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INTERNAP

The Internap® Network-Based Route Optimization Solution: Executive Summary

Internap developed the industry's first proprietary routing and route management technology, specifically designed to directly deliver data to and from destinations across the Internet in a faster, more reliable manner. The Internap cure for slow Internet performance is its Private Network Access Point (P-NAP®) facility. This white paper addresses the Internap managed service solution, including its Network-Based Route Optimization solutions, redundant network architecture and world-class Network Operations Center (NOC).

An Internap White Paper

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Table of Contents

Introduction

The Internet was never designed to deliver the level of performance that most businesses have come to expect from their own private networks. External problems can be assigned to the limitations of the de facto standard routing protocol used between backbones, Border Gateway Protocol (BGP), which has no mechanism to account for performance when deciding how traffic is moved among providers. Additionally, there are fundamental scaling flaws in the design of the Internet that can often cause latency, jitter and data packet loss at the interconnection points between backbone providers. These scaling flaws include:

- Routing inefficiencies
- Lack of adequate network technology
- Distributed management of public network access points (NAPs)

Internap® service sets a new standard, using a unique architecture, the Private Network Access Point (P-NAP®), to achieve a high level of internal and external reliability. Each P-NAP facility is a localized architecture that houses direct interconnectivity with the major backbones, thus abrogating any functional dependency of the P-NAP facility's ability to deliver traffic upon the health of any one backbone. Within the P-NAP facility, Internap uses ASsimilator 3 (AS3) route-optimization technology to augment BGP with performance based routing capabilities that take full advantage of the P-NAPs' redundant architecture and backbone interconnections. Both the architecture and intelligent routing components are supported by an approach to customer service that also sets a new industry standard. Internap diligently executes a strategy of service excellence, providing customers with direct access to engineering support, and timely, accurate, proactive information regarding Internet events that Internap monitors and manages.

A provider of superior solutions since 1996, Internap established the intelligent routing (IR) market and has been delivering IR solutions and evolving the technology ever since. In fact, Internap was the first to recognize the need to go beyond BGP capabilities, and developed a solution set and technology that did so.

This white paper addresses the Internap managed service solution, including its Network-Based Route Optimization solutions, redundant network architecture and world-class Network Operations Center (NOC).

Network-Based Route Optimization

The Internap proprietary routing technology, AS3, was developed to overcome the limitations of the Border Gateway Protocol (BGP). BGP, used by nodes on the borders of Autonomous Systems (AS), selects which adjacent AS should be transited in order to reach any node located in some external AS. Rather than using actual performance measurements, BGP uses heuristics to select the path that is assumed to provide the best performance. BGP generally assumes that paths that transit fewer ASes will offer superior performance. This assumption would be valid if every AS were equal. However, the assumption breaks down in practice because the performance penalty incurred from transiting each AS can vary substantially. If a chosen path bypasses a congested router, this path may be superior to one that transits fewer

ASes. Similarly, if there are several paths to a given destination, each transiting the same number of ASes, then minimizing the number of AS hops does not disambiguate the paths. In this scenario, BGP's path selection is usually arbitrary. It does not incorporate sufficient path characteristics to effectively distinguish between alternatives. While BGP's assumptions may have been valid when first introduced, the Internet has changed substantially since then. The BGP algorithm is no longer adequate, given the more demanding nature of the applications that run on the Internet as well as the increased scale and complexity that now characterize the Internet.

Because BGP is not able to access the full range of path characteristics that are sometimes necessary to make correct path selections, BGP allows operators to specify preferences to control the path selection. However, manually overriding BGP is not very scalable beyond simple traffic shaping and shunting around large-scale routing phenomena. The performance of a given AS may change regionally and over time, but manually accounting for all such special cases is not feasible. Even if it were possible to manually adjust routing to account for dynamic performance changes, the simultaneous problem of assigning traffic based on available capacity can be computationally very challenging. If capacity is provisioned efficiently, this problem can become too difficult to solve manually.

AS3 addresses the algorithmic limitations of BGP by adding performance and other path and traffic characteristics to its route selection process. It runs continuously in each Private Network Access Point (P-NAP®) and dynamically adjusts to changing network and traffic conditions. When it selects a new routing table, those path selections are automatically injected into BGP without any human intervention.

