White Paper

Ensuring Mobile Broadband Service Quality with Route Analytics

Packet Design

Executive Summary

Faced with considerable mobile phone market penetration causing greater competition and price erosion, mobile operators are under increasing pressure to compensate by increasing their data service revenues. Operators have responded in recent years by deploying High Speed Packet Access capabilities in their 3G networks to achieve broadband speeds, and are rolling out IP Multimedia Subsystem (IMS) control planes to enable a plethora of converged, IP-based person to person and person to content applications and services. All of these trends mean that mobile operators are increasingly reliant on underlying IP networks to deliver data traffic that is far more sensitive than "best effort" Internet access. Given that service quality is a critical differentiator for mobile operators, it is imperative that these IP networks meet the highest quality standards themselves. The challenge is that due to their dynamic routing control planes, IP networks are inherently unpredictable in their behavior and worse—that very unpredictability means that traditional network management tools cannot deliver critical management visibility into the changing behavior of routing and service traffic flows.

Route analytics technology, which taps into the network's live routing protocol control plane to provide real-time, network-wide insight of the operational routing topology and the traffic flowing across all network paths and links, provides the missing visibility. With route analytics, mobile broadband IP network engineers can establish and maintain SIGTRAN compliance for the IP network control plane, speed problem resolution, strengthen change management processes, proactively uncover network vulnerabilities, increase capacity planning efficiency and accurately simulate failure scenarios and resulting network behavior. Effective use of route analytics as part of the IP network management portfolio can help mobile operators build more profitable data service revenue streams by ensuring high service quality, leading to lower subscriber churn and reacquisition costs while increasing network engineering and operations efficiency.

The Drive for Mobile Broadband Services

High speed mobile data service deployments and subscriber bases are growing rapidly globally. For example, as of mid 2008, well over 100 operators supported 3.6Mbps High Speed Packet Access (HSPA) networks and services with nearly 50 million subscribers, with double that number of operators committed to deploying HSPA or HSPA+ capabilities that will raise maximum downlink speeds to 42Mbps. This accelerating commitment to broadband mobile network deployment has dovetailed with the market appearance of truly data and video enabling handsets such as the iPhone and its constellation of competitors. The business imperative behind all this market movement is to increase ARPU by replacing commoditized voice services with higher margin data services and increase data service market penetration within the upwards of 2 billion GSM subscribers worldwide. In order to achieve these levels of penetration, mobile operators need to build not only the hardware infrastructure to support higher data rates and enable a wide variety of data-enabled services, but they also need to ensure that their OA&M capabilities match the complexity of ever-larger IP networks.

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Why IP Networks Are Inherently Unpredictable

A major reason that IP became the de facto worldwide standard for data communications networks is its automated resiliency based on intelligent IP routing protocols that control the traffic routing topology. But while IP's distributed routing intelligence makes it efficient and resilient, it also makes IP network behavior unpredictable and harder to manage. IP routing protocols automatically calculate traffic routes or paths from any point to any other point in the network based on the latest known state of network elements. Any change to those elements causes the routing topology to be recalculated dynamically. While this means highly resilient traffic delivery with low administrative overhead, it also creates endless variability in the active routing topology. Large networks with many redundant links can be in any one of millions of possible active routing topology states, which makes it much harder to understand and manage ***how*** traffic will be delivered.

The lack of IT management visibility into dynamic network behavior can be seen in the time-consuming process of correlating application problems to non device-specific network causes. For example, when a user reports an application performance problem that doesn't stem from an obvious hardware failure, pinpointing the root cause can be quite difficult because in a large, complex network, IT engineers have no way to know the route the traffic took through the network, the relevant links servicing the traffic, whether those links were congested at the time of the problem, or even which devices were servicing the traffic. Change management processes suffer from the same problem, since engineers making planned configuration changes in the network have little or no idea of how the network-wide routing and traffic delivery behavior will change once the change is effected, leading to many unforeseen and unwanted consequences during change processes.

For relatively non-critical applications like email and web browsing, the impact of routing and traffic changes may be slight, but for VoIP, gaming, streaming media and data services which have sensitive latency requirements or other delivery constraints, the impact can be dire.

