METHODS AND APPARATUS FOR

LARGE SCALE SEAMLESS ROAMING ACROSS VLAN

BACKGROUND OF THE INVENTION

Field of Invention:

The present invention relates to seamless roaming for mobile users in large scale. The example scenarios would be hotspot for commuters in public transportation system. And more specifically, it reveals the methods and apparatus for implementing seamless roaming across vlan so that the broadcast domain is reduced while roaming is seamless and transparent to mobile user.

In particular, the apparatus, a customized high performance NAT router that maintains the translation table while mobile users move across VLAN and the methods for setup and use the system is described.

Description of the Prior Art:

Currently, there are two ways to implement the mobile hotspot for transportation market: Layer 2 and Layer 3 solution.

In the layer 2 solution, all mobile users are connected in a layer 2 network through direct switch, MPLS layer 2 VPN or Ethernet over IP technology. Although this method realizes the seamless roaming, it has serious issues to scale up. The major problem is:

1. The broadcast domain grows with number of users. Take a typical city train system for example, the number of active users can easily exceed 12000 users based on 30 trains with 400 passengers in each train. Put all this IP address in one broadcast domain, creates a lot of unnecessary broadcast burden. Especially when WiFi hotspot is used, the broadcast traffic will dramatically reduce the system capacity.
2. When a train travels, each time when the train connects to a new WiFi AP, the number of MAC entries that needs to be updated in the switch forwarding table is in a burst manner. This also creates a bursting load to the switch which has a big impact to the performance.

In the layer 3 solution, mobile users in each train is connected through router to the network. It avoids the aforementioned big broadcast domain problem and bursting mac table update issue, but it performs poorly for seamless roaming when user moves in and out of trains.

NAT routers in the market allows clients belong to different VLAN to reuse private IP address space by using separate Virtual Routing and Forwarding(VRF) instance. To allow traffic from different VLAN to access shared internet, it does the VRF aware NAT. But even in this solution, when user travel across different VLAN, the user traffic will break and reconnection is needed.

Clearly a better solution is needed for implementing large scale hot spot for public transportation system.

SUMMARY OF THE INVENTION

In the present invention, an apparatus called Enhanced Network Address Translation (ENAT) router is described. The ENAT router is location aware. It makes use of VLAN to partition the clients. Each VLAN can be a separate routing domain supported by a Virtual Routing and Forwarding (VRF) instance. Each NAT mapping entry will map the internal IP:Port:LocationID tuple to an External IP:Port where the LocationID could be the VLAN number or VRF index.

The present invention separates the IP addresses into two different categories: category 1 that supports seamless roaming cross VLAN and category 2 that doesn't support seamless roaming as in traditional NAT.

In this way all the mobile users could be put in category 1 and share the same overlapped IP subnet. By adopting a global IP address scheme across all VLANs, client's assigned IP could move between VLANs without conflict with each other. When the clients first initiate the connection, the mapping entry is created with the initial Internal IP, Port and VLAN number mapped to External IP and Port.

To ensure a continuous TCP, UDP session without broken when clients move between different VLANs(VRF number also changed), a simple but effective algorithm could be used to keep track of the latest Locan ID(VLAN Number) for IP addresses in category 1. For every outgoing traffic passing through ENAT, it searches for a mapping entry and updates the LocationID based on the internal IP:Port:LocationID tuplet. When an entry is found, the LocationID is updated if the value is changed. When the entry is not found, the new entry will be created.

In summary, the present invention solves the large scale mobile user roaming issue effectively with the following methods:

- Partitioning mobile users into different VLAN according to their physical location to solve the big broadcast domain issue.
- Adopting a global overlapped IP subnet and put mobile users IP to category 1 so that they can roam between VLAN without connection broken.
- Use location aware ENAT to update the LocationID with the VLAN number when users move across VLAN so that the TCP/UDP session remains the same for outgoing traffic and deliver to user's current VLAN for the incoming traffic.

This unique solution combines the benefits of both Layer 2 and Layer 3 roaming solution. It supports the seamless roaming like in Lay 2 but it can scale up to public transportations as solutions in Layer 3 solution. And it also works seamless with traditional NAT method just by configuring the

IP to be category 2.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

A preferred form of the present invention is illustrated in the accompanying drawings in which:

Fig. 1 illustrates the typical setup diagram for ENAT usage.

Fig. 2 illustrates the information contained inside a the internal to external mapping entry.

Fig. 3 illustrates the packet processing flow for ingress traffic to the LAN interface.

