

How to Deploy OpenStack Swift on OpenPOWER

Version 1.2

INTRODUCTION

This document along with referenced links describes a comprehensive set of instructions, rules, and automation tools for building an OpenPOWER-based platform for hosting the OpenStack Swift (Object Storage) Service. This provides a standalone configuration for OpenStack Swift. For an OpenStack Swift configuration that is integrated with a private compute cloud, see the private compute cloud documentation. The standalone OpenStack Swift configuration may include distinct nodes for the controller, proxy, metadata, and object storage.

The build process is broken out into a series of Steps listed below. Some of these steps are preparatory in nature. The final step is fully automated. At the completion of this step, a standalone OpenStack Swift cluster should be operational.

HIGH LEVEL DEPLOYMENT STEPS

EACH STEP BELOW IS DESCRIBED IN MORE DETAIL BELOW

- | | |
|---|--|
| 1 | Acquire the hardware |
| 2 | Choose deployment parameters |
| 3 | Prepare the deployment node |
| 4 | Rack the servers, switches and JBODs |
| 5 | Cable the systems |
| 6 | Deploy the cluster |

STEP 1: ACQUIRE THE HARDWARE

Go [here](#) to view the Design Proposal for recipe required hardware.

<https://github.com/open-power-ref-design/standalone-swift/blob/master/docs/design.pdf>

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

<https://github.com/open-power-ref-design/standalone-swift/blob/master/docs/bom.pdf>

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

<https://www-01.ibm.com/marketing/iwm/dre/signup?source=MAIL-power&disable-Cookie=Yes>

The Bill of Materials lists three possible configurations for your OpenStack Swift solution: "Swift Small", "Swift Medium", and "Swift Large". Use the guidelines in the Bill of Materials to choose which configuration to build.

STEP 2: CHOOSE YOUR DEPLOYMENT 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 configuration file which will in turn be used to automatically tune the infrastructure and add other needed software.

Parameter	Description	Example
Domain Name	The local domain where the cluster is being built.	mycompany.domain.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 range	Management for the cluster happens on its own internal network. Labeled <i>ipaddr-mgmt-network</i> in the config.yml example below.	192.168.16.0/24
Data network IP address range	Private data network internal to the cluster. Labeled <i>external1</i> in the config.yml example below.	10.0.16.0/22
Management switch IP address	IP address of the management switch. Labeled <i>ipaddr-mgmt-switch</i> in config.yml in example below	192.168.16.20
Data switch IP address	IP address of the data switch on the rack. Labeled <i>ipaddr-data-switch</i> in config.yml in example below	192.168.16.25
External floating IP address	Floating ip-address that can be used to view the cluster GUI (Horizon) externally	10.0.16.50
Default login data	Both IDs and passwords	BMC network, OS Mgmt. network
Client-OS-Level	What operating system to install on the nodes	ubuntu-16.04.1-server-ppc64el

Go [here](#) to see more options in the config.yml files for each swift configuration:

Swift Small

<https://github.com/open-power-ref-design/standalone-swift/blob/master/config-small.yml>

Swift Medium

<https://github.com/open-power-ref-design/standalone-swift/blob/master/config-medium.yml>

Swift Large

<https://github.com/open-power-ref-design/standalone-swift/blob/master/config-large.yml>

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. The deployment node is not included in the Bill of Materials (BOM).

You can establish the deployer node as a temporary or a 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 (high-speed), 1G (Mgmt.).
- Ubuntu 16.04 LTS before beginning with deployment.

If you do not already have Ubuntu installed on the deployer node, you can obtain it from the following locations:

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

STEP 4: RACK THE SERVERS, SWITCHES AND STORAGE

There are various compute, storage and networking components in an OpenStack Swift solution. Optimal server resources have been selected to attain the right balance between compute, storage and network I/O.

The five classes of servers in a standalone OpenStack Swift solution are:

Controller Nodes: These servers host the OpenStack Control services and Operational Management services. The design is triple redundant and allows for scaling to larger (intra-rack) clusters. This solution has three [Briggs Power S822LC MTM 8001-22C](#) nodes serving this role. These nodes are referenced in the rest of the document with a prefix of 'Ctrl'. These nodes are present in the 'Swift Small', 'Swift Medium', and 'Swift Large' configurations.

Swift Proxy Nodes: These servers host the OpenStack Swift Proxy services. The 'Swift Medium' and 'Swift Large' configurations for this solution have three [Briggs Power S822LC MTM 8001-22C](#) nodes serving this role. These nodes are referenced in the rest of the document with a prefix of 'Proxy'. In the 'Swift Small' configuration, the Swift Proxy services run inside an lxc container on the Controller Nodes so there is no dedicated hardware for 'Proxy' nodes in the rack.

Swift Metadata Nodes: These servers, along with their built in storage, host the OpenStack Swift Metadata. The 'Swift Large' configuration for this solution has three [Stratton Power S812LC MTM 8001-12C](#) nodes with SSDs (solid state drives) to serve this role. These nodes are referenced in the rest of the document with a prefix of 'Meta'. In the 'Swift Small' and 'Swift Medium' configurations for this solution, the Metadata services and Object storage services are converged onto the same hardware (see Swift Object and Metadata Nodes below) so there is no dedicated hardware for 'Meta' nodes in the rack.

Swift Object Nodes: These servers, together with their attached JBOD (just a bunch of disks) storage drawers, provide Object storage services. The 'Swift Large' configuration for this solution has three [Stratton Power S812LC MTM 8001-12C](#) nodes with attached SMC 4U90 disk drawers serving this role. These nodes are referenced in the rest of the document with a prefix of 'Obj'. In the 'Swift Small' and 'Swift Medium' configurations for this solution, the Metadata services and Object storage services are converged onto the same hardware (see Swift Object and Metadata Nodes below) so there is no dedicated hardware for 'Obj' nodes in the rack.

