In-Depth Carrier Ethernet Device Configuration Representation - The Foundation for Troubleshooting

Processing network events into root-cause alarms is aimed at providing network operations staff with actionable indications of apparent network problems. Once alerted to a network problem, network operations staff is typically tasked with trouble verification and isolation. An accurate representation of device and network configurations is key to facilitate the trouble verification and isolation process. In particular, for service provider's Carrier Ethernet networks, a clear view of the various ways that customer traffic is mapped to different network transport technologies is fundamental toward isolating a network issue. Cisco® Active Network Abstraction (ANA) provides the in-depth representation of device configurations for network elements deployed in Carrier Ethernet networks.

Introduction

Cisco ANA is a network management foundation for Cisco-based service provider networks.

Cisco ANA addresses the challenge of managing converged, multiservice IP networks through its unique, model-based virtual network abstraction. This virtual network abstraction represents, in detail, the configuration of network elements deployed in Carrier Ethernet and IP Radio Access Network (RAN) backhaul/Mobile Transport over Packet (MToP) networks.

Having detailed configuration information available, at a glance, and being able to navigate along the associations among physical and virtual components gives a user (or external application) the roadmap toward isolating the location and cause of a network issue.

Scope of Virtual Network Abstraction

Cisco ANA’s focus is on network and device support for converged IP next-generation networks (IP NGNs). Specifically, Cisco ANA's benefits extend to:

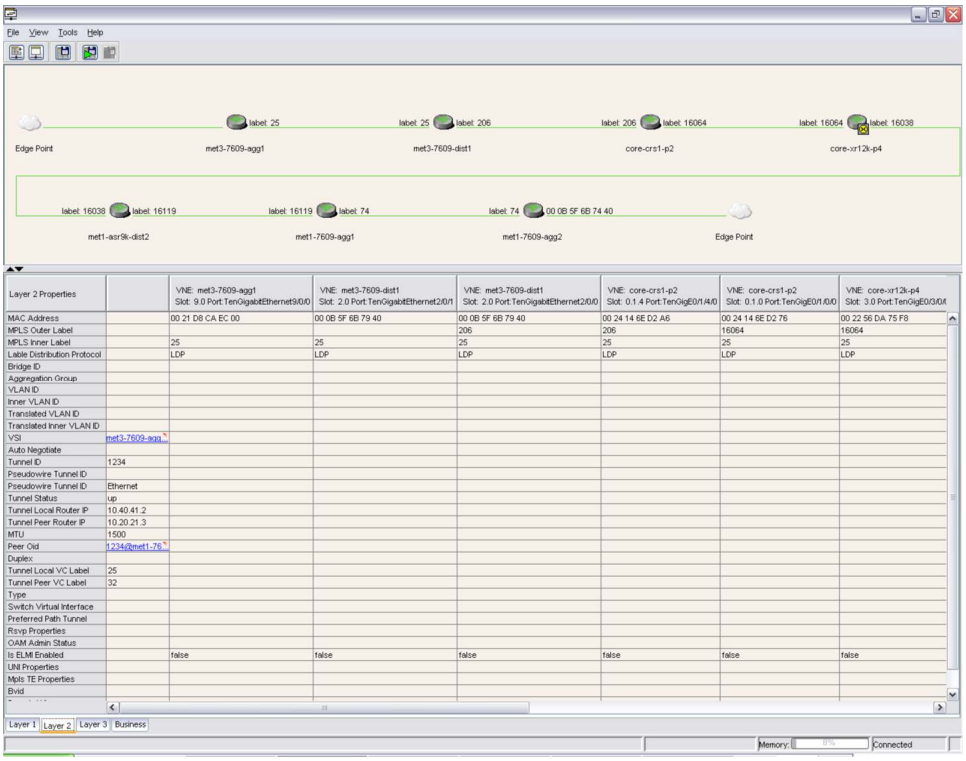
- Converged IP/Multiprotocol Label Switching (MPLS) core and service edge networks
- Carrier Ethernet networks
- IP RAN backhaul/MToP networks

Representation of Relationship Among Technology Layers

The fundamental network transport and IP technologies play a crucial role in IP NGN solutions. Cisco ANA's virtual network abstraction represents the relationships among various networking layers and technologies. For example, as operators trace Carrier Ethernet or IP RAN backhaul services, Cisco ANA relates these to underlying technologies, such as MPLS Pseudowires, Ethernet links, or Generic Routing Encapsulation (GRE) tunnels. Similarly, access technologies like Point-to-Point Protocol (PPP) and multilink PPP are made visible. This ability for detailed representation of the relationships among network technologies makes it possible to recognize causality among event and status indicators. Mismatches among technology configurations also become more apparent.

