Dell | Cloudera Solution Deployment Guide v2.3

A Dell Deployment Guide for Apache ™ Hadoop ®

Crowbar v1.6

June 11, 2013

Dell Next Generation Compute Solutions

The power to do more

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Trademarks

June 11, 2013

Notes, Cautions, and Warnings

A **NOTE** indicates important information that helps you make better use of your computer.

A **CAUTION** indicates potential damage to hardware or loss of data if instructions are not followed.

A **WARNING** indicates a potential for property damage, personal injury, or death.

Abbreviations

Abbreviation	Definition
BMC	Baseboard Management Controller
CDH	Cloudera Distribution for Hadoop
DBMS	Database management system
EDW	Enterprise data warehouse
EoR	End-of-row switch/router
HDFS	Hadoop Distributed File System
IPMI	Intelligent Platform Management Interface
NIC	Network interface card
LOM	Local area network on motherboard
OS	Operating system
ToR	Top-of-rack switch/router

Overview

Summary

This deployment guide for the Dell™ | Cloudera™ Solution describes the steps to install the solution on a predefined hardware and network configuration as specified in the Dell | Cloudera Solution Reference Architecture v2.3 document. It covers the steps required to prepare hardware platforms for the deployment of Cloudera Manager or Cloudera Hadoop (CDH). For deployment of Cloudera Manager, use the *Dell | Cloudera Solution Crowbar Administrator User Guide*.

Table 1: Dell | Cloudera Solution Software Locations

Daemon	Primary Location	Secondary Location
JobTracker	Master Name Node	
TaskTracker	Data Node(x)	
NameNode	Master Name Node	Secondary Name Node
Operating System Provisioning	Admin Node	
Chef	Admin Node	
Yum Repositories	Admin Node	
Cloudera Management Suite	Edge Node(x)	
Zookeeper	Data Node(x)	
HMaster	Master Name Node	
RegionServer	Data Node(x)	
Crowbar Admin	Admin Node	

Table 2: Dell | Cloudera Solution Support Matrix

RA Version	OS Version	Hadoop Version	Available Support
2.3	Red Hat® Enterprise Linux® 6.4	CDH 4.3.0/Cloudera Manager 4.6.0	Dell Hardware support Cloudera Hadoop support Red Hat Linux support
2.3	CentOS 6.4	CDH 4.3.0/Cloudera Manager 4.6.0	Dell Hardware support

Network Setup

The network configuration assumes a flat L2 wiring. All network connections should be accessible at that layer. Where isolation between different logical networks is required, VLANs are used.

Managing Growth

The system architecture is organized into three components, for sizing as the Hadoop environment grows. From smallest to largest, they are:

- Rack
- Pod
- Cluster

Each has specific characteristics and sizing considerations. You can scale the environment by adding additional capacity as needed, without the need to replace any existing components.

Rack

A rack is the smallest component in a Hadoop environment, and consists of all of the power, network cabling, and two Ethernet switches required to support up to 20 data nodes. These nodes should utilize their own power connectivity and data center space – separate from other racks – and be treated as a fault zone.

Pod

A pod is a single set of stacked Ethernet switches. For the Dell | Cloudera Reference Architecture, both the maximum and minimum are six. A pod consists of the administration and operation infrastructure to support three racks.

Cluster

A cluster is a set of greater than one pod, up to a maximum of 12 pods. A cluster is a set of Hadoop nodes that share the same Network Node and management tools for operating the Hadoop environment.

Please see the *Dell | Cloudera Solution - Reference Architecture Guide* for more detailed information

High-level Network Architecture

Network Overview

The Dell | Cloudera solution implements at a minimum four distinct, separate vLANs:

Table 3: Default Networks

Usage	Description	Default reserved vLAN tag	Tagged
Management vLAN	Used for administrative functions such as Crowbar node installation, TFTP booting, DHCP assignments, system logs, backups, and other monitoring. There is only one vLAN set up for this function and it is spanned across the entire network.	100	Not tagged
BMC vLAN	Used for connecting to the BMC of each node.	100	Not tagged
Production vLAN	Used by the Hadoop system to handle traffic between all nodes for HDFS operations, MapReduce jobs, and other Hadoop traffic.	200	802.1q Tagged

Usage	Description	Default reserved vLAN tag	Tagged
Edge vLANs	Used for connections to devices external to the Hadoop cluster; these include externally visible services such as load balancers and web servers. Use one or many of these networks, dependent on the need to segregate traffic among groups of servers	300	802.1q Tagged

The admin and BMC networks are expected to be in the same L2 network.

All servers in a Hadoop cluster are tied together using TCP/IP networks. These networks form a data interconnect across which individual servers pass data back and forth, return query results, and load/unload data. These networks are also used for management.

The Admin Node manages all the cluster nodes. It assigns the other nodes IP addresses, PXE boots them, configures them, and provides them the necessary software for their roles. To provide these services, the Admin Node runs the Dell™ Crowbar software framework, Chef, DHCP, TFTP, NTP, and other services, and this must be the only DHCP server visible to the compute and storage nodes. Details follow:

- **DHCP server—assigns and manages IPs for the compute and storage nodes**
- **NTP server (Network Time Protocol server)—makes sure all nodes are keeping the same clock**
- **TFTP server—PXE boots compute and storage nodes with a Linux kernel; the TFTP server services any PXE boot request it receives with its default options.**
- **DNS server—manages the name resolution for the nodes and can be configured to provide external name forwarding.**

Due to the nature of the different software used, the network is set up as flat as possible using a dedicated BMC port and bonded LOMs. If the Crowbar software framework is used to deploy the cluster, it manages all networks, and comes out of the box preconfigured to allow the initial configuration to come up quickly by predefining the admin, public, and BMC networks.

The Crowbar network configuration can be customized to better map to site-specific networking needs and conventions. These changes include adding additional vLANs, changing vLAN mappings, and teaming NICs.

Layout

Due to the nature of Crowbar's network layout, addresses are assigned to a whole network based upon interface, Network Type (Production, Management, and External) and teaming type.

Table 4: Master/Secondary (Admin) Name Nodes Network Connections

Interface	Network Type	Teaming Type
BMC	Management LAN	Single
LOM1	Production LAN	Teamed
LOM2	Production LAN	Teamed
Eth1	Production LAN	Teamed
Eth2	Management LAN	Single

Table 5: Edge Nodes Network Connections

Interface	Network Type	Teaming Type
BMC	Management LAN	Single
LOM1	Production LAN	Teamed 1
LOM2	Production LAN	Teamed 1
Eth1	Edge LAN	Teamed 2
Eth2	Edge LAN	Teamed 2

Table 6: Data Nodes Network Connections

Interface	Network Type	Teaming Type
BMC	Management LAN	Single
LOM1	Production LAN	Teamed 1
LOM2	Production LAN	Teamed 1

IP Addressing

The IP address can be assigned in this fashion, using large subnets to support many machines on the production network. The management network is a Class C network with 254 IP addresses. The Production network is what is known as a /23 with 512 IP addresses. In each network, the first 10 IP addresses are reserved for switches, routers, and firewalls.

Each network's ".1" address is reserved for the network gateway.

Table 7: IP Addressing Schema

LAN	Network	Subnet	Gateway	Reserved
Management LAN	172.16.0.0	255.255.255.0	172.16.0.1	0.1 – 0.10
Production LAN	172.16.2.0	255.255.254.0	172.16.2.1	2.1-2.20
Name Nodes	DHCP Allocated			
Data Nodes	DHCP Allocated			
External LAN	TBD by Customer			

Rack Awareness

With the network set up using Top of Rack (ToR) switches, Rack Awareness can be programmed using the Chef information about which switch the LOM1 is plugged into. A simple script has been added to the Hadoop configuration to pull the information out of Chef, and then use it for Rack Awareness.

Table 8: Pod 1 IP Example Addressing Layout

Network: 172.16.0.0	Netmask: 255.255.252.0
Multicast: 172.16.0.0	Broadcast 172.16.3.255

Pod	Rack Number	Network	Server Type	IP Range	Subnet Mask	Gateway
1	1	Production	Data Node	172.16.0.1-42	255.255.252.0	172.16.0.1
1	2	Production	Data Node	172.16.1. 1-42	255.255.252.0	172.16.0.1
1	3	Production	Data Node	172.16.2. 1-42	255.255.252.0	172.16.0.1
1		Production	Master Name Node	172.16.3.1-19	255.255.252.0	172.16.0.1

Pod	Rack Number	Network	Server Type	IP Range	Subnet Mask	Gateway
1		Production	Secondary Name Node	172.16.3.20-30	255.255.252.0	172.16.0.1
1		Production	Edge Node	172.16.3.41-50	255.255.252.0	172.16.0.1
1	1	BMC	Data Node	172.16.0.200-242	255.255.252.0	172.16.0.1
1	2	BMC	Data Node	172.16.1.200-242	255.255.252.0	172.16.0.1
1	3	BMC	Data Node	172.16.2.200.242	255.255.252.0	172.16.0.1
1		BMC	Master Name Node	172.16.3.201-219	255.255.252.0	172.16.0.1
1		BMC	Secondary Name Node	172.16.3.220-230	255.255.252.0	172.16.0.1
1		BMC	Edge Node	172.16.3.231-250	255.255.252.0	172.16.0.1

Table 9: Pod 2 IP Example Addressing Layout

Network: 172.16.0.0	Netmask: 255.255.252.0
Multicast: 172.16.0.0	Broadcast: 172.16.3.255

Pod	Rack Number	Network	Server Type	IP Range	Subnet Mask	Gateway
2	1	Production	Data Node	172.16.4.1-42	255.255.252.0	172.16.4.1
2	2	Production	Data Node	172.16.5. 1-42	255.255.252.0	172.16.4.1
2	3	Production	Data Node	172.16.6. 1-42	255.255.252.0	172.16.4.1
2		Production	Master Name Node	172.16.7.1-19	255.255.252.0	172.16.4.1
2		Production	Secondary Name Node	172.16.7.20-30	255.255.252.0	172.16.4.1
2		Production	Edge Node	172.16.7.41-50	255.255.252.0	172.16.4.1
2	1	BMC	Data Node	172.16.4.200-242	255.255.252.0	172.16.4.1
2	2	BMC	Data Node	172.16.5.200-242	255.255.252.0	172.16.4.1
2	3	BMC	Data Node	172.16.6.200.242	255.255.252.0	172.16.4.1
2		BMC	Master Name Node	172.16.7.201-219	255.255.252.0	172.16.4.1
2		BMC	Secondary Name Node	172.16.7.220-230	255.255.252.0	172.16.4.1
2		BMC	Edge Node	172.16.7.231-250	255.255.252.0	172.16.4.1
2		External	Edge Node	TBD by Customer	TBD	TBD