Today's Network Management—Many Points of View, No Big Picture

Network management's purpose is to overcome the complexity inherent in a large network and provide better visibility to network operations and engineering. The overarching architectural principle of today's network management is to gather information on a vast number of different "points" in the network, and then correlate various point data to infer service conditions. The key mechanism for doing this is the Simple Network Management Protocol (SNMP), which gathers information at point devices such as routers, switches, security devices and servers, and their interfaces. The main data gathered is:

- Device health: uptime, current status, CPU and memory utilization
- Fault indicators: up/down status, uptime, dropped packets, errors
- Traffic information: interface utilization: bytes in/out, packets in/out, configuration
- Service utilization information: utilization per class of service, threshold violations

While having this point data is critical – for example, an interface or device that fails, runs out of memory, or is congested with traffic can have a direct impact on service traffic – the sum of all

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this point data is much less than the whole picture. Just knowing that an interface is full of traffic doesn't tell you *why* it is full. Where is the traffic coming from and going to? Is the traffic usually on this interface, or was there a change in the network or elsewhere that caused it to shift to this interface? If so, from where, when and for how long? Without answers to these questions, there is no real understanding of the behavior of the network as a whole, which robs the point data of much of its contextual meaning.

While there are correlation algorithms for deducing certain types of network conditions, the fact of the matter is that SNMP was never built to understand the complexities within complex, routed IP networks. SNMP's key limitation is that it is too periodic – polling cycles from 30 seconds to several minutes long simply cannot produce an accurate portrait of the network's routing state, with its sometimes rapid and high-volume state changes. Even speeding up the polling cycle – say, to every five seconds – would still miss many routing state changes, and anyway would generate so much management traffic overhead as to be impractical.

Route Analytics—Seeing the Network like a Router

Route analytics technology, adopted globally by hundreds of service providers, mobile operators, cable MSOs, large enterprises, and government agencies, provides a new level of network visibility. Route analytics is built on the foundation of a different type of network visibility, afforded by tapping into the routing protocols – the source of intelligence that determines how IP networks deliver traffic.

Route analytics is the technique of acting like a router and peering with select routers across a network, using routing protocols—OSPF, IS-IS, EIGRP and BGP—to record the control messages that routers use to calculate how traffic will be sent across the network. By taking this information and processing it just the way routers do – albeit in a more comprehensive fashion – route analytics knows every Layer 3 routed path in the network, from every host to every other host, and thus can create an analyzable routing topology of the entire network that exactly reflects the way the real network is operating. Since routing protocols report changes to the topology within milliseconds, the topology map maintained by route analytics is continuously updated in real-time.

Route analytics integrates traffic information into this live topology map by collecting Netflow data from key traffic ingress points such as IP edge routers and Internet and roaming peering points, and then using knowledge of the precise path that every flow takes at any time through the network to project the traffic data onto the component links of that path. The result is a highly accurate, integrated routing and traffic map that shows the volume of class-of-service (CoS) traffic on every link in the network. Since both routing and traffic data is recorded continuously into a database, route analytics allows for "rewinding" history to see network conditions exactly as they were at a past moment in time. In addition, since the topology is algorithmically calculated, route analytics allows for modeling of routing and traffic changes and simulation of the change in network-wide behavior.

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Improving Network Management Processes with Route Analytics

Route analytics changes the game back in favor of mobile operators who must manage their IP networks to deliver excellent service quality. Route analytics allows engineers for the first time to understand the relationship between service delivery and network operations. The result: greatly improved accuracy and efficiency of key business processes, restrained costs, increased subscriber loyalty and lower customer churn.

Real-Time, Network-Wide Routing and Traffic Monitoring and Alerting: Route Analytics provides monitoring visibility into traffic and flows on all internal and external links in the network. Operations can now easily monitor key traffic paths, and traffic thresholds across the entire network, be alerted in real-time to emerging issues that can impact service delivery and respond proactively, rather than simply reacting to customer problems after the fact. Route Analytics can also monitor for IP signaling plane stability issues such as excessive overall Layer 3 network churn or particular problems such as link flaps, or the loss of routing redundancy to key Internet Autonomous Systems or peering partners.

Benefit: Network operations can detect and anticipate problems much faster, reducing and preventing service impacts.

"Rewindable" Routing and Traffic History for Improved Troubleshooting: By continuously recording the state of routing and traffic over time, route analytics can accurately portray the network-wide state of all links, peerings, paths, and prefixes along with all traffic flows at any point in its recorded history. With route analytics, engineers can rewind the network topology to a specific past point in time analysis functions such as pinpointing the precise path that impacted service traffic took through the network and the state of utilization on the component links at the time of the problem and identifying any routing or traffic congestion root causes. With route analytics' historical forensics, engineers can solve more problems in less time, increasing operations efficiency. In addition, as underlying root causes for problems can be more readily identified and fixed, network and service quality is improved over time. Finally, accurate and thorough forensics enables improves customer service responsiveness.

Benefits: Improved network and service quality, and customer service responsiveness, resulting in higher customer satisfaction and lower churn.