For example, Cisco ANA's PathTracer application (described in a later section) displays key attributes for various networking layers that are encountered by a hypothetical data packet as it traverses network elements toward its destination. Figure 1 highlights Layer 2 attributes. Tabs within this user interface offer users access to attributes associated with other, traversed networking layers.

Figure 1. PathTracer with Networking Layer Information

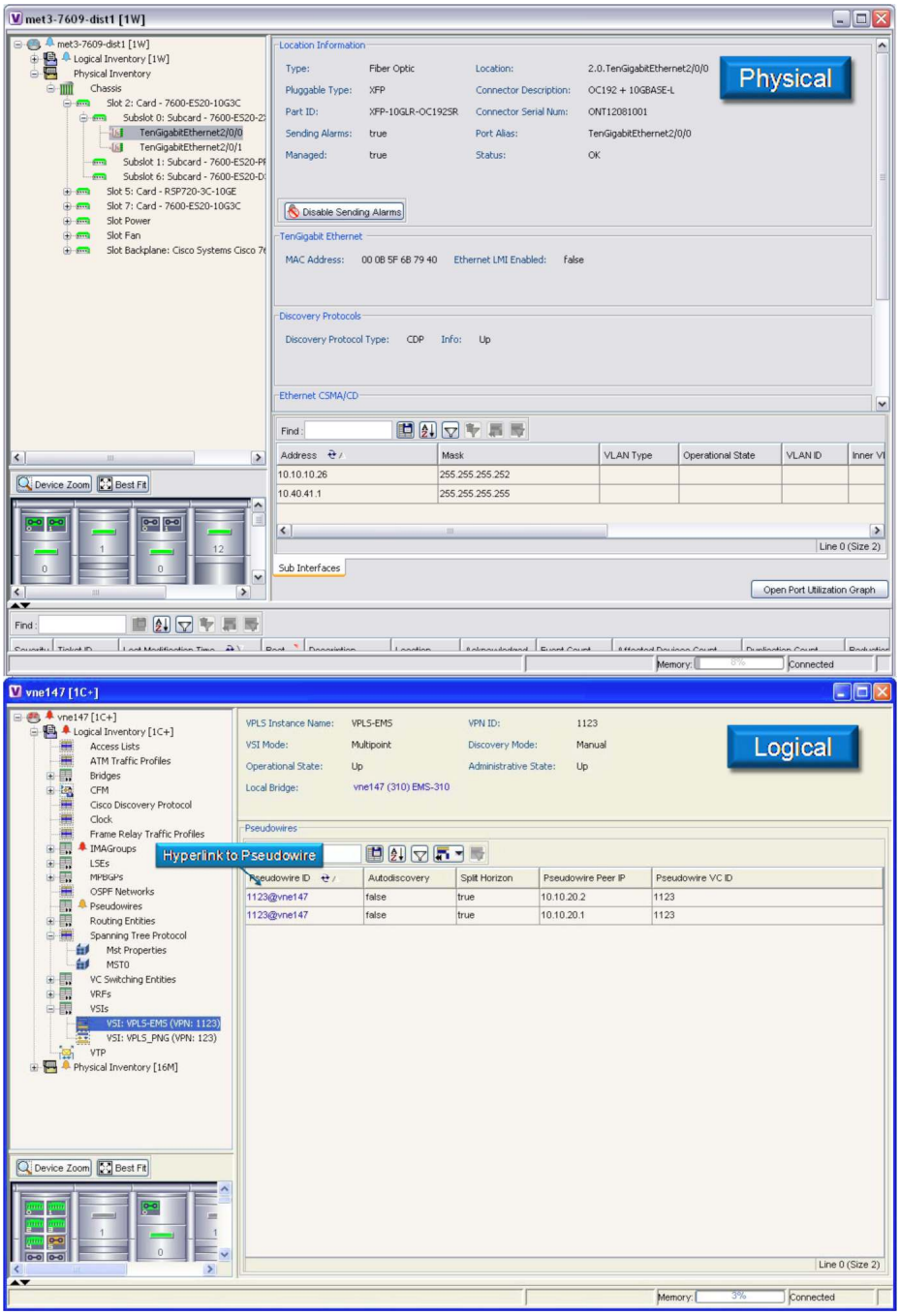


Physical and Logical Interface Configurations

Cisco ANA supports Carrier Ethernet network troubleshooting and verification activities through some of the following operations (see also Figure 2):

