L2 Switching

Software Enabled Transformation

Table of Content

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Switching cards

Cards	Eth Ports	VCG Ports	Uplink	Product Supported
CEF1	4FE + 2GE	16 VCGs	STM-8	TJ14XX
CEF3	4x10GE + 12GE	32 VCGs	20G	TJ16XX
CEF4	2x1GE + 2x10GE	16 VCGs	STM-8	TJ14XX
CEF5	8x10GE / (6x10GE + 12GE)	32 VCGs	20G	TJ16XX
CEF7G	4GE	-	-	TJ14XX (GPON)
CEF1-9P	4FE + 4FX + 1GE	16 VCGs	2G	TJ14XX (MADM)

ELAN Features

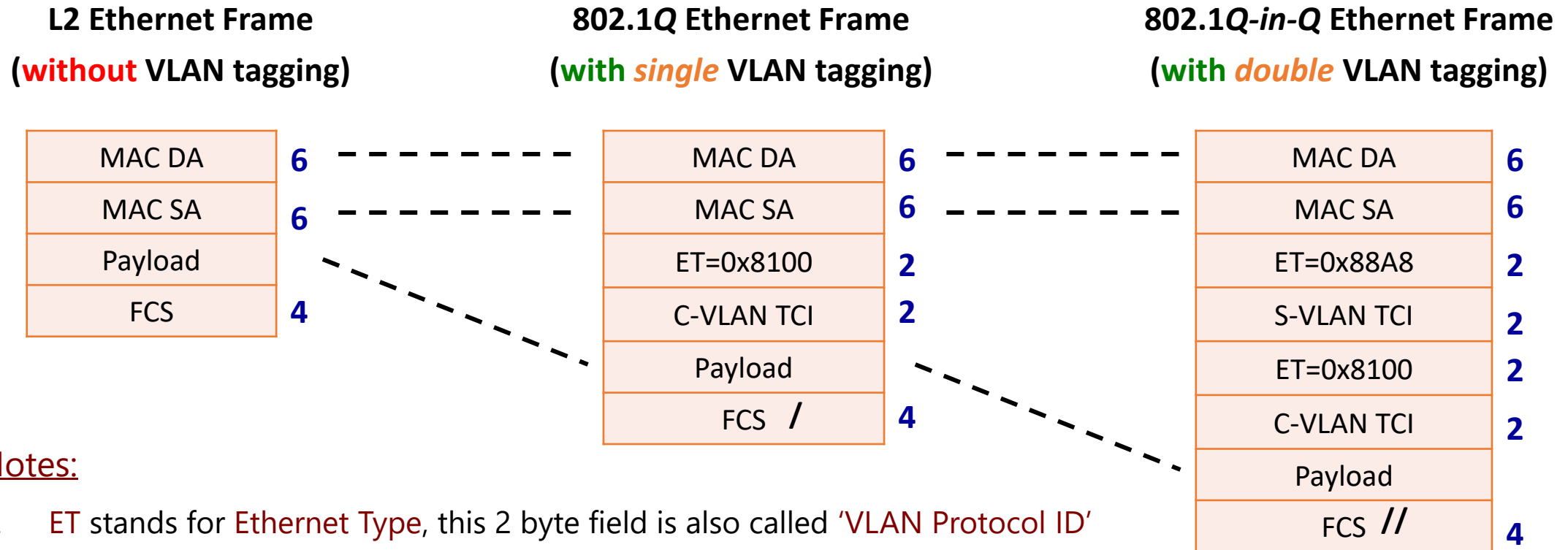| Ingress	Switching	Egress
VLAN Tagging / Untagging Acceptable Frame Type Port VLAN ID (PVID) Ingress VLAN Filtering	VLAN table	Tagging/ Un-tagging (only in .Q mode)
Dynamic MAC Learning	Static Unicast Table Static Multicast Table Dynamic Unicast Table Ageing Time	
	Port Mirroring	
	STP, RSTP, MSTP	STP, RSTP, MSTP
Access Control Lists (ACL)		
Link Aggregation Group (LAG) B-cast/M-cast/DLF storm control Port rate limiting		Egress Rate Limiting Link Aggregation Group (LAG)
Ingress Rate Limiting Port Priority Bandwidth Profiling Diffserv classification and policies Trust mode Configuration		CoS queue templates Traffic Scheduling