Swift Object and Metadata Nodes: These servers, together with their attached JBOD (just a bunch of disks) storage drawers, provide Metadata and Object storage services. The 'Swift Small' and 'Swift Medium' configurations for this solution have three [Stratton Power S812LC MTM 8001-12C](#) nodes serving this role. The Swift Metadata resides on SSDs (solid state drives). The Swift Object storage resides on HDDs (hard disk drives) in the attached (JBOD) SMC 4U90 disk drawers. These nodes are referenced in the rest of the document with a prefix of 'Obj+Meta'. In the 'Swift Large' configuration for this solution, the 'Obj' and 'Meta' nodes are on separate dedicated hardware so there are no converged 'Obj+Meta' nodes in the rack.

Racking the components

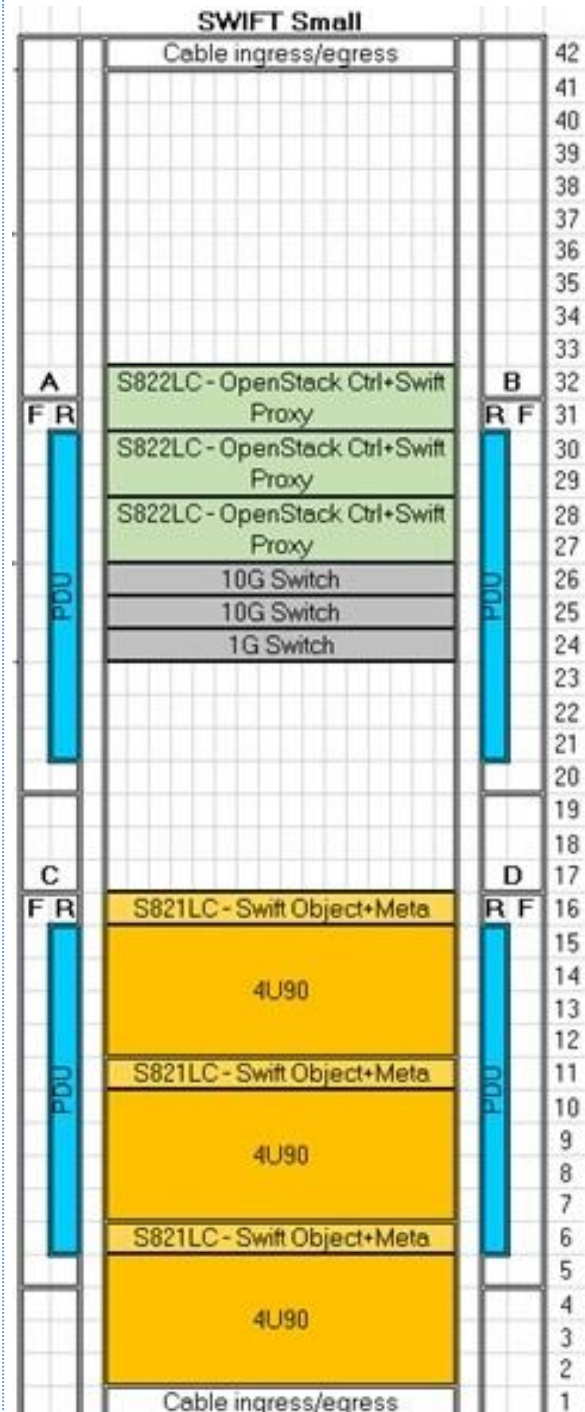
Place the intra-rack (leaf) network switches in **U24-U26** as follows:

- 10G data plane switches in **U25 and U26** (part 8831-S48)
- 1G management plane switch in **U24**. (part 7120-48E)

Place the Obj + Meta nodes with the attached Storage drawers at the bottom of the rack. Place the OpenStack Ctrl nodes (which include Swift Proxy services) above the switches.

If more than 4 PDUs are needed, place 2 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: 6 NODE OPENSTACK SWIFT SMALL CLUSTER



Racking the components

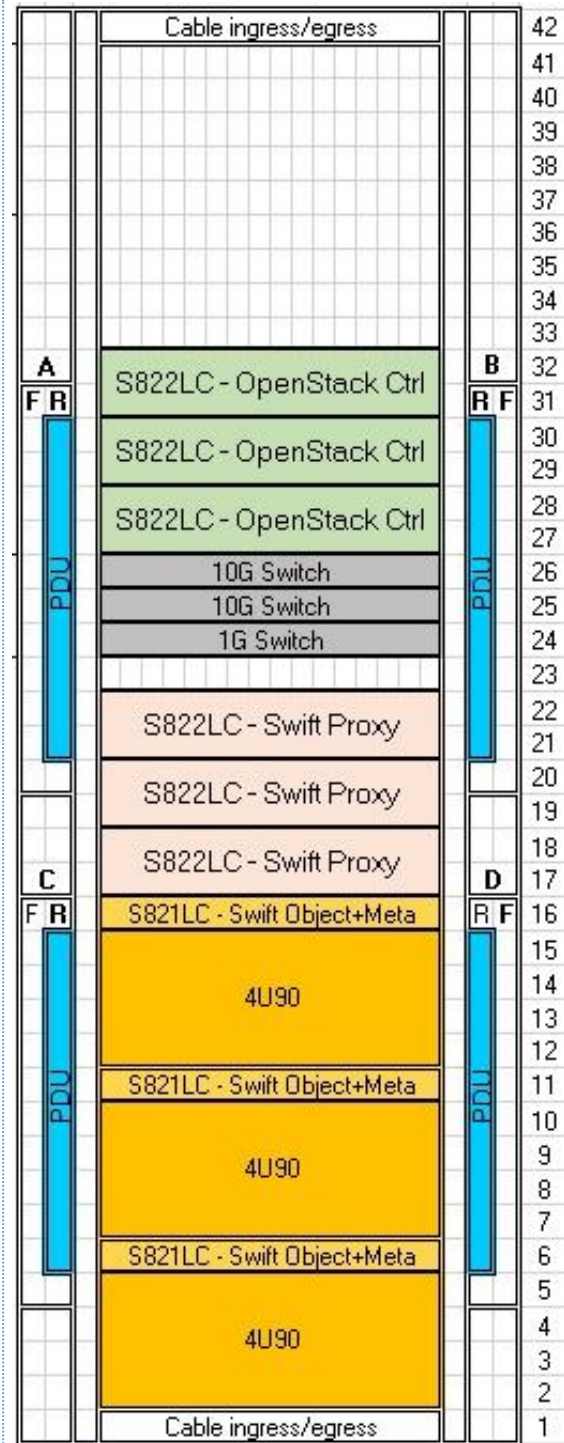
Place the intra-rack (leaf) network switches in **U24-U26** as follows:

- 10G data plane switches in **U25 and U26** (part 8831-S48)
- 1G management plane switch in **U24**. (part 7120-48E)

Place the Obj + Meta nodes with the attached Storage drawers at the bottom of the rack. Place the Proxy nodes above the Obj + Meta nodes. Place the OpenStack Ctrl nodes above the switches.

If more than 4 PDUs are needed, place 2 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: 9 NODE OPENSTACK SWIFT MEDIUM CLUSTER



Racking the components

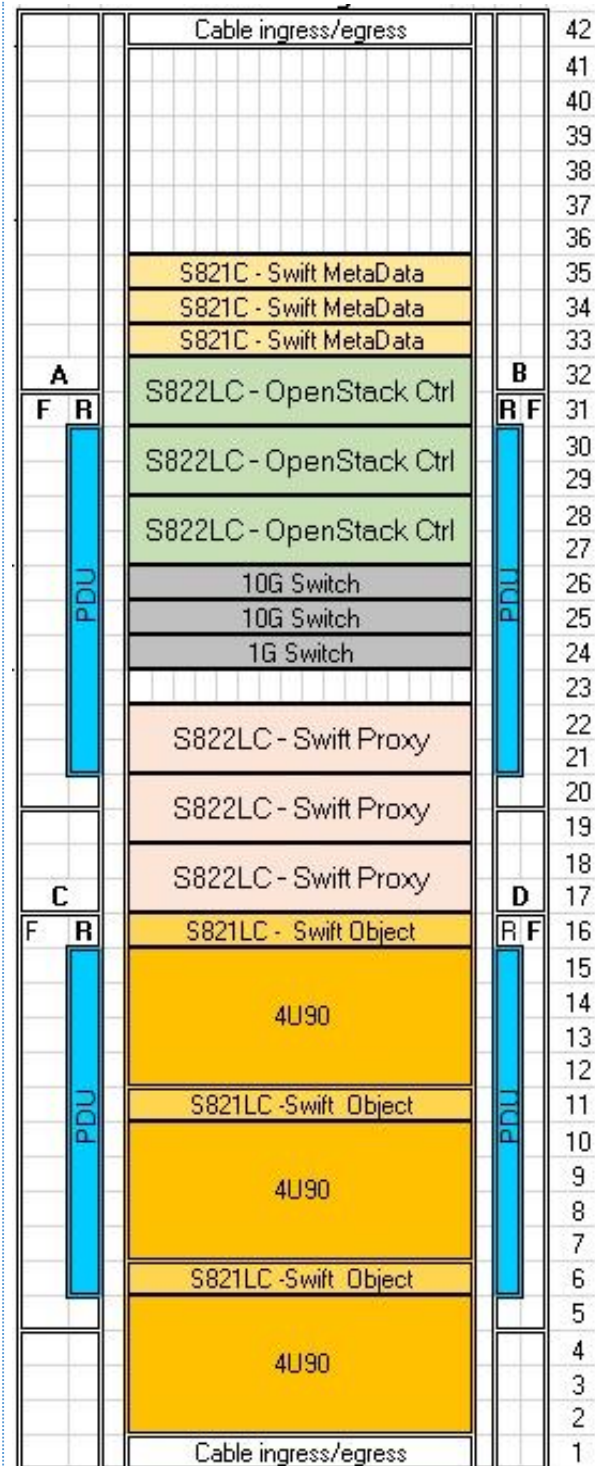
Place the intra-rack (leaf) network switches in **U24-U26** as follows:

- 10G data plane switches in **U25 and U26** (part 8831-S48)
- 1G management plane switch in **U24**. (part 7120-48E)

Place the Obj nodes with the attached Storage drawers at the bottom of the rack. Place the Proxy nodes above the Obj nodes. Place the OpenStack Controller nodes above the switches. Place the Meta nodes at the top of the Controller nodes, leaving some room for expansion (i.e. additional Meta nodes).

If more than 4 PDUs are needed, place 2 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: 12 NODE OPENSTACK SWIFT LARGE CLUSTER



STEP 5: CABLE THE SYSTEMS

Cabling of an OpenStack Swift solution consists of these distinct efforts. One is the storage cabling, another is the network cabling, and finally powering the systems and switches. Presented first is the storage cabling.

In this step connect the Swift Object nodes (or Swift Object + Metadata Nodes) to the storage drawers, using the SAS cables.

EXAMPLE: SWIFT OBJECT NODE

Rear view of Swift Object node connections with labels.



Rear view of Swift Storage drawer with labels.



