White Paper

Unify Virtual and Physical Mobile Network Management

Cisco Prime Carrier Management's First Application of Network Function Virtualization in Mobility

What You Will Learn

If you're like most mobile operators today, you now have or are planning a heterogeneous environment – of mixed virtual and physical mobile infrastructure – to manage. Managing both separately is costly, time-consuming, complex, and inefficient. What if the same management solution could be available for hybrid environments? Now it is made possible with Cisco® Network Function Virtualization (NFV) technology and the Cisco Prime™ Carrier Management suite. As a first step, the Cisco Virtualized Packet Core (Cisco VPC) provides a virtual evolved packet core (EPC) instance of the industry-leading Cisco mobility solution based on the same, proven StarOS software used in the Cisco ASR 5000 Series Aggregation Services Router platforms. Service providers can manage both physical and virtual infrastructure using the same features, with the same user interface of the Cisco Prime Carrier Management solution. This white paper focuses on describing how the Cisco Prime for Mobility solution extends support for the two deployment options of Cisco VPC: single and distributed instance and visibility into the underlying data center infrastructure. Additionally, use cases that encompass various management and monitoring functions within the virtual and physical mobile infrastructure are presented.

Challenge

With new devices, technologies, and applications being introduced on a daily basis, mobile operators must move quickly and intelligently to respond with infrastructure and services that meet subscribers' needs. The virtualization of workloads and network functions has brought new agility and better resource use. But now operators must manage a mixed environment of both physical and virtual devices, with many layers of complexity, multiple vendor products, and operations team silos. Administrators in different groups are using disparate tools with different workflows to monitor and manage service infrastructure. Introducing new management solutions in this environment entails the complexity of integration, certification, and training. The current environment has made mobile operator environments once again less agile, less competitive, and less profitable over time.

Cisco has responded with a solution that uses NFV to unify the management of physical and virtual service infrastructure workflows. The solution brings a new level of extended visibility into the data center. It helps to minimize or eliminate the cycle of building out and managing networks in silos, so skilled IT staff can spend more time focusing on innovation instead of stitching services together and learning how to use different management tools. Plus, the automation of service assurance with the Cisco solution lowers costs, reduces the risks of human intervention, and speeds troubleshooting to enhance the customer experience.

The Cisco solutions that provide these features to mobile networks include the Cisco VPC and the Cisco Prime for Mobility solution from the Cisco Prime Carrier Management software suite.

The Cisco Virtualized Packet Core - Virtualizing the Cisco ASR 5000

The Cisco EPC and Cisco VPC use the same base software to control packet core functions across both purpose-built hardware and standardized server platforms, so you can easily transition from physical to virtualized packet core services or use both simultaneously in your network. Hundreds of mobile operators throughout the world run the Cisco StarOS Software on the Cisco ASR 5000 Series, providing the capabilities and flexibility necessary to meet the dynamic and ever-evolving demands of the mobile Internet. Cisco VPC adds further elasticity through virtualization and a flexible architecture for adjusting the capacity of the Cisco VPC node across multiple virtualized instances on an x86-based server.

The Cisco VPC is a virtualized mobile gateway that has the same mobile gateway elements, tools, and interfaces as the implementation of the Cisco ASR 5000 Series. It can be deployed as a single instance or as distributed instances. The Cisco Prime Carrier Management support for Cisco Prime for Mobility further extends this commonality into the management workflows so that the operator is presented with a familiar paradigm whether the end nodes are physical Cisco ASR 5000 Series or virtualized through the Cisco VPC. The operator also has the power to drill into the virtualized environment for enhanced root-cause analysis when needed. This support is available whether the Cisco VPC is deployed as a single virtual-machine (VM) instance (VPC-SI) or as a collection of interoperating virtual machines across one or more physical servers (VPC-DI) for larger capacity and increased failover redundancy.