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Virtual LAN-Advantages

- Increase performance

- Form virtual work groups

- Easy Network Administration

- Enhance network security

- Reduce cost

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Service based switching

L2 Ethernet Frame
(without VLAN tagging)

MAC DA	6
MAC SA	6
Payload	
FCS	4

802.1*Q* Ethernet Frame
(with *single* VLAN tagging)

MAC DA	6
MAC SA	6
ET=0x8100	2
C-VLAN TCI	2
Payload	
FCS /	4

802.1*Q-in-Q* Ethernet Frame
(with *double* VLAN tagging)

MAC DA	6
MAC SA	6
ET=0x88A8	2
S-VLAN TCI	2
ET=0x8100	2
C-VLAN TCI	2
Payload	
FCS //	4

Notes:

1. ET stands for Ethernet Type, this 2 byte field is also called 'VLAN Protocol ID'

   This field when present, indicates that the frame is VLAN tagged and that the next 2 bytes in the frame contain 'Tag Control Information' (TCI)
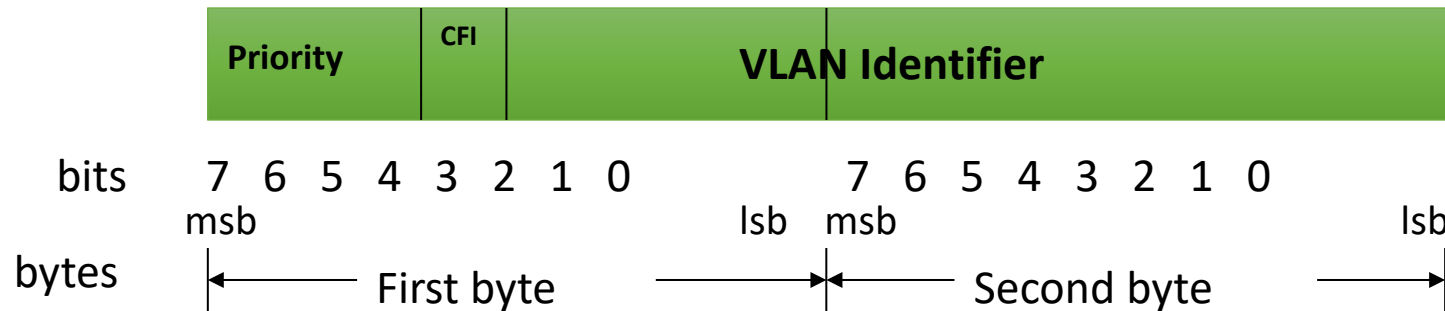
   Hex value of 8100 indicates that the next 2 bytes contain C-VLAN TCI
   Hex value of 88A8 indicates that the next 2 bytes contain S-VLAN TCI

2.   C-VLAN stands for Customer VLAN, S-VLAN stands for Service Provider VLAN

3.   In each VLAN Tag Control Information of 2 bytes,

Priority	CFI	VLAN Identifier

bits   7 6 5 4 3 2 1 0   7 6 5 4 3 2 1 0

       msb   lsb   msb   lsb

bytes |←———— First byte ————→|←———— Second byte ————→|

12 bits are for VLAN Tag (possible no.s 1 to 4094)   **

     **
Tag 0 is used to indicate NO VLAN tagging WITH priority tagging, Tag 4095 unused.

               1 bit is for Canonical Form Indicator (CFI), CFI=0 for Ethernet

     and 3 bits are for Priority Tag (possible no.s 0 to 7, with 7 is higher priority)

4.   MAC DA, SA, and the Payload areas remain the same in all three frame format.

5.   FCS keeps on changing as Frame Check Sequence is calculated on more and more bytes.

6.   Usage of VLAN Tag and Priority Tag will be described later.

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Acceptable Frame Type

- ➤ **_Either_** **'Admit All'** (**default**)

  _Or_ **'Admit Only VLAN Tagged'**

- ➤ User-configurable per-port basis, i.e., individually for each Eth / VCG port

- ➤ **_If_** 'Admit Only VLAN Tagged',

  then any untagged traffic coming to the Eth / VCG port

    will be dropped without being admitted into the switch.

