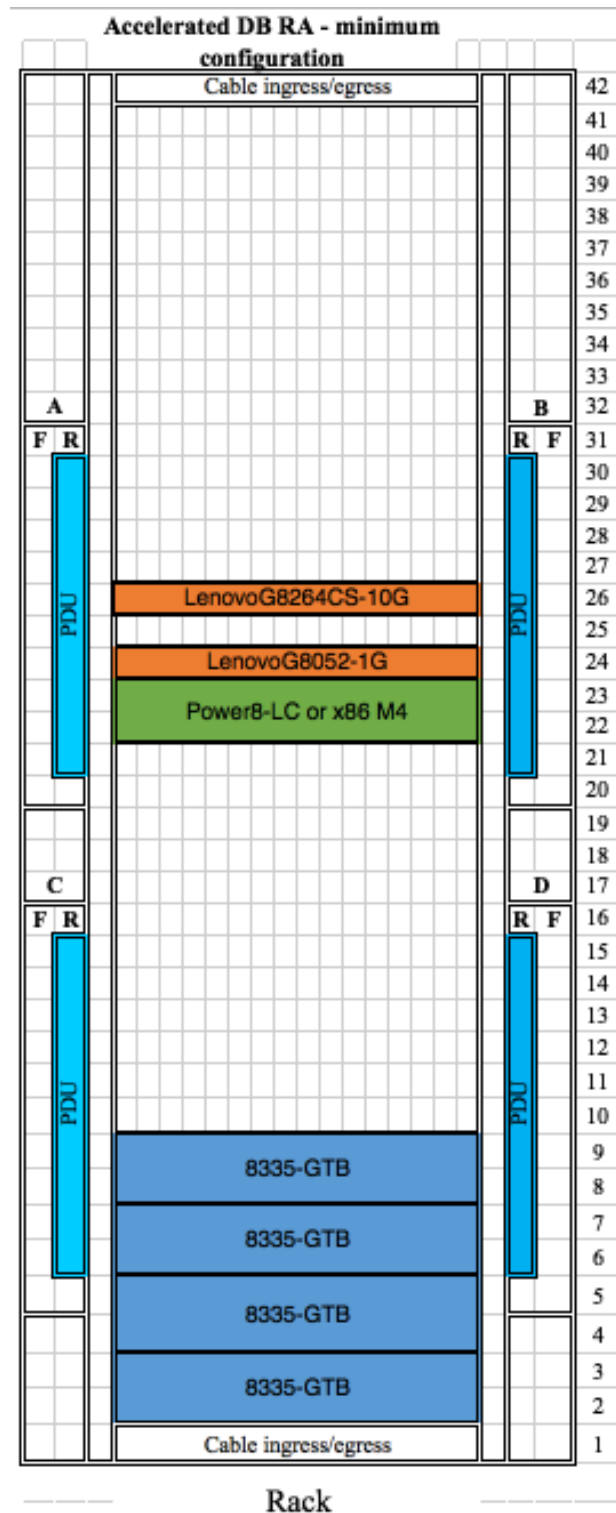
Place the inter-rack (spine) switches in slots **U37-U41** as follows:

