

# End-to-End Network–Centric Performance Management

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# Application Performance

- Networks exist to support applications and services
  - Application or End-User Experience is what matters
- Application performance is often very specific to the application
  - Audio and video streaming
  - Interactive audio and video (e.g., conferencing)
  - Data transfer (e.g., cloud data backup solutions, peer-to-peer file sharing)
  - Gaming
  - Texting, Tweeting, blogging, etc.
  - Enterprise applications (e.g., database applications, Citrix applications)
  - LTE
- Performance measurements need to relate to the perception of the end-user
- Requires adequate network service performance and network element

# Network Service Performance

- Network service performance exists as a middle layer contract between network providers and network consumers
  - Abstraction of layers is important both organizationally and in technical solutions
- Network service level performance measures are independent of carried applications
  - Delay
  - Jitter
  - Loss
  - Throughput
  - Availability
- E.g., Metro Ethernet Forum Service Definitions

# Network Element Performance

- Traditional network management focuses at an element level
  - Interface utilization
  - Per-hop delay, jitter, loss
  - Queue statistics
  - Buffer statistics
  - Device CPU utilization(s)
  - Device RAM utilization(s)
  - Connection statistics
  - Routing protocol statistics
  - Up/down status
- Network element performance is required to achieve higher-layer requirements

# Performance Management Goals

- Monitor and report on performance
- Bring attention to performance problems
- Perform triage
  - Identify the type and scope of the problem
  - Prioritize
  - Assign to appropriate domain
- Support troubleshooting, root cause analysis, and resolution

# Application-Aware Network Performance Management

- Integrate application level awareness into network performance management solutions
- Various levels of integration in ANPM
  - Individual product and domain silos
  - Suite or cross-vendor data integrations
  - Suite or cross-vendor workflow integrations
  - Seamless workflow integrations
- Solution options and challenges depend on contexts
  - Service provider delivering their service over their network
  - Over-the-top service provider over multiple network service providers
  - Enterprise application over a service provider network
  - Enterprise application hosted at a cloud platform

# Unified Data Management

- Bring different types of data together from many different sources
  - Multiple domains
  - Multiple layers
- Provide intelligent data management capabilities to manage the data deluge
  - Filtering
  - Aggregation
  - Alarming/Alerting
- Present relevant data in specific application or network context
- Handle missing and incomplete data
- Aided by vendor in-device instrumentation and standardization

## Examples of Data Types

- Utilization (e.g., Interface , CoS , LSP load)
- Device Metric Data (e.g., RAM, CPU, up/down)
- Traffic Data
  - NetFlow, NetStream, jFlow, sFlow, IPFIX, etc.
  - Packet capture
- Point-to-Point Performance Data
  - Cisco IPSLA, Juniper RPM, Huawei NQA
  - Synthetic tests (e.g., ping-like)
- Operational Routing Information
  - Routing tables, BGP RIB-IN
  - LSP routes
  - Layer-2 spanning trees, CDP, LLDP, CAM/MAFT
  - Arbitrary show command output
  - ARP tables
- Topology and Configuration Data
  - Running/startup configuration files, config change history
- Event Data (e.g., Syslog messages, SNMP traps)
- Application and Server Information
  - Application architectures
  - VM and server locations



# Unified Data Presentation

- Dashboard and monitoring views correlating data across multiple domains
- Network performance
- Traffic
- Routing

