Guest Operating System (Guest OS) Installation and Configuration

This chapter details Guest Operating System (Guest OS) installation for the Cisco IR800.

Guest Operating System Overview

The IR800 supports a Hypervisor architecture to support user-specified operating systems within an independent Virtual Machine (VM).

When you install the IR800 IOS software bundle (image) on the router, the image automatically installs the supported Guest OS (Cisco IOS and Linux OS) instance(s). You can use the Linux Guest OS running on a VM on the IR800 to run applications.

The following example shows connectivity of Guest OS and Cisco IOS. A virtual interface managed by Cisco IOS provides network connectivity to Guest OS. Cisco IOS forwards traffic from Guest OS through regular IP forwarding mechanisms.

Figure 1: Connectivity Between Cisco IOS and Guest OS
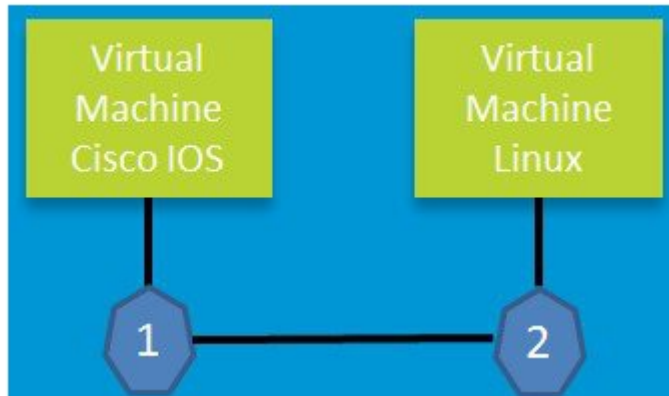
In this example, number 1 is the interface being used on the router and number 2 is the interface on the Linux OS.

For the Cisco IR809, 1 is Gigabit Ethernet 2 and 2 is Eth 0.

For the Cisco IR829, 1 is Gigabit Ethernet 5 and 2 is Eth 0

Additionally, the Virtual Machine Linux has a virtual console, and two virtual serial ports.

Prerequisites

Router must be running Cisco IOS 15.6(2)T or higher.

Note   The IOXVM image delivered in the IOS bundle may not be the most recent. Check Cisco.com for the latest version at: http://software.cisco.com/download/cart.html?imageGuId=F51FECDC2E4FE5814715000B44317E5500EB47C5&i=rs

Guidelines and Limitations

- The bundled Guest OS delivered with 15.6(2)T is based on Yocto Linux Project 1.8 Reference Distro, with basic services enabled:
  - IPv4/IPv6
  - DHCP
  - NTP
  - AAA (Radius)

  ◦ Python 2.7

  ◦ Basic debugging tools (tcpdump, top, etc)

  ◦ bash

- Serial relay for Guest OS control of the Serial Interface

  ◦ Async 0 and Async 1 respectively reserve line 1/5 and 1/6 to relay serial data to the corresponding Guest OS /dev/ttyS1 and /dev/ttyS2

Note Prior to 15.6(3)M, Serial Interface parameters needed to be set through IOS. 15.6(3)M allows setting the parameters directly from the Guest OS, through standard Linux commands.

- You must configure Cisco IOS to provide Guest OS connectivity.

Note There is an IOXVM image more recent than IOS bundle, (IOXVM 1.0.4) available on Cisco.com

Default Settings

The bundled Linux Guest OS:

- Uses DHCP to acquire the IPv4 address.

- Does not have a default root password.

- Uses IPv6 stateless auto-configuration to get an IPv6 address.

Note Without an IPv6 address set on both GXX and ETH0, the Guest OS will never get displayed as registered under show iox host list detail. GXX is defined as GI5 on the IR829 and GI2 on the IR809.

Installation and Upgrade

By default, IR800s ship with a software bundle that includes the latest versions of all of the required images such as Cisco IOS, Guest OS, and Hypervisor.

Note Before performing a bundle installation, shutdown the Guest OS. Performing a bundle installation on a device with an active Guest OS may result in it not functioning upon reboot.

Use the following procedure to upgrade your router to the latest software bundle. It can take several minutes for the router to upgrade and install all of the images (Hypervisor, Cisco IOS, and Guest OS).

