

Mellanox 交换机简明配置手册



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1. 交换机初始配置

交换机前面板：



交换机后面板：



1.1 Console 连接配置

使用 RS232 连接交换机的串口，X86 交换机（SX1410，SX1710，XN2100，SN2410，SN2700）连接速率 115200，PPC 交换机（SX1012，SX1024，SX1036，SX1016）连接速率 9600

默认用户名：admin

默认密码：admin

第一次进入交换机会进行配置向导，按照向导可以进行初始配置。如果希望手工配置，输入 N 退出即可。

1.2 自动向导配置

- 交换机名称
- 交换机是否在管理地址开启 DHCP 自动获取地址
- 交换机管理地址是否开启 IPv6
- 是否需要更改默认用户名 admin 的密码

```
...

Mellanox MLNX-OS Switch Management

Password:

Mellanox Switch

Mellanox configuration wizard

Do you want to use the wizard for initial configuration? y

Step 1: Hostname? [switch-5fa5a0] my-switch-hostname
Step 2: Use DHCP on mgmt0 interface? [yes]
Step 3: Enable IPv6? [yes] no
Step 4: Admin password (Enter to leave unchanged)?

You have entered the following information:

1. Hostname: my-switch-hostname
2. Use DHCP on mgmt0 interface: yes
3. Enable IPv6: no
4. Admin password (Enter to leave unchanged): (unchanged)

To change an answer, enter the step number to return to.
Otherwise hit <enter> to save changes and exit.

Choice:

Configuration changes saved.
```

1.3 手工配置管理网

- 进入配置模式
- 进入管理接口配置模式
- 关闭 DHCP 获取地址
- 手工配置 IP 地址
- 开启管理接口
- 配置管理接口路由

```

SX2700-1 [standalone: master] >
SX2700-1 [standalone: master] >
SX2700-1 [standalone: master] > en
SX2700-1 [standalone: master] # configure terminal
SX2700-1 [standalone: master] (config) # interface mgmt0
SX2700-1 [standalone: master] (config interface mgmt0) # no dhcp
SX2700-1 [standalone: master] (config interface mgmt0) # ip address 10.12.71.201
SX2700-1 [standalone: master] (config interface mgmt0) # ip address 10.12.71.201 /24
SX2700-1 [standalone: master] (config interface mgmt0) # no shutdown
SX2700-1 [standalone: master] (config interface mgmt0) # exit
SX2700-1 [standalone: master] (config) # ip route 0.0.0.0 0.0.0.0 10.12.71.1
SX2700-1 [standalone: master] (config) #

```

1.4 远程管理交换机

管理网接口配置完成后，交换机默认开始 SSH 远程管理方式。

默认用户名和密码与 Console 一致。

如需配置单独用户管理，可以使用以下命令：

```

SX2700-1 [standalone: master] (config) # username test capability admin
SX2700-1 [standalone: master] (config) # username test password test

```

如果需要打开 Telnet 管理，需要在配置界面开启如下命令：

```

SX2700-1 [standalone: master] (config) # telnet-server enable
SX2700-1 [standalone: master] (config) #

```

1.5 交换机操作系统升级

使用 web 页面升级操作系统。登录管理地址，输入用户名和密码。

选择“System”下的“MLNX-OS Upgrade”，并选择从本地升级。

将新版的操作系统上传到交换机，交换机进行自动解压缩升级。

待新系统更新后，重启交换机即可。

Mellanox MLNX-OS MSX1710 Management Console
Host: mti-mar-sx01 User: admin Logout

Standalone

Setup
 System
 Security
 Ports
 Status
 IB SM Mgmt
 Fabric Inspector
 ETH Mgmt
 IP Route
 Gateway
 Save

MLNX-OS Upgrade
Product Documents

Modules
Inventory
Power Management
MLNX-OS Upgrade
Reboot

Installed Images

Partition 1
SX_X86_64 SX_3.4.0012 2014-12-15 23:27:48 x86_64

Partition 2 - Active Image (partition of next boot)
X86_64 3.4.2002 2015-05-20 18:18:49 x86_64

Switch Next-Boot Partition

Next-Boot Options

☒ Fallback reboot

Apply changes

Install New Image to (non-active) Partition 1

☐ Install from URL:

☐ Install via scp or sftp pseudo-URL format:
{scp or sftp}://[username[:pw]@]hostname[:port]/path/image.img
SCP for USB format:
scp://admin@localhost/var/mnt/usb1/image.img

URL: admin

Password: ****

☒ Install from local file: Choose File image-X86_...4.2002.img
(Progress tracking begins after file is uploaded)

☐ Ignore image signature for upgrade

☒ View image upgrade progress

Image validation: Require signature and validate

Install Image

使用 CLI 升级操作系统。

进入配置模式后，可以通过以下命令查看当前交换机系统。

```

SX2700-1 [standalone: master] (config) # show images
Installed images:

  Partition 1:
  X86_64 3.6.2102 2016-11-14 19:13:14 x86_64

  Partition 2:
  X86_64 3.6.2100 2016-10-25 19:05:07 x86_64

Last boot partition: 1
Next boot partition: 1

Images available to be installed:

  webimage.tbz
  X86_64 3.6.2102 2016-11-14 19:13:14 x86_64

Serve image files via HTTP/HTTPS: no

No image install currently in progress.

Boot manager password is set.

Image signing: trusted signature always required
Admin require signed images: yes

Settings for next boot only:
  Fallback reboot on configuration failure: yes (default)
SX2700-1 [standalone: master] (config) #

```

通过以下命令使用 SCP 或其他方式将操作系统拷贝到交换机上，安装之后进行重启

```

switch (config)#image delete XXX // --> delete old images, if exist
switch (config)#image fetch scp://root:password@server/path-to-image/image-X86_64-3.4.2002.img
switch (config)#image install image-X86_64-3.4.2002.img
switch (config)#image boot next
switch (config)#configuration write
switch (config)#reload

```

配置参考 <https://community.mellanox.com/docs/DOC-1448>

2. 配置物理接口

2.1 查看接口和线缆状态

查看端口是否正常工作：

```
SX2700-1 [standalone: master] (config) # show interfaces ethernet 1/30

Eth1/30
  Admin state: Enabled
  Operational state: Up
  Last change in operational status: 17:49:15 ago (1 oper change)
  Boot delay time: 0 sec
  Description: N\A
  Mac address: 7c:fe:90:ea:78:1a
  MTU: 1500 bytes (Maximum packet size 1522 bytes)
  Fec: auto
  Flow-control: receive off send off
  Actual speed: 100 Gbps
  Width reduction mode: Not supported
  Switchport mode: trunk
  MAC learning mode: Enabled
  Last clearing of "show interface" counters : Never
  60 seconds ingress rate: 64 bits/sec, 8 bytes/sec, 1 packets/sec
  60 seconds egress rate: 16 bits/sec, 2 bytes/sec, 1 packets/sec

Rx
  2673          packets
  0             unicast packets
  2673          multicast packets
  0             broadcast packets
  416988        bytes
  0             error packets
  0             discard packets

Tx
  2136          packets
  0             unicast packets
  2136          multicast packets
  0             broadcast packets
  239232        bytes
  0             error packets
  0             discard packets

SX2700-1 [standalone: master] (config) #
```