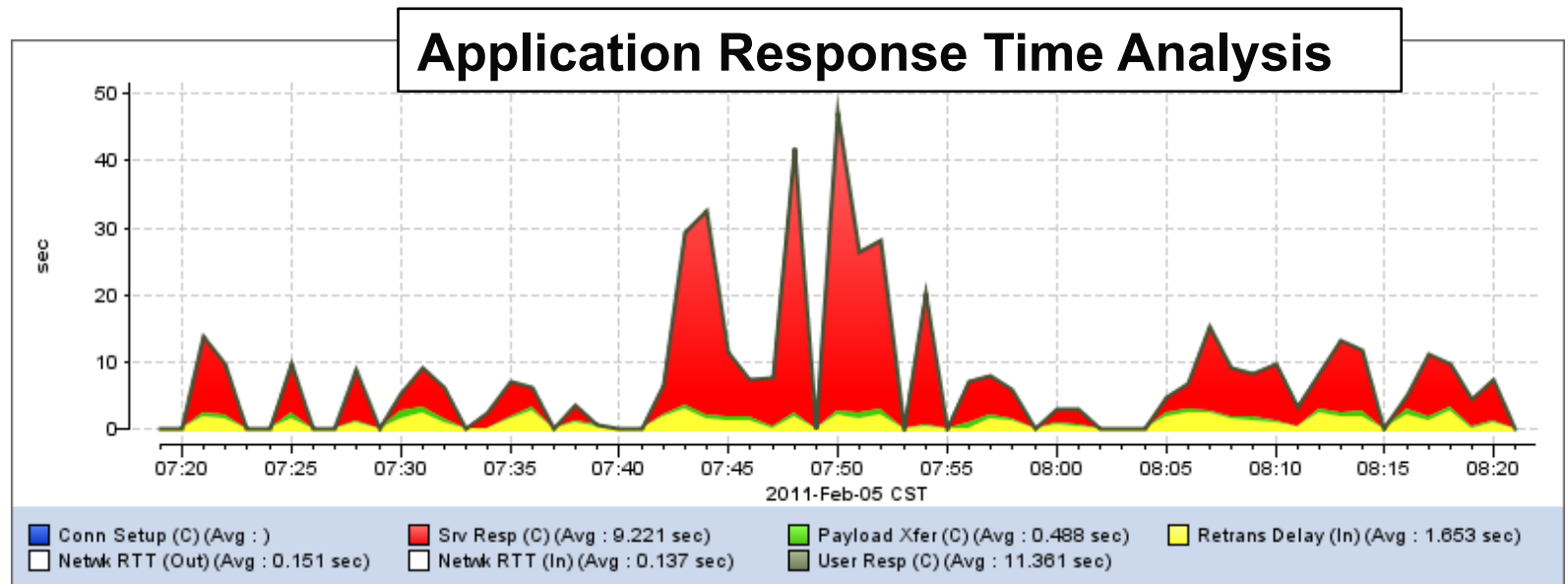
The screenshot displays the nCompass network management interface. At the top, there's a 'General' tab and a 'Network Topology' window showing a map of the Americas with various nodes and connections. To the right, there are several performance gauges: 'Node SNMP Polling Notifications Network' (a green circle), 'Interface Utilization (Out) % Network' (a gauge showing 0-100%), and 'RAM Utilization % Network' (a gauge showing 0-100%). Below these are two log windows: 'Administrative Log' and 'Network Log', both with columns for Date, Severity, Object Type, Object Name, Event Type, Source, and Description. At the bottom, there's a traffic analysis window titled 'DENCSDST01\_Serial1/0 <> PE1\_Serial2/0 Traffic'. It shows a tree view of traffic flows and a pie chart titled 'Top 5 Applications by Volume (Pie)'. The pie chart data is as follows:

Application	Volume	Percentage
HTTP	56.53%	56.53%
ICMP	25.82%	25.82%
SMTP	2.28%	2.28%
Other	1.65%	1.65%
21	1.65%	1.65%