Cisco Prime for Mobility – Now Extended to Virtualized Mobile Infrastructure

The Cisco Prime Carrier Management software suite includes various integrated tools for end-to-end performance monitoring and fault management of the network, compute, and storage environments within data centers. The Cisco Prime for Mobility solution is a use case of the suite that provides mobile network management, including:

- Cisco Prime Central: Provides a common user management interface for all components of the solution, with a single view of integrated operator workflows across the small cells, Radio Access Network (RAN) backhaul, EPC and VPC, and centralized monitoring and troubleshooting capabilities
- Cisco Prime Performance Manager: Provides fast, actionable information for the entire mobile network, including detailed network and traffic statistics for both Cisco and multivendor devices; it supports both custom reports and more than 5000 prepackaged reports that are easily extensible
- Cisco Prime Network: Provides fault monitoring and isolation for these Cisco offerings; capabilities include virtual connectivity discovery, root-cause identification, and alarm reduction through topology-based correlation and de-duplication

Unified Service-Assurance Benefits

With distributed systems that include virtual machines, VNFs, physical hardware, and different applications and management solutions, troubleshooting problems across mobility services and infrastructure from the cell tower to the data center is time-consuming, complex, and often error-prone. It’s like trying to translate information from one language to another, and then another.

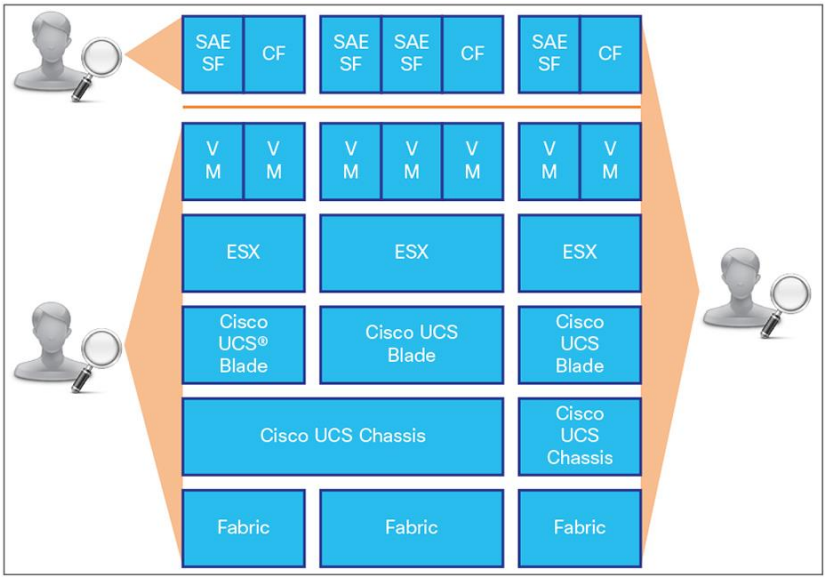
The lack of correlation of events across physical and virtual layers results in slow and inaccurate service impact and root-cause analysis. Capacity planning and resource management across virtual and physical infrastructure with monitoring and management systems is incredibly challenging if not impossible.

Now imagine using one integrated management solution to quickly and easily monitor and troubleshoot service problems across the entire mobile infrastructure. Faults and other problems are correlated across physical and virtual resources, and the root cause is determined and highlighted in one instead of multiple alarms. Recommended troubleshooting steps are given. Problems are quickly handled before service disruption is even detected. The entire mobile services environment gains new elasticity as monitoring and reporting show you usage and capacity trends that help with more proactive resource and capacity planning.

This type of solution contributes to a much-improved quality of experience for subscribers. It also clearly lowers total cost of ownership for mobile operators based on a truly comprehensive, unified management view that speeds troubleshooting, saves time for administrators, and thus lowers operational costs.

Figure 1 shows the operational views of the Cisco VPC infrastructure, including, in this example, Long Term Evolution-System Architecture Evolution (LTE-SAE) and Charging Function (CF) above the red line and the physical mobile services infrastructure below the red line. The administrator at right has views of both domains thanks to the deeper visibility and assurance provided by the Cisco Prime for Mobility solution on Cisco VPC and the Cisco ASR 5000 Series hardware.