Fig. 4 illustrates the packet process flow for ingress traffic to the WAN interface

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the following description, the preferable embodiment will be explained based on the accompanying drawings . It shall be apparent to one skilled in the art, however, the invention may be practiced without such details.

ENAT Architecture

As shown in figure 1, ENAT could be used to serve multiple VLAN. It consists of the following major components:

- Item 1 is the WAN interface which has the external IP,
- Item 2 is the location aware enhanced network translation engine which does the address translation,
- Item 3 is the ENATMap table which contains the entries that maps internal IP:Port:LocationID to external IP:Port,
- Item 4 is the LAN interface which is logically separated into different VRF domain to serve different VLAN.
- Item 5 represents users insides one VLAN.

ENAT Data structure

The location information to support seamless roaming is stored inside the ENATMapTable. The information contained in each entry is described in figure 2. It contains the following items as the minimum:

- Internal IP
- Internal Port
- Internal Location ID
- External IP
- External Port.

Internal IP refers to the IPs assigned to each of client inside each VLAN. Single or multiple DHCP could be used to assign IP addresses to each client. When multiple DHCP server is used, they use preallocated IP address pools without overlapping.

Internal Port refers to the TCP or UDP port when client sends out ip packet.

Internal LocationID refers to the VLAN ID that the packet is received from the ENAT internal LAN interface.

External IP refers to the WAN interface IP.

External Port refers to the assigned TCP/UDP port for the outgoing packet corresponds to the packet with internal IP:Port:LocationID tuplet.

The entry could contain more information to identify the destination IP, port information for enhanced security check.

Traffic Processing Flow and Algorithm

For traffics ingress to LAN interface, the translation engine is activated after the routing is done and the processing flow is described in figure 3.

When the ENAT system starts, it will wait for the ingress packet to internal LAN interface. Based on the received internal IP, Port and VLAN ID, it will build a search criteria based on the internal IP address categories.

- For category 1 internal IP that allows roaming, the searching criteria will only contains the internal IP:Port.
- For category 2 internal IP address that no cross VLAN seamless roaming is allowed, the searching criteria will contains the internal IP:Port:Location ID. The location ID could be just the incoming VLAN interface ID.

With the search criteria ready, ENAT will search the Map entry inside the ENATMapTable. If an entry is not found, a new map entry will be created. Otherwise, if the LocationID is different from the existing entry, a roaming has been detected and the new LocationID will be updated inside the table.

With the updated internal IP-Port-LocationID to external IP-Port mapping, the internal address is then translated to the external IP and Port. The packet is then transmitted from the WAN interface with the address translated.

For traffic ingress to WAN interface, the translation engine is activated before routing and the processing flow is described in figure 4.

FOr each received packet from WAN interface, it will search for the Map Entry based on external IP and Port. If no entry found, the packet is ignored. When an entry is found, the external IP:Port is then translated to the recorded internal IP:Port. And the packet is then transmitted through the correct VLAN based on the LocationID.

What is claimed is:

1. A method to enable mobile users to roam across VLAN without connection broken that comprising:
   an apparatus that comprises of WAN interface, LAN interface and a location aware network address translation engine that can track internal user's location information and

   a data structure of internal to external mapping entry that contains internal IP, internal Port, LocationID, external IP and external Port and

   a configuration item to differentiate the internal IP to be roaming allowed category and roaming not allowed category and

   a search algorithm for the network address mapping entry which is based on the configured internal IP's category and

   a packet processing algorithm for packets ingress to LAN interface and

   a packet processing algorithm for packets ingress to WAN interface.

2. An apparatus as claimed in claim 1, wherein the said address translation engine updates the location information of the mapping entry when user move to a different VLAN.
3. An apparatus as claimed in claim 2, wherein the said updating of user's latest VLAN information is updated for each packet ingress to LAN interface.
4. A search algorithm as claimed in claim 1, wherein the said algorithm searching for the network address mapping entry is based on whether roaming cross VLAN is allowed for the internal IP.
5. A search algorithm as claimed in claim 4, wherein if the internal IP is allowed to roam, the mapping entry is identified only by the internal IP and port.
6. A search algorithm as claimed in claim 4, wherein if the internal IP is not allowed to roam, the mapping entry is identified by the internal IP, Port and Location ID where the location ID could use VLAN number.
7. A packet processing algorithm for packets ingress to LAN interface as claimed in claim 1, wherein the said algorithm updates the Location ID information in the mapping table when user move from one VLAN to another.
8. A packet processing algorithm for packets ingress to WAN interface as claimed in claim 1, wherein the VLAN number that the network address translated packets will be transmitting is determined by the Location ID information inside the mapping entry.