查看线缆和模块信息：

```
SX2700-1 [standalone: master] (config) # show interfaces ethernet 1/30 transceiver
Port 1/30 state
    identifier           : QSFP+
    cable/ module type   : Passive copper cable
    ethernet speed and type: 100GBASE-CR4
    vendor               : Mellanox
    cable length         : 3m
    part number          : MCP1600-E003
    revision             : A2
    serial number        : MT1553VS13730
```

查看线缆 EEPROM RAW 信息:

```
SX2700-1 [standalone: master] (config) # show interfaces ethernet 1/30 transceiver raw
Port 1/30 raw transceiver data:

I2C Address 0x50, Page 0, 0:255:
0000 0d 05 06 00 00 00 00 00 00 00 00 00 00 00 00 .....
0010 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
0020 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
0030 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
0040 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
0050 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
0060 00 00 00 00 00 00 00 00 00 00 00 00 02 00 04 .....
0070 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
0080 0d 00 23 88 00 00 00 00 00 00 00 00 ff 00 00 ..#.....
0090 00 00 03 a0 4d 65 6c 6c 61 6e 6f 78 20 20 20 ....Mellanox
00a0 20 20 20 20 1f 00 02 c9 4d 43 50 31 36 30 30 ....MCP1600-
00b0 45 30 30 33 20 20 20 20 41 32 06 08 0a 10 00 E003 A2.....K
00c0 0b 00 00 00 4d 54 31 35 35 33 56 53 31 33 37 ....MT1553VS1373
00d0 30 20 20 20 31 36 30 31 31 31 20 20 00 00 67 0 160111 ..gR
00e0 31 32 38 38 35 31 36 43 4c 32 57 34 00 00 00 1288516CL2W4....
00f0 00 00 00 00 00 00 00 00 00 00 00 00 00 30 00

I2C Address 0x50, Pages 1, 128:255:
0080 0d 00 23 88 00 00 00 00 00 00 00 ff 00 00 ..#.....
0090 00 00 03 a0 4d 65 6c 6c 61 6e 6f 78 20 20 20 ....Mellanox
00a0 20 20 20 20 1f 00 02 c9 4d 43 50 31 36 30 30 ....MCP1600-
00b0 45 30 30 33 20 20 20 20 41 32 06 08 0a 10 00 E003 A2.....K
00c0 0b 00 00 00 4d 54 31 35 35 33 56 53 31 33 37 ....MT1553VS1373
00d0 30 20 20 20 31 36 30 31 31 31 20 20 00 00 67 0 160111 ..gR
00e0 31 32 38 38 35 31 36 43 4c 32 57 34 00 00 00 1288516CL2W4....
00f0 00 00 00 00 00 00 00 00 00 00 00 00 00 30 00

I2C Address 0x50, Pages 2, 128:255:
0080 0d 00 23 88 00 00 00 00 00 00 00 ff 00 00 ..#.....
0090 00 00 03 a0 4d 65 6c 6c 61 6e 6f 78 20 20 20 ....Mellanox
00a0 20 20 20 20 1f 00 02 c9 4d 43 50 31 36 30 30 ....MCP1600-
00b0 45 30 30 33 20 20 20 20 41 32 06 08 0a 10 00 E003 A2.....K
00c0 0b 00 00 00 4d 54 31 35 35 33 56 53 31 33 37 ....MT1553VS1373
00d0 30 20 20 20 31 36 30 31 31 31 20 20 00 00 67 0 160111 ..gR
00e0 31 32 38 38 35 31 36 43 4c 32 57 34 00 00 00 1288516CL2W4....
00f0 00 00 00 00 00 00 00 00 00 00 00 00 00 30 00

I2C Address 0x50, Pages 3, 128:255:
0080 0d 00 23 88 00 00 00 00 00 00 00 ff 00 00 ..#.....
0090 00 00 03 a0 4d 65 6c 6c 61 6e 6f 78 20 20 20 ....Mellanox
00a0 20 20 20 20 1f 00 02 c9 4d 43 50 31 36 30 30 ....MCP1600-
00b0 45 30 30 33 20 20 20 20 41 32 06 08 0a 10 00 E003 A2.....K
00c0 0b 00 00 00 4d 54 31 35 35 33 56 53 31 33 37 ....MT1553VS1373
00d0 30 20 20 20 31 36 30 31 31 31 20 20 00 00 67 0 160111 ..gR
00e0 31 32 38 38 35 31 36 43 4c 32 57 34 00 00 00 1288516CL2W4....
00f0 00 00 00 00 00 00 00 00 00 00 00 00 00 30 00
```

2.2 配置 1 分 4 接口



接口的 1 分 4 模式可以将 1 个 40G 接口配置为 4 个 10G 接口，或者将一个 100G 接口配置为 4 个 25G 接口。不同类型的交换机可以配置 1 分 4 的接口不同。具体：

SX1012 交换机所有接口都可以配置为 1 分 4 模式

SX1024 和 SX1410

7	10	13	16	19	22	25	28	31	34	37	40	43	46	49	51	53	55	57	59
8	11	14	17	20	23	26	29	32	35	38	41	44	47					×	
9	12	15	18	21	24	27	30	33	36	39	42	45	48					×	
														50	52	54	56	58	60

SX1036 和 SX1710

1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	
✗		███		███		✗	███		✗	███	███	✗	███		✗	███		
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
		███	✗		███		███			███	███	✗		███	✗	███	███	✗

SN2100 交换机所有接口都可以配置为 1 分 4 模式

SN2410



SN2700



配置方式:

- shutdown 接口
- 配置 1 分 4 模式即可

```
switch (config) # interface ethernet 1/4 shutdown
switch (config) # interface ethernet 1/4 module-type qsfp-split-4 force
```

端口恢复:

