DOME Milestone S2.i

July 15, 2101

Description

Develop a plan for extending VLAN connectivity to DOME endpoints on buses, etc.

Problem Statement

The GPO has a vision of interconnecting test beds via VLANs. This is because VLANs can isolate network traffic and allow the interconnected test beds to be a single subnet. VLANs also allow for the possibility that a researcher could perform protocol research, bypassing TCP/IP and directly access layer 2.

VLANs are implemented by configuring cooperative switches. A switch is configured to identify traffic received on a particular port as belonging to a specific VLAN. The switch tags the packet, and the other switches that make up the VLAN are configured to forward the packets through the appropriate ports. A VLAN is typically implemented as a single broadcast domain, i.e., all nodes that are a member of the VLAN receive a packet broadcast on the VLAN.

UMass has a single VLAN tag allocated for GENI. The UMass VLAN terminates at the service used to manage both the ViSE and DOME projects.

DOME is a test bed consisting of approximately 35 transit buses. Experiments running on the buses have access to a PCI WiFi card. If desired, experimenters may modify the kernel and directly access the driver. The WiFi card and its policy for associating with access points belong exclusively to the experiments. Experiments also have access to a 3G link via a TCP/IP Ethernet port that is NAT-routed through a 3G PPP link in the host domain. In contrast to the WiFi card, the 3G link is a shared resource and used as the DOME control plane.

DOME is a mobile, wireless test bed. Connectivity to nodes outside of the test bed are opportunistic: either through open access points, sessions that often last only a few seconds; or through the 3G network, which on average has connectivity approximately 90% of the time. In either case, connectivity to nodes outside of the test bed is through the Internet, via foreign access points, routers and switches.

It is obvious that directly connecting the test bed to the VLAN using the existing hardware is not feasible. We investigated how it might be possible to extend the VLAN to the buses, i.e. how an experiment on a bus might be part of the subnet as the VLAN.

Tunnels, Layer 3 IP Routing

We looked at layer 2 tunnels and decided against them. A layer 2 tunnel would allow layer 3 software to execute over a TCP/IP network, as if it were directly connected to the physical layer. Protocols such as L2TP have been defined to standardize the packets exchanged by tunneling implementations. The implementations have several drawbacks for our environment:

- They tend to be implemented for use with PPP or an implementation of a VPN. Their purpose is not to serve as a general-purpose layer 2 interface.
- They are typically point-point. We would need to bridge and multiplex the buses over a single VLAN interface on our host server.

In short, there is no existing client implementation that we are aware of that could export a straight-forward L2 interface on the buses, with compatibility to a server that could bridge the multiple buses over the VLAN. Attempting to implement such a solution ourselves is well beyond the scope of our available resources.

However, even if such a solution existed we would have to question whether it was the correct approach.

- If an experiment needs to tunnel over the Internet then it's unclear that the endpoint should be the UMass VLAN. It may make more sense to tunnel directly to the researcher's system.
- A user that requires direct layer 2 access might expect a particular interface (and potentially already have a tunneling implementation).
- It's not clear any experiment would require the appearance of layer 2 access from the buses to a VLAN subnet. Nor is it even understood that the buses would need to be a member of the VLAN subnet. If VLAN connectivity were required, it's possible that it would be sufficient to have TCP/IP routing from buses to the VLAN subnet. And, if that was what was required, the specifics of the experiment might dictate whether this would need to be through the 3G control plane or the experiment-managed opportunist WiFi interface.

It's impossible to extend VLAN connectivity with software when you have no ownership or control of the intermediate network. If someone had a lot of time and resources they might be able to hide, through abstraction, that each bus is a member of its own subnet separate from the VLAN, and hide that the Internet and TCP/IP separates the buses and VLAN (aside from performance factors, of course). However, it's not clear that whatever solution was chosen would meet the needs of any specific experiment.

If an experiment were to need only to route from the buses to the VLAN using standard IP routing, then we may be able to configure port forwarding or configure some similar solution without requiring a custom software solution. However, the VLAN is shared between ViSE and DOME so no configuration can be made static. Also, the subnet that the VLAN belongs to is subject to change as the VLAN is reconfigured.

Hardware Solution

UMass plans to install WiMAX clients on a few buses next year. The configuration on the buses is to be determined, but we will have control over the WiMAX base station. We have requested of our Office of Information Technology (OIT) a separate VLAN port and tag to the WiMAX base station. Assuming we get the port, we will have control of the networking hardware between the buses and VLAN endpoint. This should allow us to physically configure the WiMAX buses to be on the same VLAN. We are looking at the resources to make it work.

Summary

We will not attempt to implement or install software on the buses to provide tunneling to the UMass VLAN endpoint.

If an experiment has a use for routing traffic sent by the buses over the Internet through the UMass VLAN, we will work with the researchers to determine how we might provide the connectivity.

We hope to connect the WiMAX base station to a VLAN and, if so, we will work with Rutgers University to provide a configuration that extends the VLAN to the buses with WiMAX clients.