Figure 1. Unified Versus Separate Management of Mobile Infrastructure



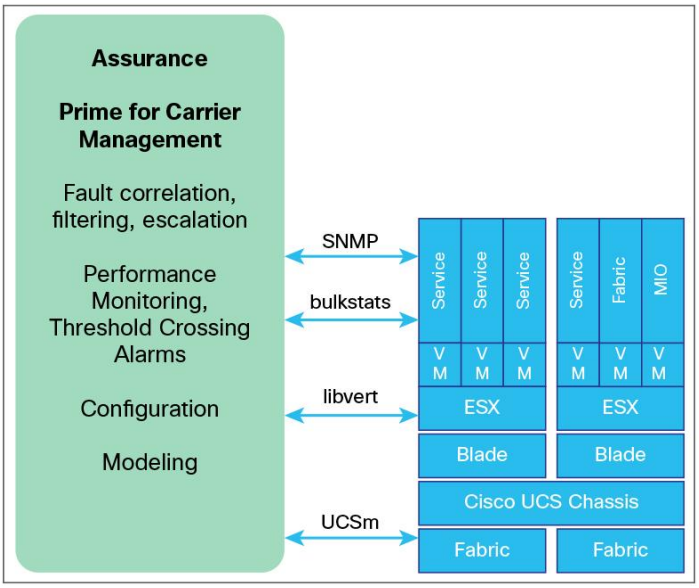
Cisco has expanded support for Cisco Prime Carrier Management to the Cisco VPC. There's no need to buy, deploy, and learn how to operate a separate management system for your virtual domain. With Cisco Prime Carrier Management, you can manage your virtual gateway using the same solution as your physical Cisco ASR 5000 Series mobile gateway. Plus, Cisco Prime Carrier Management offers capabilities to bridge between the virtual software of Cisco VPC to the underlying infrastructure for deeper visibility that would not be achieved with the virtualized layer only. This offering from Cisco lets the operator associate the faults, configuration, and performance metrics from the virtual-machine deployment with the activities of the vCenter and computer server layers. This association enables additional navigation through the Cisco VPC active footprint (such as inventory) to the underlying supporting layers or, conversely, from either the Cisco Unified Computing System™ (Cisco UCS®) servers server layer or the vCenter layer upward to the Cisco VPC software instances

The Cisco Prime for Mobility solution can therefore be used to manage the faults and performance of the entire device stack. It can preview the impact of taking a server out of service, study the distribution of the Cisco VPC virtual machines for failure-mode planning, and provide other such capabilities that mobile operators require for virtual mobile and cloud services (e.g., virtual machines, servers, and hypervisors)

Unified Management and Monitoring in Action

The Cisco Prime for Mobility solution includes service-assurance features that encompass modeling, fault, performance, and configuration management for service infrastructure (Figure 2). The solution integrates data from various other device and software tools and protocols, including Simple Network Management Protocol (SNMP), bulk statistics (bulkstats), the libvert API, and Cisco UCS Manager. It does not matter if the Cisco VPC virtual machines are on the same hypervisor instance, the same server, or within the same chassis. As long as the Cisco Prime platform is enabled for collecting the management information and made aware of the management IP addresses for each layer, it is fully operational. It is enabled with optional features for managing vCenter and Cisco UCS along with the mobility features.

Figure 2. Manage Service Assurance across Physical and Virtual Resources with Cisco Prime for Mobility



Once discovered on the network using the Cisco Prime for Mobility feature set, the Cisco VPC is treated like part of the physical network inventory. Its components are represented as a chassis, cards, and interfaces of a virtual Cisco ASR 5000 Series platform – in the same way you would expect from a physical one. The logical inventory of the Cisco VPC, such as the mobility management entity (MME), service gateway (S-GW), Packet Data Network (PDN) Gateway (P-GW), and more are maintained and managed in the same manner as the physical Cisco ASR 5000 hardware. Thus the familiarity between the two deployment environments provides for greater operator efficiency, eliminating the confusion from using different management applications or paradigms for physical gateways and virtualized gateways.

Modeling

When you discover Cisco VPC in Cisco Prime Network, you can click it and see the logical and physical inventory of the virtualized gateway instances. For example, within logical inventory, you can see if it has Authentication, Authorization, and Accounting (AAA) services configured, or IP pools, or whether a device is a MME or PW-GM or SGM. You can view all the resources available for both VPC-SI and VPC-DI.