DETAILED STEPS

Procedure

Step 1 Copy the bundle image to the IR800 IOS flash partition using scp or sftp.
Example bundle name: **ir800-universalk9-bundle.SPA.**<*VERSION*>

Step 2 Enter the following commands at the IR800 prompt:

Command	Purpose
bundle install flash: <*bundle name*>**.CG**	Installs the specified bundle.
copy running config-config startup-config	Saves the current running configuration.
reload	Reloads the router.

Configuring Cisco IOS

This section describes how to configure the Cisco IOS VM to provide network connectivity to the Guest OS VM.

Guest OS connects to the network through a virtual Network Interface Card (VNIC) provided by the Hypervisor. Network attributes such as IP address, Default gateway, DNS server (as shown in the Configuring DHCP Pool, on page 5 section) on the interface are statically configured or configured for DHCP to dynamically obtain IP addresses. Guest OS network connectivity is only through Cisco IOS, using the virtual network interface provided by the Hypervisor. Network attributes such as IP address, can be configured statistically or dynamically, and are obtained from Cisco IOS using DHCP requests. The bundled Linux Guest OS is configured to use DHCP.

This section outlines the task to configure a Cisco IOS DHCP pool to provision the Linux Guest OS with an IP address, and an external Ethernet interface in Cisco IOS to allow the Guest OS network connectivity.

This section includes the following topics:

Configuring the IR800 Ethernet Interface

You must enable one of the external Ethernet interfaces on the IR800 to provide network connectivity. For details on interface configuration refer to the Cisco 800 Series Integrated Services Routers Software Configuration Guide: http://www.cisco.com/c/en/us/td/docs/routers/access/800/software/configuration/guide/SCG800Guide.html

Note The IR809 uses Gigabit Ethernet 2, and the IR829 uses Gigabit Ethernet 5.

IPv6 Gigabit Ethernet

On Guest OS, IPv6 is enabled by default. The following example configuration uses IPv6 on Guest OS, where Guest OS is automatically assigned an IPv6 address on the Cisco IOS interface GigabitEthernet 5.

Command	Purpose
ipv6 unicast-routing	Enables unicast routing.
ipv6 cef	Enables cef.
interface GigabitEthernet 5	Set the internal virtual interface that connects to the Linux Guest OS.
ipv6 address autoconfig	Sets the IPv6 address.
ipv6 enable	Enables IPv6.

Enabling IPv4 Gigabit Ethernet

Note Configuring an IPv4 address on a Gigabit port is not a required part of configuring the Guest OS. However, IOS interfaces must be set to enable external devices to communicate with the Guest-OS through IOS.

To enable an external Gigabit Ethernet IPv4 interface on the IR800 to provide network connectivity, enter the following commands:

Command	Purpose
config terminal	Enters global configuration mode.
interface gig 0	Configures an IPv4 address on Gigabit Ethernet interface 0, and enters interface configuration mode.
ip address 10.1.2.1 255.255.255.0	Sets the IP address and subnet mask for Gigabit Ethernet interface 0.
no shutdown	Enables the Gigabit Ethernet interface.

Configuring DHCP Pool

To configure a local DHCP pool, enter the following commands, one per line:

Note The subnet used for the local DHCP pool must be reachable externally. If you cannot allocate the whole subnet to Guest OS, use a NAT-based configuration. See Configuring Network Address Translation (NAT), on page 10.

Command	Purpose
config terminal	Enters global configuration mode.
ip dhcp pool gospool	Names the local DHCP pool.
network 10.1.2.0 255.255.255.0	Sets the network address.
default-router 10.1.2.1	Sets the router address.
domain-name utility.com	Sets the subnet address.
dns-server 10.1.1.1	Sets the DNS server address.
lease 5	Sets the duration of the IP address lease to five days.

Configuring Guest OS GigabitEthernet on Cisco IOS

The Guest OS Ethernet port (eth0) connects to a GigabitEthernet interface on Cisco IOS. The IR829 uses GigabitEthernet 5, and the IR809 uses GigabitEthernet 2.

To configure the GigabitEthernet interface with the default gateway address of the DHCP pool, enter the following commands:

Note IPv6 must always be enabled on the GigabitEthernet interface.

Note The IR809 uses Gigabit Ethernet 2, and the IR829 uses Gigabit Ethernet 5.