- 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



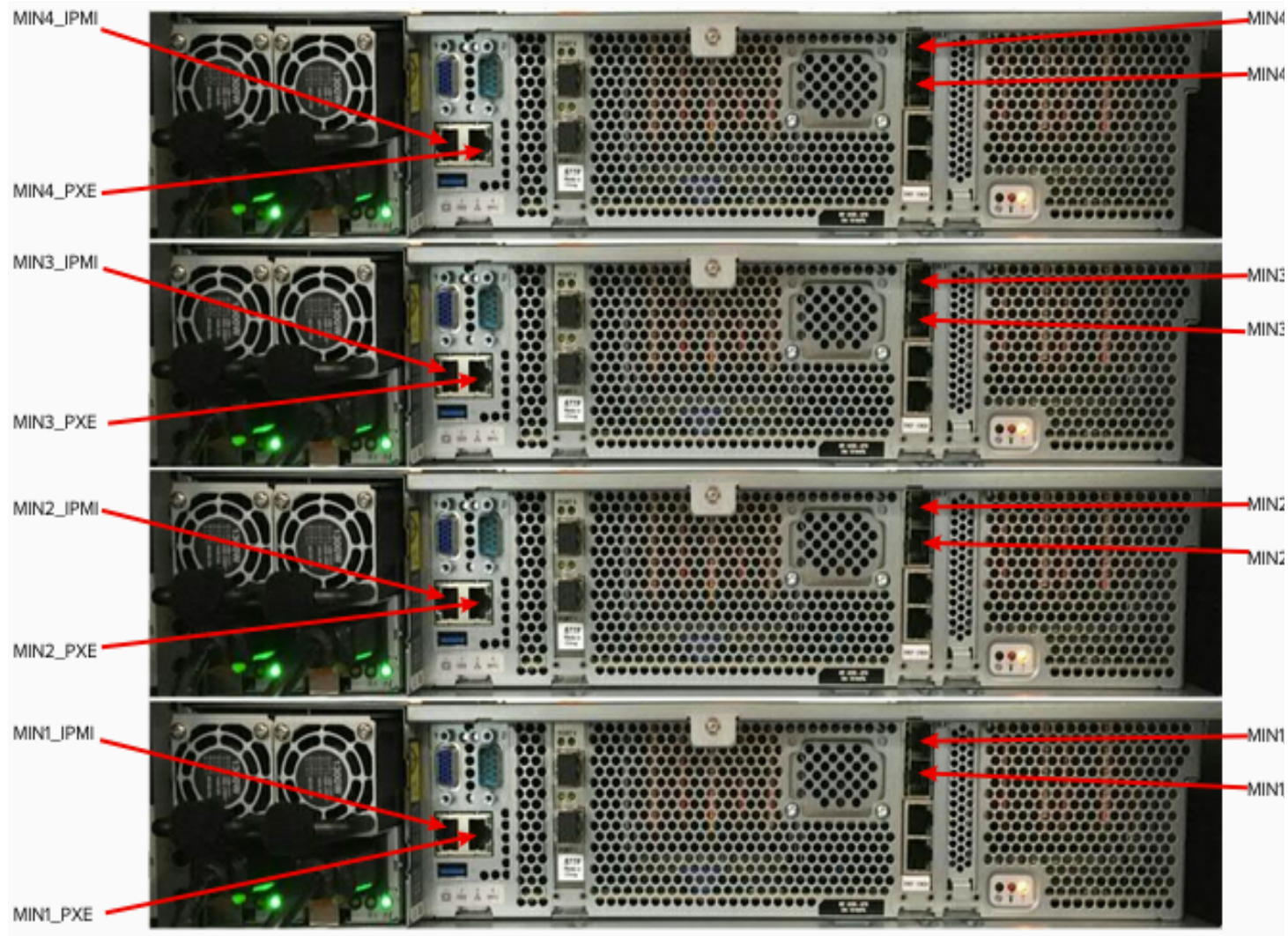


## CABLE TOGETHER ALL COMPONENTS

To following these cabling rules, simply cable the like labels on the servers to the applicable network switches. We show here the approach via the minimum 4 server cluster config.