Dell | Cloudera Solution Hardware Configuration

Table 10: Edge Node Hardware Configuration

Component	Setting	Parameter
BIOS	Boot Order	LOM 1 PXE Internal Boot Device PERC H710 LUN 0
	PXE Boot LOM 1	Enable
	PXE Boot LOM 2	Disable
	C-State	Disable
PERC H710 BIOS	RAID	Enabled
	LUN 0	Disk 0-5 RAID 10
	Boot Order	LUN 0

Table 11: Master and Standby Name Node Hardware Configuration

Component	Setting	Parameter
BIOS	Boot Order	LOM 1 PXE Internal Boot Device PERC H710 LUN 0
	PXE Boot LOM 1	Enable
	PXE Boot LOM 2	Disable
	C-State	Disable
PERC H710 BIOS	RAID	Enabled
	LUN 0	Disk 0-5 RAID 10
	Boot Order	LUN 0

Table 12: Data Node Hardware Configuration

Component	Setting	Parameter
BIOS	Boot Order	LOM 1 PXE Internal Boot Device

Component	Setting	Parameter
	PXE Boot LOM 1	Enable
	PXE Boot LOM 2	Disable
PERC H710 Controller BIOS	**RAID**	**Enabled**
	LUN0	Disk0 RAID0
	LUN1	Disk1 RAID0
	.	.
	LUN23	Disk23 RAID0
	Boot Order	Disk 0 Disk 1

Table 13: Network Top of Rack Configuration

Setting	Parameter	Ports
Spanning-Tree	Enable	ALL
Port-Fast	Enable	ALL
Flow-Control	Enable	ALL

Dell | Cloudera Solution Network Configuration

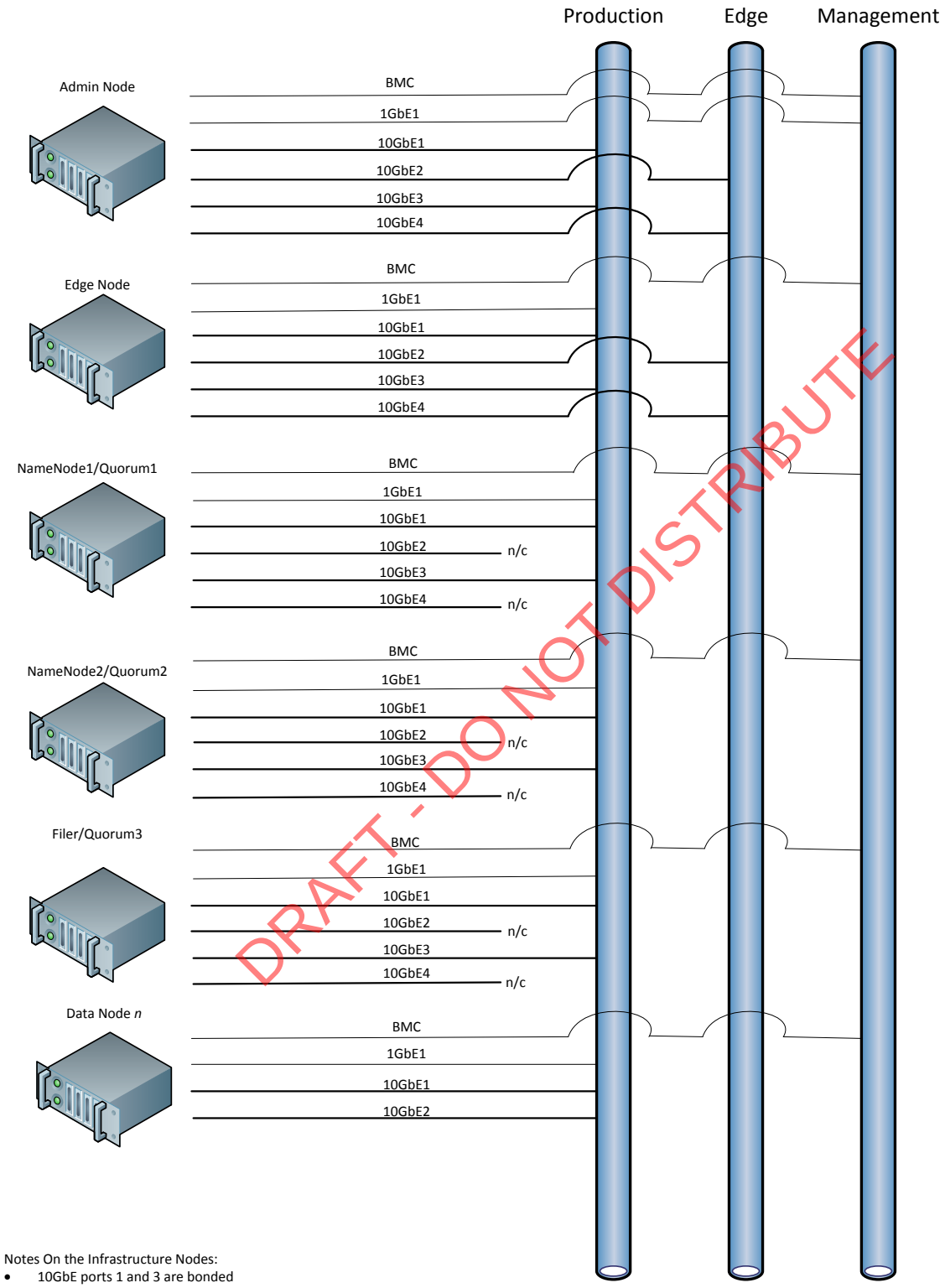
Table 14: IP Scheme

A	B	C	D	Use
First POD				
172	16	0/22		Rack Number
			1-42	Data Node[XX] bond0, by Rack Unit
		4/22		Rack Number (1xx)
			200-242	Data Node [XX] BMC, by Rack Unit
172	16	3	1-19	Master Node[XX]
		3	20-30	Data Node[XX]
		3	41-50	Edge Node[XX]
172	16	7	1-19	Master Node[XX]
		7	20-30	Master Node[XX]
		7	41-50	Edge Node[XX]

- **All Master Nodes will be addressed in the first Pod only. Additional Pods will not contain additional Master Nodes.**
- **Master Nodes running Zookeeper-related services will be distributed among Pods for larger deployments. Please consult with your Dell sales team when designing your solution.**

Dell | Cloudera Solution Network Interconnects

Figure 1: Dell Cloudera Solution Cabling



Notes On the Infrastructure Nodes:

- 10GbE ports 1 and 3 are bonded
- 10GbE ports 2 and 4 are bonded.
- all ports are not used.

Rack Configuration

Configuring the Dell™ Force10™ Network Solution

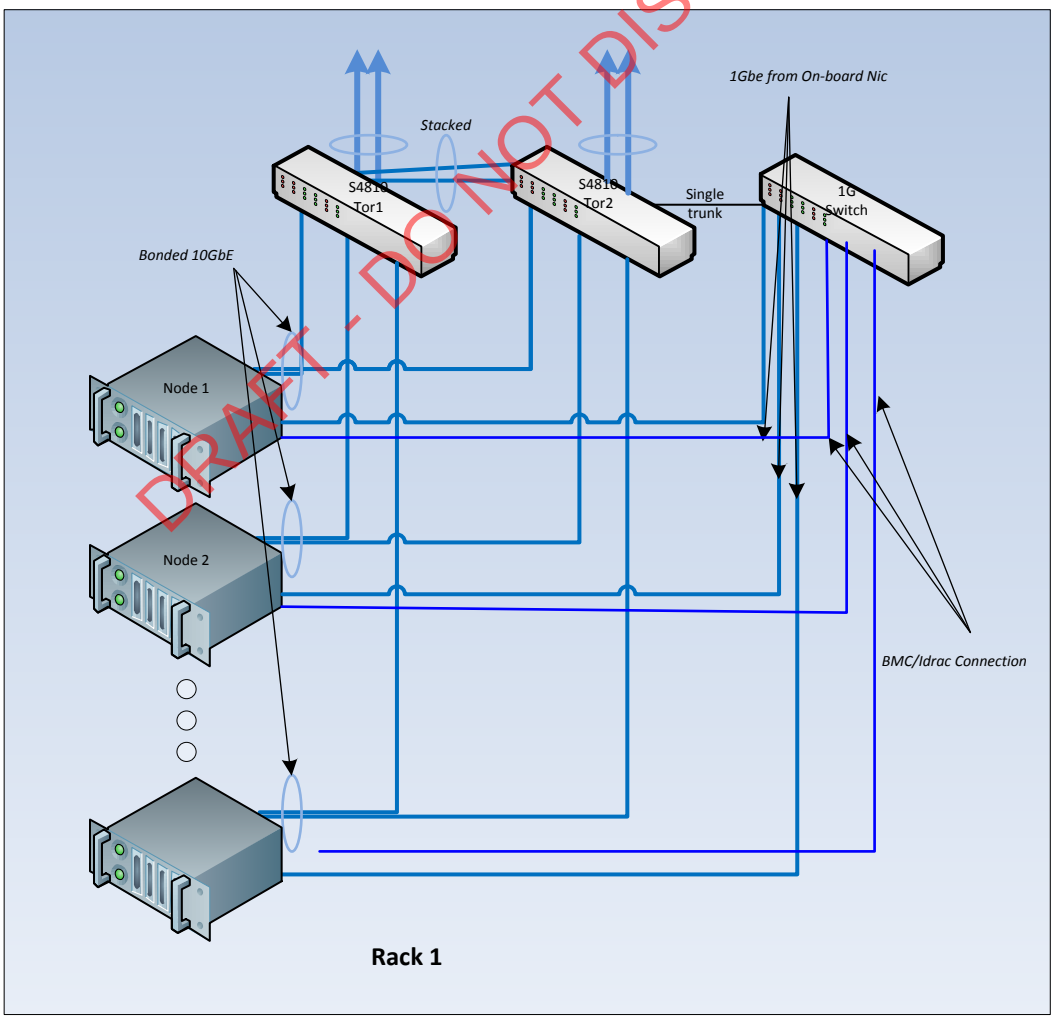
Single Rack Configuration

With 1G nodes, Dell Force10 recommends using Dell™ Force10™ S60 ToR switches in the rack. Each rack could have a maximum of 20 servers. Each rack has two ToR S60 switches that are stacked, and this stack connects to both of the Dell™ Force10™ S4810 switches. The S60 stack offers a single switch view to the servers. Each Data Node has two data 1GbE NIC ports. It forms a LAG of two ports with one port on each switch in the stack, thereby offering high availability and redundancy.

For the 10G servers, the pair of ToR switches are Dell Force10 S4810, that run high availability feature called the Virtual Link Trunking (VLT). This feature allows the servers to terminate their LAG interfaces into two different switches instead of one. This allows HA as well as active-active bandwidth utilization. This feature gives redundancy within the rack if one switch fails or needs maintenance. The uplink to the aggregation pair is a LAG, from each ToR, of 80G bandwidth. This is achieved using 2 x 40G interfaces in a LAG connecting to the aggregation pair. Therefore from each rack there is a collective bandwidth of 160G available.