- shutdown 接口
- 配置为单一模式

```
switch (config) # interface ethernet 1/4/1 shutdown
switch (config) # interface ethernet 1/4/2 shutdown
switch (config) # interface ethernet 1/4/3 shutdown
switch (config) # interface ethernet 1/4/4 shutdown
switch (config) # interface ethernet 1/4/1 module-type qsfp force
the following interfaces are being unmapped: 1/4/1 1/4/2 1/4/3 1/4/4
switch (config) #
```

2.3 配置 1G 接口

使用 QSA 可以将一个 QSFP 接口转化为 SFP+接口，而后通过使用电口模块可以配置为 RJ45 千兆接口。

使用 QSA28 可以将一个 QSFP28 接口转化为 SFP28 接口。



配置方式如下：

```
switch (config) # interface ethernet 1/1 speed 1000  
switch (config) # configuration write
```

2.4 使用长距离 LR4 模块



40G 长距离模块 LR4 在 Mellanox 交换机上支持情况：

- SX1036 的 1,3,33,35 接口
- SX1024 的 50,52,54,56,58,60 接口
- SX1012 和 SX1710 的所有接口
- SN2700 的 1,2,3,29,31,32 接口

3. 二层交换配置

3.1 配置二层接口模式

交换机每一个端口可以配置为以下二层模式

- Access 模式：只接收没有 VLAN 标记的数据包，带有 VLAN 标记的数据包会被丢弃。接收到的数据包会自动标记为端口的 VLAN 信息。通常用于服务器和交换机之间的链接。
- Access-DCB：和 access 模式类似，但从该端口发出的流量会被标记为 VLAN ID=0
- Trunk 模式：接收和发送带有 VLAN 标记的数据包，没有 VLAN 标记的数据包将被丢弃。这个模式可以配置多个 VLAN ID。
- Hybrid 模式：带有 VLAN 标记和没有 VLAN 标记的数据包均可以被接收
- QinQ tunnel 模式：可以对带有 VLAN 标记的数据包再次进行 VLAN 标记

创建 VLAN

```
switch (config) # vlan 10
...
switch (config) # no vlan 10
```

```
switch (config) # vlan 100-200
```

配置端口为 Access 模式：

```
switch (config) # interface ethernet 1/1
switch (config interface ethernet 1/1 ) # switchport mode access
```

```
switch (config interface ethernet 1/1 ) # switchport access vlan 1
```

配置端口为 Trunk 模式：

```
switch (config) # interface ethernet 1/1
switch (config interface ethernet 1/1 ) # switchport mode trunk
```

```
switch (config interface ethernet 1/1 ) # switchport trunk allowed-vlan 100-200
```

配置端口为 Hybrid 模式：

```
switch (config) # interface ethernet 1/1
switch (config interface ethernet 1/1 ) # switchport mode hybrid
```

```
switch (config interface ethernet 1/1 ) # switchport hybrid allowed-vlan 100-200
```

```
switch (config interface ethernet 1/1 ) # switchport access vlan 1
```

验证配置：

```
switch (config) # show interfaces switchport
```

Interface	Mode	Access vlan	Allowed vlans
Eth1/1	hybrid	1	100
Eth1/2	hybrid	1	100
Eth1/3	access	1	
Eth1/4	access	1	
Eth1/5	trunk	N/A	1, 100
...			
Eth1/36	access	1	

```
# show vlan
```

VLAN	Name	Ports
1	default	Eth1/1, Eth1/2, Eth1/3, Eth1/4, Eth1/6, Eth1/7, Eth1/8, Eth1/9, Eth1/10, Eth1/11, Eth1/12, Eth1/13, Eth1/14, Eth1/15, Eth1/16, Eth1/17, Eth1/18, Eth1/19, Eth1/20, Eth1/21, Eth1/22, Eth1/23, Eth1/24, Eth1/25, Eth1/26, Eth1/27, Eth1/28, Eth1/29, Eth1/30, Eth1/31, Eth1/32, Eth1/33, Eth1/34, Eth1/35, Eth1/36
100		Eth1/1, Eth1/2, Eth1/5

配置参考 <https://community.mellanox.com/docs/DOC-2332>

3.2 配置生成树

Mellanox 交换机支持 RST, RPVST 和 MSTP 三种模式。默认为 RST 模式。

- 配置生成树模式为 MSTP

```
SX2700-1 [standalone: master] (config) # spanning-tree mode mst
SX2700-1 [standalone: master] (config) #
```

- 配置 MSTP 名称

```
SX2700-1 [standalone: master] (config) # spanning-tree mst name test
SX2700-1 [standalone: master] (config) #
```

- 配置 Reversion 信息

```
SX2700-1 [standalone: master] (config) # spanning-tree mst revision 1
SX2700-1 [standalone: master] (config) #
```

- 映射 VLAN 到 MSTP

```
SX2700-1 [standalone: master] (config) # spanning-tree mst 1 vlan 100
This may take a few minutes

SX2700-1 [standalone: master] (config) #
```

- 修改 MSTP 优先级

```
SX2700-1 [standalone: master] (config) # spanning-tree mst 1 root primary
SX2700-1 [standalone: master] (config) #
```

- 查看 MSTP 配置


```

SX2700-1 [standalone: master] (config) # show spanning-tree mst details
Global Configuration
Revision:1
Max-hops:20
Name:test

MST0
vlans mapped: 1-99,101-1023,1025-2047,2049-3071,3073-4094
Bridge
    address 7c:fe:90:ea:78:00
    priority 32768
Root
    address 7c:fe:90:ea:78:00
    priority 32768
Operational Hello time 2 , forward delay 15 , max-age 20
Configured Hello time 2 , forward delay 15 , max-age 20

L - Loop Inconsistent
R - Root Inconsistent
G - BPDU Guard Inconsistent

Interface      Role      Sts      Cost      Prio      Type
----
Eth1/30        Designated Forwarding 200        128.30    normal

MST1
vlans mapped: 100
Bridge
    address 7c:fe:90:ea:78:00
    priority 8192
Root
    address 7c:fe:90:ea:78:00
    priority 8192

L - Loop Inconsistent
R - Root Inconsistent
G - BPDU Guard Inconsistent

Interface      Role      Sts      Cost      Prio      Type
----
Eth1/30        Designated Forwarding 200        128.30    normal
SX2700-1 [standalone: master] (config) #

```

3.3 配置 LACP

- 开启 LACP

```
switch (config) # lacp
```

- 创建 LACP 接口

```

switch (config) # interface port-channel 1
switch (config interface port-channel 1) # exit
switch (config) #

```

- 划分物理接口到 LACP

```
switch (config) # interface ethernet 1/1
switch (config interface ethernet 1/1) # channel-group 1 mode active
switch (config) # interface ethernet 1/2
switch (config interface ethernet 1/2) # channel-group 1 mode passive
```