Command	Purpose
interface GigabitEthernet 5	Sets the internal virtual interface that connects to the Linux Guest OS.
ipv6 enable	Enables IPv6.
ipv6 address autoconfig	Sets the IPv6 address.
ipv4 address 10.1.2.1 255.255.255.0	Sets the IPv4 address.

Command	Purpose
no shutdown	Enables the Ethernet interface, changing its state from administratively down to administratively up.

VDS Configuration

Note There exists a condition where the IR800 could display slow performance if the Guest OS is consuming too many CPU resources. This should only be done under the recommendation of Cisco or an authorized partner. 4G performance may be impacted if changed without proper guidelines.

By default, Guest OS gets 50% of one of the cores of the CPU. The following command allows you to change the percentage of CPU allocation to VDS out of 100. The rest will go to Guest OS. In the situation where you don't use the Guest OS, the CPU can be allocated 90% to VDS.

For Example:

```
IR800>en
IR800#config t
Enter configuration commands, one per line.  End with CNTL/Z.
IR800(config)#iox hypervisor ?
  sched-policy  percentage of CPU ticks to VDS
IR800(config)#iox hypervisor sched-policy ?
  10  VDS  10%   Guest OS 90%
  20  VDS  20%   Guest OS 80%
  30  VDS  30%   Guest OS 70%
  40  VDS  40%   Guest OS 60%
  50  VDS  50%   Guest OS 50%
  60  VDS  60%   Guest OS 40%
  70  VDS  70%   Guest OS 30%
  80  VDS  80%   Guest OS 20%
  90  VDS  90%   Guest OS 10%
IR800(config)#iox hypervisor sched-policy 90
```

Enabling Virtual Guest OS Console

For heightened security, the Guest OS console is disabled by default. To enable the Guest OS console, enter the following commands:

Command	Purpose
config terminal	Enters global configuration mode.
line 1/4	Specifies line 1/4 for configuration and enters line configuration collection mode.
transport input all	Defines which protocols to use to connect to a specific line of the router.

Configuring Guest OS

This section describes how to set the root password for Guest OS and enable SSH access. By default, SSH is disabled in Guest OS. This section describes the steps to reverse-Telnet into Guest OS, and enable SSH access.

Starting Guest OS

By default, Guest OS starts after installation. To manually start the Guest OS, enter the following commands:

Command	Purpose
show iox host list detail	Displays OS: RUNNING if Guest OS is already running. If it is, go to Accessing Virtual Guest OS Console , on page 8.
guest-os 1 start	Starts Guest OS.

During start up, Guest OS sends a DHCP request and is assigned an IP address from the local DHCP pool and an IPv6 address through IPv6 stateless auto-configuration. Guest OS is then configured with a hostname and sync time from IOS.

Note It can take a few minutes for the Guest OS to start.

Accessing Virtual Guest OS Console

The Guest OS console is accessible at port 2070 on any Cisco IOS interface. Use the following commands to access the Linux Guest OS console from Cisco IOS.

Note You must first enable the Guest OS console as described in Enabling Virtual Guest OS Console , on page 7.

Command	Purpose
telnet 10.1.2.1 2070	Accesses the Virtual Guest OS console. This uses the IP address of the Gigabit Ethernet 5 port. The following is the example result:

EXAMPLE

```
Poky 9.0 (Yocto Project 1.4 Reference Distro) 1.4 qemux86 ttyS0
qemux86 login: root
root@qemux86:~#
```

Setting the Root Password

Guest OS does not have a default root password. To set a root password, at the GOS prompt enter the following command.

Note   You must set a root password before turning on SSH access.

Command	Purpose
[GOS] # passwd	Runs the following UNIX password script. Enter your desired password at the prompt.

EXAMPLE

```
Changing password for user root.
New UNIX password:
Retype new UNIX password:
passwd: all authentication tokens updated successfully.
[GOS]#
```

An alternate method for changing the root password from the IOS CLI is shown in the following example:

```
IR800#iox host exec "resetpw cisco" IR800-GOS-1

Password reset successfully.
```

Enabling Remote SSH Access

By default, SSH access is disabled to prevent unauthorized access to Guest OS. To enable SSH server on the guest OS:

Procedure

Step 1   Launch the vi editor to edit the sshd_config file:

Example:

```
vi /etc/ssh/sshd_config
```

Step 2   Set the **PermitRootLogin** and **PasswordAuthentication** parameters to **yes**.
          Note   Ensure that the **PermitEmptyPasswords** parameter is set to **no**.