In addition, each 10G node will have a single the On-Board NIC, eth0, connected to either a Dell Force10 S55, S60 or Dell PowerConnect 6248, along with the BMC of each node. The On-Board NIC will be used for PXE booting and initial configuration of each node.

Figure 2: Single Rack View



Use the switch configuration guide (manual) for the initial configurations. Examples of these are: enabling the interfaces ('no shut'), configuration of IPs on the management interfaces, enabling SSH (telnet is enabled by default), and authorization details.

Stacking S60s

The following configuration helps stack the two S60 switches together within the rack. This configuration assumes the stacking module in both S60 switches is in module 0 (IO-facing side) and the 10G uplink module is in slot 1 (power supply and fan side).

Connect port 49 on module 0 (IO side from the left) to port 49 of the second S60 and similarly connect port 50 on both switches. The stack is automatically detected and formed without a user configuration. Using the CLI command 'show system brief' verify that the stacking module is detected by the S60.

When you are adding units to a stack, you can either:

- **Allow FTOS to automatically assign the new unit a position in the stack, or**
- **Manually determine each unit's position in the stack by configuring each unit to correspond with the stack before connecting it.**

Three configurable system variables affect how a new unit joins a stack: priority, stack number, and provision.

After the new unit loads, it synchronizes its running and startup configurations with the stack.

```
TOR-Rack1#stack-unit renumber
TOR-Rack1(conf)# stack-unit priority <higher priority determines primary role>
```

After connecting the switches together run the following command to check the status of the stack.

```
TOR-Rack1#show system brief

Stack MAC : 00:01:e8:d5:ef:81

-- Stack Info --

Unit    UnitType   Status   ReqTyp   CurTyp   Version    Ports
-----------------------------------------------------------------------
0       Standby    online    S60      S60     8.3.3.7    52
1       Management online    S60      S60     8.3.3.7    52
```


Uplinking the S60s

The following configuration helps create configurations for the uplink of the stack. This configuration assumes the 10G uplink module is in slot 1 (power supply and fan side). The uplink ports are going to be numbered 0/51,0/52 and 1/51,1/52 respectively. All four 10G interfaces would be part of a single LAG or port-channel. The following illustrates that.

```
# Put the user ports in the switchport mode
TOR-Rack1(config)# interface range gigabitethernet 0/1 - 47
TOR-Rack1(config-if-range-gi-0/1-47)# no shutdown
TOR-Rack1(config-if-range-gi-0/1-47)#switchport
TOR-Rack1(config-if-range-gi-0/1-47)#end

# Repeat the same for ports on the second unit
TOR-Rack1(config)# interface range gigabitethernet 1/1 - 47
<snip>…
```

```
# Create port-channel of the 4 10G ports. The example below shows it for 1
port.
# Repeat the same configs for other 10G ports 0/52,1/51 and 1/52.

TOR-Rack1(conf)#interface Gigabitethernet 0/51
TOR-Rack1(conf-if-gi-3/15)#no shutdown
TOR-Rack1(conf-if-gi-3/15)#port-channel-protocol lacp
TOR-Rack1(conf-if-gi-3/15-lacp)#port-channel 1 mode active

# Change the defaults on the port-channel that gets created automatically
# From the above commands.

TOR-Rack1(conf)#interface port-channel 1
TOR-Rack1(conf-if-po-1)#no shutdown
TOR-Rack1(conf-if-po-1)#switchport

# Add the Data ports 0 through 30 and the port-channel 1 to vlan 100

TOR-Rack1#config
TOR-Rack1 (conf)#int vlan 100
TOR-Rack1 (conf-if-vlan)#tagged po 1
TOR-Rack1 (conf-if-vlan)#untagged gi 0/0-21
TOR-Rack1 (conf-if-vlan)#untagged gi 1/0-21
TOR-Rack1 (conf-if-vlan)#show conf
!
interface Vlan 100
no ip address
tagged Port-channel 1
untagged gi 0/0-21
untagged gi 1/0-21

TOR-Rack1#config
TOR-Rack1 (conf)#int vlan 300
TOR-Rack1 (conf-if-vlan)#tagged po 1
TOR-Rack1 (conf-if-vlan)#untagged gi 0/29-41
TOR-Rack1 (conf-if-vlan)#show conf
!
interface Vlan 300
no ip address
tagged Port-channel 1
untagged gi 0/29-41
```


So far the configuration is sufficient to link the nodes to the ToR switches, stacking the ToR and uplinks from ToR.

The uplink port-channel links are all active and forward traffic to the aggregate switches. Each *flow*, a unique combination of a source and a destination, gets hashed internally and gets load-balanced across the port-channel.

Server Gateway

The nodes in a rack have a single virtual IP as their gateway for routing purposes. The VRRP protocol runs on the aggregation S4810 switches. It does not need any configuration on the ToR. The VRRP master owns the virtual IP and does the routing but the combination of VLT and VRRP makes it certain that backup also routes or switches the traffic if it has a path in its forwarding table. This is an active-active brained capability where routing is independent of which switch owns the virtual IP.

Management Network

The BMC ports from all the nodes connect to the same ToR switches as the data ports. However the management vLAN is separate from the data vLAN. Ports 0 to 30 on the ToR are reserved for data connections and 31 to 48 are configured for the management network. This is achieved by creating a separate vLAN on the ToR and adding all the management ports as part of that vLAN.

```
TOR-Rack1(conf)#int vlan 300
TOR-Rack1(conf-if-vlan)#tagged po 1
TOR-Rack1(conf-if-vlan)#untagged gi 0/31-47
TOR-Rack1(conf-if-vlan)#untagged gi 1/31-47
```

Multi-Rack Configuration

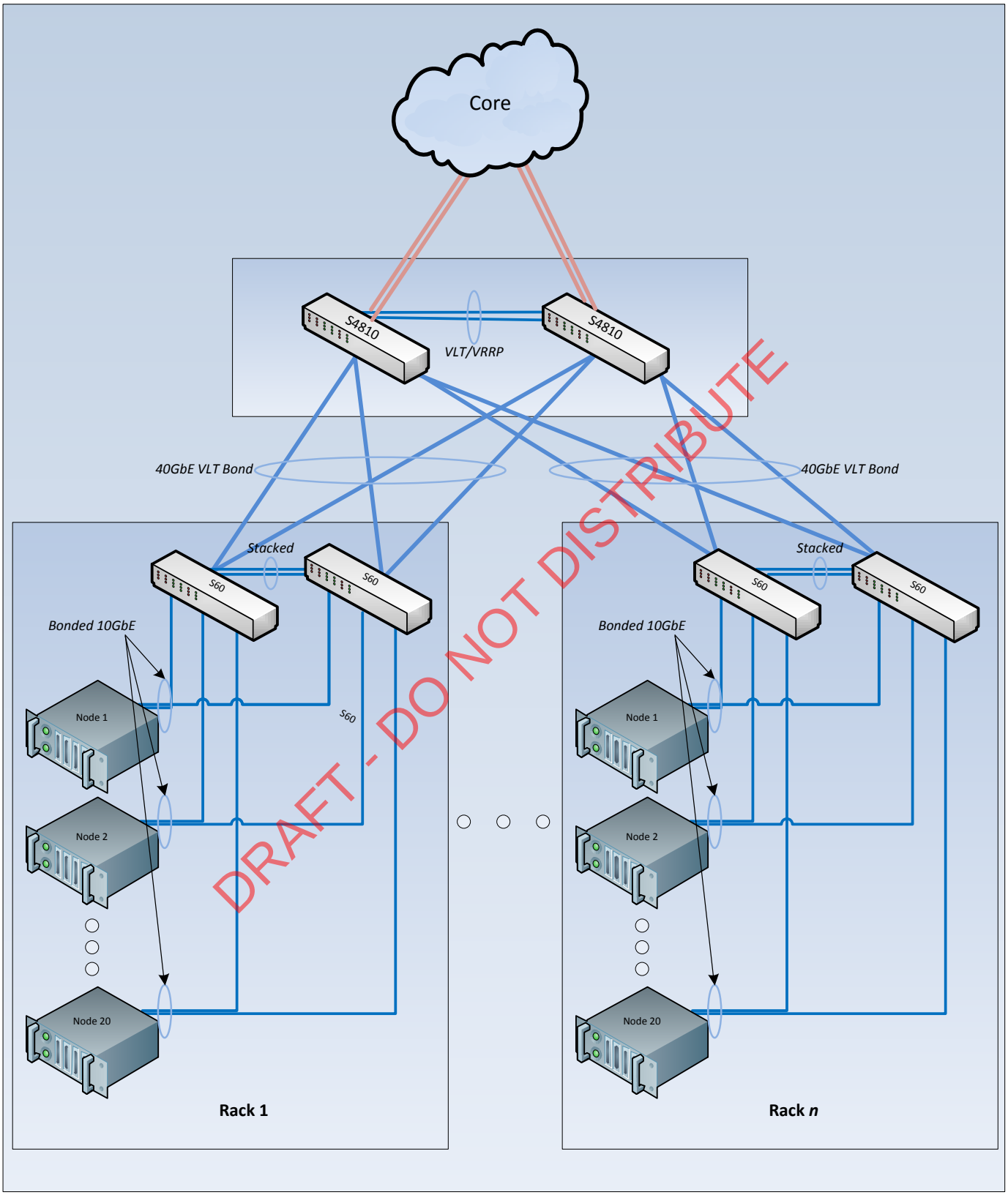
Once the single rack is deployed from the server and network perspective we can take a look at the multi-rack view and then move on to configure the aggregation switches that connect the racks together. This section shows the S4810 switch aggregating the clusters together to enable inter-rack traffic as well as the management network. As we saw there are two separate vLANs for data and management; all port-channels on the S4810 and ToR are tagged in these two vLANs.

The following table shows the network inventory details in a full cluster of three racks.

Table 15: 60 Node Network

Total Racks	**3 (15-20 nodes per rack)**
Top of Rack Switch	6 S60 (2 per rack)
Pod-interconnect Switch	2 S4810
Server	2RU R720/R720xd
Over-subscription at ToR	1:1
Modules in Each ToR	1x 12-2port Stacking, 1x 10G -2 port uplink

Figure 3: Multi-Rack View



VRRP on S4810

The following configuration shows a sample VRRP configuration on the S4810 switches. This configuration is created on the vLAN interfaces of the S4810. Since there is only a single vLAN 100 in the cluster of three racks, a single instance of this configuration is needed.