- 验证 LACP

```
switch (config) # show lacp interfaces ethernet 1/1
Port : 1/1
-----
```

```
Port State = Up
Channel Group : 1
Pseudo port-channel = Po1
LACP port-priority = 32768
LACP Rate = Slow
LACP Activity : Active
LACP Timeout : Short
```

```
Aggregation State : Aggregation, Defaulted,
```

Port	State	LACP Port Priority	Admin Key	Oper Key	Port Number	Port State
1/1	Up	32768	13826	13826	0x23	0x1

```
switch (config) #
```

- 验证 LACP 计数器

```
switch (config) # show lacp counters
```

LACPDUs Port	Marker		Marker Response		LACPDUs		Illegal	Unknown
	Sent	Recv	Sent	Recv	Sent	Recv		
Port-channel: 1								
1/1	0	0	0	0	5865	5864	0	0
1/2	0	0	0	0	5865	5864	0	0

配置参考 <https://community.mellanox.com/docs/DOC-2313>

4. 三层路由配置

4.1 配置三层路由接口

- 配置三层 VLAN 接口

```
switch (config) # interface vlan 1
switch (config) interface vlan 1 # ip address 11.11.11.5 /24
switch (config) interface vlan 1 # no shutdown
switch (config) interface vlan 1 # exit
```

- 配置物理接口为路由接口

```
SX2700-1 [standalone: master] (config) # interface ethernet 1/29
SX2700-1 [standalone: master] (config interface ethernet 1/29) # shut
SX2700-1 [standalone: master] (config interface ethernet 1/29) # no switchport
SX2700-1 [standalone: master] (config interface ethernet 1/29) # ip address 192.168.101.2 /24
SX2700-1 [standalone: master] (config interface ethernet 1/29) # no shut
SX2700-1 [standalone: master] (config interface ethernet 1/29) #
```

4.2 配置静态路由

可以通过以下方式配置静态路由和默认路由

```
SX2700-1 [standalone: master] (config) # ip route 192.168.200.0 255.255.255.0 192.168.100.1
SX2700-1 [standalone: master] (config) # ip route 192.168.210.0 /24 192.168.100.1
SX2700-1 [standalone: master] (config) #
```

4.3 配置 OSPF 路由协议

- 开启路由功能

```
switch (config)# ip routing
```

- 加载 OSPF 路由协议

```
switch (config)# protocol ospf
```

- 全局开启 OSPF 协议

```
switch (config)# router ospf
```

- 配置 router-id

```
switch (config router ospf)# router-id 10.10.10.10
```

- 在端口下使能 OSPF

```
switch (config interface vlan 10)# ip ospf area 0
switch (config interface vlan 10)# exit
switch (config)# interface vlan 20
switch (config interface vlan 20)# ip ospf area 0
```

- 修改 OSPF 端口类型

```
switch (config interface vlan 10)# ip ospf network point-to-point
```

- 查看 OSPF 运行状态

```
switch (config) # show ip ospf

Routing Process 1 with ID 10.10.10.10 vrf-default

Stateful High Availability disabled
Graceful-restart is not supported
Supports only single TOS (TOS 0) route
Opaque LSA not supported
OSPF Admin State is enabled
```

- 查看 OSPF 邻居状态

```
switch (config) # show ip ospf neighbors

Neighbor 10.10.10.1, interface address 10.10.10.2
In the area 0.0.0.0 via interface Vlan 10
Neighbor priority is 1, State is FULL
BDR is 10.10.10.1
Options 0
Dead timer due in 35

Neighbor 10.10.20.1, interface address 10.10.20.2
In the area 0.0.0.0 via interface Vlan 20
Neighbor priority is 1, State is FULL
BDR is 10.10.20.1
Options 0
Dead timer due in 35
```

- 查看 OSPF 接口状态

```

switch (config) # show ip ospf interface

Interface Vlan is 10 Enabled, line protocol is Down
IP address 10.10.10.2, Mask 255.255.0.0
Process ID 1 VRF Default, Area 0.0.0.0
OSPF Interface Admin State is enabled
State DOWN, Network Type BROADCAST, Cost 1
Transmit delay 1 sec, Router Priority 1
No designated router on this network
No backup designated router on this network
Timer intervals (sec's): Hello 10, Dead 40, Wait 40, Retransmit 5
No authentication
Number of opaque link LSAs: 0, checksum sum 0

Interface Vlan is 20 Enabled, line protocol is Up
IP address 10.10.20.2, Mask 255.255.0.0
Process ID 1 VRF Default, Area 0.0.0.0
OSPF Interface Admin State is enabled
State DESIGNATED ROUTER, Network Type BROADCAST, Cost 1
Transmit delay 1 sec, Router Priority 1
No designated router on this network
No backup designated router on this network
Timer intervals (sec's): Hello 10, Dead 40, Wait 40, Retransmit 5
No authentication
Number of opaque link LSAs: 0, checksum sum 0

```

配置参考 <https://community.mellanox.com/docs/DOC-1452>

4.4 配置 BGP 路由协议

- 加载 BGP 路由协议

```
switch (config)# protocol bgp
```

- 全局配置 BGP

```

switch (config) # router bgp 100
switch (config router bgp 100) #

```

- 配置 BGP 邻居

```
switch (config router bgp 100)# neighbor 10.10.10.2 remote-as 100
```

- 通告网络进入 BGP

```
switch (config router bgp 100) # network 12.12.5.0 /24
```

- 查看 BGP 状态

```

switch (config)# show ip bgp summary
BGP router identifier 10.10.10.1, local AS number 100
BGP table version is 100, main routing table version 100
0 network entries using 0 bytes of memory
0 path entries using 0 bytes of memory
0 BGP AS-PATH entries using 0 bytes of memory
0 BGP community entries using 0 bytes of memory
0 BGP extended community entries using 0 bytes of memory
Neighbor      V      AS MsgRcvd MsgSent  TblVer  InQ OutQ Up/Down    State/PfxRcd
10.10.10.2    0      100    100    76      3    0    0 00:0:10:19 ESTABLISHED
switch (config)#
BGP summary information for VRF default, address family IPv4

```

- 查看 BGP 邻居

```

switch (config)# show ip bgp neighbors
BGP neighbor is 10.10.10.2, remote AS 100, external link
  BGP version 0, remote router ID 0.0.0.0
  BGP State = ESTABLISHED
    Last read 0:00:00:00, last write 0:00:00:00, hold time is 180, keepalive
interval is 60 seconds
    Configured hold time is 180, keepalive interval is 60 seconds
    Minimum holdtime from neighbor is 0 seconds
switch (config)#