Repeat the above step for all the Swift Object Server nodes.

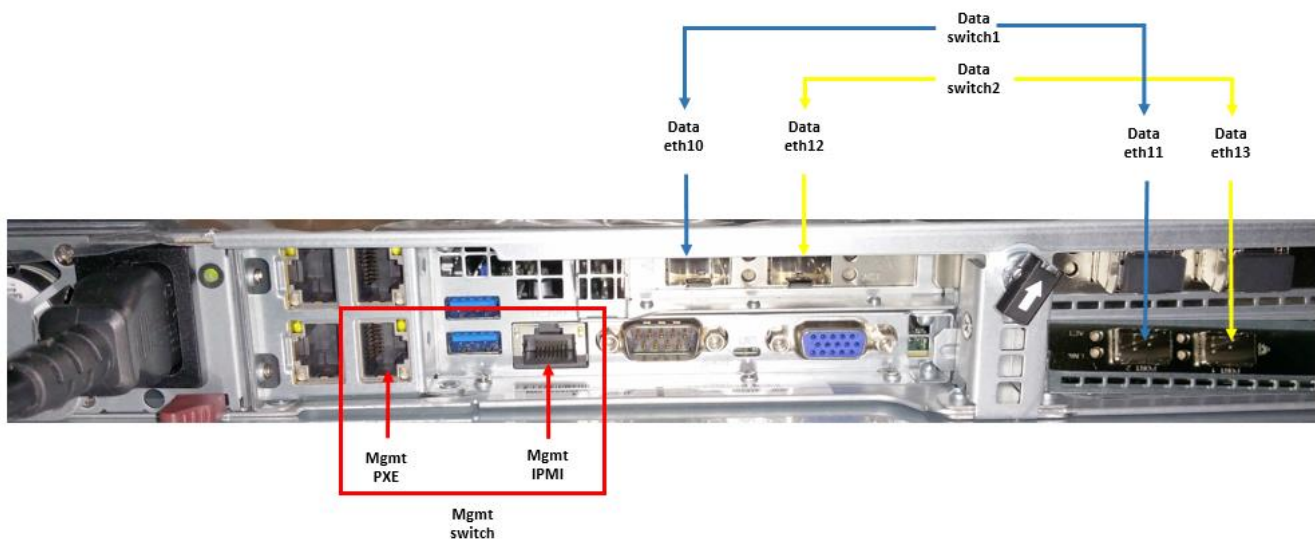
Next we will provide an example of cabling up the network. There are three networks in the OpenStack Swift solution. There is a management network with a single dedicated switch and two data networks using two high speed data switches.

Take the network cables and connect the IPMI port on the server to the management switch at the location marked on the switch for that node. Perform the same step next with the port marked PXE. Finally take high speed network cables and connect the ports marked with Data on the server to the data switches at the location marked for that node.

Since the S822LC (8001-22C) "Briggs" and S821LC (8001-12C) "Stratton" server nodes are not identical we include below examples depicting ports for both models.