Example:

```
PermitRootLogin yes
PasswordAuthentication yes
```

```
                    PermitEmptyPasswords no
```

Step 3   Restart SSHD:

Example:

```
[GOS]# /etc/init.d/sshd stop
Stopping sshd:       [  OK  ]
[GOS]# /etc/init.d/sshd start
Starting sshd:       [  OK  ]
[GOS]#
```

Step 4   From the IOS command line, enter the following:

Example:

```
IR800#iox host exec enablessh IR800-GOS-1
 ssh enabled successfully.
```

You now have remote SSH access to Guest OS.

Configuring Network Address Translation (NAT)

The following example configuration uses NAT for Guest OS network connectivity, where:

- 10.1.1.0 is the externally reachable subnet.

- 10.1.1.131 is the external IP address made available for Guest OS access.

- 192.168.1.0 is the private subnet created for Guest OS to Cisco IOS connectivity. This is not directly reachable outside the IR800.

- The IP address acquired by Guest OS through IOS local DHCP pool is 192.168.1.2. This address can be obtained using **show iox host list details** command from IOS.

Note   This example shows outgoing communications. For incoming communications, proper port mapping will be required.

```
ip dhcp pool gospool
 network 192.168.1.0 255.255.255.0
 default-router 192.168.1.1
 domain-name utility.com
 dns-server 10.1.1.1
 lease 5
interface gig 5
 ip nat inside
 ip address 192.168.1.1 255.255.255.0
 ipv6 enable
 no shutdown

interface gig 0
 ip nat outside
 ip address 10.1.1.5 255.255.255.0
 no shutdown
ip nat inside source static 192.168.1.2 10.1.1.131
```

```
! End of configuration

IR800#sh ip nat trans
Pro Inside global Inside local  Outside local  Outside global
tcp 10.1.1.131:22 192.168.1.2:22  10.1.1.3:53649 10.1.1.3:53649
tcp 10.1.1.131:60100 192.168.1.2:60100 10.1.1.3:22   10.1.1.3:22
--- 10.1.1.131  192.168.1.2   ---      ---
```

For more information about NAT, please see the Configuring Network Address Translation: Getting Started Guide.

http://www.cisco.com/c/en/us/support/docs/ip/network-address-translation-nat/13772-12.html

IR800 Guest-OS USB Access from IOS

IR800 IOS releases don't support an external USB storage directly accessible from IOS. However, it is possible to mount an external USB storage on the IR800 Guest-OS, then use it from IOS through SCP

Plug an external USB storage, wait for its recognition.

Edit "/etc/fstab" to add the new sdc1 drive, then mount it.

```
root@IR800-GOS-1:# vi /etc/fstab
Rootfs   /           auto     defaults            1  1
Proc     /proc       proc     defaults            0  0
devpts   /dev/pts    devpts   mode=0620,gid=5     0  0
usbdevfs /proc/bus/usb usbdevfs noauto            0  0
tmpfs    /var/volatile tmpfs  defaults            0  0
tmpfs    /media/ram   tmpfs   defaults            0  0
/dev/sdc1 /mnt/sdc1   auto     defaults            0  0
```

Example of no USB storage recognized

```
root@IR800-GOS-1:~# ls /dev/sd*
/dev/sda  /dev/sda1  /dev/sdb
```

Example of USB storage recognized

```
root@IR800-GOS-1:~# ls /dev/sd*
/dev/sda  /dev/sda1  /dev/sdb  /dev/sdc  /dev/sdc1
root@IR800-GOS-1:/etc# fdisk -l /dev/sdc

Disk /dev/sdc: 1993 MB, 1993342976 bytes, 3893248 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk identifier: 0x00000000
Device Boot      Start          End      Blocks   Id  System
/dev/sdc1          2        3893247   1946623   b   W95 FAT32
```

Mount the drive

```
root@IR800-GOS-1:/etc# mount –a
```

Check that the drive is correctly seen

```
root@IR800-GOS-1:/etc# df -H /dev/sdc1
Filesystem     Size  Used Avail Use% Mounted on
/dev/sdc1      2.0G  869k  2.0G   1% /mnt/sdc1
```

