CHAPTER **10**

Upgrading Field-Programmable Devices

Field-programmable devices (FPDs) are hardware devices implemented on router cards that support separate software upgrades. A field-programmable gate array (FPGA) is a type of programmable memory device that exists on most hardware components of a Cisco 10000 series router. The term "FPD" was introduced to collectively and generically describe any type of programmable hardware device on SIPs and SPAs, including FPGAs.

This chapter describes how to verify image versions and perform an upgrade for SPA FPD images when incompatibilities occur.

This chapter includes the following sections:

SPA FPD Image Upgrade Support

An FPD image package is used to upgrade FPD images. Each time a Cisco IOS software image is released that supports SPAs, a companion SPA FPD image package may also be released for that Cisco IOS software release. The FPD image package is available from Cisco.com and is accessible from the Cisco Software Center page where you also go to download your Cisco IOS software image.

If you are running SPAs on your router and are upgrading your Cisco IOS image, you should download the FPD image package file before booting the router using the new Cisco IOS release. If the SPA requires an FPD upgrade and the Cisco IOS image is unable to locate an FPD image package, the system messages indicate that the FPD image is incompatible. You will need to go to the Cisco Software Center on Cisco.com to download the FPD image package for your Cisco IOS software release. An FPD incompatibility on a SPA disables all interfaces on that SPA until the incompatibility is addressed.

Automatic FPD Image Upgrades

By default, the Cisco 10000 series router automatically upgrades the FPD images when it detects a version incompatibility between the FPD image on the SPA and the FPD image required to run the SPA. The FPD automatic upgrade feature only searches for the FPD image package file with the same version number as the running Cisco IOS release.

Upgrading SPA FPD Images

This section provides the procedures to perform the following SPA FPD image upgrades:

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Caution   Upgrading the FPD image on a SPA places the SPA offline while the upgrade is taking place. The time required to complete an FPD image upgrade can be lengthy.

Upgrading SPA FPD Images Before Booting the New Cisco IOS Release

If you are running your old Cisco IOS release but are preparing to load a newer version of Cisco IOS, you can place the FPD image package for the new version of Cisco IOS onto one of your router's flash file systems. For example, if you are running Cisco IOS release 12.2(32)S and are upgrading to Cisco IOS release 12.2(33)SB, place the FPD image package for Cisco IOS release 12.2(33)SB onto a flash file system while still running Cisco IOS release 12.2(32)S.

To place an FPD image package on a flash disk before upgrading IOS, perform the following steps:

Step 1   While still running the Cisco IOS release that will be upgraded, place the FPD image package for the new version of Cisco IOS onto one of your router's flash file systems. The FPD image package for a specific IOS release can be located on Cisco.com from the same area where you downloaded that Cisco IOS software image. Your router and SPAs should continue to operate normally, because this action has no impact on the current FPDs.

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Caution   Do not change the filename of the FPD image package file. The Cisco IOS software searches for the FPD image package file by filename, so the FPD image package file cannot be found if it is renamed.

Step 2   Reboot your router using the new upgraded Cisco IOS image.

Step 3   When the router has booted, verify the upgrade was successful by entering the **show hw-module all fpd** command.

Upgrading SPA FPD Images After Booting the New Cisco IOS Release

The following procedure explains how to upgrade FPD images if you have already upgraded your Cisco IOS release but still need to upgrade your FPD images.

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Note   If multiple SPAs require upgrades, you must update the different pieces of hardware individually.

To perform an FPD upgrade after the new Cisco IOS release boots, perform the following steps:

Step 1   If you are unsure if your FPD images for your SPAs are compatible, enter the **show hw-module all fpd** command to verify compatibility of all SPAs. If all of your SPAs are compatible, you do not need to perform this upgrade.

Step 2   If an FPD upgrade is necessary, place the FPD image package for the new version of Cisco IOS onto the router's flash disk or on an accessible FTP or TFTP server. The FPD image package can be located on Cisco.com from the same area where you downloaded your Cisco IOS software image.

Step 3   Enter the **upgrade hw-module subslot** *slot*/*subslot fpd file file-url* command in privileged EXEC mode. The *file-url* keyword specifies the location of the FPD image package file. For example, if you are upgrading the FPD image in SPA subslot 0 on the SIP installed in chassis slot 1, and the FPD image package for Cisco IOS release 12.2(32)S is on the TFTP server mytftpserver/myname/fpdpkg, you would enter:

```
Router# upgrade hw-module subslot 1/0 fpd file tftp://mytftpserver/myname/fpdpkg/
c10k-fpd-pkg.122-32.S.pkg
```

Step 4   Verify the upgrade was successful by entering the **show hw-module all fpd** command.