  *   Unless specifically mentioned, Switching parameters for an Eth port or a VCG port will behave similarly.

Port VLAN ID (PVID)

➢ User can assign any no. between 1 and 4094 as PVID

  of any Eth / VCG port on per-port basis (default is 1).

➢ In **.Q** mode

  ▪ **If** Ingress traffic is Tagged **then** PVID is not used

  ▪ **If** ((Ingress traffic is Untagged) & (Acceptable frame type is 'Admit all'))

    then the traffic is C-VLAN-tagged by the PVID of the Ingress port

➢ In **Q-in-Q** (also called VLAN stacking) mode

  ▪ **Irrespective** of whether the Ingress traffic is C-VLAN tagged or not,

    the traffic is S-VLAN-tagged by the PVID of the Ingress port

    Ex: Eth 5 of an CEF card is the Ingress port, getting customer traffic with C-VLAN tag of 200 and the PVID of Eth 5 is 300. The number 300 will be unused in .Q mode, whereas in Q-in-Q mode the traffic will get S-VLAN tagged by 300.

Forwarding

➢ Once a traffic approaches the ingress port, forwarding of that traffic to the next egress port happens based on port mode and the forwarding type selected. There are 2 types of forwarding, namely:
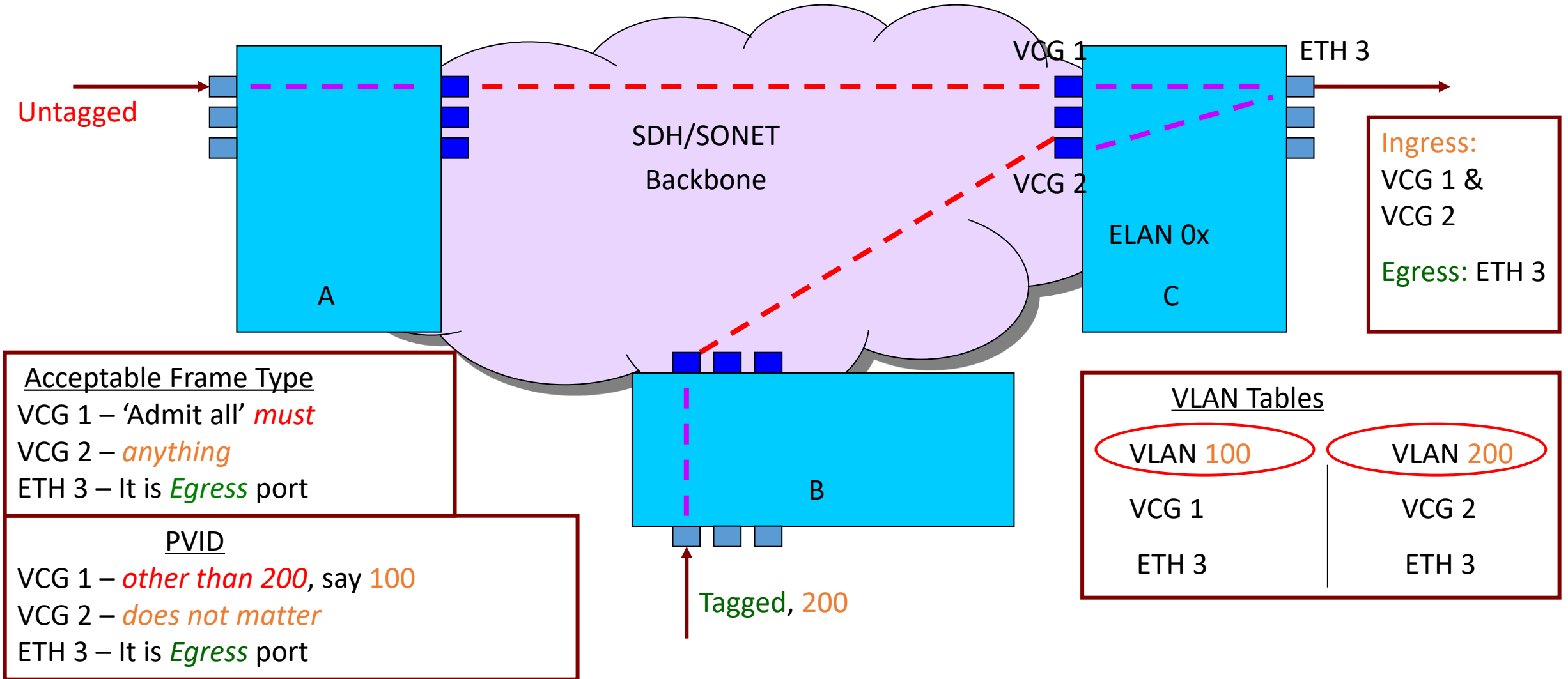
1. **CVLAN forwarding**

