IEEE 802.1Q

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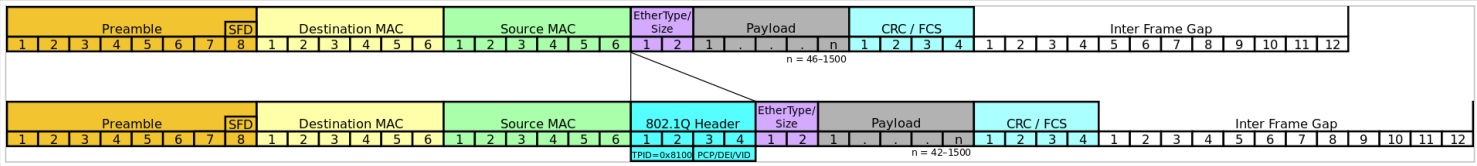
IEEE 802.1Q is the networking standard that supports virtual LANs (VLANs) on an Ethernet network. The standard defines a system of **VLAN tagging** for Ethernet frames and the accompanying procedures to be used by bridges and switches in handling such frames. The standard also contains provisions for a quality of service prioritization scheme commonly known as IEEE 802.1p and defines the Generic Attribute Registration Protocol.

Portions of the network which are VLAN-aware (i.e., IEEE 802.1Q conformant) can include VLAN tags. When a frame enters the VLAN-aware portion of the network, a tag is added to represent the VLAN membership of the frame's port or the port/protocol combination, depending on whether port-based or port-and-protocol-based VLAN classification is being used. Each frame must be distinguishable as being within exactly one VLAN. A frame in the VLAN-aware portion of the network that does not contain a VLAN tag is assumed to be flowing on the native (or default) VLAN.

The standard was developed by IEEE 802.1, a working group of the IEEE 802 standards committee, and continues to be actively revised. One of the notable revisions is 802.1Q-2014 which incorporated IEEE 802.1aq or (shortest path bridging) and much of the 802.1D standard.[1] In 2012, it was stated by David Allan and Nigel Bragg, in *802.1aq Shortest Path Bridging Design and Evolution: The Architect's Perspective* that shortest path bridging is one of the most significant enhancements in Ethernet's history.[2]

Contents

Frame format



Insertion of 802.1Q tag in an Ethernet frame

802.1Q does not encapsulate the original frame. Instead, for Ethernet frames, it adds a 32-bit field between the source MAC address and the EtherType/length fields of the original frame, leaving the minimum frame size unchanged at 64 bytes (octets) and extending the maximum frame size from 1,518 bytes to 1,522 bytes (for the payload a 42-octet minimum applies when 802.1Q is present; when absent, a 46-octet minimum applies. IEEE 802.3-2005 Clause 3.5). Two bytes are used for the tag protocol identifier (TPID), the other two bytes for tag control information (TCI). The TCI field is further divided into PCP, DEI, and VID.[3]

16 bits	3 bits	1 bit	12 bits
TPID	TCI		
	PCP	DEI	VID

- *Tag protocol identifier (TPID)*: a 16-bit field set to a value of 0x8100 in order to identify the frame as an IEEE 802.1Q-tagged frame. This field is located at the same position as the EtherType/length field in untagged frames, and is thus used to distinguish the frame from untagged frames.

- *Tag control information (TCI)*
  - *Priority code point (PCP)*: a 3-bit field which refers to the IEEE 802.1p class of service and maps to the frame priority level. Values in order of priority are: 1 (background), 0 (best effort), 2 (excellent effort), 3 (critical application), ..., 7 (network control). These values can be used to prioritize different classes of traffic (voice, video, data, etc.).
  - *Drop eligible indicator (DEI)*: a 1-bit field. (formerly CFI[note 1][4]) May be used separately or in conjunction with PCP to indicate frames eligible to be dropped in the presence of congestion.[5]
  - *VLAN identifier (VID)*: a 12-bit field specifying the VLAN to which the frame belongs. The hexadecimal values of 0x000 and 0xFFF are reserved. All other values may be used as VLAN identifiers, allowing up to 4,094 VLANs. The reserved value 0x000 indicates that the frame does not carry a VLAN ID; in this case, the 802.1Q tag specifies only a priority and is referred to as a *priority tag*. On bridges, VID 0x001 (the default VLAN ID) is often reserved for a management VLAN; this is vendor-specific. The VID value 0xFFF is reserved for implementation use; it must not be configured or transmitted. 0xFFF can be used to indicate a wildcard match in management operations or filtering database entries.[6]