```

配置参考 <https://community.mellanox.com/docs/DOC-1830>

配置参考 <https://community.mellanox.com/docs/DOC-1851>

5. Spectrum 交换机 QoS 配置

5.1 QoS 分类配置

Spectrum 交换机支持多种 QoS 的分类配置。支持基于端口，二层 CoS 和三层 DSCP 的数据包分类。

- 信任端口配置：交换机使用默认的接口设定，所有数据包都默认映射到同一个交换机优先级（switch priority）
- 信任二层配置：交换机信任数据包头中所携带的二层 PCP 或 DEI 信息，并映射到对应的交换机优先级。如果没有二层 PCP 信息，则使用默认的端口映射。
- 信任三层配置：交换机信任数据包头中所携带的三层 DSCP 信息，并映射到对应的交换机优先级。如果没有三层 DSCP 信息，则使用默认的端口映射。
- 信任二层和三层配置：首选 DSCP 映射到交换机优先级，其次使用 PCP 和 DEI 映射，最后使用默认接口映射

Ethernet Header	IP Header	Trust Port	Trust L2	Trust L3	Trust Both
Vlan Tag	Yes	Port default	PCP/DEI	DSCP	DSCP
Untagged	Yes	Port default	Port default	DSCP	DSCP
Vlan Tag	No	Port default	PCP/DEI	Port default	PCP/DEI
Untagged	No	Port default	Port default	Port default	Port default

- 配置映射

```
switch (config) # qos trust [port | L2 | L3 | both]
```

- 配置端口映射

```
switch (config) # interface ethernet 1/1 qos default switch-priority <0-7>
```

- 配置基于二层的映射

```
switch (config) # interface ethernet 1/1 qos map pcp <0-7> dei <dei> to switch-priority <0-7>
```

- 配置基于三层的映射

```
switch (config) # interface ethernet 1/1 qos map dscp <0-63> to switch-priority <0-7>
```

- 验证

```
switch (config) # show qos interface ethernet 1/1
Eth1/1
Trust mode: L2
Default switch-priority: 0
Default PCP: 0
Default DEI: 0
PCP,DEI rewrite: disabled
IP PCP,DEI rewrite: enable
DSCP rewrite: disabled
```

配置参考 <https://community.mellanox.com/docs/DOC-2468>

5.2 配置 PFC

- 配置连接服务器的端口为 Trunk 模式

```
switch (config) # vlan 100
switch (config vlan 100) # exit
switch (config) # interface ethernet 1/1 switchport mode trunk
switch (config) # interface ethernet 1/2 switchport mode trunk
```

- 关闭全局的 flow control

```
switch (config) # interface ethernet 1/1-1/2 flowcontrol send off force
switch (config) # interface ethernet 1/1-1/2 flowcontrol receive off force
```

- 全局开启 PFC，并在对应的优先级上使能

```
switch (config) # dcb priority-flow-control enable
This action might cause traffic loss while shutting down a port with priority-flow-control mode on
Type 'yes' to confirm enable pfc globally: yes
switch (config) # dcb priority-flow-control priority 4 enable
switch (config) # interface ethernet 1/1 dcb priority-flow-control mode on force
switch (config) # interface ethernet 1/2 dcb priority-flow-control mode on force
```

- 调整端口入向缓存用于一般流量

```
switch (config)# interface ethernet 1/1 ingress-buffer iPort.pg0 map pool ipool0 type lossy reserved 20K shared alpha 8
```

- 调整端口入向和出向缓存保证高优先级流量

```
switch (config)# interface ethernet 1/1 ingress-buffer iPort.pg4 map pool iPool0 type lossless reserved 70K xoff 17K xon 17K shared alpha 2
switch (config)# interface ethernet 1/1 egress-buffer ePort.tc4 map pool ePool0 reserved 1500 shared alpha inf
```

- 绑定优先级到缓存

```
switch (config)# interface ethernet 1/1 ingress-buffer iport.pg4 bind switch-priority 4
```

- 查看端口 PFC 开启情况


```

switch (config)# show dcb priority-flow-control
PFC enabled
Priority Enabled List   :4
Priority Disabled List  0 1 2 4 5 6 7

Interface      PFC admin      PFC oper
-----
...
1/1            On            Enabled
1/2            On            Enabled

```

- 查看端口缓存设定

```

switch (config) # show buffers details interfaces ethernet 1/1
Flags: Y - Lossy, L - Lossless
      S - Static, D - Dynamic
Shared size is in Bytes for static pool and in alphas for dynamic pool.

Interface: Eth1/1

  Buffer      Resv    Xoff    Xon    Shared  Pool      Description
         [Byte] [Byte] [Byte] [%/a]
  -----
iPort(Y)      0      -      -      inf    iPool0(D)
iPort(Y)      0      -      -      0      iPool1(D)
iPort(Y)      0      -      -      0      iPool2(D)
iPort(Y)      0      -      -      0      iPool3(D)
iPort.pg0(Y) 20.0K  -      -      inf    iPool0(D)  Data    --> Lossy
iPort.pg1(Y) 0      -      -      0      iPool0(D)
iPort.pg2(Y) 0      -      -      0      iPool0(D)
iPort.pg3(Y) 0      -      -      0      iPool0(D)
iPort.pg4(L) 70K   16.7K  16.7K  2      iPool0(D)    --> Lossless
iPort.pg5(Y) 0      -      -      0      iPool0(D)
iPort.pg6(Y) 0      -      -      0      iPool0(D)
iPort.pg7(Y) 0      -      -      0      iPool0(D)
iPort.pg9(Y) 20.0K  -      -      inf    iPool0(D)  Control
ePort        0      -      -      inf    ePool0(D)
ePort        0      -      -      inf    ePool1(D)
ePort        0      -      -      inf    ePool2(D)
ePort        0      -      -      inf    ePool3(D)
ePort.tc0    1.5K  -      -      2      ePool0(D)
ePort.tc1    1.5K  -      -      2      ePool0(D)
ePort.tc2    1.5K  -      -      2      ePool0(D)
ePort.tc3    1.5K  -      -      2      ePool0(D)
ePort.tc4    1.5K  -      -      inf    ePool0(D)    --> Lossless
ePort.tc5    1.5K  -      -      2      ePool0(D)
ePort.tc6    1.5K  -      -      2      ePool0(D)
ePort.tc7    1.5K  -      -      2      ePool0(D)
ePort.tc16   96     -      -      inf    ePool0(D)  Control

Switch-priority  Buffer
-----
0                iPort.pg0
1                iPort.pg0
2                iPort.pg0
3                iPort.pg0
4                iPort.pg4
5                iPort.pg0
6                iPort.pg0

