VLAN and IEEE 802.1Q standard

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Parallel independent LANs

- Need of separated parallel LANs for privacy and security purpose
  - \( n_{\text{LAN}} = n_{\text{Media}} + n_{\text{Equipment}} \) per any distribution point
  - Hardware waste
  - Maximum LAN separation
Parallel independent LANs example
Virtual LAN (VLAN)

- Possibility to realize virtually independent parallel LAN
  - Unique Physical infrastructure
  - LAN virtually or logically separated
- VLAN can be implemented
  - On a single switch
  - On entire extended LAN
- VLAN advantages
  - High flexibility
  - Hardware saving
Why VLAN

- Security or privacy purpose
  - Separated VLAN
    - No communication between VLAN
  - VLAN connection enough secure with Access-List configuration on router, Layer 3 Switch or Firewall
- To limit or reduce the broadcast domain
  - VLAN communication through router or Layer 3 Switch
VLAN Inter-Switch

- VLAN configuration on the switches
  - Need classify packet per VLAN
  - VLAN tagging
VLAN tagging

- Frame Tagging
  - Encapsulation technique
    - Ethernet, Token Ring or FDDI frame are encapsulated on VLAN frame
    - ISL (Inter Switch Link) Cisco proprietary solution

- Packet Tagging
  - The original Ethernet frame is modified by adding an header witch contain VLAN-ID
  - Technique adopted by IEEE 802.1Q standard
IEEE 802.1Q tagging

- Destination Address
- Source Address
- Length/Type = TPID
- Tag Control Information
- Client Length/Type
- MAC Client DATA
- PAD
- FCS

81-00
801.Q Tag

3 1
user priority CFI
VID (VLAN ID) - 12 bit

Defined on:
- IEEE 802.3ac
- IEEE 802.1p
- IEEE 802.1Q

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Bridge 802.1Q

- Port State Information
- Ingress Rules
- Forwarding Process
- Filtering database
- Egress Rules
- Frame Transmission
- Frame Reception
IEEE 802.1Q characteristics

- Per port based VLAN assignment
- Unique spanning tree
- Multiple filtering database identified by FID (Filtering Identifier)
  - Can exist only one entry per MAC address on filtering database
  - A MAC Address may be present in different filtering database
Port-based VLAN

VLAN 11

Access link

Tagged frame

VLAN 24

Trunk link

VLAN 11

Tagged frame

Access link

VLAN 24
Equipment e Link type

- **Equipment:**
  - VLAN-Aware manage tagged and untagged frames
  - VLAN-Unaware don’t manage tagged frames

- **Access link:**
  - Receive and transmit Untagged frames
  - default port configuration on the switch

- **Trunk link:**
  - Receive and transmit Tagged frames
VLAN configuration on the switch

- 3 typical steps:
  - VLAN creation on the switch;
  - VLAN port association;
  - Trunk ports definition.
VLAN configuration example

Network before VLAN configuration

SW-A  SW-C  SW-B
## Ports association before VLAN configuration

```
SW-C# show vlan brief

<table>
<thead>
<tr>
<th>VLAN</th>
<th>Name</th>
<th>Status</th>
<th>Ports</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>default</td>
<td>active</td>
<td>Fa0/1, Fa0/2, Fa0/3, Fa0/4, Fa0/5, Fa0/6, Fa0/7, Fa0/8, Fa0/9, Fa0/10, Fa0/11, Fa0/12, Fa0/13, Fa0/14, Fa0/15, Fa0/16, Fa0/17, Fa0/18, Fa0/19, Fa0/20, Fa0/21, Fa0/22, Fa0/23, Fa0/24, Fa0/25, Fa0/26, Fa0/27, Fa0/28, Fa0/29, Fa0/30, Fa0/31, Fa0/32, Fa0/33, Fa0/34, Fa0/35, Fa0/36, Fa0/37, Fa0/38, Fa0/39, Fa0/40, Fa0/41, Fa0/42, Fa0/43, Fa0/44, Fa0/45, Fa0/46, Fa0/47, Fa0/48, Gi0/1, Gi0/2</td>
</tr>
</tbody>
</table>
```
VLAN to be created
VLAN Creation

SW-C# **vlan database**
Switch(vlan)# **vlan 2 name Administration**
VLAN 2 added:
   Name: Amministrazione
Switch(vlan)# **vlan 3 name Selling**
VLAN 3 added:
   Name: Vendite
Switch(vlan)# **vlan 4 name test-1**
VLAN 4 added:
   Name: prova-1
Switch(vlan)# **vlan 5 name test-2**
VLAN 5 added:
   Name: prova-2
Switch(vlan)# **vlan 6 name test-3**
VLAN 6 added:
   Name: prova-3
Switch(vlan)# **vlan 100 name Production**
VLAN 100 added:
   Name: Produzione
SW-Prova(vlan)# **exit**
APPLY completed.
Exiting....
SW-C#
Ports VLAN association