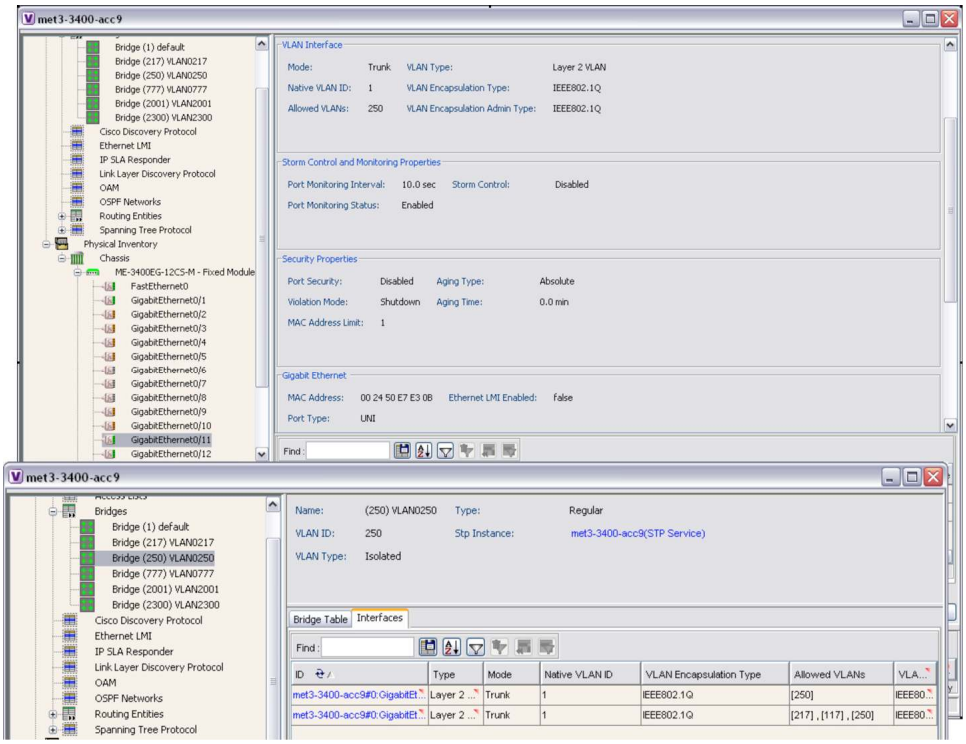
- Visibility into port, VLAN, Virtual Private LAN Service (VPLS), Traffic Engineering (TE) tunnels, and Pseudowires on network elements.
- Representation of detailed VPLS configurations, including the configuration of Virtual Switching Instance, associated Pseudowires, attachment circuit ports, plus hyperlinks among these components in the user interface to facilitate navigation among the associated configuration properties.
- Visibility into VLAN tag manipulation on network elements to assist network operators in following Ethernet paths across multiple VLAN domains.
- At-a-glance view of Resilient Ethernet Protocol (REP) configurations showing participating devices and traffic direction, for example, around a REP ring away from a blocked port.
- Easy-to-follow device component relationships through point-and-click links for navigation from one component to a related component.

Figure 2. Physical and Logical Interface Properties



Visibility into particular port configurations further assist users in determining whether network traffic is allowed to traverse this port or pass from one port to another, even if the ports are operationally active. Specifically for the Cisco ME 3400 Series of devices, ANA represents the currently configured port type, including User to Network Interface (UNI) or Network to Network Interface (NNI), along with other attributes that either block (Isolated port) or allow (Community port) traffic to be exchanged among UNI ports (see Figure 3).