```

配置参考 <https://community.mellanox.com/docs/DOC-2483>

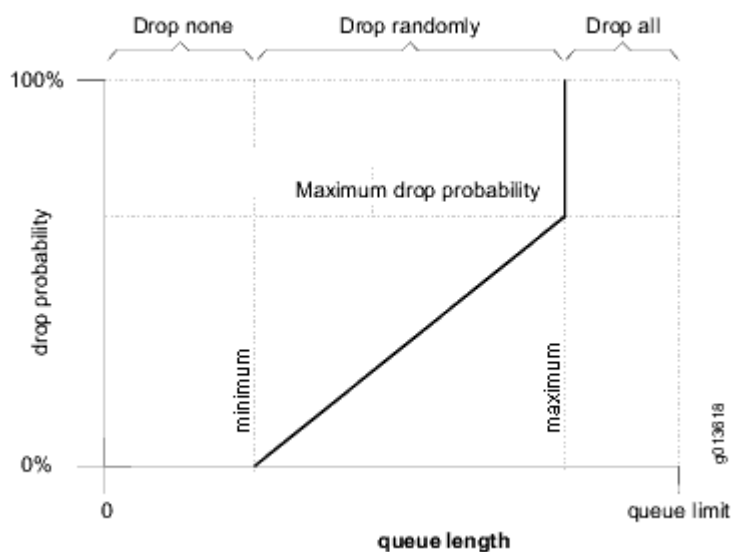
配置参考 <https://community.mellanox.com/docs/DOC-2673>

5.3 配置 ECN

Spectrum 交换机同时支持 RED 和 ECN 配置。

可以针对不同的出口队列 TC 设定不同的阈值。将不同优先级的数据映射到不同的 TC。

阈值支持相对值（Relative）和绝对值（Absolute）两种设定。其中相对值可以设定为可用缓存的百分比%，绝对值可以设定为可用缓存大小值 KB。



在最小值以下的数据包将不会被 ECN 标记，在最大值以上的数据包会全部被 ECN 标记。在二者之间时标记概率线性增加。

- 配置出接口 ECN 的绝对阈值

```
switch (config interface ethernet 1/1) # traffic-class 0 congestion-control ecn minimum-absolute 150K maximum-absolute 1500K
```

- 查看配置

```

switch (config interface ethernet 1/1) # show interfaces ethernet 1/1 congestion-control
Interface ethernet: 1/1

ECN marked packets: 0
TC-0
    Mode: ECN
    Threshold mode: absolute
    Minimum threshold: 150 KB
    Maximum threshold: 1500 KB
    RED dropped packets: 0
TC-1
    Mode: none
TC-2
    Mode: none
TC-3
    Mode: none
TC-4
    Mode: none
TC-5
    Mode: none
TC-6
    Mode: none
TC-7
    Mode: none

```

配置参考 <https://community.mellanox.com/docs/DOC-2500>

配置参考 <https://community.mellanox.com/docs/DOC-2566>

5.4 配置 ETS

Spectrum 交换机的出向队列调度支持轮询调度 WRR 和优先级调度 SP 两种模式。每个端口出方向均有 8 个队列，可以配置为 WRR 和 SP 调度。

- 查看默认端口的调度方式。所有的 8 个队列采用默认的 WRR 调度，每个端口的带宽平均分配

```

switch (config) # show dcb ets interface ethernet 1/1
Eth1/1
Interface Bandwidth Shape [Mbps]: N/A
Multicast unaware mapping : disabled

ETS per TC :
TC Scheduling Mode Weight Weight (%)
-- -----
0 WRR 12 12
1 WRR 13 13
2 WRR 12 12
3 WRR 13 13
4 WRR 12 12
5 WRR 13 13
6 WRR 12 12
7 WRR 13 13

```

- 调整高优先级别 6 采用 SP 调度

```
switch (config) # interface ethernet 1/1 traffic-class 6 dcb ets strict
```

- 优先级 0 和 3 按照一定 40%和 60%带宽比例调度

```

switch (config) # interface ethernet 1/1 traffic-class 0 dcb ets wrr 40
switch (config) # interface ethernet 1/1 traffic-class 3 dcb ets wrr 60

```

- 其余优先级不分配带宽

```

switch (config) # interface ethernet 1/1 traffic-class 1 dcb ets wrr 0
switch (config) # interface ethernet 1/1 traffic-class 2 dcb ets wrr 0
switch (config) # interface ethernet 1/1 traffic-class 4 dcb ets wrr 0
switch (config) # interface ethernet 1/1 traffic-class 5 dcb ets wrr 0
switch (config) # interface ethernet 1/1 traffic-class 7 dcb ets wrr 0

```

- 查看结果

```

switch (config) # show dcb ets interface ethernet 1/1
Eth1/1
Interface Bandwidth Shape [Mbps]: N/A
Multicast unaware mapping : disabled

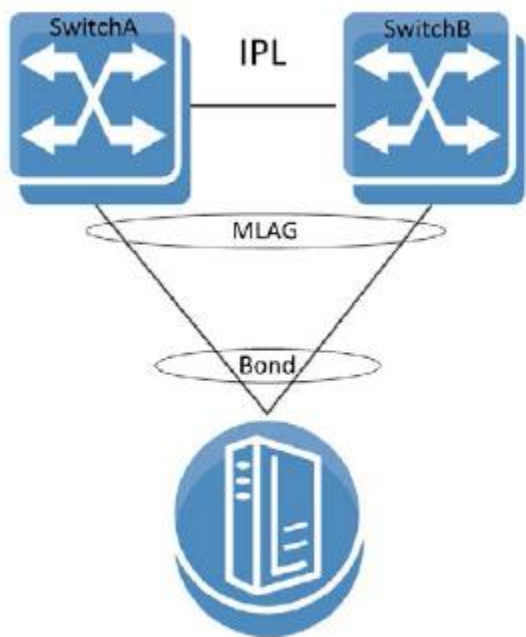
ETS per TC :
TC Scheduling Mode Weight Weight (%)
-- -----
0 WRR                40    40
1 WRR                0     0
2 WRR                0     0
3 WRR                60    60
4 WRR                0     0
5 WRR                0     0
6 Strict             0     0
7 WRR                0     0

```

配置参考 <https://community.mellanox.com/docs/DOC-2635>

6. 虚拟化 MLAG 配置

6.1 MLAG 介绍



MLAG 是跨机箱链路捆绑的缩写。MLAG 将两台交换机虚拟为一台设备，对外提供高可靠冗余连接。

两台交换机之间采用 IPL 互联，提供两台设备之间的信息同步（如 MAC 地址同步，IGMP 同步等），并进行 keepalive 检测。IPL 链路上必须启用流量控制，从而确保在流量拥塞情况下，控制流量不会被丢弃。