SW-Prova(config)#int fastEthernet 0/12
SW-Prova(config-if)#switchport access vlan 100
Switch(config-if)#exit

SW-Prova(config)#int fastEthernet 0/16
SW-Prova(config-if)#switchport access vlan 2
SW-Prova(config-if)#exit

SW-Prova(config)#int fastEthernet 0/20
SW-Prova(config-if)#switchport access vlan 3
SW-Prova(config-if)#exit

SW-Prova(config)#int fastEthernet 0/24
SW-Prova(config-if)#switchport access vlan 4
SW-Prova(config-if)#exit

SW-Prova(config)#int fastEthernet 0/28
SW-Prova(config-if)#switchport access vlan 5
SW-Prova(config-if)#exit

SW-Prova(config)#int fastEthernet 0/32
SW-Prova(config-if)#switchport access vlan 6
SW-Prova(config-if)#exit
## Ports and VLAN after switch configuration

```plaintext
SW-Prova# show vlan brief

<table>
<thead>
<tr>
<th>VLAN Name</th>
<th>Status</th>
<th>Ports</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 default</td>
<td>active</td>
<td>Fa0/1, Fa0/2, Fa0/3, Fa0/4, Fa0/5, Fa0/6, Fa0/7, Fa0/8, Fa0/9, Fa0/10, Fa0/11, Fa0/36, Fa0/37, Fa0/38, Fa0/39, Fa0/40, Fa0/41, Fa0/42, Fa0/43, Fa0/44, Fa0/45, Fa0/46, Fa0/47, Fa0/48, Gi0/1, Gi0/2</td>
</tr>
<tr>
<td>2 Administration</td>
<td>active</td>
<td>Fa0/16, Fa0/17, Fa0/18, Fa0/19</td>
</tr>
<tr>
<td>3 Selling</td>
<td>active</td>
<td>Fa0/20, Fa0/21, Fa0/22, Fa0/23</td>
</tr>
<tr>
<td>4 test-1</td>
<td>active</td>
<td>Fa0/24, Fa0/25, Fa0/26, Fa0/27</td>
</tr>
<tr>
<td>5 test-2</td>
<td>active</td>
<td>Fa0/28, Fa0/29, Fa0/30, Fa0/31</td>
</tr>
<tr>
<td>6 test-3</td>
<td>active</td>
<td>Fa0/32, Fa0/33, Fa0/34, Fa0/35</td>
</tr>
<tr>
<td>100 Production</td>
<td>active</td>
<td>Fa0/12, Fa0/13, Fa0/14, Fa0/15</td>
</tr>
</tbody>
</table>
```
Trunk port static configuration

- Trunk port static configuration without implementation of GVRP protocol

```
SW-C(config)#interface GigabitEthernet 0/1
SW-C(config-if)#switchport mode trunk
SW-C(config-if)#switchport trunk allowed vlan add 1,2,5,6
SW-C(config-if)#exit
SW-C(config)#interface GigabitEthernet 0/2
SW-C(config-if)#switchport mode trunk
SW-C(config-if)#switchport trunk allowed vlan all
```
GVRP protocol

- Garp VLAN Registration Protocol (GVRP)
  - Use to register or cancel dynamically VLAN attribute on the switches
  - Participate to STP active topology
# GVRP frame format

<table>
<thead>
<tr>
<th>DSAP</th>
<th>SSAP</th>
<th>Length</th>
<th>DSAP</th>
<th>SSAP Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multicast</td>
<td>Singlecast</td>
<td>MAC bridge Address</td>
<td>XY</td>
<td>042H</td>
</tr>
<tr>
<td>01-80-C2-00-00-21</td>
<td>042H</td>
<td>042H</td>
<td>XID</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Protocol Identifier:</th>
<th>00-01</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attribute Type:</td>
<td>00-01</td>
</tr>
<tr>
<td>Attribute Length:</td>
<td>04</td>
</tr>
<tr>
<td>Attribute Event</td>
<td>VLAN ID</td>
</tr>
<tr>
<td>VLAN ID</td>
<td></td>
</tr>
</tbody>
</table>

### Attribute List

<table>
<thead>
<tr>
<th>Attribute Length:</th>
<th>04</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attribute Event</td>
<td>VLAN ID</td>
</tr>
</tbody>
</table>

### Attribute 1

<table>
<thead>
<tr>
<th>Attribute Length:</th>
<th>04</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attribute Event</td>
<td>VLAN ID</td>
</tr>
</tbody>
</table>

### Attribute n

<table>
<thead>
<tr>
<th>Attribute Length:</th>
<th>04</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attribute Event</td>
<td>VLAN ID</td>
</tr>
</tbody>
</table>

### End Mark

| 00 |

| 1÷2 |
| 3   |
| 4   |
| 5   |
| 6÷7 |

- 0 = LeaveALL
- 1 = JoinEmpty
- 2 = JoinIn
- 3 = Leave Empty
- 4 = LeaveIN
- 5 = Empty