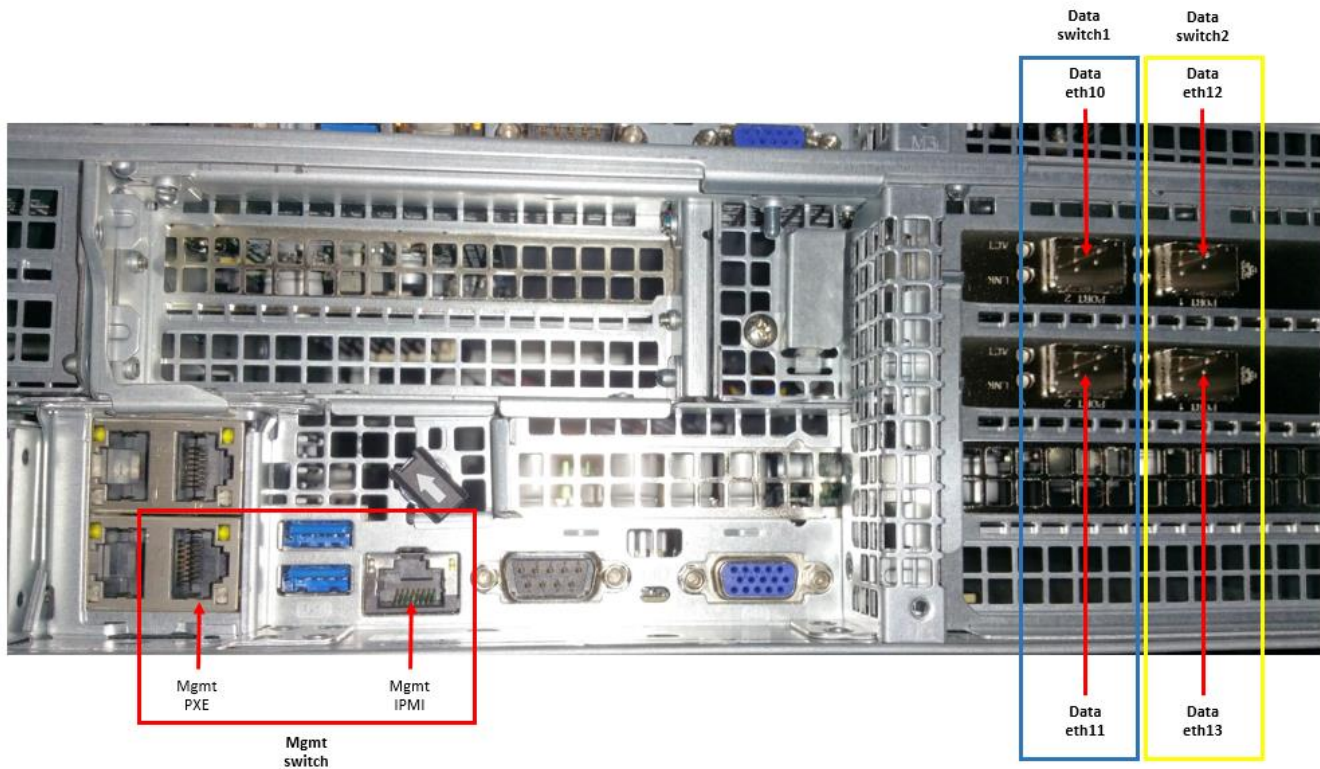
EXAMPLE: STRATTON NODE

Rear view of Stratton server with labels



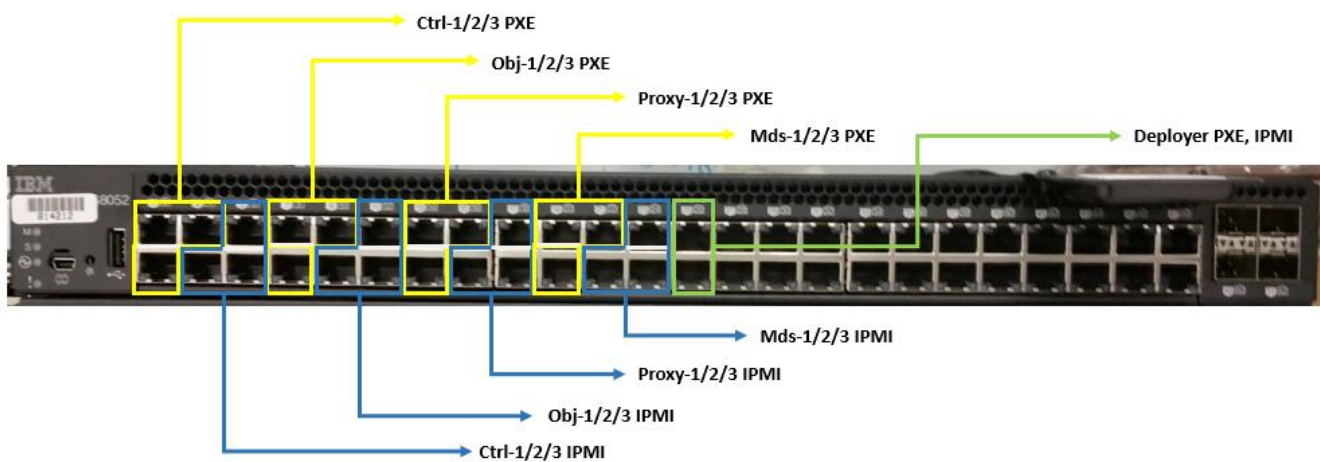
EXAMPLE: BRIGGS NODE

Rear view of Briggs server with labels



Once the server nodes are cabled please complete cabling connections on the Mgmt and Data switches.

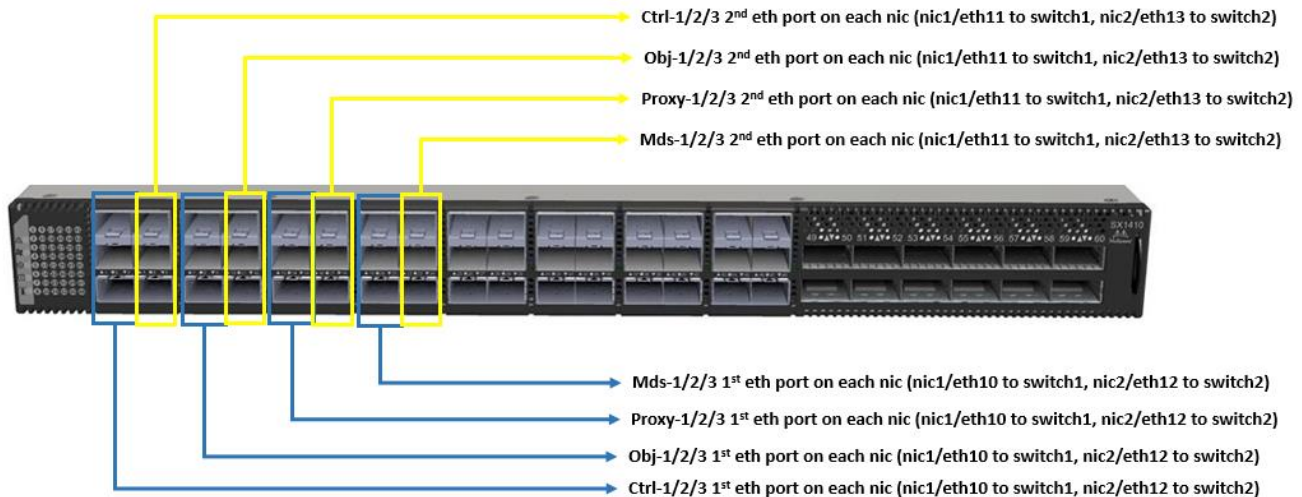
Rear-view of management network switch.



Wiring of the management switch depends on the Swift configuration used: small, medium or large. Start with the control nodes (Ctrl), 3 at a time and use the initial ports of the switch – first PXE and then IPMI networks. Next wire similarly the first 3 Swift object (Obj), then Swift

proxies (Proxy) and Swift metadata (Mds) - if your configuration has them. Towards the end of the switch you will also need a couple of ports to wire the deployer node.

Rear-view of Data Network Switch.