Figure 3. Port Properties

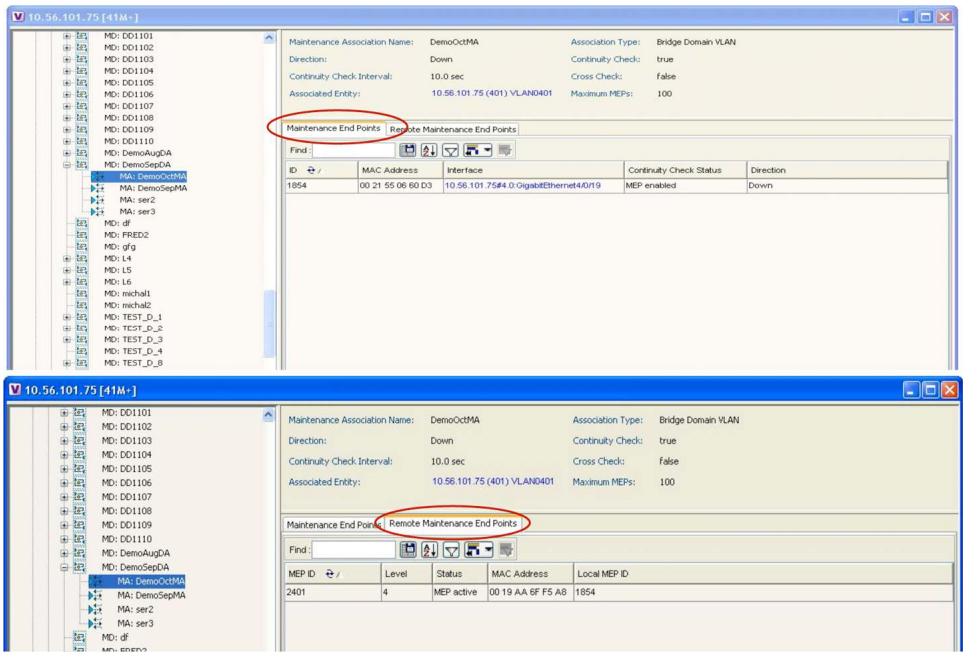


Connectivity Fault Management (CFM) Configurations

Various methods designed for Carrier Ethernet problem isolation are provided by the network itself. The primary method for end-to-end Ethernet virtual connection (EVC) monitoring is Connectivity Fault Management (CFM). See Figure 4. CFM is supported on devices such as the current versions of Cisco 7600 Series Routers or Cisco ME 3400 Series Switches. Cisco ANA interacts with devices to offer:

- Representation of CFM (802.1ag) configurations
- Access to CFM device features (CFM ping, CFM trace)

Figure 4. Connectivity Fault Management Properties

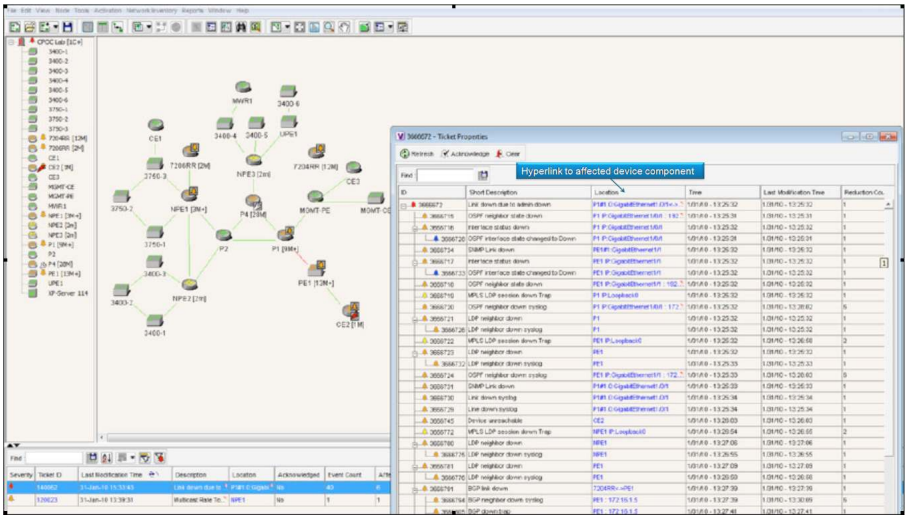


Here, too, the representation of CFM configurations makes it easier for users to identify trouble isolation points and determine where to initiate CFM-based tests. Cisco ANA also retrieves from a device the information about any remote maintenance endpoints (MEPs) that the device discovered from far-end devices for a given maintenance association. When initiating CFM-based tests, the readily available information about remote MEPs and corresponding status greatly simplifies selecting remote MEPs for connectivity tests.

Network Maps

Cisco ANA NetworkVision supports the creation of multiple network maps, which can represent different network views. These views can cover specific network segments, customer networks, or any other mix of network elements desired. The network maps provide a graphic display of active faults and alarms and serve as an easy starting point for problem isolation. Once created, the maps are available for all connecting clients (according to their access privileges).