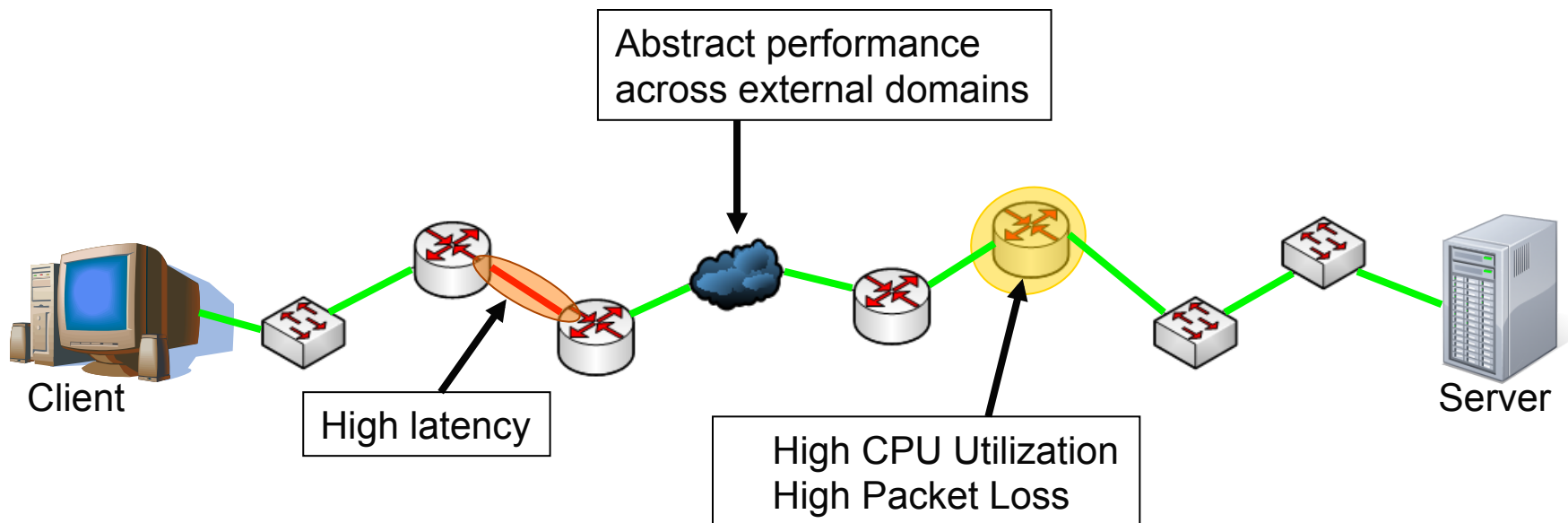
# Troubleshooting (1): Functional Isolation

- Identify the primary culprit
  - Application versus network
  - Server processing versus chattiness or TCP
- Just Me or Everyone



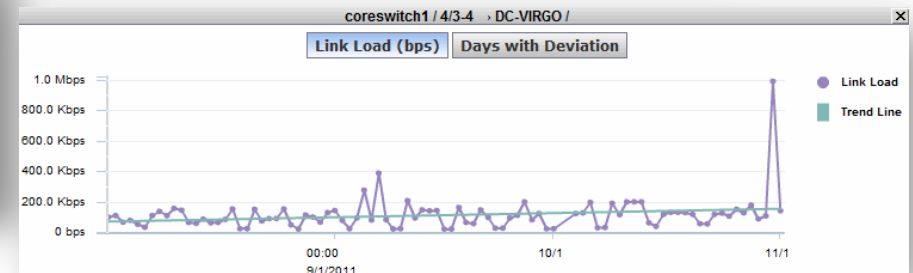
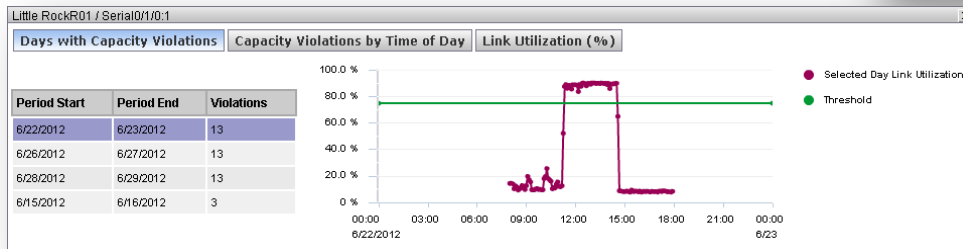
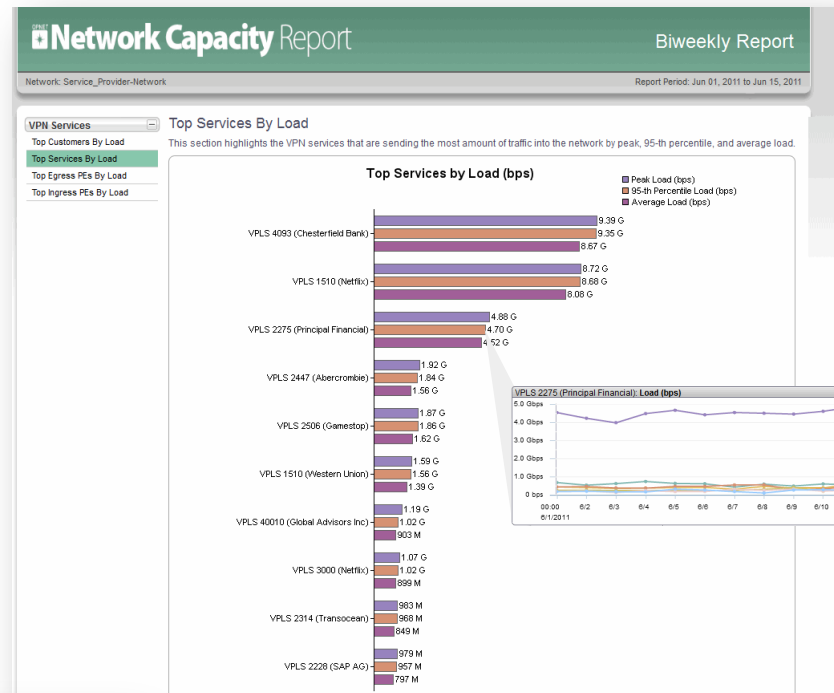
## Troubleshooting (2): Domain and Component Isolation

