Application Note

VLAN Stacking or Q-in-Q

Where is it and why?

MT9090A/MU909060A

Network Master GigE

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Background

Telecom operators test their networks in many different ways for many different reasons.
When testing an Ethernet network it's important to note what type of testing is required and where it's required, this document aims to explain if testing VLAN Stacking is required in the Access network.

In order to do this the document will also overview the technologies involved and the reasons why people test in different areas. Q-in-Q or VLAN Stacking are common terms used by today's telecom operators which are the same thing. For convenience we will reference it as "VLAN Stacking" for the rest of this document.

First let's quickly look at the difference between VLAN and VLAN stacking.

VLAN

Where does a VLAN come from?

The IEEE standard 802.1Q which was first standardized in Dec 1998 and has since been revised and referenced many times. The full standard can be downloaded from the IEEE website at http://www.ieee.org and there are many websites which explain the standard in details including http://en.wikipedia.org/wiki/IEEE_802.1Q, for comprehensive and definitive details you should always reference the standard itself.

What is a VLAN?

A **VLAN** is a **V**irtual **L**ocal **A**rea **N**etwork which allows the network LAN to be broken down into more logical networks simplifying management of the network and allowing configuration and traffic priority across the network. It also has the effect of increasing security, reducing broadcast traffic and better management of areas such as traffic flow.

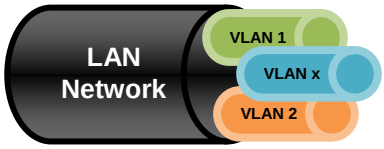

Figure 1. LAN with 3 VLAN's inside.

VLAN Stacking

Where does VLAN Stacking come from?

VLAN Stacking comes from the IEEE Standard 802.1.ad which was first standardized in Dec 2005. The full standard can be downloaded from the IEEE website at http://www.ieee.org and there are also many other websites that offer an overview such as http://en.wikipedia.org/wiki/QinQ. Once again the definitive reference point should be the standard itself. This standard is very closely related to the VLAN standard as it is all about placing one VLAN inside another (or on top of). This is why the name VLAN Stacking is often used and because the VLAN standard ends in the letter "q" it is often called Q-in-Q.

What is VLAN Stacking?

VLAN allows the user to better manage his network and prioritize this traffic though the network but for the service provider or telecom operator this meant multiple connections from one customer. The telecom operator is normally interested in having a single connection for each user. VLAN Stacking allows all traffic from a single user to transfer the telecom network combined in one logical group.

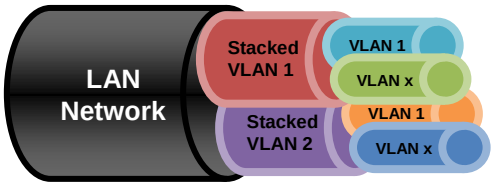

Figure 2. LAN with 2 Staked VLAN's each with 2 VLAN's inside.

The VLAN Stacking allows the telecom operator to place all traffic from a single customer (which could be multiple VLAN's) into a single VLAN simplifying management across his network.
Next, let's look at the differences in the Ethernet network. How a network is divided and where VLAN Stacking is in the network.

How is an Ethernet Network divided?

Many telecom operators divide their network in different ways thus the below should be considered a broad guideline or reference only. Some common terms used in dividing the networks are as follows,

- Access Network,
  - From the customer premises to the Telecom network.
- Metro Network,
  - The network confined to a region only (City, Suburb, Campus etc).
- Core Network,
  - The backbone of the telecom operator's network connecting all major areas.
- Point of Demarcation,
  - Where the network changes from telecom operator control to customer control.