两台交换机组成 MLAG Cluster，并属于同一个 MLAG Domain。两台交换机使用管理接口互联，作为 IPL 链路的备份。

V-SID 是虚拟系统的 ID 标识，用于发送 LACP PDU 使用。在 MLAG Domain 中，两台交换机使用相同的 V-SID，使得连接到 MLAG Domain 中的设备认为其连接到一台设备。

MLAG 接口是对于跨机箱链路接口的标识。

6.2 MLAG 配置

- MLAG 配置准备。在 MLAG 配置之前，需要开启 LACP 和 MLAG 协议，关闭生成树协议，开启 QoS 并打开 IP 路由

```

sx01 (config) # lacp
sx01 (config) # no spanning-tree
sx01 (config) # ip routing
sx01 (config) # protocol mlag
sx01 (config) # dcb priority-flow-control enable force

```

- 配置 IPL 链路。IPL 链路必须为两个或多个物理接口进行绑定，从而提供冗余性。并且需要开启 QoS。IPL 链路为三层链路，需要在每台设备上配置三层 IP 地址。

```

sx01 (config) # interface port-channel 1
sx01 (config interface port-channel 1 ) # exit
sx01 (config) # interface ethernet 1/35 channel-group 1 mode active
sx01 (config) # interface ethernet 1/36 channel-group 1 mode active
sx01 (config) # vlan 4000
sx01 (config vlan 4000) # exit
sx01 (config) # interface vlan 4000
sx01 (config interface vlan 4000 ) # exit
sx01 (config) # interface port-channel 1 ipl 1
sx01 (config) # interface port-channel 1 dcb priority-flow-control mode on force

```

- 在两台设备上应分别配置 IPL 的三层地址，并互相指定对方为邻居。

```

sx01 (config) # interface vlan 4000
sx01 (config interface vlan 4000) # ip address 10.10.10.1 255.255.255.0
sx01 (config interface vlan 4000) # ipl 1 peer-address 10.10.10.2

```

- 配置 MLAG-VIP。MLAG 使用管理网进行交换机之间的 Keepalive 信息传递。MLAG-VIP 是两台设备共同虚拟出的 IP 地址，用于标识整个 MLAG Domain 信息。这个地址必须和管理网 IP 地址在同一网段，并且不同的 MLAG Domain 之间不能重复。

```

sx01 (config)# mlag-vip my-mlag-vip-domain ip 10.209.28.200 /24 force

```

- 全局开启 MLAG

```

switch config) # no mlag shutdown

```

- 配置 MLAG 接口

```

sx01 (config) # interface mlag-port-channel 1-2
sx01 (config interface port-channel 1-2 ) # exit

```

- 划分物理接口到 MLAG

```

sx01 (config) # interface ethernet 1/1 mlag-channel-group 1 mode on
sx01 (config) # interface ethernet 1/2 mlag-channel-group 2 mode on

```

- 线路检查无误之后，开启 MLAG 接口

```

sx01 (config) # interface mlag-port-channel 1-2 no shutdown

```

- 检查 MLAG 配置。MLAG 状态为 UP。对端交换机状态应该为 UP。


```

sx01 [my-mlag-vip-domain: master] (config) # show mlag
Admin status: Enabled
Operational status: Up
Reload-delay: 30 sec
Keepalive-interval: 1 sec
System-id: F4:52:14:11:E5:38
MLAG Ports Configuration Summary:
Configured: 2
Disabled: 0
Enabled: 2

MLAG Ports Status Summary:
Inactive: 0
Active-partial: 0
Active-full: 2

MLAG IPLs Summary:
ID   Group          Vlan      Operational  Local      Peer
    Port-Channel Interface State      IP address  IP address
-----
1    Po1            4000      Up           10.10.10.1  10.10.10.2
sx01 [my-mlag-vip-domain: master] (config) #

```

- 查看 MLAG Domain。所有 MLAG 信息一致，VIP 状态为 Master 和 Standby。

```

sx01 [my-mlag-vip-domain: master] (config) # show mlag-vip
MLAG VIP
=====
MLAG group name: my-mlag-vip-domain
MLAG VIP address: 10.209.28.200/24
Active nodes: 2
Hostname          VIP-State      IP Address
-----
sx01              master         10.209.28.50
sx02              standby        10.209.28.51

```

- 查看 MLAG 接口。所有 MPO 为 U 状态，所有物理接口为 P 状态。

```

sx01 [my-mlag-vip-domain: master] (config) # show interfaces mlag-port-channel summary
MLAG Port-Channel Flags: D-Down, U-Up
                        P-Partial UP, S - suspended by MLAG
Port Flags: D - Down, P - Up in port-channel (members)
            S - Suspend in port-channel (members), I - Individual

```

Group			
Port-Channel	Type	Local Ports	Peer Ports
(D/U/P/S)		(D/P/S/I)	(D/P/S/I)

1 Mpo1(U)	Static	Eth1/1(P)	Eth1/1(P)
2 Mpo2(U)	Static	Eth1/2(P)	Eth1/2(P)

6.3 MLAG 升级

在同一个 MLAG Domain 中的交换机必须具有同样版本的操作系统。

当进行升级操作时，应先从 Slave 交换机进行升级，系统默认支持 60 分钟版本不一致时间。在这个时间内，系统不会 shutdown MLAG 接口。这个时间可以通过 `upgrade-timeout` 修改。

Slave 升级完成后，进行 Master 升级。

配置参考 <https://community.mellanox.com/docs/DOC-1434>

配置参考 <https://community.mellanox.com/docs/DOC-2262>

配置参考 <https://community.mellanox.com/docs/DOC-2564>

配置参考 <https://community.mellanox.com/docs/DOC-2643>

7. 冗余网关配置

7.1 VRRP 配置

- 开启全局 VRRP

```
switch (config) # ip routing
switch (config) # protocol vrrp
```

- 配置物理接口

```
switch (config) # interface vlan 1

//Configure on SX01
switch (config interface vlan 1) # ip address 11.11.1.101 /24

//Configure on SX02
switch (config interface vlan 1) # ip address 11.11.1.102 /24
```

- 配置 VRRP 接口

```
switch (config) # interface vlan 1 vrrp 100
switch (config interface vlan 1 vrrp 100) # address 11.11.1.100
```