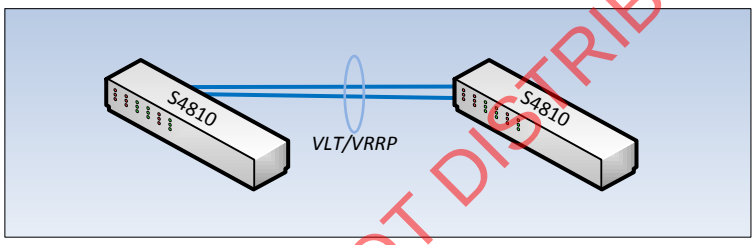
```
Force10_VLTpeer1(conf)#int vlan 100
Force10_VLTpeer1(conf-if-gi-1/1)#vrrp-group 100
Force10_VLTpeer1(conf-if-gi-1/1-vrid-111)#virtual-address 10.10.10.1
#One or more these virtual IP addresses can be configured, which can be used
#as the unique gateway per rack or cluster.
Force10_VLTpeer1(conf-if-gi-1/1-vrid-111)# priority 125
# Priority from 1-255 can be used to determine which switch owns the VIP and
becomes the VRRP master.

# Repeat the same configuration on the second VLT peer, except for a different
priority.
```

VLT on S4810

The second part of configuration involves the pod-interconnect switches that run VLT with each other.

Figure 4: S4810 VLT interconnect



With the following steps we will configure VLT on the pair of S4810 switches that interconnect the racks. To configure virtual link trunking, you must create a VLT domain, configure a backup link and interconnect trunk, and connect the peer switches in a VLT domain to an attached access device (switch or server). But first RSTP should be configured, as a best practice, on the S4810 as well as the S60 switches.

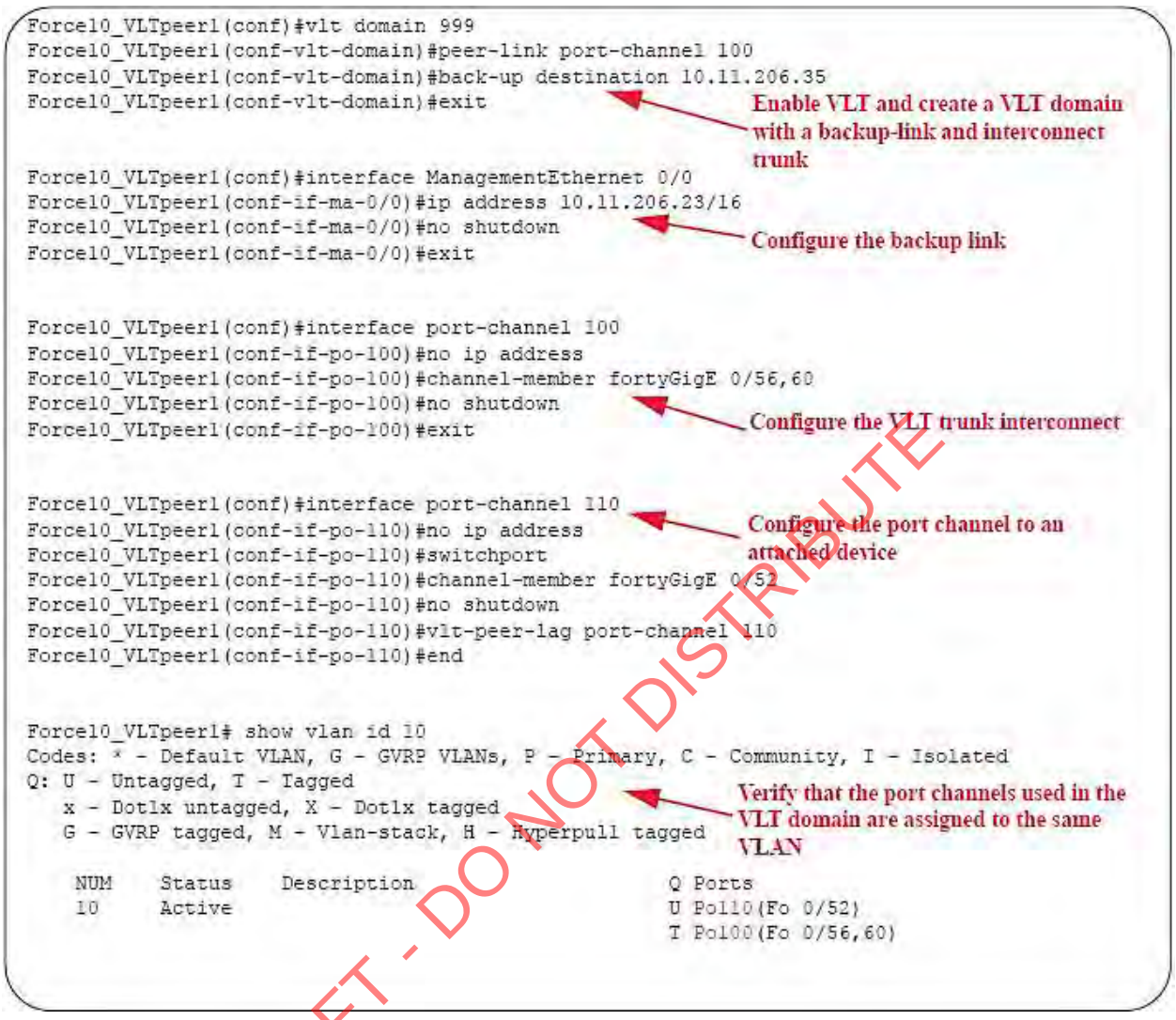
```
Force10_VLTpeer1(conf)#protocol spanning-tree rstp
Force10_VLTpeer1(conf-rstp)#no disable
Force10_VLTpeer1(conf-rstp)#bridge-priority 4096

#Repeat the same on VLTPeer2 with a different bridge priority to make it the
root.

Force10_VLTpeer2(conf-rstp)#bridge-priority 0
```

The next figure shows a sample configuration on VLT. The VLT works over a primary link and a backup link. Therefore this configuration consists of configuring the IP connectivity details of each switch. In addition each port-channel to the layer-2 switch, S60 stack in this case, gets a configuration specifying the port-channel that acts as the ICL link. In absence of a direct path to the destination, the ICL link would carry the traffic to the peer. The backup link is only for heartbeat status of the peer; no data traffic flows over it.

Figure 5: VLT Configuration on peer1



Configuring the Force10 switch

1. Use a serial communication hyperterminal (e.g. Minicom) to configure the switch. The following are the instructions for using Mincom:

minicom –s

- Serial port settings: /dev/ttyUSB0, 9600,n,8,1
- Modem and Dialing:
  - Delete init, dial and hangup lines
- Save settings as dfl

minicom

force10> enable

configure

interface range gigabitethernet 0/0 - 46

no ip address

switchport

spanning-tree rstp edge-port

no shutdown

exit

interface range gigabitethernet 1/0 – 46

no ip address

switchport

spanning-tree rstp edge-port

no shutdown

exit

Int vlan 100

description Production

no ip address

untagged gigbitethernet 0/0-30

untagged gigabitethernet 1/0-30

no shutdown

exit

int vlan 300

description BMC

no ip address

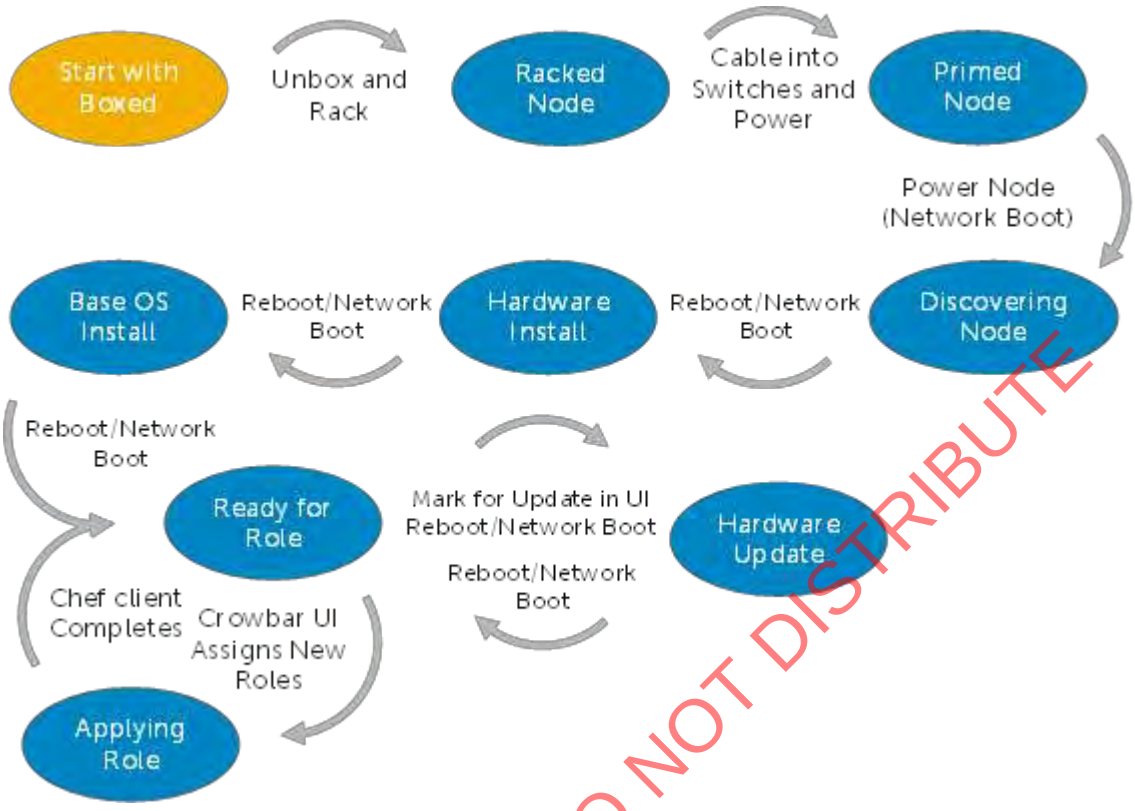
untagged gigabitethernet 0/31-39

no shutdown

exit

Dell | Cloudera Solution Deployment Process Overview

Figure 6: Dell | Cloudera Solution Deployment Process Overview



Dell | Cloudera Solution Automated Software Installation

Admin Node Installation

To use the Crowbar software framework, you must first install an Admin Node. Installing the Admin Node requires installing the base operating system, optionally customizing the Crowbar configuration, and installing Crowbar itself.

The following is required to bootstrap the Admin Node by PXE booting:

1. The user is required to make the physical arrangements to connect a VM to the network in such a way that the Admin Node (when there is one) can PXE boot from it. A network crossover cable may be required.
2. All BIOS and RAID configuration for the Crowbar Admin Node will need to be completed manually, prior to the installation from the Crowbar ISO image.
3. A VM image provides an initial TFTP/DHCP/Boot server. A VMware Player (free download from VMware) is required to execute it.