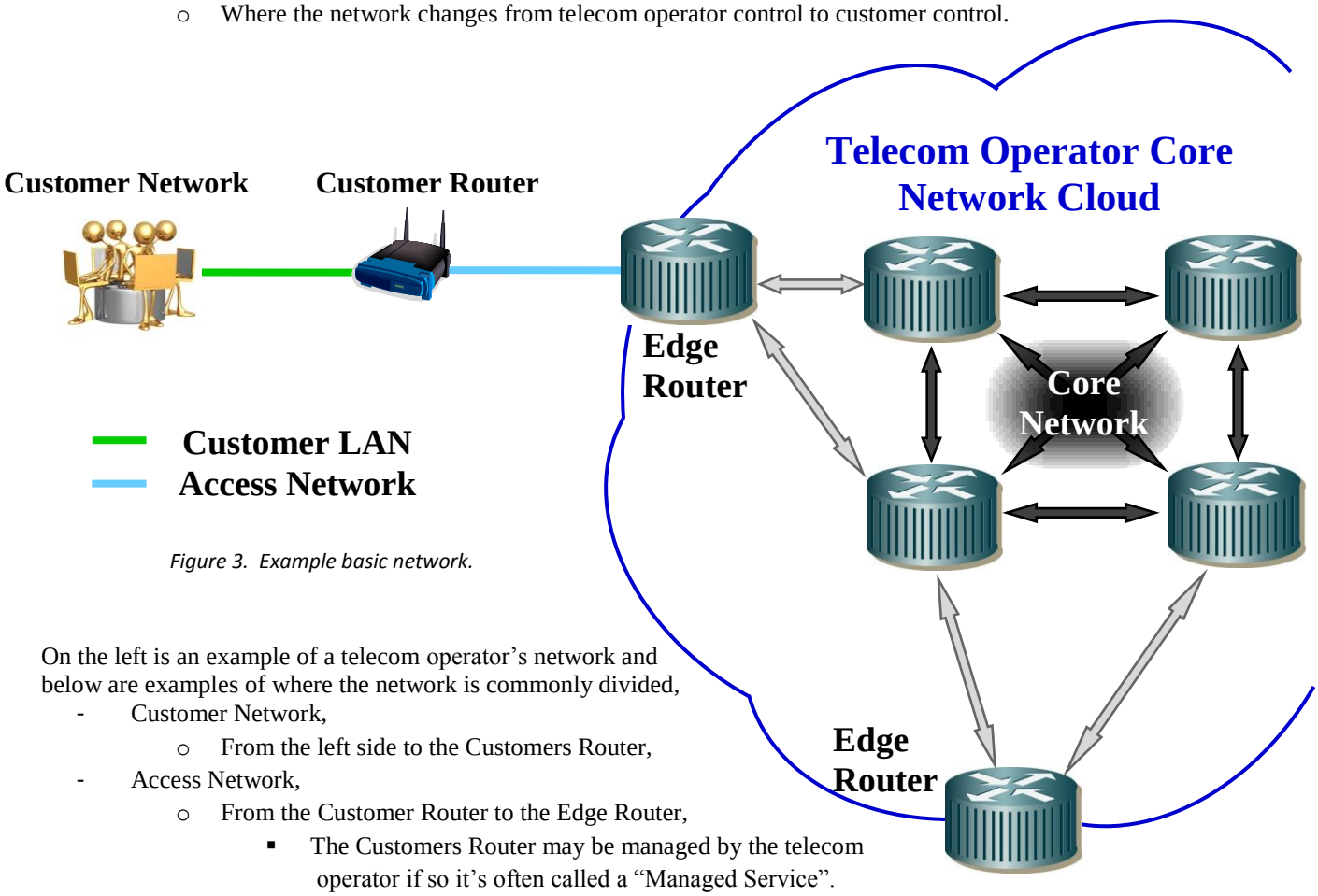

Figure 3. Example basic network.

On the left is an example of a telecom operator's network and below are examples of where the network is commonly divided,

- Customer Network,
  - From the left side to the Customers Router,
- Access Network,
  - From the Customer Router to the Edge Router,
    - The Customers Router may be managed by the telecom operator if so it's often called a "Managed Service".

The difference between the two above areas is often referred as the "Point of Demarcation".

- Metro and Core Network,
  - From the Edge Router into the cloud.

Where is there VLAN Stacking on the network and why?

Often customers are working with the telecom operators to reduce the cost of running their network. One way some telecom operators are assisting their customers with this is offering different levels of service at different price plans. For example,

- Higher priority traffic,
  - Higher cost.
- Non guarantee or lower priority traffic,
  - Lower cost.

Commonly the telecom operator will offers this by having the customer place different network traffic on different VLAN's, this can be completed in a number of different ways some examples would be,

- DSCP/TOS Bit's
  - Part of the standard Ethernet frame which is normally set by the end device application,
- TCP/UDP port numbers (layer 4 of the Ethernet frame),
  - Also normally set by the end device application for example VoIP or Video Over IP would be carried on set port numbers.

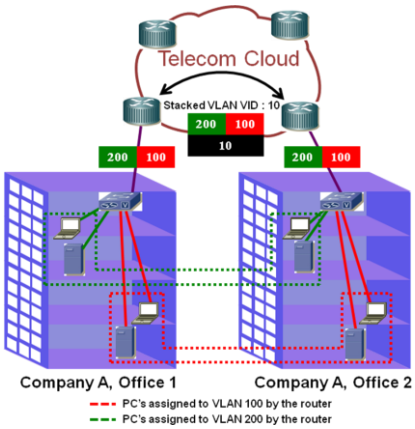

Figure 4. Example network of one company with two VLAN's.