Optional FPD Procedures

This section provides information for optional FPD-related functions. None of the topics discussed in this section are necessary for completing FPD upgrades, but may be useful in some FPD-related scenarios. This section includes the following topics:

- Manually Upgrading SPA FPD Images, page 10-3
- Upgrading FPD from an FTP or TFTP Server, page 10-4
- Modifying the Default Path for the FPD Image Package File Location, page 10-5
- Upgrading Multiple FPD Images, page 10-6
- Disabling Automatic FPD Upgrades, page 10-6
- Displaying Current and Minimum Required FPD Image Versions, page 10-6
- Displaying Information About the Default FPD Image Package, page 10-7
- Verifying the FPD Image Upgrade Progress, page 10-7

Manually Upgrading SPA FPD Images

The FPD manual upgrade feature provides the ability to manually upgrade the FPD image on a SPA. To manually upgrade the current FPD version on a SPA, enter the following command in privileged EXEC mode:

```
Router# upgrade hw-module subslot slot/subslot fpd file file-url [reload]
```

In the command, *slot* is the slot where the SIP is installed, *subslot* is the subslot number where the SPA is located, *file-url* is the location and name of the FPD image package file, and **reload** is an option that forces the SPA to perform an FPD upgrade even if FPD is compatible (the **reload** option is almost never necessary and should be entered only if requested by a technical support representative). The SPA will be reloaded automatically to complete the FPD upgrade.

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Caution   Upgrading the FPD image on a SPA places the SPA offline while the upgrade is taking place. The time required to complete an FPD image upgrade can be lengthy.

Upgrading FPD from an FTP or TFTP Server

The recommended method to perform an FPD image upgrade is to download the FPD image package to a flash file system and use the FPD automatic upgrade. By default, the system searches the flash file systems for the FPD image package file when an FPD incompatibility is detected.

This default behavior of loading an FPD image from flash can be changed using the **upgrade fpd path** global configuration command, which sets the path to search for the FPD image package file to a location other than the router's flash file systems.

For large deployments where all the systems are being upgraded to a specific Cisco IOS software release, we recommend that the FPD image package file be placed on an FTP or TFTP server that is accessible to all the affected systems, and enter the **upgrade fpd path** global configuration command to configure the routers to look for the FPD image package file from the FTP or TFTP server prior to the reloading of the system with the new Cisco IOS release.

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Note   This approach can also be used if there is not enough disk space on the system flash card to hold the FPD image package file.

To download an FPD image package file to an FTP or TFTP server, use the following procedure:

Step 1   Copy the FPD image package file to the FTP or TFTP server.

Step 2   Access the router from a connection that does not use the SPA interface for access, if possible. We recommend not using the SPA interface as your connection to the router because an FPD incompatibility disables all interfaces on the SPA, making a manual FPD upgrade impossible through a SPA interface. If access through one of the SPA ports is the only access to the router you have, do not use the TFTP or FTP upgrade method. Instead, copy the FPD image package to your router's default flash card before upgrading your Cisco IOS release. This method allows the router to find the FPD image package during the first IOS boot and upgrade FPD automatically.

Step 3   From global configuration mode, enter the **upgrade fpd path** command to instruct the router to locate the FPD image package file from the FTP or TFTP server location. For example, enter one of the following global configuration commands from the target system's console:

```
Router(config)# upgrade fpd path tftp://my_tftpserver/fpd_pkg_dir/
```

or

```
Router(config)# upgrade fpd path ftp://login:password@my_ftpserver/fpd_pkg_dir/
```

✎

Note   The slash (/) at the end of each example is required. If the path is specified without the trailing slash, the command does not work properly.

In these examples, *my_tftpserver* or *my_ftpserver* is the path to the server, *fpd_pkg_dir* is the directory on the TFTP server where the FPD image package is located, and *login:password* is your FTP login name and password.

Step 4   Make sure that the FPD automatic upgrade feature is enabled by examining the output of the **show running-config** command (look for the *upgrade fpd auto* configuration line in the output). If there are no upgrade commands in the output, the FPD automatic upgrade feature is enabled. If automatic upgrades are disabled, use the **upgrade fpd auto** global configuration command to enable automatic FPD upgrades.

Step 5   Enter the **show upgrade fpd file** command to ensure your router is connecting properly to the default FPD image package. If you are able to generate output related to the FPD image package using this command, the upgrade should work properly.

Step 6   Save the configuration and reload the system with the new Cisco IOS release.