Network Modeling for Strengthened Change Management Processes: Route analytics provides a powerful modeling capability that can be used to greatly strengthen change management processes. Gartner Group studies report that a large percentage of network problems are due to configuration and change errors due to increasing network complexity. Route analytics allows engineers to model and simulate planned routing and traffic changes, and to see the exact effect on the entire network's behavior and any impact on service levels. After making changes, engineers can use route analytics to validate correct network-wide routing and traffic behavior in real-time. Route analytics' highly accurate modeling can help ensure that critical prefix/router pairs will continue to maintain Sigtran-compliant path diversity after proposed changes.

Benefit: Reduced service impacts from change management errors.

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Internet Routing and Analysis for Improved Service Performance: Mobile broadband service customers who are accessing the Internet judge their mobile operator's service quality by how well they can access their favorite applications and websites. By utilizing route analytics' deep analysis capabilities for BGP Internet routing, network engineers and planners can identify important sources of traffic for key customer groups, then use simulation and modeling to find ways to optimize routing between multiple Internet peerings to achieve the shortest number of Autonomous System hops from those sources, which can improve the latency and performance of traffic from those key sites. Route analytics also provides real-time monitoring of BGP AS_Paths to critical external networks, alerting network operators to a loss of redundancy so that they can take measures to ensure service delivery continuity.

In addition, route analytics can be used to ensure acceptable external peering utilization levels and optimize transit and peering arrangements, which can significantly reduce mobile operator operating costs. Route analytics provides engineers with the most complete set of capabilities including the ability to monitor peering or transit traffic to ensure it is within contracted ranges, as well as analyze, identify and justify new peering relationships. Route analytics also allows engineers to accurately simulate proposed peering changes and projects exactly how traffic would behave with the proposed changes, helping optimize operational and capital costs. Whether moving traffic from paid transit to settlement-free peering, or balancing between multiple transit providers, route analytics provides the intelligence operators need to optimize their peering traffic and maximize their bottom line.

Benefit: Improved customer service quality experience, higher customer loyalty and lower customer churn.

Network-Wide Routing Health Audits for Improved Service Continuity: One of the hardest challenges in the midst of complex network operations is to achieve a proactive stance in anticipating and fixing problems before they occur. A chief cause is that there is often no insight into potential causes of service impacts. Route analytics provides a network-wide routing health auditing tool that systematically examines the network for problems and vulnerabilities, such as out of policy asymmetric routes, routing black holes, lack of or potential loss of Sigtran-compliant path diversity between prefixes, underutilized assets and potential redundancy failures. By proactively identifying problems in the network, Route Explorer enables engineers to prioritize proactive fixes, increase network quality and prevent service impacts.

Benefit: Higher network quality, lower service impacts.

Proactive Monitoring for Sigtran-Compliant IP Control Plane Recovery Latency: Route analytics can be deployed in a solution to monitor end-to-end route propagation delay from diverse parts of a large, geographically diverse IP network. Centralized monitoring can automatically advertise and withdraw synthetic routes and capture the relative propagation delay of those announcements. Route propagation delay monitoring reports provide insight into how well the network is performing against recovery latency KPIs. When the network experiences recovery latency issues, the historical rewind and detailed event stream details of route analytics help engineers to isolate the root cause and restore proper network operation.

Benefit: Higher network quality, lower service impacts.

Network-Wide Capacity Planning for Reduced Capex: One of the most important network management processes for capital-intensive mobile operator networks is accurate capacity planning. Unfortunately, often-times network planners don't posses accurate and comprehensive information about the network's traffic utilization over time, meaning that

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planning exercises are often inaccurate, leading to wasted capital expenditures, sub-optimally deployed resources, and sometimes out of budget capital expenses. Route analytics' bottoms-up accurate visibility into the entire network's routing and traffic behavior serves as the basis for easy-to-use, automated capacity planning and traffic trending tools that can be used to analyze capacity needs in great analytical depth.

Benefit: Capital Expense Savings

Conclusion

As pressure increases on mobile operators to shore up their market positions by increasing ARPU with HSPA data services, it is imperative that the foundational health of the IP networks that data service traffic be well managed. Route analytics provides the global network visibility needed to increase the effectiveness of key network management processes, achieve critical network KPI's and deliver the service quality needed to increase subscriber loyalty and business profitability.

To learn more about Packet Design and its industry-leading route analytics solutions, please:

- Email us at info@packetdesign.com
- Visit Packet Design's web site at http://www.packetdesign.com
- Call us at 408.490.1000

Packet Design

Corporate Headquarters
Packet Design Inc.
2455 Augustine Drive
Santa Clara, CA 95054
Phone: 408.490.1000
Fax: 408.562.0080
http://www.packetdesign.com

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