Troubleshoot FEC on Catalyst 9000 Switches

Contents

Introduction

This document describes basics of Forwarding Error Correction (FEC) and how to validate the feature on the Catalyst 9000-family of switches.

Prerequisites

Requirements

Cisco recommends that you have knowledge of these topics:

- Catalyst 9000-series switches
- Optical Transceivers

Background Information

What is FEC?

FEC is a technique used to detect and correct a certain number of errors in a bitstream by appending redundant bits and error-checking code to the message block before transmission. The addition contains sufficient information on the actual data to enable the FEC decoder at the receiver end to reconstruct the original message. The FEC decoder can identify the bits received in error and correct them. It then removes the redundant bits before passing the message to the upper layers of the network. Because the FEC decoder uses only the redundant bits to detect and correct errors, it does not request retransmission of the entire errored frame, saving bandwidth that would otherwise be used for retransmission.
FEC provides a way for networks to increase data rate while maintaining an acceptable bit error rate(BER). There are trade-offs, however. The improvement is the result of adding overhead in the form of error-correcting parity bits, which consumes some of the available bandwidth. In general, the higher the coding gain, the greater the number of parity bits, which increases the size of the codewords. FEC decoders need to receive the full codeword before they can act on it. Stronger FEC algorithms offer higher coding gains, but they require larger codewords, and larger codewords increase latency.

Why do fiber optic networks need FEC?

The growing popularity of cloud computing, streaming video, and social networking has massively increased internet traffic. To meet the skyrocketing bandwidth demand, the optical networking industry has pushed data rates to 100 Gbps and beyond. Optical transmission is vulnerable to various sources of signal

degradation, including chromatic dispersion, modal dispersion, polarization mode dispersion, and noise.

In the real world, the ability of an optical receiver to resolve information is impacted by the presence of noise. As a result, a receiver cannot accurately resolve all bits, introducing errors into the data transmission. This problem is exacerbated at higher speeds because receiver filter bandwidths must be widened to allow the faster signals and must also then allow more noise energy to pass through. Fortunately, FEC can help compensate for this problem. Although the technique cannot correct all errors under all network conditions, when properly specified, it can help network operators run at higher transmission rates while maintaining target Bit Error Ratios (BERs), all while using less expensive optics.

Catalyst 9000-series switches support 2 types of FECs:

FC-FEC

RS-FEC

FC-FEC configuration value is **cl74**

RS-FEC has two configuration values depending of the speed of the link:

25GBs or 50GBs: **cl108**

100GBs: **cl91**

How we negotiate FEC value and when FEC is required?

FEC is required at 25GBs speed or higher when the cable length is longer than 2 meters.
The FEC block that performs the coding and decoding is often in the ASIC of the switch/router. In other cases, for example in certain 100G optics, it is in the module itself.
FEC is enabled in auto mode by default; however, there could be other FEC clauses for specific application protocols that can be supported by the host software. The user can decide to enable these, depending on their specific application.

Topology

Topology 1

Configuration and Verification

Configuration:

```
Cat9300X-24Y(config)# interface tw1/1/2
Cat9300X-24Y(config-if)#fec ?
auto    Enable FEC Auto-Neg
```

```
cl108    Enable clause108 with 25G
cl74     Enable clause74 with 25G
off      Turn FEC off

Cat9300X-24Y(config-if)#fec auto
```

Verification:

```
Cat9300X-24Y# show running-config interface tw1/1/2
!
interface TwentyFiveGigE1/1/2
end
```

The absence of FEC configuration indicates that FEC is set to auto or you can check the status of the interface

```
Cat9300X-24Y# show interface tw1/1/2
TwentyFiveGigE1/1/2 is up, line protocol is up (connected)
--snip--
  Full-duplex, 25Gb/s, link type is force-up, media type is SFP-25GBase-SR
  Fec is auto                < -- The configured setting for FEC is displayed here
  input flow-control is on, output flow-control is off
  ARP type: ARPA, ARP Timeout 04:00:00
--snip--
```

The mismatch of FEC on both sides of the link can break the connection between the devices even if everything else is good.