AS3 Key Advantages

Three key advantages to using AS3 include:

1. Performance
2. Automation
3. Efficiency

Performance

AS3 provides superior performance compared to BGP. AS3 considers actual path characteristics when making routing decisions. In contrast, BGP uses rules to select paths that it believes are likely to exhibit superior performance, usually preferring the shortest possible paths. However, it has been empirically observed that BGP's heuristics can result in less-than-optimal path selections. The longer path may be the best choice at a particular point in time. For example, a path from Paris to London that transits a few networks and crosses the Atlantic Ocean is likely to be inferior to a path that transits several European networks. Similarly, BGP must frequently select among several paths of equal length without sufficient data to make an effective decision.

Automation

The state of the network changes frequently, so a routing system should be able to adapt to network changes. AS3 makes decisions dynamically and instantiates them automatically into the network to account for network performance changes, without the need for manual configuration updates. It also automatically solves the challenging “traffic juggling” problem of assigning traffic to available backbones such that the headroom constraints are not exceeded. This is not addressed at all by BGP. It can also be too difficult to solve manually if the traffic or available capacity changes rapidly.

Efficiency

By ensuring that routing decisions never cause traffic to exceed headroom thresholds, AS3 significantly reduces the provisioning burden. As long as there is sufficient capacity through the set of providers, a routing table will be selected that ensures that headroom will not be exceeded on any of the providers. If traffic grows faster than expected, or if a circuit upgrade takes longer than expected, the system will automatically shift excess traffic to keep all circuits operating correctly. AS3 uses the capacity resources very efficiently by finding the optimal routing solution, given the resource constraints.

Today, Internap delivers its Network-Based Route Optimization solutions via its proprietary P-NAP facilities. The next section describes the attributes of the Internap P-NAP facility.

The Network Architecture

The P-NAP infrastructure is engineered to have several independent levels of redundancy. Redundancy is built in at the system level, the router level, the local access level, the National Service Provider (NSP) level and includes multiple, redundant Full Duplex Fast and/or Gigabit Ethernet connections between each router and switch. The P-NAP facilities are configured to support connectivity from Fractional T1 to OC12 and 10 Mbps Ethernet to Gigabit Ethernet.

The P-NAP architecture is designed to scale to the demands of: 1) customers’ connections, as well as 2) the demands of NSP connections. The Internap P-NAP model allows for the evaluation of and possible addition of new NSPs to the architecture.

Within this robust design, every router has redundant paths to each other router via the switching fabric. Internap, in the spirit of innovation that has provided current unique approaches to Internet routing, actively evaluates new routing and switching platforms from a variety of vendors as they become available.

The Internap world-class Network Operations Centers (NOC) adeptly manages both the P-NAP facility and Internap Network-Based Route Optimization solution.

The Network Operations Center

The Internap NOC is staffed 24 hours a day, every day of the year, with knowledgeable engineers who are trained in network diagnostics and engineering. The NOC is staffed so that when a customer contacts the NOC, the engineer who answers the phone or responds to the

email is the engineer that will also work directly on the trouble or request on behalf of the customer. NOC staff are trained in all areas of network diagnostics, TCP/IP routing and routing protocols (specifically RIPv2, OSPF and BGP4), IP network performance, DNS and general network engineering.

The Internap NOC provides post-installation support to customers in the following areas:

- Monitoring, Repair, and Trouble Tracking
- Circuit Troubleshooting and Repair
- Managed Customer Premise Equipment
- Data Collection and Analysis
- Service Changes
- Customer Service

While the Internap Network-Based Route Optimization solutions, network architecture and NOC mitigate risk on behalf of its customers, the Internap Service Level Agreement delivers unmatched service guarantees.

Service Level Agreement

Internap Service Level Agreements (SLA) cover latency, packet loss, jitter, network availability, install intervals, service response time, colocation and domain name services (DNS). Within the continental U.S., SLA guarantees 45 milliseconds or less latency, less than 0.3% packet loss, 0.5 milliseconds or less jitter and 100% network availability.

For more details on Service Level Agreements outside of the U.S., please contact your account representative.

Summary

Internap developed the industry's first proprietary routing and route management technology, specifically designed to directly deliver data to and from destinations across the Internet in a faster, more reliable manner. The Internap cure for slow Internet performance is the Private Network Access Point (P-NAP) facility. The P-NAP facility is designed to address the causes of degraded Internet performance. In conjunction with the Internap world-class NOC and best-in-class Service Level Agreement, the Internap Network-Based Route Optimization solutions are unmatched in the industry.