Create a symbolic link in order to get the device directory (or subdirectory if created) associated to the SSH login

```
root@IR800-GOS-1:# ln -s /mnt/sdc1 ~/testUSB
```

Show a long listing of the testUSB directory which displays the symbolic link

```
root@IR800-GOS-1:~# ls -l testUSB
lrwxrwxrwx 1 root root 9 Oct 13 18:00 testUSB -> /mnt/sdc1
root@IR800-GOS-1:~#
```

Now you can use the "test" directory to transfer files from and to the IR800 IOS.

IR800 IOS SCP From/To Guest-OS USB Storage

Now that the USB device is available to the Guest OS, you can copy files to and from it.

```
IR800#copy
ir800-universalk9-mz.SPA.155-3.M0ascp://10.15.15.2/testUSB/ir800-universalk9-mz.SPA.155-3.M0a
Address or name of remote host [10.15.15.2]?
Destination username [IR800]? root
Destination filename [testUSB/ir800-universalk9-mz.SPA.155-3.M0a]?
Writing testUSB/ir800-universalk9-mz.SPA.155-3.M0a
Password:
 Sink: C0644 62083137 ir800-universalk9-mz.SPA.155-3.M0a
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
62083137 bytes copied in 51.640 secs (1202230 bytes/sec)
IR800#copy scp://10.15.15.2/testUSB/hosts flash:
Source username [IR800]? root
Destination filename [hosts]?
Password:
 Sending file modes: C0755 44 hosts
!
44 bytes copied in 13.930 secs (3 bytes/sec)
```

New for IOS 15.6(1)T

Guest OS enhancements include:

- Cisco distribution is based on Yocto Project 1.8 Reference Distro, with basic services enabled:

  ◦ IPv4/IPv6

  ◦ DHCP

  ◦ NTP

  ◦ AAA (Radius)

  ◦ Python 2.7

  ◦ Basic debugging tools (tcpdump, top, etc)

  ◦ bash

- Serial relay for Guest OS control of the Serial Interface

  ◦ Async 0 and Async 1 respectively reserve line 1/5 and 1/6 to relay serial data to the corresponding Guest OS /dev/ttyS1 and /dev/ttyS2

New for IOS 15.6(3)M

USB Support

Previous to 15.6(3)M, the USB devices, which are connected to external USB port could be emulated on the Guest OS through OHCI mode only. With this feature Hypervisor will be enhanced to support EHCI emulation to Guest OS.

Serial Device Configuration

Previously, the Guest OS could not configure the physical serial port on the device. The serial port configuration (e.g. baud rate change) of the serial port needed to be done in IOS.

With 15.6(3)M, hypervisor and IOS are enhanced so that if the Guest OS changes the virtual serial port configuration, it notifies IOS, and IOS applies the configuration to the physical serial port.

Command line changes consist of the following:

- A new option is appended to allow the baudrate, databits, stopbits and parity propagation from Guest OS. If "propagation" is present, the control parameters will be passed from Guest OS to IOS physical port. Otherwise it functions as before.

- The serial port control parameters included in the propagation are: baudrate, databits, stopbits and parity.

```
relay line <linex> <liney> [propagation]
```

Serial Relay Configuration

```
IR800#conf term
Enter configuration commands, one per line.  End with CNTL/Z.
IR800(config)#inter asyn 0
IR800(config-if)# encap relay-line
IR800(config-if)# end
IR800(config)# line 1
IR800(config-line)# transport input all
IR800(config-line)#
IR800(config)# relay line 1 1/5 propagation
IR800# show line 1/5
Guest OS output for /dev/tty
```

GOS is installed through the IOX bundle install process and can be started/stopped and upgraded from IOS CLI

Verification for digitally-signed GOS image distributed via Cisco DevNet must be installed using the guest-os image install command only.

Memory Allocation Optimization

Improvements have been made in the memory allocation optimization between VDS, IOS and GOS on the IR800. Previously, the 2GB RAM was allocated as follows:

- VDS: 512MB

- IOS: 512MB

- Guest OS: 725MB

- Remainder: used by hypervisor (e.g. device share memory)

Now with optimization, the VDS memory was reduced to give at least 1GB to the Guest OS.