In preparation for running VMware Player on a particular machine, please make sure that:

- **Support for Intel VT is enabled in BIOS**
- **There is only one NIC enabled (turn off the wireless NIC if there is one and leave only the wired NIC enabled)**

Procedure:

1. Install VMware Player on a laptop.
2. Open the VMware machine configuration distributed with the Crowbar software framework. (e.g., Crowbar_Installer-1.3.tgz)
3. Edit the machine settings (see figures that follow) and ensure that:
    - **The CD/DVD drive is mounting the Crowbar ISO distribution**
    - **The Network adapter is configured to use Bridged Networking**
4. Obtain the ISO of Crowbar (from your Dell Account Representative) and configure VMware Player to mount it as a DVD in the VM.
5. Plug the crossover cable into eth0 of the server and your network port on the laptop.
6. Start the VMware Player and configure it to use the network port.
7. Power on the Admin Node, and ensure that:
    - **It is set up to boot from the hard disk for subsequent boots**
    - **The first boot is a network boot**

The machine will obtain its image from the VMware Player VM and start the installation process.

Figure 7: VMware Player Configuration for DVD

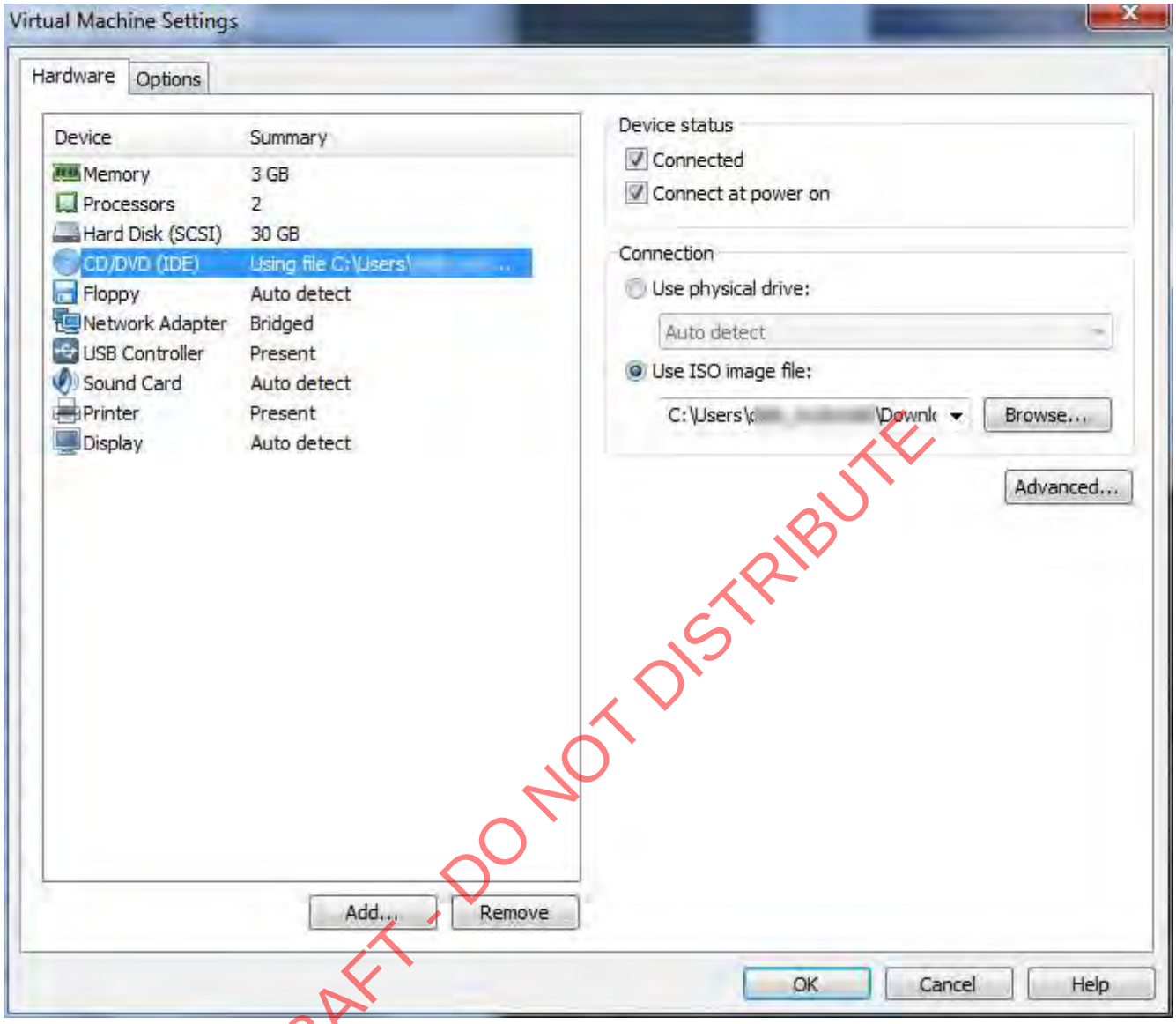
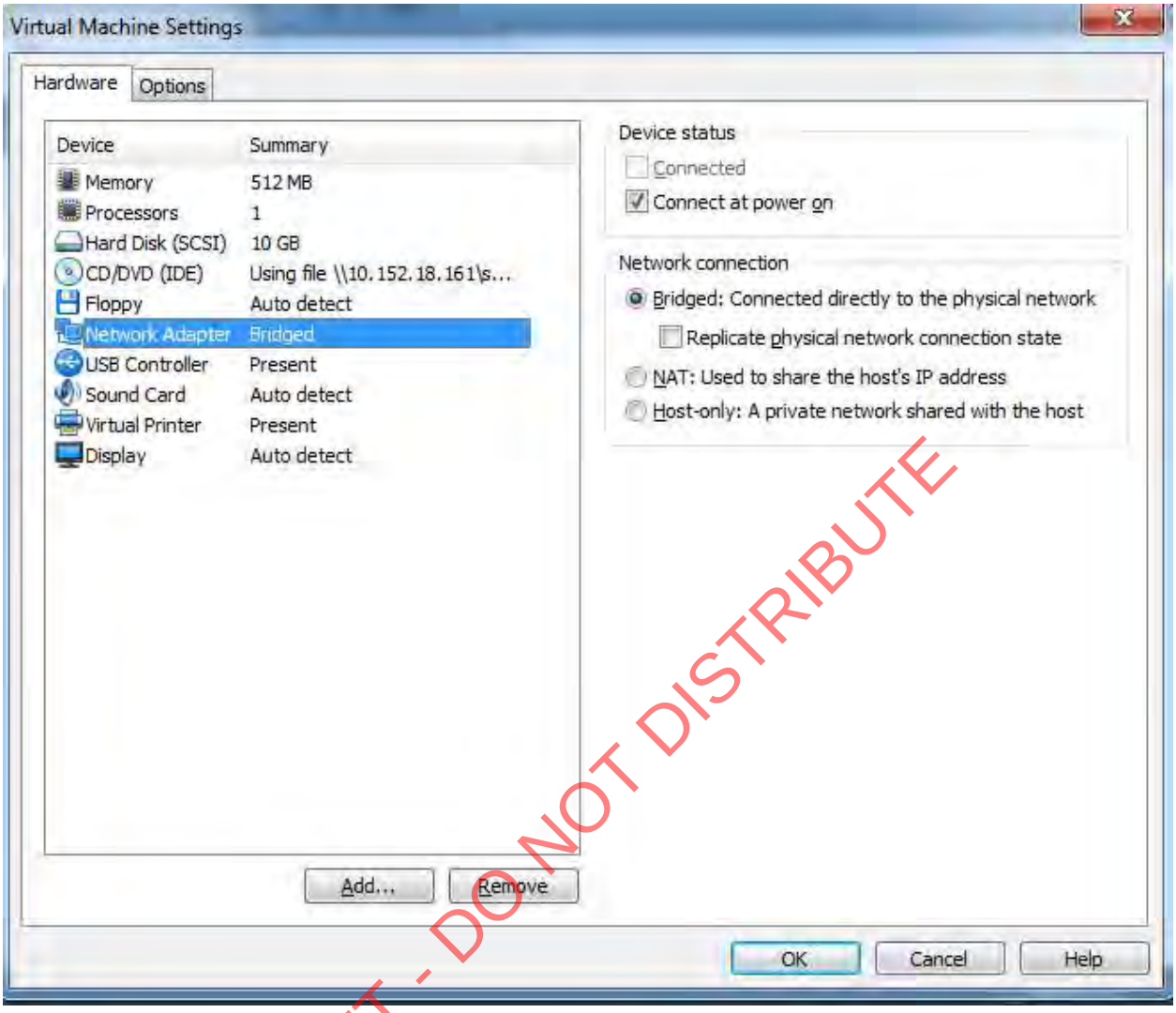


Figure 8: VMware Player Configuration for Network Adapter



Installing the Crowbar Software Framework

The image installed in the previous steps includes all the required Crowbar components. Before actually installing the Crowbar software framework, there is the opportunity to customize the installation to fit into the deployment environment. The steps below assume default configuration.

To install the Crowbar software framework:

1. Log onto the Admin Node. The default username is root, password: crowbar.
2. If necessary, edit the file /opt/dell/barclamps/network/chef/data_bags/crowbar/ bc-template-network.json to customize the network information for the deployment. A detailed description of how to edit the network JSON can be found in the next section.
    a. The networks cannot be reconfigured once the system is installed.
3. cd /tftpboot/redhat_dvd/extra
4. ./install admin.your.cluster.fqdn
    a. where admin.your.cluster.fqdn is the fully qualified domain name of the admin machine, for example admin.dell.com

5. Verify in /var/log/install.log that the install completed successfully. Look for "*Script done on <date_time>*"
6. Verify that no installation errors occurred.
7. Reboot the Crowbar admin node.

> Because there are many dependencies some transient errors might be visible on the console. This is expected.

Editing the Network JSON

The JSON is located at /opt/dell/barclamps/network/chef/data_bags/crowbar/bc-template-network.json. The file should be edited before the install command is run to create your Admin Node.

The information you will need:

1. vLAN ID for each of the vLANs used by Crowbar
2. Network subnet for each vLAN
3. Ranges for each network (i.e., host, dhcp, switch, admin)
4. Netmask for each vLAN
5. Gateway for the public network and possibly the BMC ranges

See Appendix B: Network JSON Example.

> The biggest error for many users is putting a comma at the end of the last statement or value within a JSON.

Other networks are specified in the same manner. The default file contains a public network, an admin network, a BMC vLAN, and a BMC network. Network configuration options are:

Table 16: Network Configuration Options

Name	Default	Description
mode	single	A string value of either single, dual, or team. This specifies the default network interface construction model.
teaming	map	A map of values specific to teaming
networks	map	A map of networks that this barclamp should manage

The system provides the following default networks:

Table 17: Default Networks

Name	Usage	Notes
admin	Private network for node-to-node communication	A router and router_pref is required; this network must be owned by the Crowbar system to run DHCP on it.
bmc	Private network for BMC communication	This can be made the same as the admin network by using the ranges to limit what IP goes where; a router, if wanted, is external to the system.
bmc_vlan	Private network for admin nodes on the BMC network	This must be the same as the BMC network and have the same vLAN. This will be used to generate a vLAN tagged interface on the Admin Nodes that can access the BMC LAN.
public	Public network for Crowbar and other components	Router and router_pref are required, router_pref should be the lowest.