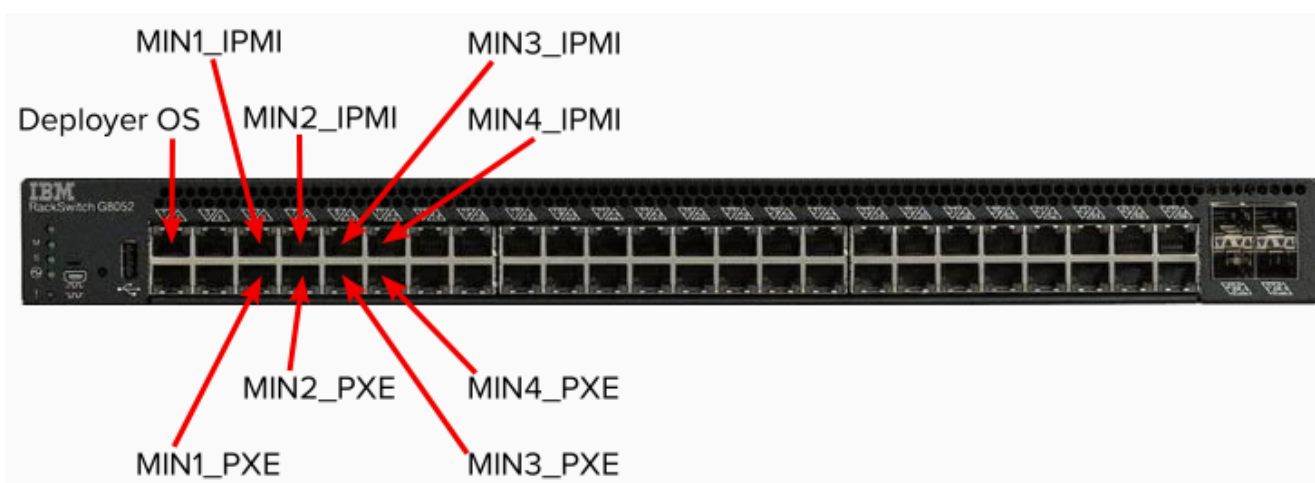
### EXAMPLE: MINIMIM FOUR 8335-GTB SYSTEM CLUSTER NETWORKING

Rear server view with labels...



Network switch port view. Labels on the ports 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 cables were used



See the Appendix for a magnified view of the physical ports on the IBM Rackswitch G8264CS 10GbE data network switch for the above minimum configuration.

## 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...

<b>A</b>	Reading the config.YML files with edited environment-specific changes
<b>B</b>	Drives the BMCs to populate the IP addresses to the nodes
<b>C</b>	Detects and populates relevant config data to the deployer node
<b>D</b>	Deploys needed firmware and operating system images to the server nodes
<b>E</b>	Configures the network switches (VLANs, MLAG) – <b><i>some manual steps required</i></b>
<b>F</b>	Configures all server management and data nodes (network interfaces, GPU drivers,...)

- power control
- Create/offer inventory

At genesis completion, control of the cluster is transferred to the operational manager (or software orchestrator) of choice. 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.

## 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.

Go [here](#) for a copy of the OpenPOWER Accelerated Database Full 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 image below zooms in on only those 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 things Genesis cannot automatically configure. Perform the following steps manually.

### COMPLETE NETWORKING CONFIG

Performed during the `deploy.sh`

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

### INSTALL NVIDIA DRIVER

Performed during the `deploy.sh`

For GPUdb only the driver is installed, but full CUDA is available local within the cluster.

## STEP 7: INSTALL OPEN SOURCE MANAGEMENT SOFTWARE

This deployment kit does not yet auto-deploy open source management tooling of 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 deploying 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

### MAGNIFIED SWITCH VIEWS

5	6	7	8
MIN3_10	MIN3_11	MIN4_10	MIN4_11
MIN1_10	MIN1_11	MIN2_10	MIN2_11
1	2	3	4

18	20	22
MGMT	LAB NET	DEPLOYER
		DEPLOYER
17	19	21

Magnified view of the physical ports on the IBM Rackswitch G8052 1GbE management network switch for a four 8335-GTB system cluster(3.3.1).

1	3	5	7	9	11
DEP OS		MIN1_IPMI	MIN2_IPMI	MIN3_IPMI	MIN4_IPMI
		MIN1_PXE	MIN2_PXE	MIN3_PXE	MIN4_PXE
2	4	6	8	10	12

### 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

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