Wiring of the data switches depends on the Swift configuration used: small, medium or large. The wiring must alternate NICs in each server and the switches it connects to provide high availability. For example, The first port on NIC1 goes to Switch1 and the first port on NIC2 goes to Switch2, then second port on NIC1 goes to Switch2 and second port on NIC2 goes to Switch1. This guarantees that if either a NIC or a Switch fails the server will still have a data connection to operate (degraded, but available). Start with the control nodes (Ctrl), 3 at a time, then proceed to wire the Swift object nodes (Obj) and the Swift proxies (Proxy) or metadata (Mds) nodes - if your configuration has them.

POWER CONSIDERATIONS

Careful consideration is required in cabling up the Power for the servers. Servers, storage drawers and switches should be distributed among different PDUs. The PDUs have to be provided independent Power drops to ensure that a single PDU failure or a single power line will not disrupt any of the services. To ensure that the Swift services are always available, servers of a given type should not all be connected to the same pair of PDUs.

STEP 6: DEPLOY THE CLUSTER

This section covers the power on, initialization, configuration and installation of an Openstack Swift cluster. 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.

THE STEPS INVOLVED IN DEPLOYING A CLUSTER INCLUDE:

A	Obtain the default configuration file
B	Tailor the configuration file for your environment
C	Validate the configuration file
D	Provision the cluster
E	Configure OpenStack services.
F	Verify the deployment

The orchestration of the above steps is performed by a tool called cluster-genesis. Please refer to the user guide [here](#) for details on cluster-genesis.

<http://cluster-genesis.readthedocs.io/en/latest/>

OBTAIN THE DEFAULT CONFIGURATION FILE

The deployment automation (cluster-genesis) 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 the deployment process.

Go [here](#) for a copy of the Swift Small configuration file.

<https://github.com/open-power-ref-design/standalone-swift/blob/master/config-small.yml>

Go [here](#) for a copy of the Swift Medium configuration file.

<https://github.com/open-power-ref-design/standalone-swift/blob/master/config-medium.yml>

Go [here](#) for a copy of the Swift Large configuration file.

<https://github.com/open-power-ref-design/standalone-swift/blob/master/config-large.yml>

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 licensing comment and YAML ~ ~ ~ ~ ~
ipaddr-mgmt-network: 192.168.16.0/24 ← Type your management network range here.
ipaddr-mgmt-switch:
  rack1: 192.168.16.20 ← Type your management switch IP address here.
ipaddr-data-switch:
  rack1:
    - 192.168.16.25 ← Type your data switch1 IP address here.
    - 192.168.16.30 ← Type your data switch2 IP address here.
external-floating-ipaddr: 10.0.16.50 ← Type your external floating IP address here.

~ ~ ~ ~ ~ series of YAML and comments ~ ~ ~ ~ ~
networks:
  external1:
    description: Organization site or external network
    addr: 10.0.16.0/22 ← Type your External Data IP address range here.
    broadcast: 10.0.19.255 ← Type your External network broadcast address here.
    gateway: 10.0.16.1 ← Type your external router address here.
```

```

dns-nameservers: 10.0.16.200      ← Type your DNS server IP address here.
dns-search: mycompany.domain.com ← Type your DNS domain name here
method: static
eth-port: osbond0

~ ~ ~ ~ ~ series of YAML and comments ~ ~ ~ ~ ~

node-templates:
  controllers:
    hostname: ctrl-                ← Type your controller-1 hostname here.
    userid-ipmi: ADMIN            ← Type your IPMI user here.
    password-ipmi: admin          ← Type your IPMI password here.
    cobbler-profile: ubuntu-16.04.1-server-ppc64el ← Type your OS Level here

~ ~ ~ ~ ~ continuation of YAML and comments ~ ~ ~ ~ ~

```

VALIDATE THE CONFIGURATION FILE

To ensure that the format of the modified configuration file is valid, it is recommended that it gets validated by following these steps:

```

$ git clone git://github.com/open-power-ref-design/standalone-swift
$ cd standalone-swift
$ TAG=$(git describe --tags $(git rev-list --tags --max-count=1))
$ cd ..
$ apt-get install python-pip
$ pip install pyyaml
$ git clone git://github.com/open-power-ref-design-toolkit/os-services
$ cd os-services
$ git checkout $TAG
$ ./scripts/validate_config.py --file ../standalone-swift/config.yml
$ cd ..

```

Before proceeding with the Provisioning step below, you will need to ensure that all the nodes in the cluster will have direct access to the internet. If the cluster is being configured in a private network without direct internet access, then it is recommended that the deployer node be provided internet access, and it acts as a NAT host to route all the nodes in the cluster.

PROVISION THE CLUSTER

Once the deployment cluster's configuration is finalized, the cluster can be provisioned by kicking off the automation tool (cluster-genesis). The initial steps are:

```
$ git clone git://github.com/open-power-ref-design-toolkit/cluster-genesis
$ cd cluster-genesis
$ TAG=$(git describe --tags $(git rev-list --tags --max-count=1))
$ git checkout $TAG
$ ./scripts/install.sh
$ source scripts/setup-env
$ gen deploy
```

If custom install images are required, more details of the steps to follow are found [here](#):

http://cluster-genesis.readthedocs.io/en/latest/OPCG_running_OPCG.html

CONFIGURING OPENSTACK SERVICES

The provisioning step above runs for about 2 hours completes the installation of the operating system on all nodes. Upon completion of the installation it then prepares the cluster (bootstrap) as well. The bootstrap step is automatically triggered when cluster-genesis is completed. At this point various OpenStack parameters need to be configured. To prepare for this phase, please collect the following information:

Parameter	Description	Example
Keystone Password	The password that will be used for the OpenStack authentication services	passw0rd
VRRP ID	Virtual Router ID that will be in the range of 1-255 and has to be unique across the network	202
USED IPs	The range of IP addresses in the private networks that are already taken, and cannot be assigned to nodes in the cluster. This includes the addresses assigned by cluster-genesis.	172.29.236.1,172.29.236.50 172.29.240.1,172.29.240.50 172.29.244.1,172.29.244.50

For complete information on all the various options to configure the OpenStack deployment, please refer to the openstack-ansible documentation available [here](https://docs.openstack.org/project-deploy-guide/openstack-ansible/newton).

<https://docs.openstack.org/project-deploy-guide/openstack-ansible/newton>

The minimal set of configuration options are provided below. To proceed with this, login to the first controller node (ctrl-1).