Figure 5. NetworkVision Map and Hyperlinked Alarms



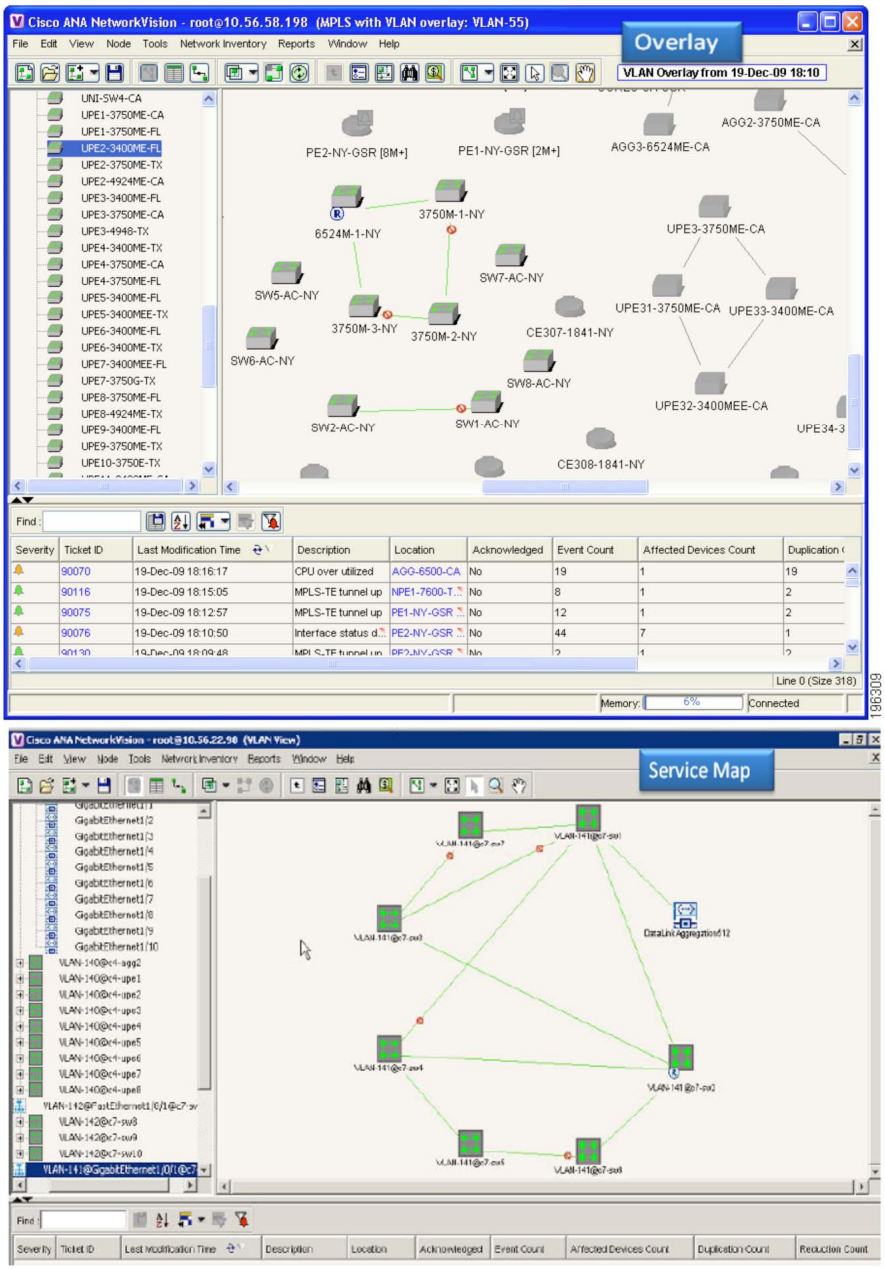
NetworkVision displays a list of root-cause alarms (referred to as Tickets). Each root-cause alarm can be expanded to show the complete correlation tree of correlated events (Figure 5). From this correlation tree, a user can navigate to the device component that has been affected by the event and review the specific component configurations that are described in the preceding sections.

Virtual Connections

In addition to network maps, Cisco ANA can be used to view virtual connections, either as an overlay on top of a physical network map or through dedicated service maps.