Each network has the following parameters:

Table 18: Network Parameters

Name	Default	Description
vlan	Integer	This is the vLAN to use on the switch and interfaces for this network.
use_vlan	true	A value of “true” indicates that the vLAN should be applied to the interface. A value of “false” assumes that the node will receive untagged traffic for this network.
add_bridge	false	This indicates whether the network should have a bridge built on top of it. The bridge will be br.
subnet	IP Address	The subnet for this network
netmask	Netmask	The netmask for this network
router	IP Address	The default router for this network
router_pref	Integer	All networks with a gateway need a unique number. The lower the number will become the default route on the machine. This is not vlan-specific, but network-specific. For example, BMC and BMC_VLAN should have different metric numbers.
broadcast	IP Address	The default broadcast address for this network
ranges	map	Contains a map of strings to start and stop values for the network; this allows for sub-ranges with the network for specific uses, e.g. dhcp, admin, BMC, hosts.

The range map has a string key that is the name and map defining the range.

Table 19: Range Map

Name	Type	Description
start	IP Address	First address in the range, inclusive
end	IP Address	Last address in the range, inclusive

JSON Configuration by Section

1. Attributes

    a. Startup delay set to 30 seconds to allow spanning tree to settle down
    b. Mode—This sets whether to build up single NICs or bonded NICs; options are single, teamed
    c. Teaming—Sets the mode of the teaming: in this case 6

2. Interface Maps—To set up the interface map for figuring out and defining eth0, eth1, eth2 on particular hardware models:

    a. Pattern—Pattern of the hardware model/type
    b. Bus order—Order to start enumerating; enumeration begins at eth0, eth1, eth2, eth3. If a bus is not defined, it will be enumerated at the end in the order in which it was presented.
    c. Conduit Maps—Determine what network gets mapped to which interface based on what role; pattern this matched to the attribute variable, the NIC type, and role

        i. mode (single, team)
        ii. NIC type 1g or 10g
        iii. role—mastername, crowbar-config-default

3. Conduit Maps—determine how networks get mapped to which interface based on what role the first match will how networks are laid out.
    a. Pattern- matches on three parts "Mode/NIC Type/Role Name"
        i. mode single, team, wildcard
        ii. NIC type and number in system. Example 1g2 matches the 2nd 1 gigabit port in the system, 10g3 matches the 3rd 10 gigabit port in the system
        iii. role—This matches a role assigned to machine. For example.*namenode would match the name node role.
    b. Conduit name (prod, mgmt, admin, intf0, intf1,...)
        i. if_list — what interfaces to use
        ii. team_mode — how to team when needed
    c. repeat for other conduits
4. Networks — define the network, IP ranges, available scopes, etc.
    a. Name of Network (admin, mgmt, prod)
        i. conduit — Name of conduit used in step 4
        ii. vlan — vLAN to use
        iii. use_vlan – weather to turn on 802.1q tagging
        iv. add_bridge – Whether to use bridging protocol or vLAN tagging
        v. subnet — The IP subnet
        vi. netmask — Subnet netmask
        vii. broadcast — Broadcast IP
        viii. router – default gateway for network
        ix. router_pref – likelihood of becoming the default route on a system
        x. ranges — The IP ranges in the subnet broken down by usage; admin, host, dhcp, are all possible examples

> The following networks are required: bmc_lan, public, and admin. Admin must have ranges set to the dhcp, admin, and host.

How to Add a Public IP to a Node

From a command prompt on the Admin Node, you can execute the following:

- **crowbar network allocate_ip default <machine name> public host**

To validate address, you can run:

- **crowbar machines show <machine name>**

You should then have your system set up with a public IP. From the admin section above, you could do "admin switch" instead of "public host" and the IP allocated will be from the switch range of the admin network.

To edit the DNS or NTP time server, please modify the DNS and NTP barclamps.

Configuring the Network for External Connectivity

1. Choose the JSON that matches your environment best:

```
a. /opt/dell/barclamps/network/chef/data_bags/crowbar/bc-network-template.json
b. /tftpboot/redhat_dvd/extra/config/network-hadoop-noteam-admin.json
c. /tftpboot/redhat_dvd/extra/config/network-hadoop-team-admin.json
```

2. Back up the old file in a temp directory:

```
cp /opt/dell/barclamps/network/chef/data_bags/crowbar/bc-network-template.json ~/bc-network-template.json
```

DO NOT LEAVE the backup in the original directory.

3. Copy the file you want to use:

```
cp <desired_json_file> /opt/dell/barclamps/network/chef/data_bags/crowbar/bc-network-template.json
```

This will overwrite the existing file.

4. Using your favorite editor edit that file:

   a. Change the section of the public IP ranges to match your network

```
"public": {
      "conduit"
      "public",
      "vlan"
      500,
      "use_vlan"
      false,
      "add_bridge"
      false,
      "subnet"
      "192.168.1.0",
      "netmask"
      "255.255.255.0",
      "broadcast"
      "192.168.1.255",
      "router"
      "192.168.1.1",
      "ranges" {
            "host" {
                  "start": "192.168.1.10",
                  "end": "192.168.1.25"
                  }
      }
},
```

b. Change the netmask,broadcast, router, and ranges.

c. Verify the file and save it.

5. Run the Install command
6. If you need to deploy the external network to the Admin Node continue or go to step 12
7. Before starting any Data Nodes
8. Connect to the Admin Node at 172.16.2.18 (unless you change the IP ranges of the Admin net) via SSH. A table of services and default credentials can be found in the next section.
9. Execute from the root command prompt:

```
a. crowbar network allocate_ip default "admin node FQDN" public host
b. "chef-client"
c. /etc/init.d/chef-server-webui restart
```

10. From the Crowbar GUI modify the DNS and NTP barclamps to use the external server and apply them
11. From a command line you can do an ntpq -p

```
a. [root@admin config]# ntpq -p
b. remote refid st t when poll reach delay offset jitter
c. ==============================================================================
d. *172.26.1.50 132.163.4.103 2 u 40 64 377 0.287 -0.433 0.169
```

12. When the "*" shows up the NTP server is now synced with your server and your server is now ready for the data nodes to come online

Verifying Master Node State

When the Admin Node finishes installation, it will remain at a shell prompt. At this point, all Crowbar services have started. Consult the table below to access these services.

Table 20: Crowbar Services

Service	URL	Credentials
SSH	root@192.168.124.10	crowbar
Crowbar UI	http://192.168.124.10:3000/	crowbar / crowbar
Nagios	http://192.168.124.10/nagios3	nagiosadmin / password
Ganglia	http://192.168.124.10/ganglia	nagiosadmin / password
Chef UI	http://192.168.124.10:4040/	admin / password

Logging into the UI requires acceptance of the EULA. It can be found on the dashboard under EULA, and in Appendix A of this document.

Data Node Installation

Nodes other than the Admin Nodes are installed when they are first powered up. A sequence boot phase is executed (rebooting multiple times) which culminates in deploying a minimal OS image installed on the local drive. Part of the basic installation includes "hooking" the nodes into the infrastructure services—NTP, DNS, Nagios, and Ganglia.

Once known to Crowbar, the node can be managed; it can be powered on and off, rebooted, and components can be installed on it.

Functional components are installed on nodes by including them in one or more barclamps' proposals. For example, when a proposal names a Master name node, the relevant packages, services, and configuration are deployed to that node when the proposal is committed.

The next section describes details for installing the different components.

Installing components

The general workflow to install any component is the same:

1. Obtain a default proposal that includes the parameters for the component and a mapping of nodes to the roles they are assigned.
2. Edit the proposal to match the desired configuration.
3. Upload the proposal to Crowbar.
4. Commit the proposal.
5. Reboot the nodes.

All these activities are achieved by using the Crowbar command line tool or the Web-based UI. The sections that follow use the command line tool: /opt/dell/bin/crowbar.

In the sections that follow, this tool is referred to as "Crowbar."

General Installation Process

Set CROWBAR Parameter

Before any of the following command lines may be used, the CROWBAR_KEY environment variable must be primed with the SSH key so they may connect.

On the admin node, use this command: `export CROWBAR_KEY=crowbar:crowbar`
On all other nodes, use this: `export CROWBAR_KEY=$(cat /etc/crowbar.install.key)`

Obtain a proposal

Crowbar can inspect the current known nodes and provide a proposal that best utilizes the available systems for the component being installed. To obtain and inspect this proposed configuration:

```
/opt/dell/bin/crowbar <component> proposal create <name>
/opt/dell/bin/crowbar <area> proposal show <name> > <local_file_name>
```

Where:

- **<area> — The area for which the proposal is made (e.g., Clouderamanager, Pig).**
- **<name> — The name assigned to this proposal. This name should be unique for the component; i.e. if two hadoop clusters are being installed, the proposals for each should have unique names.**
- **<local_file_name> — Any file name into which the proposal will be written.**

Update a proposal

The local file created above can be inspected and modified. The most common changes are:

- **Change default passwords and other barclamp parameters (e.g. swift replica count).**

- **Change assignment of machines to roles.**

Once edits are completed, Crowbar must be updated. To update Crowbar with a modified proposal, execute:

```
/opt/dell/bin/crowbar <area> proposal --file=<local_file_name> edit <name>
```

Where the parameters in this command are exactly as mentioned above, Crowbar will validate the proposal for syntax and basic sanity rules as part of this process.

Committing a proposal

Once the proposal content is satisfactory, the barclamp instance can be activated. To achieve that, execute:

```
/opt/dell/bin/crowbar <area> proposal commit <name>
```

This might take a few moments, as Crowbar is deploying the required software to the machines mentioned in the proposal.

Modifying an active configuration

When committing a proposal that was previously committed, Crowbar compares the new configuration to the currently active state and applies the deltas.

To force Crowbar to reapply a proposal, the active state needs to be deleted:

```
/opt/dell/bin/crowbar <area> delete <name>
```


Installing Cloudera Manager

Cloudera Manager is installed as part of the Clouderamanager barclamp. To install it, refer to the *Dell | Cloudera Solution Crowbar Administrator User Guide*.

Hadoop Ecosystem Components

Some ecosystem components are installed via Cloudera Manager (HUE, Oozie, Hbase, Hive, and Zookeeper). The *Dell | Cloudera Solution Crowbar Administrator User Guide* shows how these services are installed or added to a Hadoop cluster. Pig and Sqoop have to be installed via Crowbar barclamps.

Table 21: Hadoop Ecosystem Components

Component	Master Node	Data Node	Edge Node	Utilize From	Administer From
Pig	X	X	X	Edge Node	Edge Node
Hive		X	X	Edge Node	Edge Node
Sqoop			X	Edge Node	Edge Node

"X" designates server location for the appropriate package binaries to be installed.