Troubleshooting

To determine common causes of configuration failure, enter the following commands:

Command	Purpose
Guest OS Commands:	
ifconfig eth0	Checks if Guest OS is assigned an IP address. The following is example output:
``eth0 Link encap:Ethernet HWaddr 02:00:03:f1:cd:05
inet addr:10.1.2.2 Bcast:0.0.0.0 Mask:255.255.255.248
UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1
RX packets:2 errors:0 dropped:0 overruns:0 frame:0
TX packets:5 errors:0 dropped:0 overruns:0 carrier:0
collisions:0 txqueuelen:1000
RX bytes:684 (684.0 B) TX bytes:894 (894.0 B)
[GOS]#```	
netstat -r	Displays the Guest OS route table. The following is example output:
``Kernel IP routing table
Destination Gateway Genmask Flags MSS Window irtt Iface
default 10.1.2.1 0.0.0.0 UG 0 0 0 eth0
10.1.2.0 * 255.255.255.0 U 0 0 0 eth0
[GOS]#```	
IOS Commands:	
show ip arp	Verifies that Cisco IOS learned Guest OS ARP mapping.The following is example output:
``Protocol Address Age (min) Hardware Addr Type Interface
Internet 10.1.1.1 - 0022.bdef.c562 ARPA GigabitEthernet0
Internet 10.1.2.1 - 0022.bdef.c569 ARPA GigabitEthernet2
Internet 10.1.2.2 112 0022.bdef.c56d ARPA GigabitEthernet2
IR800#```	
show ipv6 neighbor	Verifies that Cisco IOS learned Guest OS IPv6 neighbor address.The following is example output:
``IPv6 Address   Age Link-layer Addr State Interface
FE80::1FF:FE90:8B05 0 0200.0190.8b05 REACH Gi2```	

Command	Purpose
show platform guest-os	Guest-OS started

<pre>Guest OS status:
Installation: Cisco-GOS,version-1.28
State: RUNNING
IR800#</pre>	

show iox host list detail	Guest-OS started, normal operation

<pre>IOX Server is running. Process ID: 319
Count of hosts registered: 1
Host registered:
===============
    IOX Server Address: FE80::76A2:E6FF:FEFD:6A6C; Port: 22222
    Link Local Address of Host: FE80::1FF:FE90:8B05
    IPV4 Address of Host: 10.15.15.2
    IPV6 Address of Host: fe80::1ff:fe90:8b05
    Client Version: 0.1
    Session ID: 1
    OS Nodename: IR809-GOS-1
    Host Hardware Vendor: Cisco Systems, Inc.
    Host Hardware Version: 1.0
    Host Card Type: not implemented
    Host OS Version: 1.28
    OS status: RUNNING
    Interface Hardware Vendor: None
    Interface Hardware Version: None
    Interface Card Type: None
    Applications Registered:
    ======================
 Count of applications registered by this host: 0
IR800#</pre>	

show iox host list detail	Guest-OS started but no IPv6 address set-up on the GI2 interface

<pre>IOX Server is running. Process ID: 319
Count of hosts registered: 0
    IOX Server Address: 0.0.0.0; Port: 22222
IR800#</pre>	

Checking Connectivity

Use standard Linux tools (for example, ping and traceroute) to check Guest OS connectivity.

Related Documentation

Note   While some of these references do not apply directly to the Cisco IR800 series of Industrial Routers, they may serve as a source of addition information.

For information on supporting systems referenced in this guide, refer to the following documentation on Cisco.com:

DevNet documentation on IOx. Provides an overview as well as details on the IR800 series by scrolling down the left hand side:

https://developer.cisco.com/site/iox/documents/developer-guide/?ref=overview

Cisco Fog Director Reference Guide:

http://www.cisco.com/c/en/us/support/cloud-systems-management/fog-director/products-technical-reference-list.html

IOx Reference Guide:

http://www.cisco.com/c/en/us/support/cloud-systems-management/iox/products-technical-reference-list.html

Release Notes:

http://www.cisco.com/c/en/us/support/cloud-systems-management/iox/products-release-notes-list.html

Other Sources:

Cisco IOS IP Application Services Command Reference

IPv6 configuration manual