```
$ ssh ctrl-1
```

Edit the keystone stanza and set the desired keystone password, in the /etc/openstack_deploy/user_secrets.yml file.

```
$ vi /etc/openstack_deploy/user_secrets.yml
```

```
## Keystone Options
keystone_container_mysql_password:
keystone_auth_admin_token:
keystone_auth_admin_password: passw0rd
keystone_service_password:
keystone_rabbitmq_password:
```

The valid range for the next parameter (external virtual router ID) is 1-255 and it must be unique for each cluster. Edit the external virtual router ID, in the /etc/openstack_deploy/user_variables.yml file.

```
$ vi /etc/openstack_deploy/user_variables.yml
```

```
# Defines the default VRRP id used for keepalived with haproxy.
# Overwrite it to your value to make sure you don't overlap
# with existing VRRPs id on your network. Default is 10 for the
# external and 11 for the internal VRRPs
haproxy_keepalived_external_virtual_router_id: 202
# haproxy_keepalived_internal_virtual_router_id:
```

Next edit the /etc/openstack_deploy/openstack_user_config.yml file to reserve ip addresses generally for the 172 networks: .1-.50. This is done with the "used_ips" field described in /etc/openstack_deploy/openstack_user_config.yml.example. The following values can be placed just above the "global_overrides" field.

```
$ vi /etc/openstack_deploy/openstack_user_config.yml
```

```
used_ips:
- "172.29.236.1,172.29.236.50"
- "172.29.240.1,172.29.240.50"
```

```
- "172.29.244.1,172.29.244.50"
```

Now the cluster is ready to complete the final step of deployment:

```
$ cd os-services  
$ ./scripts/create-cluster.sh 2>&1 | tee -a /root/create-cluster.out
```

Monitor the /root/create-cluster.out file for progress and indication of completion.

(OPTIONAL) CONFIGURE OPERATIONAL MANAGEMENT SERVICES

Part of the software stack deployed in the Controller nodes is a set of services that are collectively called "Operational Management" (or OpsMgr for short). This complements Swift with popular DevOps tools that provide additional function to monitor availability and health of your cluster and to collect log information from all elements of the cluster and present key metrics that are useful for continued operations. These tools are, respectively, Nagios Core and the Elastic Stack. In addition, Operational Management also offers Hardware inventory and integration services as an extension to the OpenStack Horizon user interface. From that extension users can visualize all their hardware devices and launch to all integrated DevOps tools to perform further operational tasks.

For more information on Operational Management and to learn about optional configuration of its installed services and tools please consult the associated [README](#).

<https://github.com/open-power-ref-design-toolkit/opsmgr/blob/master/recipes/private-cloud-newton/README.rst>

VERIFY THE DEPLOYMENT

The create-cluster provisioning step above will run for several hours (~3). After its completion to verify that the OpenStack Swift cluster is operational, please follow the 'Verifying an install' section of the [README](#).

<https://github.com/open-power-ref-design/standalone-swift/blob/master/README.rst>

REFERENCE LINKS

Go [here](#) for the Stratton Power S821LC MTM 8001-12C Redbook:

<http://www.redbooks.ibm.com/abstracts/redp5406.html?Open>

Go [here](#) for the Briggs Power S822LC MTM 8001-22C Redbook.

<http://www.redbooks.ibm.com/abstracts/redp5407.html?Open>

Go [here](#) for standalone-swift repository:

<https://github.com/open-power-ref-design/standalone-swift>

Go [here](#) for the OpenStack-Ansible documentation:

<https://docs.openstack.org/developer/openstack-ansible/newton>

NOTICES

This information was developed for products and services that are offered in the USA.

IBM may not offer the products, services, or features discussed in this document in other countries. Consult your local IBM representative for information on the products and services currently available in your area. Any reference to an IBM product, program, or service is not intended to state or imply that only that IBM

Product, program, or service may be used. Any functionally equivalent product, program, or service that does not infringe any IBM intellectual property right may be used instead. However, it is the user's responsibility to evaluate and verify the operation of any non-IBM product, program, or service.

IBM may have patents or pending patent applications covering subject matter described in this document. The furnishing of this document does not grant you any license to these patents. You can send license inquiries, in writing, to:

*IBM Director of Licensing
IBM Corporation
North Castle Drive, MD-NC119
Armonk, NY 10504-1785
United States of America*

For license inquiries regarding double-byte character set (DBCS) information, contact the IBM Intellectual Property Department in your country or send inquiries, in writing, to:

*Intellectual Property Licensing
Legal and Intellectual Property Law
IBM Japan Ltd.
19-21, Nihonbashi-Hakozakicho, Chuo-ku
Tokyo 103-8510, Japan*

The following paragraph does not apply to the United Kingdom or any other country where such provisions are inconsistent with local law:

INTERNATIONAL BUSINESS MACHINES CORPORATION PROVIDES THIS PUBLICATION "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Some states do not allow disclaimer of express or implied warranties in certain transactions, therefore, this statement may not apply to you.

This information could include technical inaccuracies or typographical errors. Changes are periodically made to the information herein; these changes will be incorporated in new editions of the publication. IBM may make improvements and/or changes in the product(s) and/or the program(s) described in this publication at any time without notice.

Any references in this information to non-IBM websites are provided for convenience only and do not in any manner serve as an endorsement of those websites. The materials at those websites are not part of the materials for this IBM product and use of those websites is at your own risk.

IBM may use or distribute any of the information you supply in any way it believes appropriate without incurring any obligation to you.

Licensees of this program who wish to have information about it for the purpose of enabling: (i) the exchange of information between independently created programs and other programs (including this one) and (ii) the mutual use of the information which has been exchanged, should contact:

IBM Director of Licensing
IBM Corporation
North Castle Drive, MD-NC119
Armonk, NY 10504-1785
US

Such information may be available, subject to appropriate terms and conditions, including in some cases, payment of a fee.

The licensed program described in this document and all licensed material available for it are provided by IBM under terms of the IBM Customer Agreement, IBM International Program License Agreement or any equivalent agreement between us.

Any performance data contained herein was determined in a controlled environment. Therefore, the results obtained in other operating environments may vary significantly. Some measurements may have been made on development-level systems and there is no guarantee that these measurements will be the same on generally available systems. Furthermore, some measurements may have been estimated through extrapolation. Actual results may vary. Users of this document should verify the applicable data for their specific environment.

Information concerning non-IBM products was obtained from the suppliers of those products, their published announcements or other publicly available sources. IBM has not tested those products and cannot confirm the accuracy of performance, compatibility or any other claims related to non-IBM products. Questions on the capabilities of non-IBM products should be addressed to the suppliers of those products.

Statements regarding IBM's future direction or intent are subject to change or withdrawal without notice, and represent goals and objectives only.

This information contains examples of data and reports used in daily business operations. To illustrate them as completely as possible, the examples include the names of individuals, companies, brands, and products. All of these names are fictitious and any similarity to the names and addresses used by an actual business enterprise is entirely coincidental.

COPYRIGHT LICENSE:

This information contains sample application programs in source language, which illustrate programming techniques on various operating platforms. You may copy, modify, and distribute these sample programs in any form without payment to IBM, for the purposes of developing, using, marketing or distributing application

Programs conforming to the application programming interface for the operating platform for which the sample programs are written. These examples have not been thoroughly tested under all conditions. IBM, therefore, cannot guarantee or imply reliability, serviceability, or function of these programs. The sample programs are provided "AS IS", without warranty of any kind. IBM shall not be liable for any damages arising out of your use of the sample programs.

Each copy or any portion of these sample programs or any derivative work, must include a copyright notice as follows:

Portions of this code are derived from IBM Corp. Sample Programs.

© Copyright IBM Corp. 2017. All rights reserved.

Trademarks

IBM, the IBM logo, and ibm.com are trademarks or registered trademarks of International Business Machines Corp., registered in many jurisdictions worldwide. Other product and service names might be trademarks of IBM or other companies. A current list of IBM trademarks is available on the web at "Copyright and trademark information" (www.ibm.com/legal/copytrade.shtml).

Java™ and all Java-based trademarks and logos are trademarks or registered trademarks of Oracle and/or its affiliates.

Linux is a registered trademark of Linus Torvalds in the United States, other countries, or both.

Terms and conditions for product documentation

Permissions for the use of these publications are granted subject to the following terms and conditions.

Applicability

These terms and conditions are in addition to any terms of use for the IBM website.

Personal use

You may reproduce these publications for your personal, noncommercial use provided that all proprietary notices are preserved. You may not distribute, display or make derivative work of these publications, or any portion thereof, without the express consent of IBM.

Commercial use

You may reproduce, distribute and display these publications solely within your enterprise provided that all proprietary notices are preserved. You may not make derivative works of these publications, or reproduce, distribute or display these publications or any portion thereof outside your enterprise, without the express consent of IBM.

Rights

Except as expressly granted in this permission, no other permissions, licenses or rights are granted, either express or implied, to the publications or any information, data, software or other intellectual property contained therein.

IBM reserves the right to withdraw the permissions granted herein whenever, in its discretion, the use of the publications is detrimental to its interest or, as determined by IBM, the above instructions are not being properly followed.

You may not download, export or re-export this information except in full compliance with all applicable laws and regulations, including all United States export laws and regulations.

IBM MAKES NO GUARANTEE ABOUT THE CONTENT OF THESE PUBLICATIONS. THE PUBLICATIONS ARE PROVIDED "AS-IS" AND WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY, NON-INFRINGEMENT, AND FITNESS FOR A PARTICULAR PURPOSE.

IBM Online Privacy Statement

IBM Software products, including software as a service solutions, ("Software Offerings") may use cookies or other technologies to collect product usage information, to help improve the end user experience, to tailor interactions with the end user, or for other purposes. In many cases no personally identifiable information is collected by the Software Offerings. Some of our Software Offerings can help enable you to collect personally identifiable information. If this Software Offering uses cookies to collect personally identifiable information, specific information about this offering's use of cookies is set forth below.

This Software Offering does not use cookies or other technologies to collect personally identifiable information.

If the configurations deployed for this Software Offering provide you as customer the ability to collect personally identifiable information from end users via cookies and other technologies, you should seek your own legal advice about any laws applicable to such data collection, including any requirements for notice and consent.

For more information about the use of various technologies, including cookies, for these purposes, see IBM's Privacy Policy at <http://www.ibm.com/privacy> and IBM's Online Privacy Statement at <http://www.ibm.com/privacy/details> in the section entitled "Cookies, Web Beacons and Other Technologies", and the "IBM Software Products and Software-as-a-Service Privacy Statement" at <http://www.ibm.com/software/info/product-privacy>.