Dell | Cloudera Solution Monitoring and Alerting

Table 22: Components Monitored by Hadoop Monitoring Console

Service Type	Resource	Warning	Critical	Nodes to Monitor
Disk	HDFS_DISK_[00-10]	60	90	DataNode[]
SWAP	SWAP	60	90	DataNode[]
		60	90	Master Node[]
		60	90	EdgeNode[]
Ping_Node_From_Admin		DELAY	NO RESPONSE	DataNode[]
		DELAY	NO RESPONSE	Master Node[]
		DELAY	NO RESPONSE	EdgeNode[]
NIC Bonding		DELAY	1 NIC in Bond	DataNode[]
		DELAY	1 NIC in Bond	Master Node[]
		DELAY	1 NIC in Bond	EdgeNode[]
DNS_From_Node		DELAY	NO RESPONSE	DataNode[]
		DELAY	NO RESPONSE	Master Node[]
		DELAY	NO RESPONSE	EdgeNode[]
DNS_About_Node		DELAY	NO RESPONSE	DataNode[]
		DELAY	NO RESPONSE	Master Node[]
		DELAY	NO RESPONSE	DataNode[]
JobTracker_Daemon		DELAY	DAEMON NOT RUNNING	Master Node[]
TaskTracker_Daemon		DELAY	DAEMON NOT RUNNING	DataNode[]
DataNode_Daemon		DELAY	DAEMON NOT RUNNING	DataNode[]
Master Node_Daemon		DELAY	DAEMON NOT RUNNING	Master Node[]
SecondaryMaster Node		DELAY	DAEMON NOT RUNNING	Master Node[]
SSH		DELAY	NO RESPONSE	DataNode[]
		DELAY	NO RESPONSE	Master Node[]

Service Type	Resource	Warning	Critical	Nodes to Monitor
Zombie_Processes		5	10	DataNode[]
		5	10	Master Node[]
		5	10	EdgeNode[]
CPU_Load		80	90	DataNode[]
		80	90	Master Node[]
		80	90	EdgeNode[]
Zookeeper_Client		DELAY	DAEMON NOT RUNNING	DataNode[]
Zookeeper_Server		DELAY	DAEMON NOT RUNNING	Master Node[]
JobTracker_Submit_Job		DELAY	NO RESPONSE	Master Node[]
Chef_Daemon		DELAY	NO RESPONSE	DataNode[]
		DELAY	NO RESPONSE	Master Node[]
		DELAY	NO RESPONSE	EdgeNode[]
Disk	MAPRED_DIR	60	90	DataNode[]
		60	90	Master Node[]
		60	90	EdgeNode[]
Memory_Capacity_Used	System Memory	80	90	DataNode[]
		80	90	Master Node[]
		80	90	EdgeNode[]
Disk	HDFS01_Capacity	60	90	Master Node[]
CPU_Utilizion				DataNode[]
				Master Node[]
				EdgeNode[]
Memory_Utilization				DataNode[]
				Master Node[]
				EdgeNode[]
NIG_LAG_Utilization				DataNode[]
				Master Node[]

Service Type	Resource	Warning	Critical	Nodes to Monitor
				EdgeNode[]
CPU Temp		As defined by SDR (Sensor Data Record)	As defined by SDR	DataNode[]
		As defined by SDR	PENDING	Master Node[]
		As defined by SDR	As defined by SDR	EdgeNode[]
Power Supplies		As defined by SDR	As defined by SDR	Master Node[]
		As defined by SDR	As defined by SDR	Edge Node[]
Master Node _NFS_Mount		DELAY	MOUNT MISSING	Master Node[]
Hbase		DELAY	SELECT FAILED	EdgeNode[]
		DELAY	INSERT FAILED	EdgeNode[]
Hive		DELAY	SELECT FAILED	EdgeNode[]
		DELAY	INSERT FAILED	EdgeNode[]
Ping_From_Admin	IPMI Interface	DELAY	NO RESPONSE	DataNode[]
		DELAY	NO RESPONSE	Master Node[]
		DELAY	NO RESPONSE	EdgeNode[]

Appendix A: The Dell End User License Agreement

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8. **Export, Import and Government Restrictions**. You are advised that the Software is subject to U.S. export laws as well as the laws of the country where it is delivered or used. You agree to abide by these laws. Under these laws, the Software may not be sold, leased, or transferred to restricted countries (currently Cuba, Iran, North Korea, Sudan and Syria), restricted end-users, or for restricted end-uses. You specifically agree that the Software will not be used for activities related to weapons of mass destruction, including but not limited to, activities related to the design, development, production or use of nuclear materials, nuclear facilities, or nuclear weapons, missiles or support of missile projects, or chemical or biological weapons. You understand that certain functionality of the Software, such as encryption or authentication, may be subject to import restrictions in the event you transport the Software from the country of delivery and you are responsible for complying with applicable restrictions.

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DELL SHALL NOT BE LIABLE TO YOU FOR ANY CLAIM BROUGHT MORE THAN TWO YEARS AFTER THE CAUSE OF ACTION FOR SUCH CLAIM FIRST AROSE.

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12. **Confidentiality**. You agree to: (A) not use Confidential Information except as necessary to exercise the rights herein and (B) use best efforts to preserve and protect the confidentiality of the Confidential Information. "Confidential Information" means any oral, written, graphic or machine-readable information disclosed by Dell that is (i) identified as confidential; (ii) designated in writing to be confidential or proprietary; or (iii) should be reasonably understood to be confidential. Confidential Information includes the Software and its trade secrets, including but not limited to source code, the development status of the Software, the appearance, content and flow of the user interface of the Software, and the content and documentation of the Software. Confidential Information does not include information that is (a) publicly available other than through a breach of this EULA; (b) known to you prior to such disclosure; or (c) subsequently lawfully obtained by you from a third party that has no obligations of confidentiality. You agree that, without Dell's prior written consent, you will not grant access to any Dell Confidential Information to any persons or entities except for your employees and agents who have a business need to have such access and who are obligated to maintain the

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13. **Development Tools**. If the Software includes development tools, such as scripting tools, APIs, or sample scripts (collectively "Development Tools"), you may use such Development Tools to create new scripts and code for the purpose of customizing your use of the Software (within the parameters set forth in this EULA and within the parameters set forth in the Development Tools themselves) and for no other purpose. Notwithstanding anything to the contrary set forth in this EULA, no warranty or technical support is provided for sample scripts contained in such Development Tools or scripts or other code written by you or any third party.

14. **Evaluation Licenses**. If you have received Software for evaluation purposes ("Evaluation Software"), you may use the Evaluation Software solely for such limited evaluation period and for internal evaluation purposes only. You acknowledge that Dell may terminate your right to evaluate the Evaluation Software, for any or no reason, effective immediately upon notice to you. IN ADDITION, THE EVALUATION SOFTWARE IS PROVIDED TO YOU "AS IS" WITHOUT INDEMNITY OR WARRANTY OF ANY KIND, WHETHER EXPRESS, IMPLIED, STATUTORY, OR OTHERWISE. NOTWITHSTANDING ANYTHING TO THE CONTRARY IN THIS EULA, DELL BEARS NO LIABILITY FOR ANY DIRECT, INDIRECT, INCIDENTAL, PUNITIVE, SPECIAL OR CONSEQUENTIAL DAMAGES RESULTING FROM USE (OR ATTEMPTED USE) OF THE EVALUATION SOFTWARE THROUGH AND AFTER THE EVALUATION PERIOD AND HAS NO DUTY TO PROVIDE SUPPORT TO YOU.

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16. **Open Source Software**. The Software may come bundled or otherwise be distributed with open source software, which is subject to the terms and conditions of the specific license under which the open source software is distributed. THIS OPEN SOURCE SOFTWARE IS PROVIDED BY DELL "AS IS" WITHOUT ANY WARRANTY, EXPRESS, IMPLIED, OR OTHERWISE, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NON-INFRINGEMENT. NOTWITHSTANDING ANYTHING TO THE CONTRARY IN THIS EULA, AS IT RELATES TO ANY AND ALL CLAIMS ARISING OUT OF OR IN CONNECTION WITH OPEN SOURCE SOFTWARE, DELL SHALL HAVE NO LIABILITY FOR ANY DIRECT, INDIRECT, INCIDENTAL, PUNITIVE, SPECIAL OR CONSEQUENTIAL DAMAGES. Under certain open source software licenses, you are entitled to obtain the corresponding source files. You may find corresponding source files for the Software at http://opensource.dell.com or other locations that may be specified to you by Dell.

17. **Right to Preliminary and Injunctive Relief**. You agree that money damages would be an inadequate remedy for Dell in the event of a breach or threatened breach by you of the provisions set

forth in this EULA; therefore, you agree that in the event of a breach or threatened breach of any such provisions, Dell may, in addition to any other remedies to which it is entitled, be entitled to such preliminary or injunctive relief (including an order prohibiting you from taking actions in breach of such provisions) and specific performance as may be appropriate to preserve all of Dell's rights. All rights and remedies afforded Dell by law shall be cumulative and not exclusive.

18. **Choice of Law and Language**. This EULA shall be governed by the laws of the State of Texas, USA, to the exclusion of the UN Convention on Contracts for the International Sale of Goods. You acknowledge that the headquarters of the Dell family of companies is located in Texas, and that the software licensed under this EULA and the related products marketed in connection with such software were in substantial part conceived, developed, and marketed by Dell personnel in Texas. Further, you acknowledge, agree, and stipulate that the laws of the State of Texas bear a substantial relationship to this EULA and that the selection of Texas law to govern this EULA and the license of the Software hereunder is reasonable and appropriate, and you consent to the selection of such law to govern this EULA and the relationship of the parties hereto. This EULA has been agreed only in the English language, which version of this EULA shall be controlling regardless of whether any translations of this EULA have been prepared or exchanged. As an exception to the preceding sentence, if Dell provides this EULA to you only in a non-English language version, then such non-English language version shall control. You acknowledge and represent that you have carefully reviewed this EULA with the involvement and assistance of your employees, advisors, and/or legal counsel fluent in the English language, that you have consulted with local legal counsel and counsel competent to render advice with respect to transactions governed by the law applicable to this EULA, that you have no questions regarding the meaning or effect of any of this EULA's terms, and that you have obtained high-quality translations of this EULA for use by you or any of your team who are not fluent in the English language, with the understanding that you alone shall bear the risk of any misunderstandings that may arise as a result of such translation. All communications in connection with this EULA shall be in the English language.

    Les parties ont demandé que cette convention ainsi que tous les documents qui s'y rattachent soient rédigés en anglais.