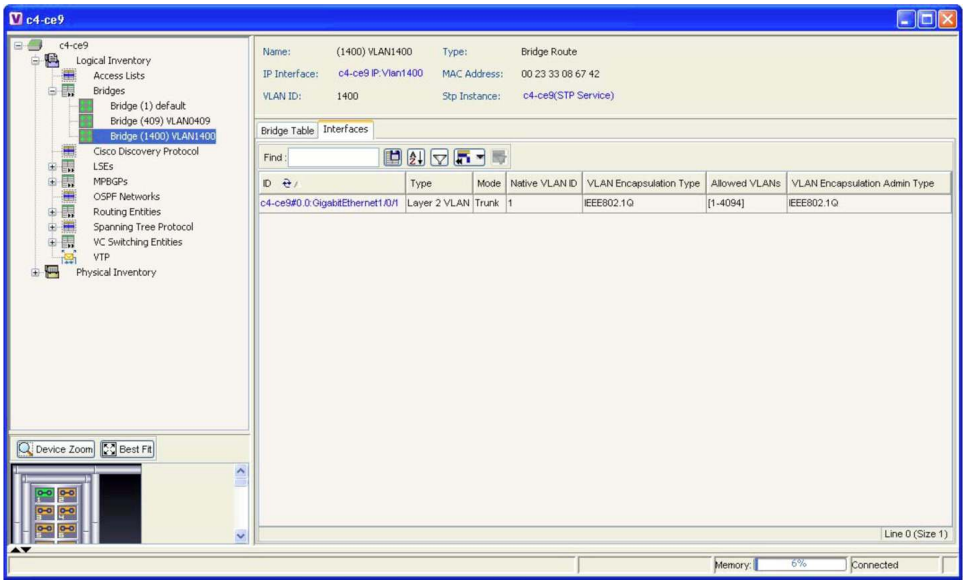
With overlays on a physical map, a user can focus the topology display on the components traversed by a selected virtual connection. Figure 6 shows an overlay of a selected VLAN. The network elements and physical links used by the selected VLAN are highlighted in the network map. All other network elements and links are dimmed. The VLAN name is displayed in the title of the window. This type of overlay assists a user in quickly identifying specific devices associated with a particular virtual connection, such as a selected VLAN, to navigate into device configurations for detailed trouble verification and isolation.

Figure 6. Virtual Connections Through the Overlay and Service Map



A service map can display the logical components and topology of virtual connections defined on the network. For VLANs, a service map illustrates the bridging elements, VLAN termination points, and VLAN links among bridging elements and termination points. Decorators illustrate the forwarding path that is dynamically determined by the active Spanning Tree Protocol. Tickets (root-cause alarms) associated with the components shown within the service map are listed in a panel below the service map. This type of service view assists users in quickly identifying logical components associated with a VLAN to navigate to for closer investigation. For example, a user can, at a glance, identify the current spanning tree root bridge element or other bridge element that is a member of a given VLAN to start further investigation. Detailed user- or protocol-configured properties, for example, associated interfaces or bridge table, of a bridging element help users identify issues in the forwarding behavior of that bridging element (Figure 7).

Figure 7. Bridging Properties, Including Bridge Table and Interfaces



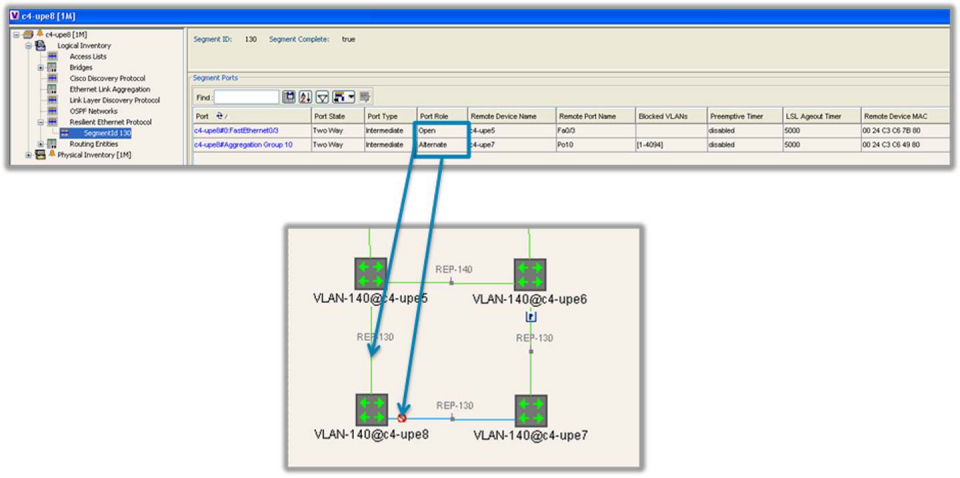
Forwarding Paths

Cisco ANA creates graphical representations of various network topologies, including VLAN and MPLS VPN topologies. These topologies provide network operations staff:

- At-a-glance views of network elements traversed by VLANs or MPLS VPNs.
- Spanning Tree Protocol overlay icons for quick determination of actual forwarding paths across a VLAN during problem investigation and verification of backup paths.
- Pseudowire topology views to help visualize emulated service paths, such as time-division multiplexing (TDM) circuits within IP RAN backhaul networks or point-to-point Ethernet connections across Ethernet-over-MPLS (EoMPLS) emulations.