Example:

`Cat9300X-24Y#show running-config interface tw1/1/2`
`Building configuration...`
 	
`Current configuration : 47 bytes`
`!`
`interface TwentyFiveGigE1/1/2`
`fec cl74`
`end`
 	
`Cat9300X-24Y#show interface tw1/1/2`
`TwentyFiveGigE1/1/2 is down, line protocol is down (notconnect)`
	`Cat9300X-48X#show running-config interfa`
	`Building configuration...`
	
	`Current configuration : 37 bytes`
	`!`
	`interface TwentyFiveGigE1/1/6`
	`end`
	
	`Cat9300X-48X#show interface tw1/1/6`
	`TwentyFiveGigE1/1/6 is  down, line proto`

`Cat9300X-24Y#show interfaces transceiver`
`If device is externally calibrated, only calibrated values are printed.`
`++ : high alarm, +  : high warning, -  : low warning, -- : low alarm.`
`NA or N/A: not applicable, Tx: transmit, Rx: receive.`
	`Cat9300X-48X#show interfaces tra`
	`If device is externally calibrat`
	`++ : high alarm, +  : high warni`
	`NA or N/A: not applicable, Tx: t`

```
mA: milliamperes, dBm: decibels (milliwatts).                        mA: milliamperes, dBm: decibels

                                     Optical   Optical
            Temperature  Voltage  Current  Tx Power  Rx Power              Temperature  Voltag
Port        (Celsius)    (Volts)  (mA)     (dBm)     (dBm)     Port        (Celsius)    (Volts
---------   -----------  -------  -------- --------  --------  ---------   -----------  ------
Twe1/1/6    37.4         3.29     7.4      -0.4      -4.9      Twe1/1/2    37.8         3.33
```

You can see that even with a receive good signal the port is down on both sides as the FEC configuration does not match. In this case, you need to match the FEC configuration, either choosing "**auto**" in both or "**cl74**".

While troubleshooting link problems take these steps:

1. Compatibility of the transceiver with the device
2. Compatibility between transceiver in the same link
3. Compatibility between the transceiver and the fiber cable in use
4. Negotiation between sites
4.1. Speed
4.2. FEC

FEC take more importance when we are connecting devices that are different. We see most problems when connected to 3rd party eqyuipment or host devices, could be UCSs or Nexus devices.

If FEC is left in default mode, both devices need to negotiate the FEC setting to be used and that could be a problem. Is better to manually set the FEC settings but it needs to match between both sides of the link.

To see what FEC setting is allow on the transceiver you need to use the TMGMatrix:

https://tmgmatrix.cisco.com/

Once there you filter by transceiver PID or device:

Cisco Optics-to-Device Compatibility Matrix

Disclaimer: Cisco makes the data in this tool available for informational purposes. Cisco does not represent, warrant, or guarantee that it is complete, accurate, or up to date. This information is subject to change without notice.

Begin your Search (Type in window)

Q QSFP-100G-PSM4-S

QSFP-100G-PSM4-S in Transceiver Product ID

Get Mobile Application

Then you click in the CUE card of the transceiver:

C9400

| Network Device Product ID | Transceiver Product ID | Transceiver Description | | | | | | | | | Software Release | |
	Click to Product Cue Card	Data Rate	Form Factor	Max. Reach	Cable Type	Media	Connector Type	Transceiver Type	Case Temp	DOM HW Capable	Minimum	DOM SW
C9400-LC-12QC	CUE QSFP-100G-PSM4-S	100 Gbps	QSFP28	500m	Parallel Fiber	SMF	MPO-12 (APC)	Optic	0 to 70C	Y	IOS XE 17.12.1	IOS XE 17.12.1

The CUE card shows all the data you need to know about the transceiver, including the FEC setting:

PID: **QSFP-100G-PSM4-S**

RS-FEC

Speed: **100G**

Reach: **500m**

Type: **QSFP28**
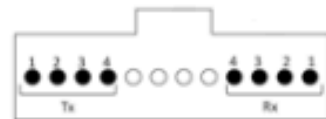
Power: **3.5W**

Temp: **0-70 C**

100GBASE PSM4

Fiber: **SMF**

Connector: **MPO-12 (APC)**
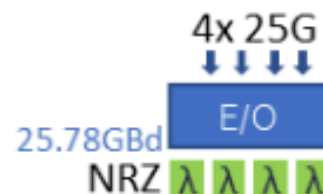
Optimized: **G.652**

Parallel

Wavelength (nm): **1310**

Number of Lanes: **4**

25G Xmt Power: **-9.4 to +2 dBm**

25G Rcv Power: **-12.7 to +2 dBm**

4x 25G

E/O

25.78GBd

NRZ λ λ λ λ

PSM4 MSA

Breakout Capable

100G-PSM4   100G-PSM4

100G-PSM4

25GBASE-LR
25GBASE-LR
25GBASE-LR
25GBASE-LR

Related Information