When the different traffic is placed on the different VLAN ID's it's also possible to assign each VLAN ID a different priority from "0" to "7". The combination of the different VLAN ID and Priority settings allows the Telecom operator to differentiate the service offered to their customers. In this way a single customer could have multiple traffic streams connecting two offices, each stream carrying different traffic with different priorities. It's also possible to have VLAN's going to all many offices and others just to a few. The telecom operator then combines these streams into one Stacked VLAN allowing simplified management of the single customer.

- In a managed network the telecom operator will normally place switchers or routers in the customer network to complete this.

Due to this the customer network is normally running on standard Ethernet while the Access network it would be on multiple VLAN's. In the Access network although the traffic is on multiple VLANs they are not stacked, each of these VLAN's is in an independent stream which is often called "Multiple Streams". When the traffic reaches the Edge Router the Telecom operator would normally place these Multiple Streams (which each have their own independent VLAN's ID's) into a single VLAN. At this point the traffic becomes a Stacked VLAN as the traffic inside the telecom operators VLAN has different VLAN's (Stacked VLAN) within it, each with different types of customer traffic within it.

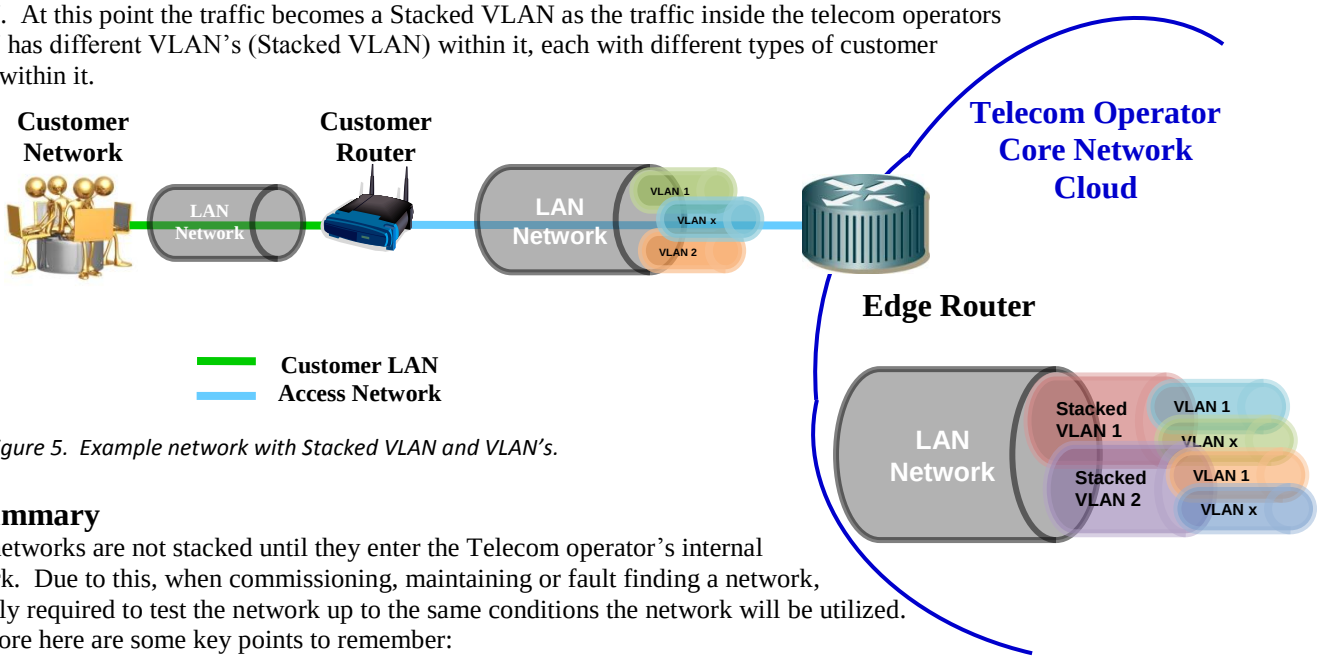

Figure 5. Example network with Stacked VLAN and VLAN's.

In Summary

Most networks are not stacked until they enter the Telecom operator's internal network. Due to this, when commissioning, maintaining or fault finding a network, it is only required to test the network up to the same conditions the network will be utilized. Therefore here are some key points to remember:

- When purchasing test equipment to test a network from the Customer LAN you would normally only require to configure your test equipment with Multiple Steams of traffic, allowing the ability to adjust the DSCP, TOS and or TCP, UDP port numbers of the Ethernet frame.
- In the Access Network it would normally be required to configure the above as well the VLAN ID and VLAN Priority settings.
- In both the above cases VLAN Stacking is not normally required.
- Testing of the Access or Customer network is normally completed during commissioning and fault finding to provision network ability from the customer's perspective.
- Testing is different when the traffic reaches the core network compared to the Access Network. This is because the telecom operator doesn't normally look at the core network with reference to a single customer but rather overall network stability.

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