These types of representations offer users the visual references of associations created by virtual network connectivity across the physical network. Additional information about the effects of dynamic path selection protocols, specifically Spanning Tree Protocols or Resilient Ethernet Protocol in the context of Carrier Ethernet scenarios, lets a user discern the network-selected forwarding path from among the possible configured network paths (Figure 8).

Figure 8. Decorators Indicate the Forwarding Path (According to the REP Configuration)



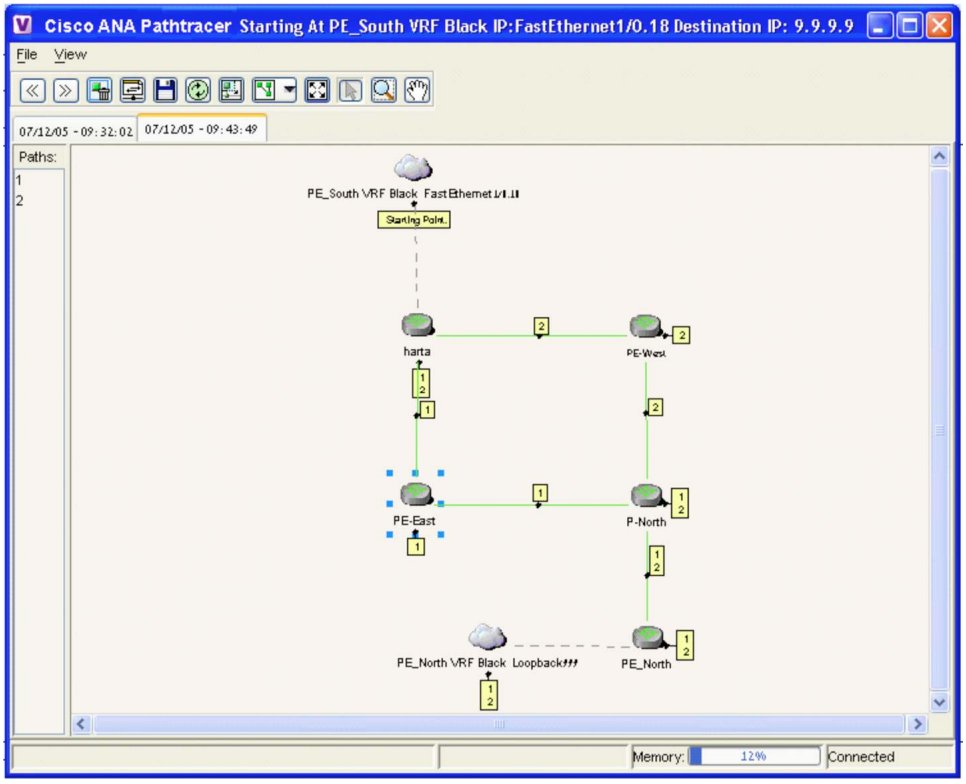
Cisco PathTracer

As previously described, Cisco ANA maintains a live virtual network abstraction model, built from the atomic components of the network (interoperable interfaces, protocol stacks, forwarding entities, and links). This virtual model of detailed device configurations helps enable Cisco ANA to trace physical and virtual connections between any two points in the network, across devices and technologies. The tracing mechanism simulates (within the ANA virtual model) the path of the traffic in the actual network. This is done by stepping hop by hop through the virtual model, moving up and down the network layer stack, and looking up the next hop in the forwarding entity (similar to the way that IP packets or Ethernet frames are forwarded in the actual network). The path is recomputed for every path-trace request to reflect the current (up-to-date) topology of the network (Figure 9).

The path tracing functionality is utilized in two ways within Cisco ANA:

- Allowing users to trace and view end-to-end paths/services using the Cisco ANA PathTracer application, which provides a graphical view of the path (with the respective properties of each node along the path, at every traversed networking layer), helping users pinpoint configuration problems along the path.
- Cisco ANA's fault correlation application uses the path tracing functionality to gather events from managed network elements along a traced path for topology-based correlation and root-cause analysis.