    - This is applicable for ports in **.q mode**

    - Forwarding of traffic incoming to a **.q port** is done based on the CTAG/CVLAN

2. **SPVLAN forwarding**

    - This is applicable for ports in **.ad/ q-in-q mode**

    - Forwarding of traffic incoming to a **.ad port** is done based on the STAG/SPVLAN (Outermost tag)

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Applications of Acceptable Frame Type, PVID, VLAN Tables in .Q mode

Untagged

VCG 1

ETH 3

SDH/SONET

Backbone

VCG 2

ELAN 0x

A

C

Ingress:
VCG 1 &
VCG 2

Egress: ETH 3

B

Tagged, 200

Acceptable Frame Type
VCG 1 – 'Admit all' *must*
VCG 2 – *anything*
ETH 3 – It is *Egress* port

PVID
VCG 1 – *other than 200*, say 100
VCG 2 – *does not matter*
ETH 3 – It is *Egress* port

VLAN Tables

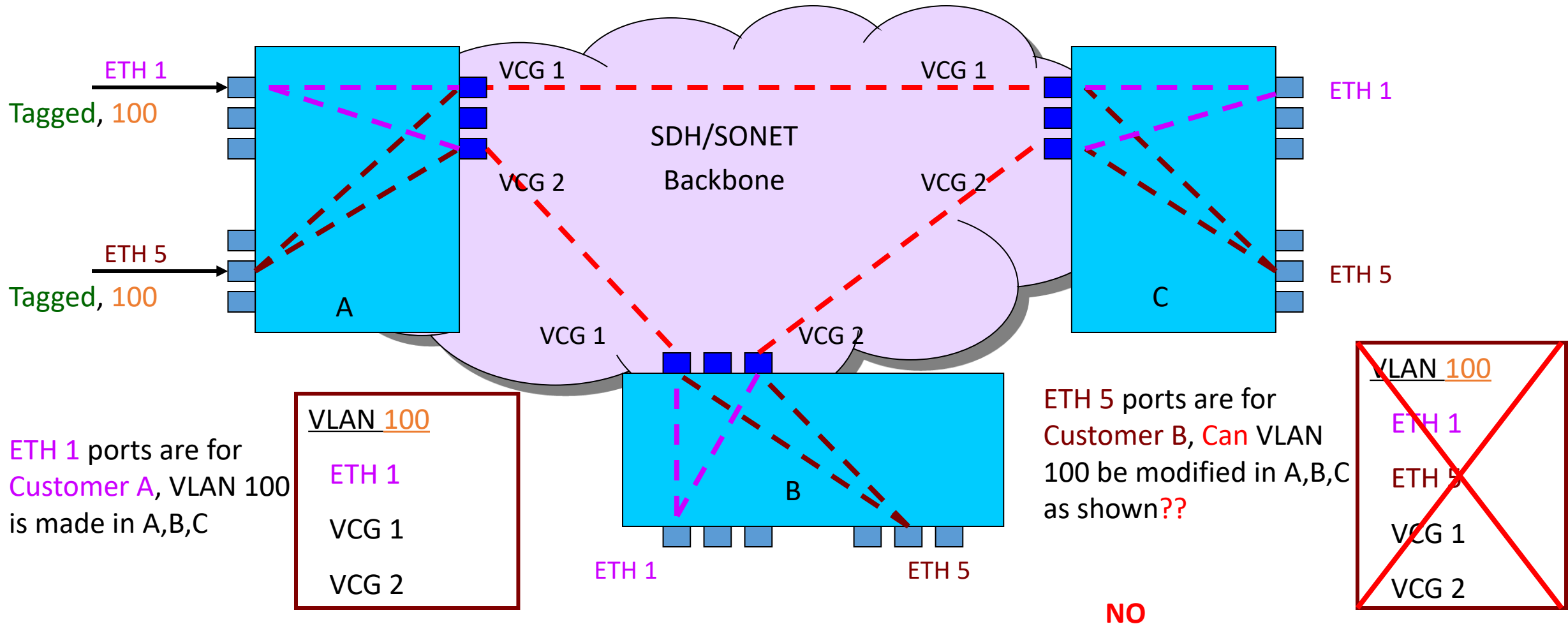| VLAN 100	VLAN 200
VCG 1	VCG 2
ETH 3	ETH 3

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Egress Untagging

➢ Untagging/removal of tag is always applicable during egress

➢For a tagged traffic going out of a **.q** port (Egress port), the tag can be removed by enabling **PVID Egress Untag** and setting **PVID** of the Egress port same as that of the outermost tag of the traffic (usually CTAG)

➢ Also, a tagged traffic handed over from a **.ad** port (NNI side) to a **.q** port (UNI side) will always be untagged traffic