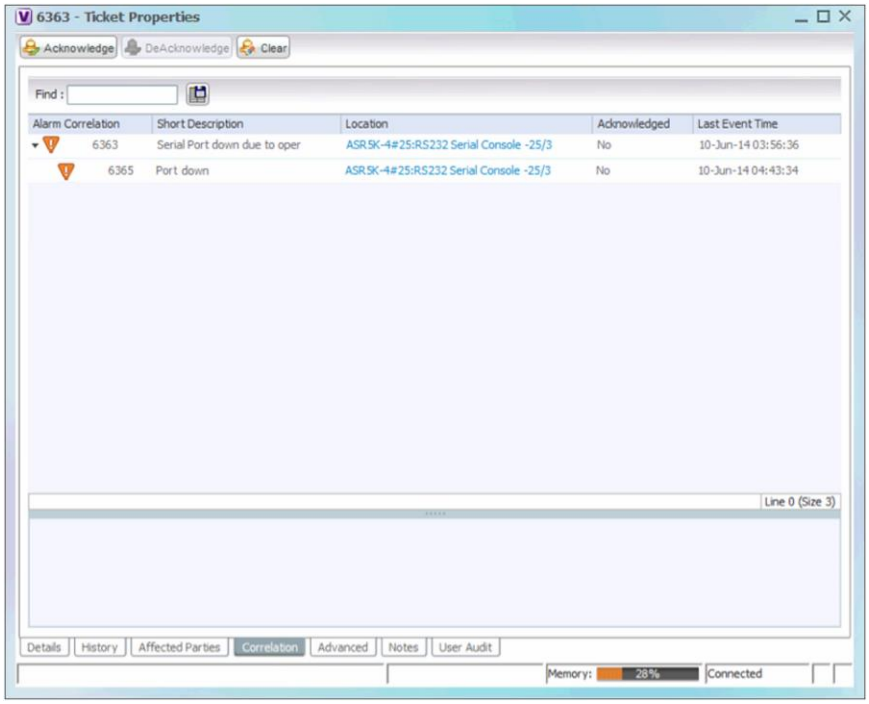
Add both physical and virtual devices into the Cisco Prime Network using their IP addresses and then enable SNMP and Telnet/SSH credentials. Cisco Prime models each device (for example, device type and what's running on it) into a repository and you can immediately start managing the devices. Contrast this scenario with using a command-line interface (CLI) to see and manage each device.

When you add a Cisco VPC device to Cisco Prime Network, Cisco Prime Network creates an autonomous virtual network element (VNE) that models that Cisco VPC device. The VNE then uses the Cisco VPC IP address and southbound management interfaces (such as SNMP or Telnet) to identify the Cisco VPC by device family, device subfamily, device type, and software version. When the Cisco VPC type is determined, the VNE collects the basic inventory, both physical and logical, determines its status, and attempts to determine its place in the network topology. The VNE negotiates with peer VNEs, which represent peer Cisco VPCs or other devices, to determine the connectivity and topology at different layers. This model of the network topology, device state, and device inventory is constantly being updated by the VNE, which tracks every change that occurs in the Cisco VPC or in the network.