Figure 9. PathTracer (Multipath Example)



Tracing Carrier Ethernet Configuration

In addition to tracing IP packets, PathTracer supports the ability to trace and visualize the path a simulated Ethernet frame would take across the network to a MAC address, providing:

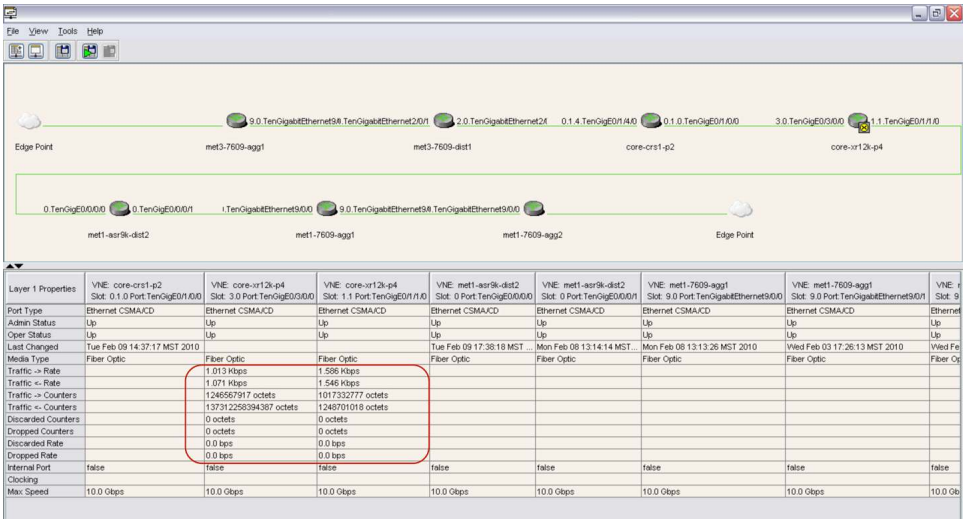
- Trace of Ethernet paths across complex network configurations involving service provider VLAN and VPLS domains for easier problem isolation.

- Assisting operators in obtaining path visualizations across VLAN translations, VPLS configurations, active paths around REP rings.

The Cisco ANA PathTracer represents detailed device component configurations encountered by a simulated IP packet or Ethernet frame as it traverses Cisco ANA's live virtual network abstraction model. The extensive static and dynamic configuration information that is displayed by Cisco ANA PathTracer greatly simplifies verification of the expected forwarding behavior and operational health of components along a traced physical or virtual path across the network. Unique to the representation offered by Cisco ANA PathTracer is the depiction of the associations among network technology stitching points (for example, VLAN translations, VLAN to VPLS mappings) and network hierarchies that are traversed by the simulated IP packet or Ethernet frame. Many network issues arise particularly when network traffic needs to traverse these stitching points or hierarchy transitions.

For a snapshot of the latest transmission rates, Cisco ANA PathTracer displays traffic and error statistics for each link and each hop across the path, helping direct users' attention to potential problems that may cause service degradation (Figure 10).

Figure 10. Path Trace of Ethernet Frame Showing the Latest Transmission Rates



Cisco ANA - The Foundation for Carrier Ethernet Troubleshooting

Cisco ANA is a network management foundation for Cisco-based service provider networks. A key aspect of this foundation is the accurate representation of physical properties and logical configurations of devices deployed in Carrier Ethernet networks.

The thorough configuration representation is facilitated by Cisco ANA's unique, virtual network abstraction, providing the foundation for Carrier Ethernet troubleshooting. For faster navigation through vast amounts of networking information, users can use Cisco ANA's ability to represent physical and logical interface properties as well as the ability to represent relationships among networking layers and technologies. Connectivity Fault Management configurations are represented by Cisco ANA, which facilitates quicker identification of trouble isolation points. Cisco ANA's network maps help users to visualize the physical topology among network elements as well as, through overlays and service maps, to visualize virtual connectivity, that is, VLAN and MPLS VPN topologies. Beyond VLAN topologies, ANA illustrates the forwarding paths, as determined by Spanning Tree Protocols and Resilient Ethernet Protocol. Using Cisco ANA's PathTracer application, users can further visualize the path a simulated IP packet or Ethernet frame would take to a destination. Here, the user can view key properties associated with various networking layers and technologies that the simulated IP packet or Ethernet frame would encounter as it traverses network elements toward its destination.

Cisco ANA provides the roadmap toward isolating the location and cause of a network issue through its continually updated configuration representation. Once alerted to a network problem, for example, through Cisco ANA's root-cause alarms, network operations staff may utilize network maps of physical and virtual topologies to determine the starting point for trouble verification and isolation. Cisco ANA's clear representation of forwarding paths, tracing of virtual connections, and in-depth device configuration information then simplify the assessment of forwarding behaviors in Carrier Ethernet networks to verify and isolate network issues in detail.

For More Information

For more information about ANA, visit http://www.cisco.com/go/ana, contact your local Cisco account representative, or send an email to ask_ana_pm@cisco.com.

Integration information can be found at http://developer.cisco.com/web/ana/home.

The latest ANA user and reference guides are available at http://www.cisco.com/en/US/products/ps6776/tsd_products_support_series_home.html.

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