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Why Q-in-Q ?

ETH 1

Tagged, 100

ETH 5

Tagged, 100

A

VCG 1

SDH/SONET

Backbone

VCG 2

VCG 1

VCG 2

VCG 1

VCG 2

ETH 1

ETH 5

C

B

ETH 1

ETH 5

ETH 1 ports are for
Customer A, VLAN 100
is made in A,B,C

VLAN 100

ETH 1

VCG 1

VCG 2

ETH 5 ports are for
Customer B, Can VLAN
100 be modified in A,B,C
as shown??

NO

VLAN 100

ETH 1

ETH 5

VCG 1

VCG 2

What is the solution?

Solution is double tagging!

➤ Give ***different*** PVID to ETH 1 and ETH 5 ports in A,B,C

  (say, for ETH 1 ports PVID is given as 1000 and for ETH 5 ports PVID is given as 2000)

➤ Configure all ETH ports in **.Q** mode and VCG ports in ***Q-in-Q*** mode

➤ Incoming traffic with C-VLAN tag 100 from Customer A

  will get S-VLAN tagged at ETH 1 port by 1000

➤ Incoming traffic with C-VLAN tag 100 from Customer B

  will get S-VLAN tagged at ETH 5 port by 2000

➤ Make two VLAN tables 1000 and 2000 in all the nodes

VLAN Tables	
VLAN 1000	VLAN 2000
ETH 1	ETH 5
VCG 1	VCG 1
VCG 2	VCG 2

It should be pretty clear now that VCG 1 and VCG 2 ports, when acting as Egress ports, should contain the second S-VLAN tag – whereas the ETH 1 and ETH 5 ports, when acting as Egress ports, should NOT contain the second S-VLAN tag.