- Horizontal path analysis across network components and domains
  - Includes internal network and/or service provider network
  - Contains network hops (routers, firewalls, switches) between endpoints
  - Enriched with performance information for hops and elements
  - Associated troubleshooting data including configuration, change information, routing tables, RIB data, traffic data, events, etc.



# Proactive Performance Management

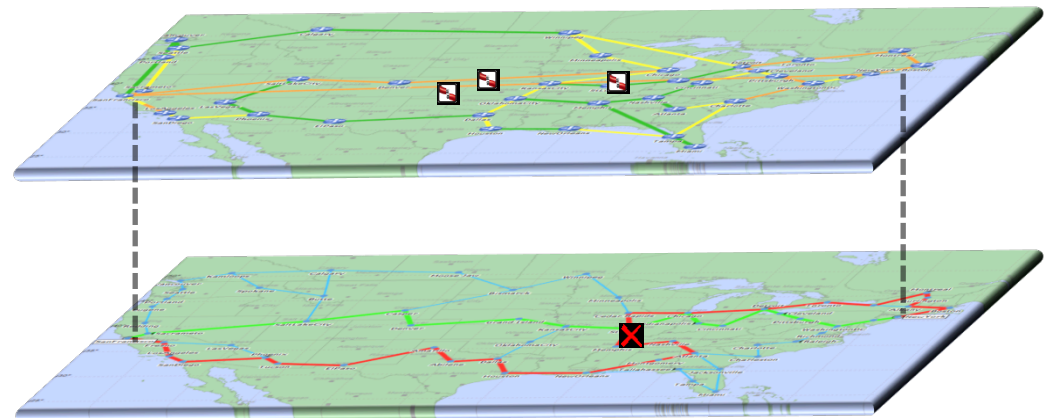
- Analyze capacity trends and identify resources at risk
- Identify atypical behavior
  - Time of day patterns
- Correlate performance metrics impacting services



# Integrating Layer Domains

- Common to have management silos based on network technologies and layers
- Propagate and correlate network data between layers
  - Association of layer-2 links with supporting circuits
  - Routing information
  - Delay
  - Utilization and throughput
  - Failures
- Integrating per-layer monitoring information
- Correlation and drill-down for troubleshooting
- Supports network planning and design

*Relate the impact of failures at the optical or transport layer on links, circuits, services and traffic in the IP/MPLS network*



# Challenges

- Managing data at the scale required for large service provider environments
- Presenting data that is meaningful and actionable (i.e., needle in the haystack problem)
- Delivering troubleshooting and root cause analysis workflows
- Handling incomplete, missing, and incorrect/inconsistent data
- Integrating data from many different sources and domains
- Inconsistencies in data formats and implementation of standards across vendors (e.g., IPFIX, CoS throughput)
- Addressing security and privacy issues across domains
- Working across organizational boundaries