- 验证 VRRP 配置

```
sx02 (config) # show vrrp
```

Interface	VR	Admin State	Priority	Adv-Intvl	Preempt	State	VR IP addr
Vlan1	100	Enabled	100	1	Enabled	Master	11.11.1.100

```
sx01 (config) # show vrrp
```

Interface	VR	Admin State	Priority	Adv-Intvl	Preempt	State	VR IP addr
Vlan1	100	Enabled	100	1	Enabled	Backup	11.11.1.100

7.2 MAGP 配置

MAGP 是双活网关协议的简称，在原有 VRRP 的基础上，支持两台网关设备同时转发数据，可以配合 MLAG 实现双活网关转发。

- 开启两端设备 VLAN 的三层物理接口

```
switch sx01 (config interface vlan 1) # ip address 11.11.11.11 /24
```

```
switch sx02 (config interface vlan 1) # ip address 11.11.11.12 /24
```

- 开启 MAGP 协议

```
switch (config) # protocol magp
```

- 配置 VLAN 虚拟 IP 和 MAC

```
switch (config) # protocol magp
switch (config) # interface vlan 1 magp 1
switch (config interface vlan 1 magp 1) # ip virtual-router address 11.11.11.254
switch (config interface vlan 1 magp 1) # ip virtual-router mac-address 00:00:5E:00:01:01
```

- 检查 MAGP 配置

```
switch (config)# show magp 1
MAGP 1
    Interface vlan:1
    MAGP state:Master
    MAGP virtual IP:11.11.11.254
    MAGP virtual MAC:00:00:5E:00:01:01
switch (config)#
```

配置参考 <https://community.mellanox.com/docs/DOC-1442>

配置参考 <https://community.mellanox.com/docs/DOC-2137>

8. 网络交换机运维

8.1 配置 SNMP

- 配置 SNMP

```
switch (config) # snmp-server enable
switch (config) # snmp-server enable notify
switch (config) # snmp-server community public ro
switch (config) # snmp-server contact "contact name"
switch (config) # snmp-server host <host IP address> traps version 2c public
switch (config) # snmp-server location "location name"
switch (config) # snmp-server user admin v3 enable
switch (config) # snmp-server user admin v3 prompt auth md5 priv des
```

- 配置 SNMPv3 用户

```
switch (config) # snmp-server user admin v3 prompt auth md5 priv des
Auth password: *****
Confirm: *****
Privacy password: *****
Confirm: *****
switch (config) #
```

- 配置 SNMP notification

```
switch (config) # snmp-server enable
switch (config) # snmp-server enable notify
switch (config) #

switch (config) # snmp-server host 10.134.47.3 traps version 3 user my-username auth sha
my-password
switch (config) #
```

- 检查 SNMP 配置

```
switch (config) # show snmp host
Notifications enabled:      yes
Default notification community: public
Default notification port:  162

Notification sinks:

  10.134.47.3
    Enabled:      yes
    Port:         162 (default)
    Notification type:  SNMP v3 trap
    Username:      my-username
    Authentication type: sha
    Privacy type:   aes-128
    Authentication password: (set)
    Privacy password:  (set)

switch (config) #
```

配置参考 <https://community.mellanox.com/docs/DOC-1525>

8.2 配置 NTP

- 全局开启 NTP

```
switch (config) # ntp enable
```

- 检查和 NTP 服务器连接

```
switch (config) # ntpdate 10.4.0.134
28 Jul 19:59:19 ntpdate[16180]: step time server 10.4.0.134 offset 1842248.046711 sec
```

- 配置 NTP 服务器

```
switch (config) # ntp server 10.4.0.134
switch (config) # show ntp
NTP is administratively enabled.
Clock is unsynchronized.
Active servers and peers:
```

Address	Conf Type	Status	Stratum	Offset (msec)	Ref Clock	Poll Interv (sec)	Last Resp (sec)
10.4.0.134	serv	pending	3	-0.789	192.114.62.250	64	2

- 检查 NTP 状态

```
mti-mar-sx01 [standalone: master] (config) # show ntp
NTP is administratively enabled.
Clock is synchronized. Reference: 10.4.0.134. Offset: 10.039 ms.
Active servers and peers:
```

Address	Conf Type	Status	Stratum	Offset (msec)	Ref Clock	Poll Interv (sec)	Last Resp (sec)
10.4.0.134	serv	sys.peer (*)	3	10.039	192.114.62.250	128	45

- 设定 timezone

```
switch (config) # clock timezone UTC-offset UTC-7
```

配置参考 <https://community.mellanox.com/docs/DOC-2252>

8.3 配置 Syslog

- 配置 syslog 服务器地址

```
switch (config) # logging <IP address> port <port>
```

- 配置 syslog 级别

```
switch (config) # logging <IP address> trap info
```

8.4 配置端口镜像

- 关闭镜像目的端口

- 设定端口镜像会话
- 增加镜像源端口和目的端口
- 使能端口镜像

```
switch (config) # interface ethernet 1/3 shutdown
switch (config) # monitor session 1
switch (config monitor session 1) # add source interface ethernet 1/1 direction both
switch (config monitor session 1) # destination interface ethernet 1/3
switch (config monitor session 1) # no shutdown
switch (config monitor session 1) # exit
switch (config) # interface ethernet 1/3 no shutdown
```

- 查看配置

```
switch (config) # show monitor session 1
Admin: Enable
Status: Up
Truncate: Disable
Destination interface: eth1/3
Congestion type: drop-excessive-frames
Header format: local
                -traffic class: 0

Source interfaces
Interface direction
-----
eth1/1    both
```

配置参考 <https://community.mellanox.com/docs/DOC-2153>

8.5 查看 CPU 使用率

- 通过命令行查看 CPU 使用效率

```

switch (config) # show resources

Total      Used      Free
Physical  2027 MB    584 MB    1443 MB
Swap       0 MB       0 MB      0 MB

Number of CPUs:    1
CPU load averages: 3.49 / 3.39 / 3.19

CPU 1
  Utilization:          18%
  Peak Utilization Last Hour: 20% at 2012/08/27 10:02:33
  Avg. Utilization Last Hour: 18%
switch (config)#

```

- 通过 SNMP 查看
OID is 1.3.6.1.2.1.25.3.3.1.2

配置参考 <https://community.mellanox.com/docs/DOC-1402>

8.6 生成 SYSTEM DUMP

- 生成系统 DUMP 文件

```

switch (config) # debug generate dump
Generated dump sysdump-switch-20160408-144821.tgz

```

- 上传 DUMP 文件

```

switch (config) # file debug-dump upload latest scp://root:password@10.10.10.10/root
Uploading file sysdump-switch-20160408-144821.tgz

```

配置参考 <https://community.mellanox.com/docs/DOC-2642>