Broadcast, Multicast, and Unicast addresses

➢ Any MAC (L2) address is a six byte address, normally represented in

　Hexadecimal pattern

➢ Source Address: **Unique**

➢ Destination Address:

- Broadcast address: all '1', i.e., FF:FF:FF:FF:FF:FF

- Multicast address: least-significant-bit (l.s.b.) of the most-significant-byte (M.S.B.)

　is '1', e.g., 15:22:33:44:55:66, FB:33:68:EA:FF:FF etc.

- Unicast address: l.s.b. of M.S.B. is '0',

　e.g., 1A:22:33:44:55:66, E4:33:68:EA:FF:FF etc.

In the address 15:22:33:44:55:66, 15 is the M.S.B. 15 when represented in Binary pattern, gives 0001 0101 – so, the l.s.b. is '1' => Multicast

In the address 1A:22:33:44:55:66, 1A is the M.S.B. 1A when represented in Binary pattern, gives 0001 1010 – so, the l.s.b. is '0' => Unicast

Static Unicast Table

➤ 'Static' => the table is operator made from the UI,

         unless operator decides to delete it from the UI, it will remain in the switch

➤ 'Unicast' => single Egress port

- Can any Egress port be selected? No, the port must be part of VLAN table 'a', if

   the 'latest' tag of the Ingress traffic is 'a'

> Note: Any MAC DA based table is a sub-table of a particular VLAN table – so, VLAN table rule can not be bypassed, e.g., switching for some Ingress traffic with 'latest' tag 'a' can not be based on any MAC DA based table which is a sub-table of VLAN table 'b'

➤ Statement is:

If (MAC DA of Ingress traffic = 'Unicast DA' entry in the static Unicast table)

Then the sole Egress port will be the 'direct to' port entry in the static Unicast table

Under the 'VLAN table' entry in the static Unicast table

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Static Multicast Table

- ➤ 'Static' *(see Static Unicast slide)*

- ➤ 'Multicast' => more than one Egress port

  - ▪ Can any Egress port be selected? No, the ports must be part of VLAN table 'a', if

    the 'latest' tag of the Ingress traffic is 'a'

    (see the note on the Static Unicast slide)

- ➤ Statement is:

  If (MAC DA of Ingress traffic = 'Multicast DA' entry in the static Multicast table)

  Then the Egress ports will be the 'direct to' ports entry in the static Multicast table

  Under the 'VLAN table' entry in the static Multicast table

Dynamic Unicast table

➢ 'Dynamic' => the table is made automatically by the switch, and

table entries are deleted automatically after some time

(if associated port(s) are inactive as ingress)

- ▪ How much time? → We need to discuss 'Ageing time' feature

➢ 'Unicast' => single Egress port

- ▪ Which port will be the Egress port? → that port, which has learned the Unicast address
- ▪ Under which VLAN(s)? → that (those) VLAN ids, which was learned by the port above

We need to discuss 'Dynamic MAC learning' feature.

➢ Statement is:

If (MAC DA of Ingress traffic = 'Unicast DA' entry in the dynamic Unicast table)

Then the sole Egress port will be the 'direct to' port entry in the dynamic Unicast table

Under the 'VLAN table' entry in the dynamic Unicast table

Dynamic MAC Learning & Ageing Time

Dynamic MAC Learning

➢ ***Per-port*** feature

For a particular port, the feature from UI

➢ ***If*** 'disabled', it can not learn any MAC address(s) sent by the client(s) associated with it.