During the system startup after the reload, the necessary FPD image version check for all the SPAs will be performed and any upgrade operation will occur automatically if an upgrade is required. In each upgrade operation, the system extracts the necessary FPD images to the SPA from the FPD image package file located on the FTP or TFTP server.

Modifying the Default Path for the FPD Image Package File Location

By default, the Cisco IOS software looks for the FPD image package file on a flash file system when performing an automatic FPD image upgrade.

Note   Be sure there is enough space on one of your flash file systems to accommodate the FPD image package file.

Alternatively, you can store an FPD image package file elsewhere. However, because the system looks on the flash file systems by default, you need to change the FPD image package file location so that the system is directed to search an alternate location (such as an FTP or TFTP server) that is accessible by the Cisco IOS software. Enter the **upgrade fpd path** *fpd-pkg-dir-url* global configuration command, where *fpd-pkg-dir-url* is the alternate location, to instruct the router to search for the FPD image package elsewhere.

When specifying *fpd-pkg-dir-url*, be aware of the following:

- *fpd-pkg-dir-url* is the path to the FPD image package, but the FPD image package should not be specified as part of *fpd-pkg-dir-url*. For instance, if the c10k-fpd-pkg.122-32.S.pkg file can be found on the TFTP server using the path mytftpserver/myname/myfpdpkg/c10k-fpd-pkg.122-32.S.pkg and you want the router to utilize this FPD image package for FPD upgrades, the **upgrade fpd path tftp://mytftpserver/myname/myfpdpkg/** command should be entered so the router knows where to find the file. The actual filename should not be specified.

- The slash (/) at the end of *fpd-pkg-dir-url* is required.

If the **upgrade fpd path** global configuration command has not been entered to direct the router to locate an FPD image package file in an alternate location, the system searches the flash file systems on the Cisco 10000 series router for the FPD image package file.

Failure to locate an FPD image package file when an upgrade is required disables the SPA. If the automatic upgrade feature is disabled, the SPA is also disabled if it requires an FPD upgrade.

Upgrading Multiple FPD Images

A single piece of hardware can contain multiple FPD images. The Cisco 10000 series router can upgrade up to four FPD images simultaneously. However, only one FPD upgrade per router slot can occur at a time. All FPD images on all SPAs in a single slot wait for the previous FPD upgrade to finish before their specific FPD upgrade begins.

During manual upgrades, you specify an upgrade for a single piece of hardware each time you enter the **upgrade hw-module** [**slot** *slot* | **subslot** *slot/subslot*] command. If you individually specify multiple manual FPD upgrades, only four FPDs can be upgraded simultaneously; the upgrades can occur only when the hardware is in different router slots. The FPD upgrade process stops when all FPDs for the specified hardware are upgraded.

Disabling Automatic FPD Upgrades

To disable automatic FPD image upgrades, enter the **no upgrade fpd auto** command in global configuration mode. If the automatic FPD image upgrade feature is disabled but an FPD image is required for a SPA, the **upgrade hw-module subslot** command can be used to manually upgrade the SPA FPD image.

Note   Disabling the automatic upgrade feature does not disable the version checking mechanism. This prevents SPAs with incompatible FPD images from becoming active.

Displaying Current and Minimum Required FPD Image Versions

To display the current version of FPD images on the SPAs installed on your router, use the **show hw-module** [*slot/subslot* | **all**] **fpd** command, where *slot* is the slot number where the SIP is installed and *subslot* is the number of the SIP subslot where a target SPA is located. Entering the **all** keyword shows information for hardware in all router slots.

The following example shows that FPD versions on SPAs in the system meet the minimum requirements:

```
Router# show hw-module all fpd

==== ==================== ====== ============================================
                          H/W    Field Programmable   Current    Min. Required
Slot Card Type            Ver.   Device: "ID-Name"    Version    Version
==== ==================== ====== ================= =========== ==============
 1/0 5xGE SPA[1/0]        1.1    1-GE I/O FPGA         1.10        1.10
---- -------------------- ------ ----------------- ----------- --------------
 1/1 5xGE SPA[1/1]        1.1    1-GE I/O FPGA         1.10        1.10
---- -------------------- ------ ----------------- ----------- --------------
 1/2 5xGE SPA[1/2]        1.1    1-GE I/O FPGA         1.10        1.10
---- -------------------- ------ ----------------- ----------- --------------
 1/3 5xGE SPA[1/3]        1.1    1-GE I/O FPGA         1.10        1.10
---- -------------------- ------ ----------------- ----------- --------------
 5/0 5xGE SPA[5/0]        1.1    1-GE I/O FPGA         1.10        1.10
---- -------------------- ------ ----------------- ----------- --------------
 7/0 5xGE SPA[7/0]        1.1    1-GE I/O FPGA         1.10        1.10
---- -------------------- ------ ----------------- ----------- --------------
 7/1 5xGE SPA[7/1]        1.1    1-GE I/O FPGA         1.10        1.10
---- -------------------- ------ ----------------- ----------- --------------
 7/2 5xGE SPA[7/2]        1.1    1-GE I/O FPGA         1.10        1.10
---- -------------------- ------ ----------------- ----------- --------------
 7/3 1x10GE XFP SPA[7/3]  1.1    1-10GE I/O FPGA       1.9         1.9
==== ==================== ====== ============================================
```