19. **Dispute Resolution and Binding Arbitration**. ANY CLAIM, DISPUTE, OR CONTROVERSY (WHETHER IN CONTRACT, TORT, OR OTHERWISE, WHETHER PREEXISTING, PRESENT OR FUTURE, AND INCLUDING STATUTORY, COMMON LAW, INTENTIONAL TORT AND EQUITABLE CLAIMS) BETWEEN YOU AND DELL arising out of or in connection with this EULA, or the breach, termination or validity thereof shall be finally settled under the Rules of Arbitration of the International Chamber of Commerce ("ICC") by one or more arbitrators with expertise in software licensing appointed in accordance with such rules. The arbitration shall be conducted in the English language. The place of the arbitration shall be a commercial center reasonably chosen by the arbitration panel in a third country so as to ensure that the award resulting from the arbitration shall be of an international character and enforceable under the New York Convention on the Recognition and Enforcement of Foreign Arbitral Awards. The arbitration panel shall be empowered to grant whatever relief would be available in court, including without limitation preliminary relief, injunctive relief, and specific performance. Any award of the arbitration panel shall be final and binding immediately when rendered, and judgment on the award may be entered in any court of competent jurisdiction. Neither you nor Dell shall be entitled to join, consolidate, or include any claims belonging to or alleged or arising from, by, or on behalf of any third party to an arbitration brought hereunder. The individual (non-class) nature of this dispute resolution provision goes to the essence of the parties' dispute resolution agreement, and if found unenforceable, the entire arbitration and dispute resolution provision shall be void. Notwithstanding the foregoing, Dell may apply to any relevant government agency or any court of competent jurisdiction to preserve its rights under this EULA and to obtain any injunctive or preliminary relief, or any award of specific performance, to which it may be entitled, either against you or against a non-party; provided, however, that no such administrative or judicial authority shall have the right or power to render a judgment or award (or to enjoin the rendering of

an arbitral award) for damages that may be due to or from either party under this EULA, which right and power shall be reserved exclusively to an arbitration panel proceeding in accordance herewith.

20. **No Waiver**. No waiver of breach or failure to exercise any option, right, or privilege under the terms of this EULA on any occasion shall be construed to be a waiver of a subsequent breach or right to exercise any option, right, or privilege.

21. **Force Majeure**. Dell shall not be responsible for any delay or failure in performance of any part of this EULA to the extent that such delay or failure is caused by fire, flood, explosion, war, embargo, government requirement, civil, or military authority, act of God, act or omission of carriers, failure of the Internet or other similar causes beyond its control.

22. **No Assignment**. Except as set forth herein, you may not assign or transfer your interests, rights or obligations under this EULA by written agreement, merger, consolidation, operation of law or otherwise, without the prior written consent of an authorized executive officer of Dell. Any attempt to assign this EULA by you without such prior written consent from Dell shall be null and void.

23. **Entire Agreement**. Unless you have entered into another written agreement with respect to the Software which has been signed by you and an authorized representative of Dell and which conflicts with the terms of this EULA, you agree that this EULA supersedes all prior written or oral agreements, warranties or representations, including any and all other click-wrap, shrink-wrap or similar licenses or agreements, with respect to the Software. No amendment to or modification of this EULA, in whole or in part, will be valid or binding unless it is in writing and executed by authorized representatives of both parties. If any term of this EULA is found to be invalid or unenforceable, the remaining provisions will remain effective. You agree that any principle of construction or rule of law that provides that an agreement shall be construed against the drafter shall not apply to the terms and conditions of this EULA.

24. **Notices**. Notice to Dell under this EULA must be in writing and sent to the address below or to such other address (including facsimile or e-mail) as specified in writing, and will be effective upon receipt.

Dell Inc., Attn: Dell Legal
One Dell Way, Round Rock, Texas 78682

Last rev. 021812

Supplemental Terms and Conditions:

Appendix B: Network JSON Example

```
{
  "id": "bc-template-network",
  "description": "Instantiates network interfaces on the crowbar managed systems. Also
manages the address pool",
  "attributes": {
    "network": {
      "start_up_delay": 30,
      "mode": "team",
      "teaming": {
        "mode": 6
      },
      "interface_map": [
        {
          "pattern": "PowerEdge R610",
          "bus_order": [
            "0000:00/0000:00:01",
            "0000:00/0000:00:03"
          ]
        },
        {
          "pattern": "PowerEdge R710",
          "bus_order": [
            "0000:00/0000:00:01",
            "0000:00/0000:00:03"
          ]
        },
        {
          "pattern": "PowerEdge C6145",
          "bus_order": [
            "0000:00/0000:00:04",
            "0000:00/0000:00:02"
          ]
        },
        {
          "pattern": "PowerEdge C2100",
          "bus_order": [
            "0000:00/0000:00:1c",
            "0000:00/0000:00:07",
            "0000:00/0000:00:09",
            "0000:00/0000:00:01"
          ]
        },
        {
          "pattern": "C6100",
          "bus_order": [
            "0000:00/0000:00:01",
            "0000:00/0000:00:03",
            "0000:00/0000:00:07"
          ]
        },
        {
          "pattern": "product",
          "bus_order": [
            "0000:00/0000:00:01",
            "0000:00/0000:00:02"
          ]
        }
      ],
      "conduit_map": [
      {
       "pattern": "team/.*/crowbar-config-default",
       "conduit_list": {
        "public": {
```

```
                "if_list": [ "10g1", "10g3" ],
                "team_mode": 6
              },
                 "prod": {
                   "if_list": [ "10g2", "10g4" ],
                     "team_mode": 6
                 },
               "mgmt": {
                 "if_list": [ "1g1" ]
               }
             }
           },
           {
             "pattern": "team/.*/.*edgenode",
             "conduit_list": {
              "prod": {
                 "if_list": [ "10g1", "10g3" ],
                 "team_mode": 6
               },
               "public" : {
               "if_list": [ "10g2", "10g4" ],
               "team_mode" : 6
               }
             }
           },
{
             "pattern": "team/.*/.*namenode",
             "conduit_list": {
                "prod": {
                  "if_list": [ "10g1", "10g3" ],
                  "team_mode": 6
                }
             }
           },
            {
           "pattern": "team/.*/.*filernode",
           "conduit_list": {
              "prod": {
               "if_list": [ "10g1", "10g3" ],
               "team_mode": 6
                  }
              }
           },
            {
           "pattern": "team/.*/.*journalingnode",
           "conduit_list": {
              "prod": {
               "if_list": [ "10g1", "10g3" ],
               "team_mode": 6
                  }
             }
           },
           {
                "pattern": "team/.*/.*datanode",
                "conduit_list": {
                   "prod": {
                    "if_list": [ "10g1", "10g2" ],
                    "team_mode": 6
                   }
                }
              },
               {
             "pattern": ".*/.*/.*",
             "conduit_list": {
               "prod": {
                 "if_list": [ "10g2" ]
```

```
            },
            "admin": {
              "if_list": [ "10g2" ]
            },
            "mgmt": {
              "if_list": [ "1g1" ]
            },
            "public": {
              "if_list": [ "10g3" ]
            }
          }
        },
        {
          "pattern": "mode/1g_adpt_count/role",
          "conduit_list": {
            "prod": {
              "if_list": [ "10g1" ]
            },
            "admin": {
              "if_list": [ "10g1" ]
            },
            "public": {
              "if_list": [ "10g1" ]
            }
          }
        }
     ],
     "networks": {
          "bmc": {
          "conduit": "bmc",
          "vlan": 300,
          "use_vlan": false,
          "add_bridge": false,
          "subnet": "172.16.0.0",
          "netmask": "255.255.255.0",
          "broadcast": "172.16.0.255",
          "router": "172.16.0.1",
          "router_pref": 30,
          "ranges": {
               "router": { "start": "172.16.0.1", "end": "172.16.0.10" },
               "host": { "start": "172.16.0.51", "end": "172.16.0.254" }
            }
        },
    "storage": {
          "conduit": "intf1",
          "vlan": 200,
          "use_vlan": false,
          "add_bridge": false,
          "subnet": "192.168.125.0",
          "netmask": "255.255.255.0",
          "broadcast": "192.168.125.255",
          "ranges": {
               "host": { "start": "192.168.125.10", "end": "192.168.125.239" }
    }
    },
       "bmc_vlan": {
          "conduit": "mgmt",
          "vlan": 300,
          "use_vlan": false,
          "add_bridge": false,
          "subnet": "172.16.0.0",
          "netmask": "255.255.255.0",
          "broadcast": "172.16.0.255",
          "router": "172.16.0.1",
          "router_pref": 30,
          "ranges": {
```

```
                "host": { "start": "172.16.0.21", "end": "172.16.0.50" }
             }
            },
            "public": {
              "conduit": "public",
              "vlan": 500,
              "use_vlan": false,
              "add_bridge": false,
              "subnet": "192.168.1.0",
              "netmask": "255.255.255.0",
              "broadcast": "192.168.1.255",
              "router": "192.168.1.1",
              "router_pref": 10,
              "ranges": {
                   "host": { "start": "192.168.1.10", "end": "192.168.1.25" }
                }
            },
            "admin": {
              "conduit": "prod",
              "vlan": 100,
              "use_vlan": false,
              "add_bridge": false,
              "subnet": "172.16.2.0",
              "netmask": "255.255.254.0",
              "broadcast": "172.16.3.255",
              "router_pref": 20,
              "router": "172.16.2.1",
              "ranges": {
                   "host": { "start": "172.16.2.21", "end": "172.16.2.254" },
                   "dhcp": { "start": "172.16.3.1", "end": "172.16.3.240" },
                   "admin" : {"start": "172.16.2.18", "end": "172.16.2.20" }
                }
              }
               }
          }
          },
        "deployment": {
         "network": {
           "crowbar-revision": 0,
           "elements": {},
           "element_states": {
             "network": [ "readying", "ready", "applying" ]
           },
           "element_order": [
             [ "network" ]
           ],
           "config": {
             "environment": "network-base-config",
             "mode": "full",
             "transitions": true,
             "transition_list": [ "discovered", "reset", "delete" ]
           }
         }
       }
     }
```

Appendix C: References

Ghemawat, S. Gobioff, H. and Leung, S.-T. The Google File System. Proceedings of the 19th ACM Symposium on Operating Systems Principles. pp. 29--43. Bolton Landing, NY, USA. 2003. © 2003, ACM.

Borthakur, Dhruba. The Hadoop Distributed File System: Architecture and Design**. © 2007, The Apache Software Foundation.**

Hadoop DFS User Guide**. © 2007, The Apache Software Foundation.**

HDFS: Permissions User and Administrator Guide**. © 2007, The Apache Software Foundation.**

HDFS API Javadoc **© 2008, The Apache Software Foundation.**

HDFS source code

Pig – http://developer.yahoo.com/hadoop/tutorial/pigtutorial.html

Pig – http://pig.apache.org/docs/r0.6.0/setup.html

Zookeeper – http://zookeeper.apache.org/doc/r3.2.2/zookeeperOver.html

Zookeeper – https://ccp.cloudera.com/display/CDHDOC/ZooKeeper+Installation

Zookeeper – http://archive.cloudera.com/cdh/3/zookeeper/zookeeperAdmin.html#sc_zkMulitServerSetup

Nagios – http://www.nagios.org/

Ganglia – http://ganglia.sourceforge.net/

Additional information can be obtained at www.dell.com/hadoop or by e-mailing hadoop@dell.com.

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