➢ ***If*** 'no limit on learning', it can learn Maximum 16K MAC addresses while port is ***Ingress***

➢ ***If*** 'limit learning', it can learn between 20 and 600 (value is configurable from UI)

MAC addresses while port is ***Ingress***

Ageing Time

➢ Feature for ***whole switch***, NOT per-port feature

➢ Value is configurable from UI between 1 second and 10^6 second

➢ Value should be entered in units of Seconds, e.g., for 5 minutes, enter value 300

Example of Dynamic MAC learning & Dynamic Unicast Table

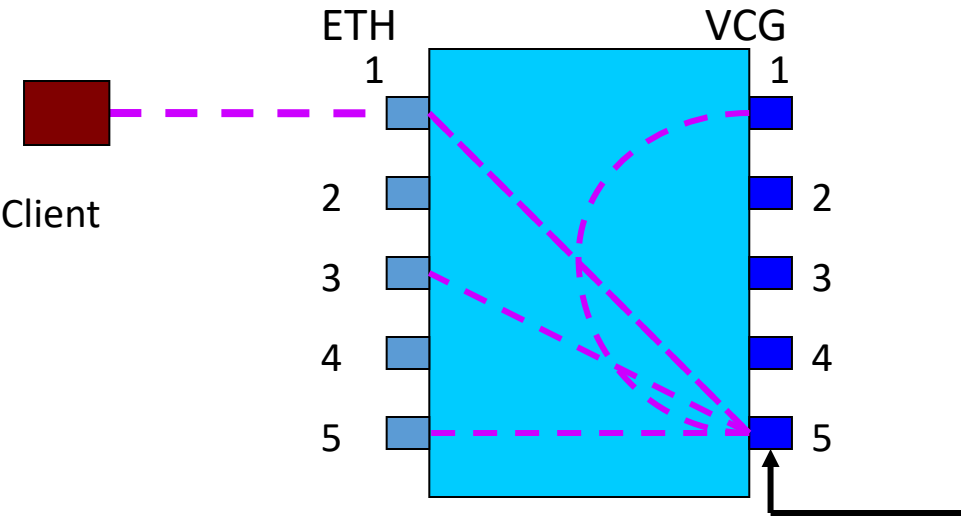**Dynamic MAC Learning**

Usage of Dynamic Unicast Table

ETH

VCG

Client

SA MAC1

1

2

3

4

5

1

2

3

4

5
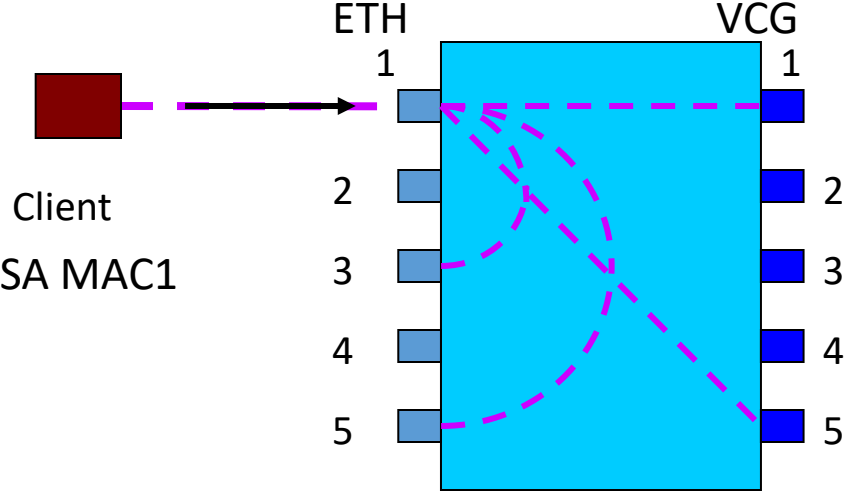
VLAN 100

ETH 1

ETH 3

ETH 5

VCG 1

VCG 5

Dynamic Unicast Table

VLAN = 100

DA = MAC 1

Egress = ETH 1

ETH

VCG

Client

1

2

3

4

5

1

2

3

4

5

VLAN = 100

DA = MAC 1

Port Mirroring

- For Monitoring and analyzing the traffic contents locally (by means of any Eth test-set) without disturbing the normal traffic flow.

- 'Source' port(s): the port(s), whose contents we want to mirror

- 'Direct to' or 'mirror' or probe port: the port, where traffic will be mirrored. Probe port is not network connected.