The following example shows the output when using the *slot*/*subslot* argument to identify a particular SPA:

```
Router# show hw-module subslot 1/0 fpd

==== ===================== ====== =============================================
                          H/W    Field Programmable   Current    Min. Required
Slot Card Type            Ver.   Device: "ID-Name"    Version    Version
==== ===================== ====== ================= =========== ==============
 1/0 5xGE SPA[1/0]         1.1    1-GE I/O FPGA         1.10        1.10
==== ===================== ====== =============================================
```

Displaying Information About the Default FPD Image Package

You can use the **show upgrade fpd package default** command to find out which SPAs are supported with your current Cisco IOS release and which FPD image package you need for an upgrade.

```
Router# show upgrade fpd package default

*******************************************************************************
This Cisco IOS software image requires the following default FPD Image
Package for the automatic upgrade of FPD images (the package is available
from Cisco.com and is accessible from the Cisco Software Center page where
this IOS software image can be downloaded):
*******************************************************************************

Version: 12.2(nightly.BEMR070920)

Package Filename: c10k-fpd-pkg.122-nightly.BEMR.pkg

       List of card type supported in this package:

                                                     Minimal
         No. Card Type                               HW Ver.
         ---- -------------------------------------- -------
           1) not supported                            0.0
           2) 8xGE SPA                                 0.0
           3) 5xGE SPA                                 0.0
           4) 1x10GE XFP SPA                           0.0
           5) 2xGE V2 SPA                              0.0
         ---- -------------------------------------- -------
```

Verifying the FPD Image Upgrade Progress

You can use the **show upgrade fpd progress** command to view a snapshot of the upgrade process while an FPD image upgrade is taking place. The following example shows the type of information this command shows:

```
Router# show upgrade fpd progress

FPD Image Upgrade Progress Table:

 ==== ================== ==================================================
                         Field Programmable    Time
 Slot Card Description   Device :"ID-Name"    Needed    Time Left  State
 ==== ================== ================== ========== ========== ===========
1/0 SPA-1XTENGE-XFP      1-10GE I/O FPGA     00:06:00   00:05:17  Updating...
 ---- ------------------ ------------------ ---------- --------- -----------
3/1 SPA-10X1GE           1-GE I/O FPGA        --:--:--   --:--:--  Waiting...
```

```
===== ================= =======================================================
```

Troubleshooting Problems with FPD Image Upgrades

This section contains information to help troubleshoot problems that can occur during the upgrade process.

Power Failure or Removal of a SPA During an FPD Image Upgrade

If the FPD upgrade operation is interrupted by a power failure or the removal of the SPA, it could corrupt the FPD image. This corruption of the FPD image file makes the SPA unusable by the router. The system displays the following message when it stops trying to power up the SPA:

```
02:10:10: %SPA_OIR-3-SPA_POWERED_OFF: subslot 1/0: SPA 1x10GE XFP SPA powered off after 5
failures within 600 seconds
```

> **Note** To find more information about FPD-related messages, check the system error messages guide for your Cisco IOS software release.

The **show hw-module subslot** *slot*/*subslot* **fpd** command can be used to verify that the SPA is using a corrupted FPD image. In this example, the SPA in slot 1/0 is corrupted.

```
Router# show hw-module subslot 1/0 fpd

==== ===================== ====== =============================================
                           H/W    Field Programmable   Current   Min. Required
Slot Card Type             Ver.   Device: "ID-Name"    Version     Version
==== ===================== ====== ================== =========== ==============
 1/0 5xGE SPA[1/0]         2.1    1-GE I/O FPGA   ?.?            ?.?
==== ===================== ====== =============================================
```

Performing a FPD Recovery Upgrade

The recovery upgrade procedure can only be performed on a SPA that has been powered off by the system after it has failed all of the retries attempted to initialize the SPA.