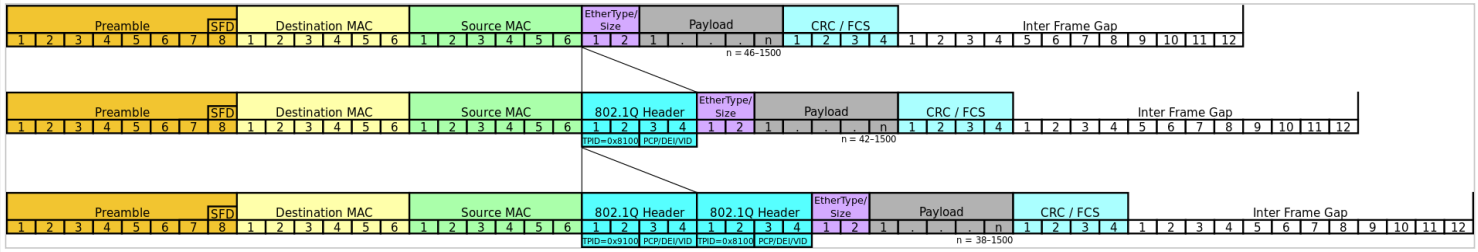
For frames using IEEE 802.2/SNAP encapsulation with an OUI field of 00-00-00 (so that the protocol ID field in the SNAP header is an EtherType), as would be the case on LANs other than Ethernet, the EtherType value in the SNAP header is set to 0x8100 and the aforementioned extra 4 bytes are appended after the SNAP header.

Because inserting the VLAN tag changes the frame, 802.1Q encapsulation forces a recalculation of the original frame check sequence field in the Ethernet trailer.

The IEEE 802.3ac standard increased the maximum Ethernet frame size from 1518 bytes to 1522 bytes to accommodate the four-byte VLAN tag. Some network devices that do not support the larger frame size will process the frame successfully but may report them as a "baby giant" anomalies.[7]

Double tagging

With the IEEE standard 802.1ad, double-tagging can be useful for Internet service providers, allowing them to use VLANs internally while mixing traffic from clients that are already VLAN-tagged. The outer (next to source MAC and representing ISP VLAN) S-TAG (service tag) comes first, followed by the inner C-TAG (customer tag). In such cases, 802.1ad specifies a TPID of 0x88a8 for service-provider outer S-TAG.



Insertion of 802.1ad double tag in an Ethernet frame

Multiple VLAN Registration Protocol

IEEE 802.1Q defines the Multiple VLAN Registration Protocol (MVRP), an application of the Multiple Registration Protocol, allowing bridges to negotiate the set of VLANs to be used over a specific link.

MVRP replaced the slower GARP VLAN Registration Protocol (GVRP) in 2007 with the IEEE 802.1ak-2007 amendment.

Multiple Spanning Tree Protocol

The 2003 revision of the standard included the Multiple Spanning Tree Protocol (MSTP) which was originally defined in IEEE 802.1s.

Notes

1. This field was formerly designated *Canonical Format Indicator (CFI)* with a value of 0 indicating a MAC address in canonical format. It is always set to zero for Ethernet. CFI was used for compatibility between Ethernet and Token Ring networks. If a frame received at an Ethernet port had a CFI set to 1, then that frame would not be bridged to an untagged port.

See also

- VLAN Trunking Protocol (VTP), a Cisco proprietary VLAN management protocol
- Cisco Inter-Switch Link (ISL), an older VLAN trunking protocol that is proprietary to Cisco
- Dynamic Trunking Protocol (DTP), another Cisco proprietary networking protocol.

Sources

- *IEEE Std. 802.1BR-2012, Virtual Bridged Local Area Networks— Bridge Port Extension* (PDF; 970 kB). line feed character in `|title=` at position 61 (help)
- *IEEE Std. 802.1Q-2011, Media Access Control (MAC) Bridges and Virtual Bridged Local Area Networks* (PDF; 6.0 MiB). ISBN 978-0-7381-6708-4.
- *IEEE Std. 802.1Q-2005, Virtual Bridged Local Area Networks* (PDF; 2.3 MiB). ISBN 0-7381-3662-X.
- *IEEE Std. 802.1Q-2003, Virtual Bridged Local Area Networks* (PDF; 3.5 MiB). ISBN 0-7381-3663-8.
- ISL & 802.1q Frame Formats (http://www.cisco.com/en/US/tech/tk389/tk689/technologies_tech_note09186a0080094665.shtml)

References

1. 802.1Q-2014 - Bridges and Bridged Networks (http://www.ieee802.org/1/pages/802.1Q-2014.html)]
2. Allan, David; Bragg, Nigel (2012). *802.1aq Shortest Path Bridging Design and Evolution : The Architects' Perspective*. New York: Wiley. ISBN 978-1-118-14866-2.
3. IEEE 802.1Q-2011 clause 9.6
4. IEEE 802.1Q-2005 clause 9.6
5. IEEE 802.1Q-2011 clause 6.9.3
6. IEEE 802.1Q-2005, 9.6 VLAN Tag Control Information
7. Understanding Baby Giant/Jumbo Frames Support on Catalyst (http://www.cisco.com/image/gif/paws/29805/175.pdf)

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