Fault Correlation, Filtering, and Escalation

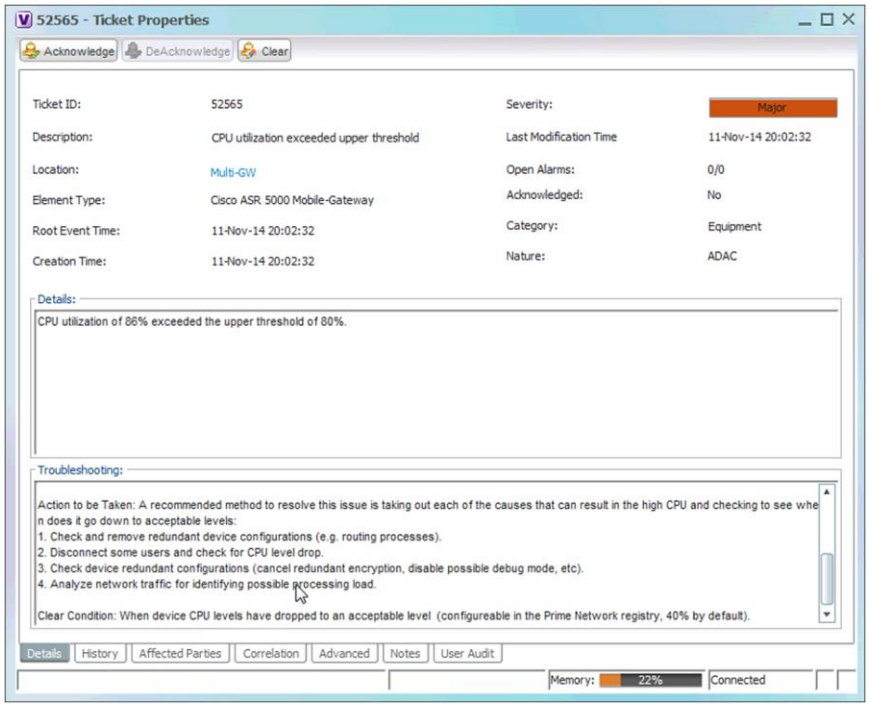
Configured to manage across the layers, Cisco Prime Network collects faults from each of the layers, including the Cisco VPC virtualized services and the server and virtual-machine host layers. Faults are clearly displayed within the alarm window, where they can be prioritized, escalated, cleared, etc. With the fault correlation feature, Cisco Prime Network performs a root-cause analysis and correlates the fault based on a cause-and-effect analysis to determine the problem that, if solved, will alleviate all other faults. With top-down analysis, events are correlated to service events with the same source. The root-cause analysis is built-in within Cisco Prime Network. Events are associated to managed elements and devices. Ultimately the solution delivers the probable cause of the top fault and suggested troubleshooting steps for its resolution. Figure 3 shows a typical fault correlation report in Cisco Prime Performance Manager.

Figure 3. Fault Correlation Report in Cisco Prime Performance Manager



In Figure 3, the main alarm is shown at the top of the screen, and its correlations (multiple services running on the interface) are then listed. If the link goes down, the correlation events along with the probable cause and troubleshooting steps are displayed (refer to Figure 4).

Figure 4. Correlation Events and Troubleshooting Steps



With the filtering feature, alarms are filtered so that only the root-cause alarm is the one you receive. It directs you to what should be fixed to solve all related problems.

Performance and Monitoring

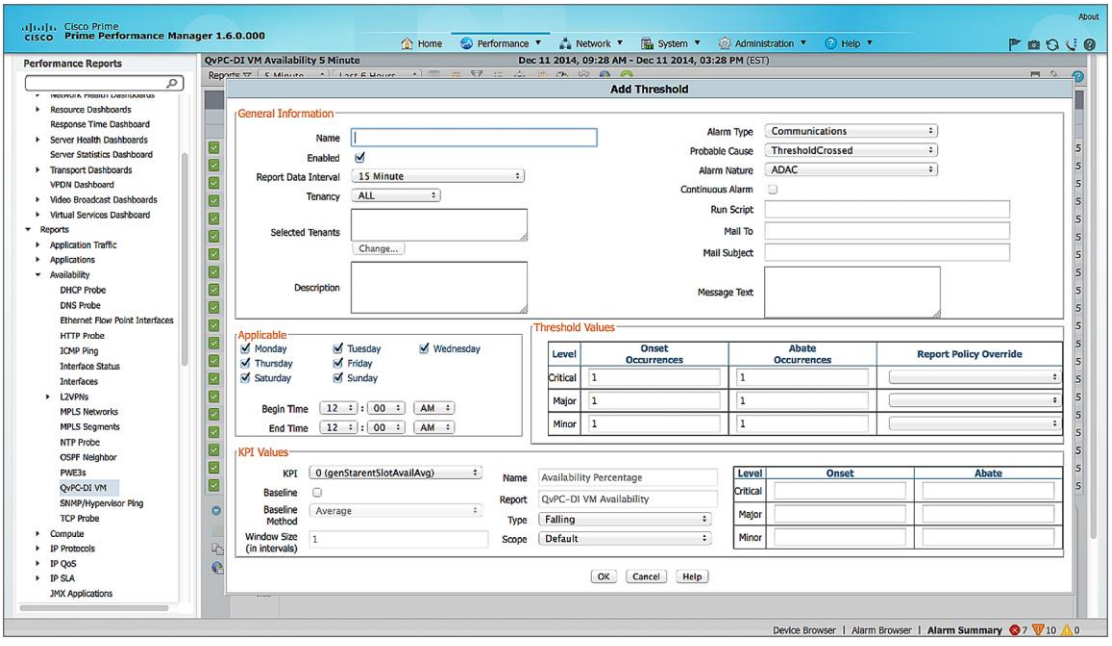
With Cisco Prime Performance Manager, you can manage the performance of each physical and virtual device in the mobile network topology based on a view of its performance statics. Performance management can be enabled for the operator to see how the deployment is using resources such as compute, disk, CPU, and memory. At all layers, the popular Cisco Prime Performance Manager capabilities for aggregating counters, developing key performance indicators (KPIs) reports, and northbound integration are available for the operator and EMS planner to use. Operator notifications, in keeping with the theme of consistent management, are available as well. You can assign threshold crossing alerts, based on KPIs or other available statistics (Figure 5), so that when the alarm goes off you get a message notifying you that a usage level or KPI has been reached.