The following example shows the output of an attempt to perform a recovery upgrade before all of the initialization retries have been attempted for the SPA in subslot 1/0.

```
02:04:08: %FPD_MGMT-4-UPGRADE_EXIT: Unexpected exit of FPD image upgrade operation for
SPA-1XTENGE-XFP card in subslot 1/0.
02:04:15: %FPD_MGMT-5-CARD_DISABLED: SPA-1XTENGE-XFP card in subslot 1/0 is being disabled
because of an incompatible FPD image version. Note that the c10k-fpd-pkg.122-32.S.pkg
package will be required if you want to perform the upgrade operation.
Router#upgrade hw-module subslot 1/0 file disk0:c10k-fpd-pkg.122-32.S.pkg

% Cannot get FPD version information for version checking. If a previous upgrade attempt
has failed for the target card, then a recovery upgrade would be required to fix the
failure.


% The following FPD(s) will be upgraded for SPA-1XTENGE-XFP (H/W ver = 2.1) in subslot
1/0:

    ================== =========== =========== ============
    Field Programmable   Current     Upgrade     Estimated
```

```
      Device: "ID-Name"    Version      Version    Upgrade Time
      ================== =========== =========== ============
      1-10GE I/O FPGA        ?.?         1.6        00:00:20
      ================== =========== =========== ============
```

```
% Do you want to perform the recovery upgrade operation? [no]: y
% Cannot perform recovery upgrade operation because the target card is not in a failed
state. Please try again later.
```

After the following error message appears, you can perform the recovery upgrade:

> ✎
> **Note**   You must wait to see this error message before you attempt the upgrade.

```
%SPA_OIR-3-SPA_POWERED_OFF: subslot 1/0: SPA 1x10GE XFP SPA powered off after 5 failures
within 600 seconds
```

Perform the manual FPD image upgrade method using the **upgrade hw-module subslot** command to recover from a corrupted image after the SPA has been powered off by the system.

> ✎
> **Note**   Before proceeding with this operation, make sure that the correct version of the FPD image package file has been obtained for the corresponding Cisco IOS release that the system is using.

The following example shows the console output of a recovery upgrade operation:

```
Router#upgrade hw-module subslot 1/0 file disk0:c10k-fpd-pkg.122-32.S.pkg

% Cannot get FPD version information for version checking. If a previous upgrade attempt
has failed for the target card, then a recovery upgrade would be required to fix the
failure.

% The following FPD(s) will be upgraded for SPA-1XTENGE-XFP (H/W ver = 2.1) in subslot
1/0:

    ================== =========== =========== ============
    Field Programmable  Current     Upgrade     Estimated
    Device: "ID-Name"   Version     Version    Upgrade Time
    ================== =========== =========== ============
    1-10GE I/O FPGA        ?.?         1.6        00:00:20
    ================== =========== =========== ============

% Do you want to perform the recovery upgrade operation? [no]: y
% Proceeding with recovery upgrade operation ...

Router#
02:14:47: %FPD_MGMT-6-UPGRADE_TIME: Estimated total FPD image upgrade time for
SPA-1XTENGE-XFP card in subslot 1/0 = 00:00:20.
02:14:47: %FPD_MGMT-6-UPGRADE_START: Unknown FPD (FPD ID=1) image upgrade in progress for
SPA-1XTENGE-XFP card in subslot 1/0. Updating to version 1.6. PLEASE DO NOT INTERRUPT
DURING THE UPGRADE PROCESS (estimated upgrade completion time = 00:00:20) ...
02:15:10: %FPD_MGMT-6-UPGRADE_PASSED: Unknown FPD (FPD ID=1) image in the SPA-1XTENGE-XFP
card in subslot 2/0 has been successfully updated from version ?.? to version 1.6.
Upgrading time = 00:00:23.540
```

```
02:15:10: %FPD_MGMT-6-OVERALL_UPGRADE: All the attempts to upgrade the required FPD images
have been completed for SPA-1XTENGE-XFP card in subslot 1/0. Number of successful/failure
upgrade(s): 1/0.
02:15:10: %FPD_MGMT-5-CARD_POWER_CYCLE: SPA-1XTENGE-XFP card in subslot 1/0 is being power
cycled for the FPD image upgrade to take effect.
```

Verifying a Successful Upgrade

After the upgrade process is complete, you can use the **show hw-module subslot** *slot*/*subslot* **fpd** command to verify that the FPD image is successfully upgraded. For example:

```
Router#show hw-module subslot 1/0 fpd

==== ===================== ====== ============================================
                           H/W    Field Programmable   Current    Min. Required
Slot Card Type             Ver.   Device: "ID-Name"    Version    Version
==== ===================== ====== ================== =========== ==============
 1/0 5xGE SPA[1/0]         1.1    1-5xGE V2 I/O FPGA   1.10        1.10
==== ===================== ====== ============================================
```