- Multiple source ports can be mirrored on to a probe port. If the combined rate of the source ports is more than the probe port, then the mirrored traffic will be dropped.

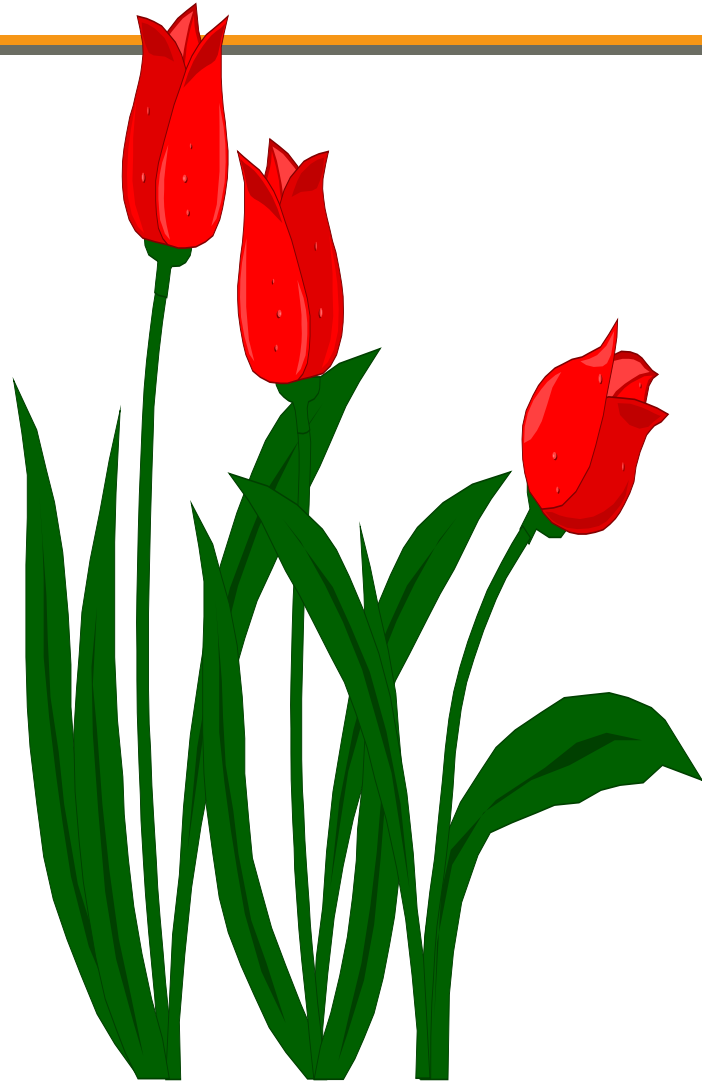- Port mirroring doesn't allow monitoring traffic on LAG port.

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Port Mirroring

Important points to note:
1. The source port (s) can be configured for mirroring nothing / only Ingress traffic / only Egress traffic / both Ingress and Egress traffic to the mirror port.

2. The mirror port will NOT act as traffic port (neither as Ingress nor as Egress)

3. Port-mirroring happens across VLAN,
   e.g., for mirroring the Ingress content of source ETH 1 with 'latest' tag 100 to mirror ETH 5, ETH 5 need NOT be part of the VLAN table no. 100

4. Even if a port is part of a VLAN then also allow that port to be configured as a destination (probe) port.

5. Even if a port is part of LAG then also allow it to be configured as a Destination (probe) port.

ACRONYMS

- VLAN- Virtual LAN

- ELINE- Ethernet Virtual Private Line (EVPL)

- ELAN- Ethernet Virtual Private LAN (EVP-LAN)

- UNI- User Network Interface

- NNI- Network Node Interface

- FCS- Frame Check Sequence

- TCI- Tag control Information

- CVLAN- Customer VLAN

- SVLAN- Service Provider VLAN

- PVID- Port VLAN ID

- LAG- Link Aggregation Group

- LACP- Link Aggregation Control Protocol

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Thank You...