You can create thresholds for any VPC KPIs displayed in Cisco Prime Performance Manager reports, views, or dashboards. Thresholds help you monitor network performance by sending notifications when a KPI exceeds or falls below a desired tolerance or performance target. In addition, you can have Cisco Prime Performance Manager define a baseline performance range for a KPI and notify you when performance changes significantly from the baseline range.

Creating baselines alerts you to network problems before they cross the prescribed thresholds. Cisco Prime Performance Manager gives you considerable flexibility in defining threshold ranges and the threshold crossing alerts that are issued when threshold ranges are exceeded.

You can create thresholds on any of the Cisco VPC objects, such as CPUs, access-point name (APN), IP pools, memory pools, and many more. In addition, you can create and apply report policies that modify report intervals when thresholds are crossed. For example, if a CPU nears 100-percent usage, you can create and apply a report policy that reduces the polling frequency until it returns to normal. Conversely, you can create and apply report policies that increase polling frequencies when KPIs pass critical thresholds.

Figure 5. Assigning Threshold Crossing Alerts



Change and Configuration Management

With the Cisco Prime Network for mobility feature set, you maintain a logical inventory of mobile gateways whether they are virtual Cisco VPC or physical Cisco ASR 5000 Series hardware. You can see what has been configured on it over time and what type of service is running on it now. Configuration details are backed up in a configuration and management archive, letting you go back to a previous configuration if desired.

Configuration management enables you to control and track changes that are made to a device configuration. The configuration management function uses a change management feature to detect ongoing changes to devices in two ways:

- Changes are detected when doing the periodic collection of device configurations; this process is called periodic archiving. If the configuration management feature detects a change in a configuration file, it will get the new version of the file from the device and copy it to the archive.
- Changes are detected when a configuration change notification is received from a device. This process is called event-triggered archiving. You can configure configuration management to copy a new version of a configuration file to the archive whenever a change is detected, or to queue the changes and then copy the files to the archive according to a schedule.

Configuration file copies are stored in a configuration archive (the configuration management archive), from which you can compare configurations, restore configuration files to devices, edit the configuration files before restoring them, and for Cisco IOS® Software devices, synchronize running and startup configuration files. Configuration files in the archive are stored in readable format, as received from the device. Significant configuration files can be labeled using the labeling facility of the configuration management function, and you can mark configurations so that purging them is prevented by configuration management.

Summary

Complex, distributed systems pervade the mobile network infrastructure. Service assurance has become more difficult, time-consuming, inaccurate, and costly, with administrators troubleshooting across physical and virtual infrastructure. Capacity planning and resource management are similarly difficult across physical and virtual domains. Until now.

The Cisco VPC extends the Cisco ASR 5000 Series gateway as a virtualized component that can now be managed as if it were a physical Cisco ASR 5000 Series platform using the Cisco Prime for Mobility solution. Managing both virtual and physical infrastructure with Cisco Prime for Mobility delivers these benefits:

- Increased operational efficiency for faster resolution of network problems through service infrastructure correlation and impact analysis
- Improved quality of experience for subscribers through more elasticity for capacity trending through monitoring, display, and reporting
- Lower total cost of ownership, with comprehensive, unified management for virtual and physical devices and reduced OpEx with easier, faster troubleshooting

For More Information

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